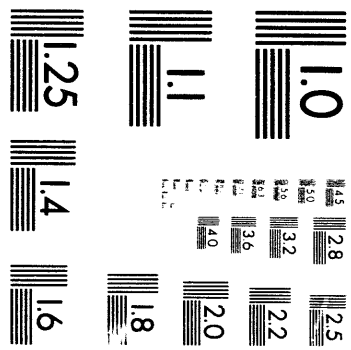

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DOE/LLW-184

Greater-Than-Class C Low-Level Radioactive Waste Shipping Package/Container Identification and Requirements Study

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DEFINITIONS

Exclusive Use. The sole use of a conveyance by a single consignor and for which all initial, intermediate, and final loading and unloading are carried out in accordance with the direction of the consignor or consignee. Any loading or unloading must be performed by personnel having radiological training and resources appropriate for safe handling of the consignment. Specific instructions for maintenance of exclusive use shipment controls must be issued in writing and included with the shipping paper information provided to the carrier by the consignor. (49 CFR 173.401)

Limited Quantity. A quantity of radioactive material not exceeding the materials package limits specified in §173.423 and that conforms with requirements specified in §173.421. (49 CFR 173.401)

Low Specific Activity (LSA). Any of the following:

- Uranium or thorium ores and physical or chemical concentrates of those ores.
- Unirradiated natural or depleted uranium or unirradiated natural thorium.
- Tritium oxide in aqueous solutions provided the concentration does not exceed 5.0 millicuries per milliliter.
- Material in which the radioactivity is essentially uniformly distributed and in which the estimated average concentration of contents does not exceed:
  - 0.0001 millicurie per gram of radionuclides for which the A_2 quantity is not more than 0.05 curie;
  - 0.005 millicurie per gram of radionuclides for which the A_2 quantity is more than 0.05 curie, but not more than 1 curie; or
  - 0.3 millicurie per gram of radionuclides for which the A_2 quantity is more than 1 curie.
- Objects of nonradioactive material externally contaminated with radioactive material, provided that the radioactive material is not readily dispersible and the surface contamination, when averaged over an area of 1 square meter, does not exceed 0.0001 millicurie (220,000 disintegrations per minute) per square centimeter of radionuclides for which the A_2 quantity is not more than 0.05 curie, or 0.001 millicurie (2,200,000 disintegrations per minute) per square centimeter for other radionuclides. [49 CFR 173.403(n)].

Packaging. The assembly of components necessary to ensure compliance with the packaging requirements of 10 CFR 71 (49 CFR 173, Subpart I). It may consist of one or more waste receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or absorbing mechanical shock. The vehicle, tie-down system, and auxiliary equipment may sometimes be designated as part of the packaging (10 CFR 71.4 and 49 CFR 173.403). Also referred to as shipping casks in this report.

Safety Analysis Report for Packaging (SARP). A document that provides a comprehensive technical evaluation and review of the design, testing, operational procedures, maintenance procedures, and quality assurance program to demonstrate compliance with the NRC regulatory safety standards, or equivalent standards established by DOE for approving packagings and issuing certificates of compliance. (DOE 1540.2)

Shipping Package. Package means the packaging together with its radioactive contents as presented for transport. (10 CFR 71.4)

Special Form. Radioactive material that: (a) must be a single solid piece or contained in a sealed capsule that can be opened only by destroying the capsule, (b) have at least one dimension not less than 5 millimeters (0.197 inch), and (c) must meet applicable test requirements as defined in 49 CFR 173.469. Special form encapsulations designed in accordance with the requirements of 49 CFR 173.389(g) in effect on June 30, 1983, and constructed prior to July 1, 1985, may continued to be used. [DOE 1540.2 and 49 CFR 173.403(z)]

Type A Package. Contents limited to Type A quantity [does not exceed A_1 (special form) or A_2 (regular form) radioactive material]. Packaging designed to retain the integrity of containment and shielding required by 49 CFR 173, Subpart I, under normal condition of transport as demonstrated by tests set forth in §173.465 and §173.466, as appropriate. (10 CFR 71.4 and 49 CFR 173.403)

Type B Package. Contains radioactive material greater than Type A quantity. Packaging designed to retain the integrity of containment and shielding required by 49 CFR 173, Subpart I, when subjected to the normal conditions of transport and to hypothetical accidents as set forth in 10 CFR Part 71. (10 CFR 71.4 and 49 CFR 173.403)

Waste Container. General term for receptacle (e.g., drum, box, can) used to contain radioactive waste. Some waste containers are designated for specific packages, others are used for storage and may not be acceptable to contain radioactive waste during transport. (Not a regulatory definition.)

Waste Package. Waste form and any containers, shielding, packing, and other absorbent materials immediately surrounding an individual waste container. (10 CFR 60.2, there is no similar definition for LLW defined in 10 CFR 61.)

Greater-Than-Class C Low-Level Radioactive Waste Shipping Packages/Containers Identification and Requirements Study

1. INTRODUCTION

This report identifies a variety of shipping packages (also referred to as casks) and waste containers currently available or being developed that could be used for greater-than-Class C (GTCC) low-level waste (LLW). Since GTCC LLW varies greatly in size, shape, and activity levels, the casks and waste containers that could be used range in size from small, to accommodate a single sealed radiation source, to very large-capacity casks/canisters used to transport or dry-store highly radioactive spent fuel. In some cases, the waste containers may serve directly as shipping packages, while in other cases, the containers would need to be placed in a transport cask.

For the purpose of this report, it is assumed that the generator is responsible for transporting the waste to a Department of Energy (DOE) storage, treatment, or disposal facility. Unless DOE establishes specific acceptance criteria, the receiving facility would need the capability to accept any of the casks and waste containers identified in this report. In identifying potential casks and waste containers, no consideration was given to their adequacy relative to handling, storage, treatment, and disposal. Those considerations must be addressed separately as the capabilities of the receiving facility and the handling requirements and operations are better understood.

This report is divided into six sections and three appendices. Section 1 introduces the report. Section 2 provides a discussion on the sources of GTCC LLW as presently identified. To some extent, Section 2 identifies the uncertainty surrounding accurate identification of some GTCC LLW. This uncertainty, coupled with receiving facility design uncertainties, forces a wider consideration of shipping packages and waste containers than might otherwise be the case. Section 3 provides a discussion on cask and container shipping requirements. This discussion is fairly broad given the uncertainties in waste container usage at this time. Section 4 provides a discussion of available shipping packages and waste containers. It is clear that DOE must establish criteria in the near term to put some limits on acceptable packaging (size, handling characteristics, etc.); otherwise, the available selection of waste containers and shipping packages are simply too large for a receiving facility to accept. Sections 5 and 6 provide conclusions and references, respectively. Appendices A, B, and C provide documentation on existing shipping packages, waste containers, and sealed sources. In addition, several commercial vendors have the capability to modify, design, or fabricate specialized casks and containers for GTCC LLW to meet shielding, physical configuration, or sizing needs.

2. CURRENT IDENTIFICATION OF GTCC LLW

The report, DOE/LLW-114,[1] categorized GTCC LLW into the following types:

- Nuclear utility waste
  - From operations
  - From decommissioning
- Sealed sources
- DOE-held potential GTCC LLW
- Other generators' waste.

Generators or sources of GTCC LLW, the four major GTCC LLW streams (activated metals, process waste, dry contaminated solids, sealed sources), and the radionuclides associated with this waste are provided in Table 1, as derived from DOE/LLW-114.[1] Some of this material is physically large, and the casks and waste containers for the material will be dependent on the extent and type of sizing.

Table 1. Potential generator or source of GTCC LLW and associated radionuclides.

GTCC LLW waste generators	Potential GTCC LLW waste stream	10 CFR Part 61 Class C radionuclides
Nuclear utility	<u>ACTIVATED METALS</u>	
	BWR operations waste Control rod blades Local power range monitors IRM/SRM instruments, dry tubes	Primary activation product and other radionuclides ^{59}Ni, ^{63}Ni, ^{94}Nb, and ^{14}C
	PWR operations waste Thimble plug assemblies Incore instruments strings Primary sources	
	BWR decommissioning waste Core shroud	
	PWR decommissioning waste Core shroud Core barrel (high case only)	
Nuclear utility/ DOE held	<u>PROCESS WASTE</u>	
	BWR decontamination resins **PWR decontamination resins**	Fission product radionuclides ^{137}Cs, ^{129}I, ^{99}Tc, and ^{90}Sr, activation product radionuclide ^{63}Ni, and transuranics
	BWR cartridge filters Control rod drive Fuel pool Underwater vacuum	
	PWR cartridge filters Seal water injection Seal water return Reactor coolant system Back-flush letdown Fuel pool	
Other generators/ DOE held	<u>DRY CONTAMINATED SOLIDS</u>	Transuranics
	Contaminated nonmetals	
	Contaminated metals	
Industrial sealed source	<u>SEALED SOURCES</u>	
	Transuranic-bearing Transuranic gamma gauges X-ray fluorescence sources Well logging devices Moisture gauges	Transuranics (^{241}Am, ^{244}Cm, ^{238}Pu, and ^{239}Pu), ^{137}Cs, ^{90}Sr, and ^{63}N
	Other Medical therapy Gamma gauges Beta gauges Well logging devices Moisture gauges Calibration devices Gamma irradiators VI Gas chromatography Beta eye applicators	

BWR — boiling water reactor
PWR — pressurized water reactor

3. SHIPPING REQUIREMENTS

The regulatory and DOE requirements for shipping GTCC LLW material are the same as those for other types of radioactive material shipments. The following sections present the general requirements for radioactive material shipments and specific requirements for transportation packaging.

3.1 General Requirements for Radioactive Shipments

There are four Federal agencies with transportation requirements that must be satisfied. The agencies are the Department of Transportation (DOT), Nuclear Regulatory Commission (NRC), Environmental Protection Agency (EPA), and DOE. The following is a list of the applicable requirements, by agency:

- 49 CFR (DOT regulations)

Part 171 General Information, Regulations, and Definitions

This subchapter prescribes the requirements of the DOT governing the transportation of hazardous materials by interstate rail car, aircraft, and vessel; and intrastate carriers by motor vehicle as related to hazardous waste and hazardous substances. It defines the requirements for manufacturing, fabrication, marking, maintenance, reconditioning, repairing, and testing of packagings and containers that are used for transportation of hazardous materials.

Part 172 Hazardous Materials Tables and Hazardous Materials Communications Regulation

This subchapter prescribes the requirements of the DOT governing hazardous material identification, shipping papers, marking, labeling, placarding, and emergency response information.

Part 173 Shippers — General Requirements for Shipments and Packagings

This subchapter prescribes the requirements governing shipper activities by requiring that shipments subject to the hazardous material regulations must be packaged, described, stored, and transported in accordance with the regulations. This part identifies the responsibilities of the shipper to instruct those persons offering hazardous materials for transportation about the applicable regulations.

Part 173 Subpart I Radioactive Materials

This subpart sets forth requirements for the transportation of radioactive materials by carriers and shippers. The requirements prescribed in this subpart are in addition to other requirements set forth in 49 CFR 173 and 10 CFR 71 for the packaging and transportation of radioactive materials.

- 10 CFR (NRC regulations)

Part 71 — Packaging and Transportation of Radioactive Material

Packaging and transportation of radioactive material regulations specify the standards for packaging of Type B, fissile, plutonium, and special form radioactive materials. They impose operating controls and procedures and set forth the quality assurance requirements for package design.

- 40 CFR (EPA regulations)

Note: Only a minimal amount of GTCC LLW is expected to be mixed waste covered by EPA regulations (GTCC LLW Mixed Waste Assessment, DOE/LLW-156, September 1992).

Parts 260 to 299 — Solid and Hazardous Waste Regulations

Solid and hazardous waste regulations of the Resource Conservation and Recovery Act (RCRA) contain provisions authorizing the states to regulate the treatment, disposal, and storage of solid and hazardous wastes. The EPA governs the activities of Federal agencies and contractors. This regulation identifies the responsibility for the proper identification and classification of wastes and for proper preparation of the manifest. It requires the carrier to obtain a waste hauler identification number from the EPA, and the carrier must be properly permitted prior to tendering hazardous waste shipments.

Part 355 — Emergency Planning and Notifications

The Emergency Planning and Notification Order of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) establishes the list of extremely hazardous substances threshold quantities and outlines the notification responsibilities and implementation of state and local emergency response plans.

- Orders (DOE requirements)

1540.1 — Materials Transportation and Traffic Management

Establishes policy and procedures for management of transportation activities, including traffic management.

1540.2 — Hazardous Material Packaging for Transport — Administrative Procedures

Establishes administrative procedures for the certification and use of radioactive and other hazardous materials packaging.

5480.3 Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes

Establishes requirements for the packaging and transportation of hazardous materials, substances, and wastes.

5820.2A Radioactive Waste Management

Establishes policies, guidelines, and minimum requirements by which DOE manages its radioactive, mixed waste, and contaminated facilities.

3.2 Shipping Requirements for Shipping Packages and Waste Containers

Packaging requirements are developed to protect the public and environment from the hazards associated with the material being transported. The more hazardous the material classification, the more restrictive the packaging requirements. Figure 1 illustrates a decision diagram used for identifying the appropriate packaging and shipping requirements for radioactive material. The following describes the packaging requirements for different radiation levels:

- **Low specific activity (LSA)**—Shipping packages used to transport radioactive materials that meet the definition of LSA as defined in 49 CFR 173.403(n) must meet the requirements for a DOT Specification 7A (49 CFR 178.350) package for regular shipments, or if an exclusive transporter is used, they must meet the requirements for "strong tight" packages as defined in 49 CFR 173.425(b).

- **Limited quantity**—Shipping packages used to transport radioactive materials meeting the definitions of limited quantity radioactive materials as defined in 49 CFR 173.423 must meet the requirements for "strong tight" packages as defined in 49 CFR 173.421.

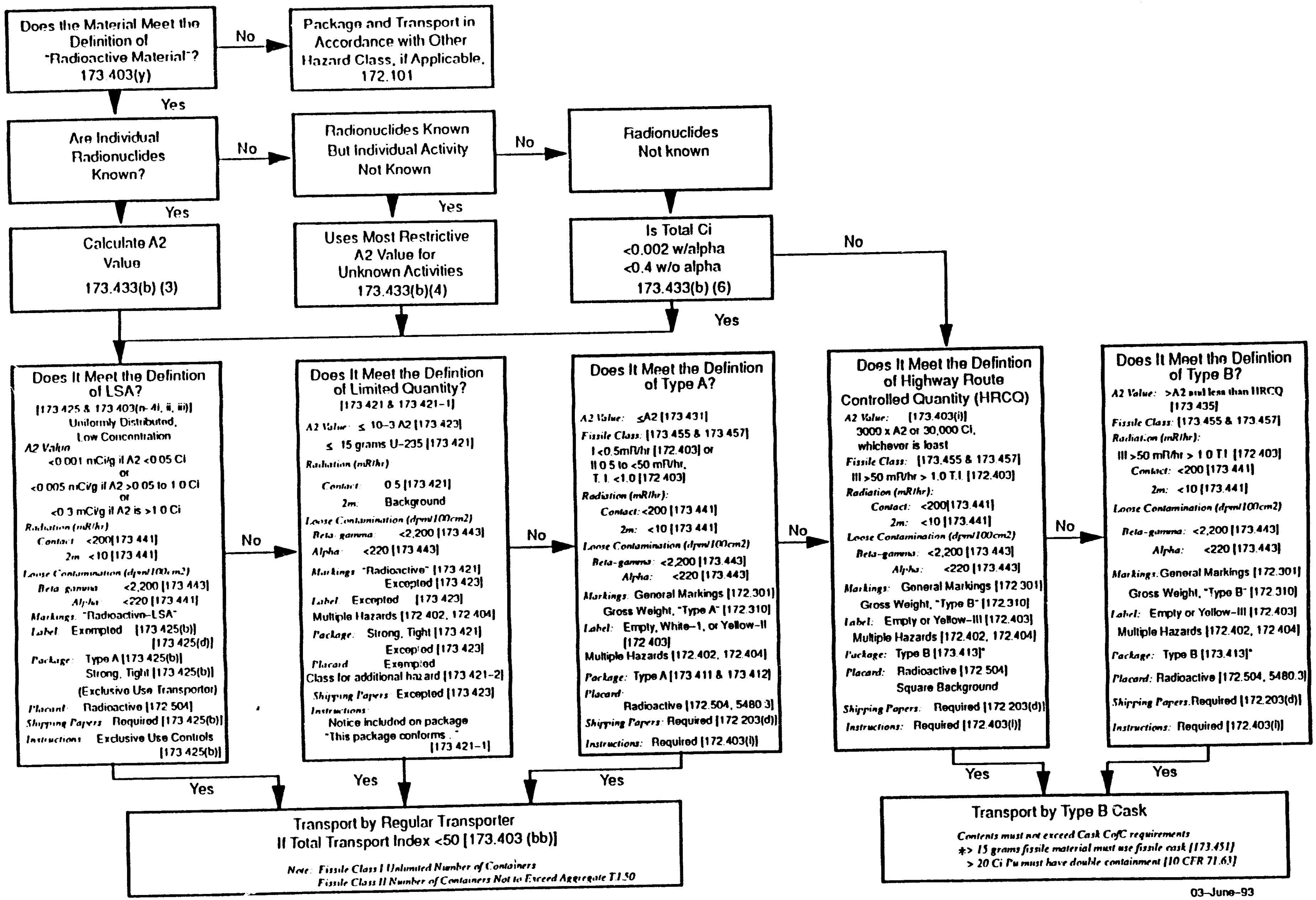
- **Type A quantities of radioactive materials**—Shipping packages used to transport radioactive materials meeting the definition of Type A_1 or A_2 quantity of radioactive materials as defined in 49 CFR 173.433 must meet the requirements of Type A packaging as defined in 49 CFR 173.415 for nonfissile material and 173.417 for fissile material, and must be able to withstand the tests required in 49 CFR 173.465.

- **Highway route controlled quantities**—Shipping packages used to transport highway route controlled quantities of radionuclides must meet the requirements for a Type B package (see the following bullet for Type B package specifics). Highway route controlled quantities are quantities of radioactive material within a single package that exceeds:

  - 3,000 times the A_1 value of the radionuclides as specified in 49 CFR 173.433 for special form radioactive material

  - 3,000 times the A_2 value of the radionuclides as specified in 49 CFR 173.433 for normal form radioactive material, or

  - 30,000 curies, whichever is least. (49 CFR 173.403)



Assumptions: A. Dedicated transporters will be used.
B. All Radioactive Materials are Normal Form, A2; Special Form, A1, has higher limits.

Figure 1. Decision diagram for determining the appropriate shipping packaging.

Highway route controlled quantities shipments are subject to specific routing controls that apply to the highway carrier. Preferred routes must be used. The reporting of these routes is the responsibility of the carrier and shipper.

- **Type B quantities of radioactive materials**—A shipping package that meets the definition of 49 CFR 173.403(hh) for a Type B package must be used to transport radioactive materials that exceed the A_1 or A_2 values for radionuclides as defined in 49 CFR 173.433. Type B packages must be reviewed and certified by NRC or DOE. NRC requirements are specified in 10 CFR 71. Certification requires submission of a safety analysis report (SAR), which describes the package and demonstrates that it will meet stringent performance requirements under normal and accident conditions specified in the regulation. The SAR must address the following topics: general information, structural evaluation, thermal evaluation, containment, shielding, criticality, operating procedures, and acceptance and maintenance programs. Specific requirements for a comprehensive quality assurance program are also defined. DOE is authorized to certify Type B packages by 49 CFR Part 173.7(d), however, DOE must use packaging standards equivalent to those specified in 10 CFR 71. DOE's certification requirements are found in DOE Order 1540.2. Since the design requirements are so rigorous for Type B shipping packages, in most cases there are no additional requirements for the inner container/waste container. However, if special requirements are needed, those requirements will be identified in the certificate of compliance and safety analysis report for packaging required for each Type B package.

Most GTCC LLW will be shipped in Type B packages because of its high radiation and activity levels. This could include LSA materials that exceed radiation limits. Sealed sources have historically been shipped in Type A packages. Otherwise, it is unlikely that GTCC LLW will be transported as normal form Type A or as limited quantity.

There are no specific transportation requirements for waste containers unless the container serves as the shipping package. Also, containers of waste are frequently overpacked with an outer container that serves as the DOT package. In this case, the certification for the outer container or cask may specify requirements for the inner (secondary) container.

4. SHIPPING PACKAGES AND WASTE CONTAINERS

Since the transport of radioactive materials is well established, shipping packages exist for transporting GTCC LLW. Two types are available: (a) spent fuel casks and (b) radioactive waste casks. Table 2 provides information about Type B casks and Table 3 provides information about Type A packages that could be considered for the GTCC LLW Program. Appendix A.1 and A.2 have more detailed information about several of the casks.

Spent fuel casks have been developed specifically for shipping spent nuclear fuel. They are large casks with fuel baskets inside to position the fuel and control criticality. The baskets contain fuel slots that are about 8-in. square and 15-ft long. The number of fuel slots varies, depending on the cask. Shielding is provided for both gamma and neutron radiation.

The fuel basket and neutron shielding may be undesirable features for carrying GTCC LLW because: (a) criticality control and neutron shielding are not required for GTCC LLW, and (b) the basket limits payload weight and restricts the volume available. For some spent fuel casks, it may be possible to remove the fuel basket. The fuel basket would be usable if the GTCC LLW is loaded in specially designed canisters that fit in the slots. This may not be practical, however, because of costs and ALARA (as low as reasonably achievable) considerations associated with sizing the GTCC LLW.

Spent fuel casks are currently available for both truck and rail use. They may be leased or bought from vendors such as Transnuclear, Pacific Nuclear, and Scientific Ecology Group (SEG). DOE's Office of Civilian Radioactive Waste Management (OCRWM) is developing two new high-efficiency large-capacity casks, one for rail/barge and one for truck. There are also several casks that are designed and licensed for both transport and storage of spent fuel.

Radioactive waste casks are also large shielded casks. Instead of a fuel basket, the interior is a large open cavity that will accommodate a variety of payload sizes and shapes. There is no neutron shielding. Waste casks are available in a variety of sizes. Contents are limited by shielding, payload weight, and interior volume. Waste casks may be leased or bought from vendors such as Transnuclear, Chem-Nuclear, SEG, and Pacific Nuclear.

The majority of GTCC LLW sealed radiation sources and devices containing such sources are transported from the manufacturer in 7A (Type A) containers. However, some sources have been transported in Type B containers because of special requirements. The Type A containers are usually retained by the users, while the Type B containers are returned to the manufacturer.

The major factors to consider in determining appropriate waste container design for GTCC LLW are loading, storage, transportation, treatment, and disposal. Table 4 identifies the waste container design considerations for these major design factors.

In the process of identifying waste containers, it is important that efficient volume utilization (i.e., packaging factors) be considered. (For information about packaging factors for GTCC LLW, see DOE report DOE/LLW-114H.[2]) Packaging factors are an important consideration in that the more efficiently the waste is packaged, the fewer the number of shipments required and the better the utilization of the storage and disposal facilities. These are important public considerations.

Table 2. GTCC LLW potential packaging (Type B).

Packaging identification	CofC number/ expiration date	Package	Description: Outside Height/ length (in.)	Description: Outside Width/ diameter (in.)	Description: Cavity Height/ length (in.)	Description: Cavity Width/ diameter (in.)	Description: Weights Empty (lb)	Description: Weights Loaded (lb)	Description: Weights Payload (lb)	Decay heat (watts)	Lead shielding equivalence (in.)	Certificate issued to/ owner	Waste container(s)	Comments
IF-300	USA/9001/B()F 31-May-95	Cylinder	210	64	180.25	37.5	119,000	140,000	21,000	40,000 Btu/hr	>4	Pacific Nuclear Systems	Special container New design	Rail cask, irradiated PWR/BWR uranium oxide fuel; solid irradiated hardware
N-55	USA/9070/B(U) 31-Aug-94	Cylinder	48	32	34.5	24	200	750	550	3	—	Nuclear Packaging	One 55-gal drum	LSA or special form — dewatered, solid, solidified; or solid metal pieces or activated solid metal components
NuPac 125-B	USA/9200/B(M)F 31-May-96	Cylinder (double)	207.5	65.5	192.5	51.25	100,500 OV 37,000 IV	181,500	20,600	700	>3.88	Department of Energy	Seven TMI fuel canisters New design	Spent fuel railcask; byproduct and special nuclear material; irradiated core structural components; internal contamination
TRUPACT-II	USA/9218/B(U)F 31-Aug-94	Cylinder (double)	122.0	94	75	73	11,985	19,250	7,265 (1,000 lb per 55-gal drum and 4,000 lb per SWB)	TRUCON DOE/WIPP 89-004, Rev. 5	Contact handled waste	Department of Energy	Fourteen 55-gal drums or Two standard waste boxes	TRU waste — dewatered solid or solidified wastes
NuPac 10-142	USA/9208/B() 30-Jun-96	Cylinder	130.0	112.0	72.00	66.00	58,100	68,000	10,000	400	4.25	Nuclear Services	Ten 55-gal drums or One ES-142 C.S. HIC or One ES-142 P.H. HIC Secondary containers	Dewatered, solid, or solidified waste; activated solid components
LN 10-135	USA/9210/B(U) 30-Nov-93	Cylinder	130	112	72.0	66.00	58,000	68,000	10,000	400	4.4	LN Technologies Corp. (SEG)	Ten 55-gal drums Secondary containers	>Type A dewatered, solids, or solidified waste; activated components

Table 2. (continued)

Packaging identification	CofC number/ expiration date	Package	Description: Outside Height/ length (in.)	Outside Width/ diameter (in.)	Cavity Height/ length (in.)	Cavity Width/ diameter (in.)	Weights Empty (lb)	Weights Loaded (lb)	Weights Payload (lb)	Decay heat (watts)	Lead shielding equivalence (in.)	Certificate issued to/ owner	Waste container(s)	Comments
3-82B	USA/6574/B() 30-Apr-96	Cylinder	74.5	66.25	62.13	54.00	41,805	50,000	8,195	205 Btu/hr	4.58	SEG	Three 55-gal drums Four 30-gal drums	Byproduct material — ion exchange resins, filter sludge, spent filter cartridges, etc.
TN-RAM	USA/9233/B(U) 30-Sep-94	Cylinder	129	51	111	35	70,500	80,000	9,500	300	>6	Transnuclear	TN-RAM liner New design	>Type A quantity of radioactive material, including fissile material not exceeding limits specified in 10 CFR Parts 71.18, 71.20, and 71.22.
CNS 1-13C II	USA/9152/B() 30-Jun-94	Cylinder	68.5	39.1	45.2	26.5	24,000	27,000	3,000	800	>5	Department of Energy	One 55-gal drum Special design	>Type A nonfissile radioactive material as solidified or dewatered process solids (resins); >Type A irradiated solid reactor components; >Type A irradiated fuel (dewatered)
CNS 1-13C	USA/9081/B() 31-Dec-92	Cylinder	68.5	39	54	26.5	21,000	26,000	5,000	600	5	Chem-Nuclear Systems, Inc.	Secondary container	>Type A byproduct material as solid metal; process solids, either dewatered, solid, or solidified; solid reactor components
CNS 1-13G	USA/9216/B()F 31-Dec-92	Cylinder	67.19	38.5	54	26.5	25,500	—	—	600	6.2	Chem-Nuclear Systems, Inc.	One 55-gal drum Secondary container	Byproduct material and special material as solid metal or oxides; irradiated fuel rods; process solids dewatered, solid nonfissile irradiated metal hardware; radioactive waste materials immobilized in cement grout
CNS 3-55	USA/5805/B() 31-Mar-94	Cylinder	133.75	50.5	116	36	60,780	70,000	9,220	250	6	Chem-Nuclear Systems	Secondary container: Three 55-gal drums	Neutron sources/irradiated metal
CNS 4-85	USA/6244/B() 31-Oct-94	Cylinder	111.5	58	100.0	46.0	40,300	46,000	5,700	10	3.38	Chem-Nuclear Systems, Inc.	Four 55-gal drum	>Type A byproduct material, dewatered, solid or solidified; >Type A solid metal components

Table 2. (continued)

			Description											
			Outside		Cavity		Weights							
Packaging identification	CofC number/ expiration date	Package	Height/ length (in.)	Width/ diameter (in.)	Height/ length (in.)	Width/ diameter (in.)	Empty (lb)	Loaded (lb)	Payload (lb)	Decay heat (watts)	Lead shielding equivalence (in.)	Certificate issued to/ owner	Waste container(s)	Comments
CNS 8-1208	USA/9168/B(U) 31-Mar-95	Cylinder	88	74	75.0	62.0	49,300	74,000	14,680	100	4.5	Chem-Nuclear Systems, Inc.	Eight 55-gal drum	Byproducts dewatered resins, solid or solidified waste; activated reactor components
TN-8 TN-8L	USA/9015/B() 31-May-96	Cylinder	192	67.5	168	Irregular	73,800	78,600	4,800	23.5 kW	7.3	Transnuclear, Inc.	Three PWR fuel assemblies Special design	Irradiated clad fuel pins, irradiated PWR uranium oxide, solid non-fissile irradiated hardware, intact BWR and PWR fuel rods
TN-9	USA/9016/B()F 31-May-96	Cylinder	200	66	178	Irregular	73,600	78,200	4,600	24.4 kW	6.5	Transnuclear, Inc.	Seven BWR assemblies Special design	Irradiated BWR unranium oxide; solid nonfissile irradiated hardware
NLI-1/2	USA/9010/B()F 31-Mar-96	Cylinder (four config-urations)	195.25	47.12	178	12.63	46,500	49,250	3,000	10.6 kW	2.12	Nuclear Assurance Corporation	Six consolidated fuel canisters Special design	Irradiated PWR or BWR uranium oxide; irradiated metallic fuels; solid, nonfissile, irradiated hardware and neutron source components; byproduct and special nuclear material of irradiated uranium and plutonium oxide
NLI-10/24	USA/9023/B()F 31-Mar-97	Cylinder (double)	204.5	96	179.5	45	178,000	194,000	34,100	70 kW	>6	Nuclear Assurance Corporation		Irradiated PWR and BWR uranium oxide — rail cask
NUHOMS MP-187	Being licensed	Cylinder	200	92.5	186/196	68	211,000	250,000	39,000	17 kW	5	Pacific Nuclear	NUHOMS-24P dry shielded canister/ NUHOMS-52B dry shielded canister Flexable internal design	Spent fuel — modified for other uses

Table 2. (continued)

Packaging identification	CofC number/ expiration date	Package	Description: Outside Height/ length (in.)	Description: Outside Width/ diameter (in.)	Description: Cavity Height/ length (in.)	Description: Cavity Width/ diameter (in.)	Description: Weights Empty (lb)	Description: Weights Loaded (lb)	Description: Weights Payload (lb)	Decay heat (watts)	Lead shielding equivalence (in.)	Certificate issued to/ owner	Waste container(s)	Comments
GA-4	Being licensed	Cylinder	187.75	<48.00	167.25	18.06	46,400	52,600	6,200	2.2 kW	>2.65	General Atomics/ DOE OCRWM	Four PWR assemblies	Legal weight truck cask
GA-9	Being licensed	Cylinder	198.00	<47.73	178.00	18.21	46,600	52,900	6,300	1.6 kW	>2.45	General Atomics/ DOE OCRWM	Nine PWR assemblies	Legal weight truck cask
BR-100	Being licensed	Cylinder	252	126	—	—	168,900/ 169,900	201,700/ 203,700	32,800/ 33,800	12 kW	>5	Babcock and Wilcox/ DOE OCRWM	Assemblies: 21 PWR 52 BWR	Rail barge cask

Table 3. GTCC LLW potential packaging (Type A).

Packaging identification	CofC number/ expiration date	Package	Description: Outside: Height/ length (in.)	Description: Outside: Width/ diameter (in.)	Description: Cavity: Height/ length (in.)	Description: Cavity: Width/ diameter (in.)	Description: Weights: Empty (lb)	Description: Weights: Loaded (lb)	Description: Weights: Payload (lb)	Decay heat (watts)	Lead shielding equivalence (in.)	Certificate issued to/owner	Waste container(s)	Comments
CNS 6-75	USA/9108/A 30-Sep-93	Cylinder	86.6	62	74.5	53	31,000	41,300	10,300	20	4.0	Chem-Nuclear Systems, Inc.	Six 55-gal drum Secondary container	>Type A radioactive material
CNS 6-80-2 CNS 6-80-2A	USA/9111/A 31-Jan-94	Cylinder	78.6	70.5	58.0	59.0	44,000	51,500	7,500	60	4.25	Chem-Nuclear Systems, Inc.	Four 55-gal drum Secondary container	LSA — >Type A byproduct solids and solidified waste; and activated solid components
CNS 8-120A	USA/6601/A 28-Feb-96	Cylinder	92	73.5	75	62	49,300	70,000	20,000	40	4.5	Chem-Nuclear Systems, Inc.	Eight 55-gal drums Secondary container	LSA — process solids (dewatered solid or solified); solid reactor components
CNS 14-195H	USA/9094/A 31-Oct-95	Cylinder	89.88	83.13	80.13	77.0	38,800	56,500	17,700		>2.19	Chem-Nuclear Systems, Inc.	Fourteen 55-gal drum Secondary container	LSA — dewatered, solid or solidified; solid reactor components
CNS 21-300 (w/Shield Insert)	USA/9096/A 30-Sep-95	Cylinder	1117.25	86.75	106.5/ 109.25	76/ 83.0	30,200/ 39,310	57,450/ 66,560	27,250	—	>1/2.0	Chem-Nuclear Systems, Inc.	Eight 55-gal drums Twenty-one 55-gal drums Secondary container	LSA — dewatered, solid or solidified; solid reactor components
NuPac 14/210L 14/210H CNSI 14/215H Series A LN 14/195L 14/195H	USA/9176/A 31-May-98	Cylinder	92.0/ 93.5	92.25/ 93.5	80.25	77.5	31,600/ 38,400	51,600/ 58,400	20,000	9	2.00/ 2.73	Pacific Nuclear/ Nuclear Packaging/ Chem-Nuclear Systems, Inc.	Fourteen 55-gal drums or One ES-210 C.S. HIC or One EL-210 P.H. HIC Secondary container	LSA — dewatered, solids or solidified, activated solid components

Table 3. (continued)

Packaging identification	CofC number/ expiration date	Package	Description: Outside Height/ length (in.)	Outside Width/ diameter (in.)	Cavity Height/ length (in.)	Cavity Width/ diameter (in.)	Weights Empty (lb)	Weights Loaded (lb)	Weights Payload (lb)	Decay heat (watts)	Lead shielding equivalence (in.)	Certificate issued to/owner	Waste container(s)	Comments
NuPac 14/190L 14/190M 14/190H LN 14-170L 14-170M 14-170H (CNS 14-190H)	USA/9159/A 31-May-93	Cylinder	80 5/ 83 25	91.5	73.38	75.5	29,200/ 45,200	49,200/ 65,200	20,000	7/25	2.00/ 3.5	Nuclear Packaging/ Chem-Nuclear Systems, Inc.	Fourteen 55-gal drums or One ES-210 C.S. HIC or One EL-210 P.H. HIC Secondary container	LSA — dewatered, solids or solidified, activated solid components
NuPac 14D-2.0 (CNS 14-170 Series II)	USA/9079/A 30-Jun-93	Cylinder	81.50	81.75	73.38	75.5	34,000	48,000	14,000	7	>1.75	Nuclear Packaging	Fourteen 55-gal drums Secondary containers	LSA — process solids either dewatered, solid or solidified; >Type A radioactive material
NuPac 14/140 LN 10/135A	USA/9177/A 31-May-93	Cylinder	—	—	73.00	66.0	41,500	56,500	15,000	24	>2.75	Nuclear Packaging	Ten 55-gal drums Secondary containers	LSA — dewatered, solids or solidified waste; activated solid components
NuPac 7/100 LN 7-100	USA/9178/A 31-May-93	Cylinder	—	—	40.75	75.5	35,900	48,900	13,000	17	3.50	Nuclear Packaging/ Chem Nuclear Systems, Inc.	Seven 55-gal drums Secondary container	LSA — dewatered, solids or solidified waste; activated solid components
NuPac 6/100L 6/100H LN 6-80L 6-80H	USA/9179/A 31-May-93	Cylinder	—	69.11/ 71.37	62.00	61.00	30,900/ 41,900	42,900/ 53,900	12,000	9/61	3.25/ 4.40	Nuclear Packaging	Six 55-gal drums Secondary container	LSA — dewatered, solids or solidified waste; activated solid components
NuPac 50-1.5L 50-2.5L 50-3.0L 50-4.0L	USA/9145/A 31-Mar-96	Cylinder	—	—	52.50	48.50	9,000/ 24,700	13,200/ 28,900	4,200	—	1.50/ 4.00	Nuclear Packaging	Secondary container Fourteen 55-gal drums	LSA — dewatered, solids or solidified waste; activated solid components

Table 3. (continued)

Packaging identification	CofC number/ expiration date	Package	Description: Outside Height/ length (in.)	Outside Width/ diameter (in.)	Cavity Height/ length (in.)	Cavity Width/ diameter (in.)	Weights Empty (lb)	Weights Loaded (lb)	Weights Payload (lb)	Decay heat (watts)	Lead shielding equivalence (in.)	Certificate issued to/owner	Waste container(s)	Comments
14-215 (with insert)	USA/9222/A 28-Feb-93	Cylinder	92.25	83.5	80.25	77.25	38,400	58,400	20,000/ 13,400	9	2.75/ 3.50	SEG	Fourteen 55-gal drums Secondary containers	LSA — dewatered, solids, or solidified waste; activated solid components
HN-194S	USA/9089/A 31-Jan-94	Cylinder	84.25	81.6	75.5	75.6	26,000	43,000	17,000	2	1.81	Hittman (SEG)	Fourteen 55-gal drums	LSA — dewatered, solids, or solidified waste
HN-190-1	USA/9086/A 31-Jul-93	Cylinder	82.5	81.5	74.5	75.63	35,500	50,000	14,500	7	2.5	Hittman (SEG)	Fourteen 55-gal drums Secondary container	LSA — dewatered, solids, or solidified waste
HN-190-2	USA/9224/A 30-Jun-93	Cylinder	81.5	81.75	73.38	75.5	30,200	48,000	14,200	7	2.5	Hittman (SEG)	Fourteen 55-gal drums Secondary container	LSA — dewatered, solids, or solidified waste
HN-100 Series 3 CNS 14-170 Series III LN 14-170 Series 1 NES-1	USA/9151/A 31-Jul-92	Cylinder	81.5/ 81.6	81.75/ 81.5	71.56/ 73.63	73.06/ 75.5	35,200/ 42,445	53,000	10,555/7 (w/o insert) 17,800 28 (w/ insert)		2.5/ 4.0	Hittman (SEG)/ Chem-Nuclear Systems, Inc.	Fourteen 55-gal drums Secondary container	LSA — dewatered, solids, or solidified waste
LN-142	USA/9073/A 28-Feb-94	Cylinder	120	101	72.0	66.0	54,000	64,000	10,000	400	4.4	LN Technologies (SEG)	Ten 55-gal drums Secondary container	LSA — dewatered ion exchange resins or solid waste; activated solid components

SEG — Scientific Ecology Group, Inc.

Table 4. Waste container design considerations for loading, storage, transport, and disposal of GTCC LLW.

Design consideration	Loading/ storage	Transportation	Treatement	Disposal
Size (capacity)	X	X	X	X
Shape (geometrical configurations)	X	X	X	X
Wall thickness (structural)	X	—	X	X
Materials (corrosion)	X	—	X	X
Loading (openings and penetrations configurations)	X	X	X	X
Handling and lifting attachments (margins of safety)	X	X	X	X
Storing, stacking, racking (crush strength)	X	—	X	X
Decontamination capability (surface finish)	X	—	X	X
Confinement capability (structural)	X	X	X	X
Criticality control (margin of safety)	X	X	X	X
Gas release (vents)	X	X	X	X
Shielding (contact or remote handled)	X	X	X	X
Storage environment compatibility (pool, weather)	X	—	X	X
Payload compatibility (corrosives)	X	—	X	X
Ease of fabrication	X	X	X	X
Standardized design and/or subcomponents	X	—	X	X
Off-the-shelf availability	X	—	X	—
Disposal site environment compatibility (longevity and external corrosion rate performance)	—	—	—	X
Puncture protection	—	X	—	—
Maximum payload weight	—	X	—	—
Heat conduction	—	X	—	—

Appendix B identifies a representative number of commercially available shipping casks and containers that could be used for GTCC LLW waste. Also, there are numerous vendors with technical and manufacturing capabilities to custom modify, design, or fabricate casks and containers specifically for GTCC LLW.

Appendix A.4 identifies the containers that have been evaluated and tested, and that qualify as DOT-7A packages (49 CFR 178.350) for DOE.[3] They are not only usable for waste containers, but also for transporting LSA, limited quantity, and Type A quantities of radioactive materials.

There are no acceptance criteria for GTCC LLW; therefore, the containers could vary significantly in size, shape, structural material, and so forth. The following sections provide a brief discussion of each type of GTCC LLW along with examples of casks and containers that could be used to transport and store the waste. Since the specific requirements for the GTCC LLW treatment, storage, and disposal facilities have not been established, this report does not try to identify the "best" casks and container(s). Instead, this report identifies a wide variety of potential casks and containers.

4.1 Activated Metals

There are two sources of activated metal components: (a) those resulting from normal refueling and maintenance operations in nuclear power facilities, and (b) structural components in reactor vessels that are removed during decommissioning at the end of the reactor operating life. The size of these components varies from (a) large boiling water reactor (BWR) and pressurized water reactor (PWR) core shrouds and PWR core barrels, to (b) smaller components such as BWR control rod blades, incore instruments, PWR thimble plugs, and primary sources.[1] The casks and waste containers needed for activated metals could vary greatly.

Larger components will most likely be sized for transport. These components are expected to be highly radioactive; therefore, they will need to be shipped in heavily shielded Type B shipping packaging. The waste container requirements will be those imposed by the shipping packaging. The most likely Type B shipping packages for this waste will be large heavily shielded casks, e.g., TN-RAM, NuPac 125-B, NUHOMS, TITAN, IF-300, GA-4, BR-100, GA-9, and TN-8. The following is a detailed description of some of these shipping casks and the waste containers for placement in these casks.

Appendix A shows examples of large capacity containers. A discussion of these large-capacity, single, and multipurpose containers is given below:

- TN-RAM high activity irradiated hardware container

  This container has a capacity of about 53 ft^3 and is transported in the TN-RAM cask. This cask system was developed to meet demand for a high capacity packaging to serve an irradiated hardware market. It is an overweight truck cask used extensively by the commercial industry, primarily BWR power stations, to transport irradiated components as LLW to the commercial LLW disposal facilities.

  Advantages of this container are: (a) it is a waste container being used in the private sector and auxiliary equipment for using the container exists; (b) the container has a large capacity and is transported by truck; (c) the TN-RAM cask is licensed by the NRC to current regulations for transport; and (d) the TN-RAM provides shielding, which allows the container to hold up to 14,000 curies of Co-60.

Disadvantages of this system are: (a) it is a patented system available through a single vendor; (b) a shielded storage cask or facility would need to be developed to store loaded canisters; (c) this system is not universally used by industry, which means that the storage and disposal facilities will need to have the capability to handle other types of large waste containers; and (d) there is no assurance that these containers will be acceptable for final disposal.

- NUHOMS dry shielded canister (DSC)

The canister, NUHOMS-24P, is part of the NUHOMS system. The NUHOMS MP-187 transportation cask is in the process of being licensed by the NRC to 10 CFR Part 71. The NUHOMS is used by some commercial nuclear reactor facilities for dry storage of spent fuel, bu other canister designs could contain GTCC LLW. The system has a 10 CFR 72 storage license from the NRC. Modifying the internals of the DSC and using the DSC to store GTCC LLW could require changes to the license. The total system is self-contained with its own transfer-shipping-storage cask, concrete storage modules, and miscellaneous loading, unloading, and transporting equipment.

Advantages of this type of system are: (a) the system is not dependent on major facilities and can be easily moved from one location to another; (b) the canister has a large capacity (two sizes, 380 ft^3 and 400 ft^3) that could reduce the number of shipments to storage or disposal facilities; (c) it is a proven technology licensed by the NRC and used by commercial reactor utilities; (d) once the canister is sealed shut, no repackaging is projected prior to disposal (assumes meeting repository or other disposal facility acceptance criteria); (e) since the concrete storage modules are designed for storing spent fuel, they either would provide adequate shielding or could be easily modified to provide additional shielding; and (f) if successful, the transfer cask will also be licensed by the NRC to serve as a transport cask and storage cask.

Disadvantages of this system are: (a) it is a patented system available through a single vendor; (b) licensing of the transfer cask as a shipping package and storage cask is still being worked; (c) this system is not universally used by industry, which means that the storage and disposal facilities will need to have the capability to handle other waste containers as well; (d) the DSC and shipping package cask are very large, requiring railroad access, which may not be available at all locations; and (e) there is no assurance that the DSC will be acceptable for final disposal.

- Universal container system (UCS)

Virginia Power is evaluating using a universal container system (UCS) for spent nuclear fuel storage, transport, and disposal. The UCS would consist of a basic metal container with three separate overpacks, one each for transportation, temporary storage, and permanent disposal. The UCS could be used, as is, if the GTCC LLW is sized and loaded into canisters that fit into the basket assembly slots, or if the internals of the UCS could be modified to accept GTCC LLW.

Advantages of this type of system are: (a) the UCS would have a large capacity, estimated to be 21 fuel assemblies, that could reduce the number of shipments to storage and disposal facilities; (b) once the UCS is sealed shut, the GTCC LLW will not need to be repackaged for disposal; (c) this system would provide a storage, transport, and disposal system; and (d) since the UCS would be designed for spent fuel storage, it would provide shielding.

Disadvantages of this system are: (a) the system may be dependent on major facilities to transfer the inner container into the various overpacks and may not be easily moved from one location to another; (b) it is not a proven technology used by commercial reactor utilities and it is not licensed by the NRC for any of the functions; (c) this system is not universally used by industry, which means that the storage and disposal facilities will need capabilities to handle a wide variety of waste containers; (d) the UCS is very large, requiring railroad access, which may not be available at all locations; and (e) there is no assurance that the UCS container and overpack are acceptable for disposal since the acceptance criteria for the disposal facility has not been established.

- DOE dual-purpose casks

  DOE, through the OCRWM, is conducting a project to demonstrate dual-purpose cask systems, e.g., casks used to transport and store spent nuclear fuel. The two casks designed and fabricated for this purpose are the TN-BRP and TN-REG. Both of these casks have been licensed by the NRC for transportation. The TN-BRP license is USA/9202/B(U)F and TN-REG license is USA/9206/B(U)F. Both casks have a right circular cylindrical design constructed primarily of forged steel. The TN-BRP is designed to hold up to 44 BWR spent fuel assemblies and the TN-REG is designed to hold up to 40 PWR spent fuel assemblies. These casks, like the DSC and UCS systems, could be used as is, if the GTCC LLW is sized and loaded into canisters that fit in the basket assembly slots, or if the internals could be modified to accept the various waste forms and configurations.

  Advantages of the DOE dual-purpose casks are: (a) both of these casks have large capacities (320 ft^3 for the TN-BRP and 380 ft^3 for the TN-REG); (b) this system provides storage and transport; (c) both casks are licensed by the NRC for transport; and (d) since the casks are designed to transport and store spent fuel, they would provide shielding.

  Disadvantages of these casks are: (a) the casks are not designed for disposal and no effort is underway to license them for storage; (b) because of criticality concerns, the casks have been licensed by the NRC for transporting only half loads of spent fuel at a time—this may not be a concern for GTCC LLW, as criticality is not an issue; (c) this system is not universally used by industry, which means that the storage and disposal facilities will need to have the capability to handle other waste containers or will need to load and seal the waste into these casks at the facility; (d) these casks are very large, requiring railroad access, which may not be available at all locations; and (e) there is no assurance that these casks are acceptable for storage at an NRC licensed facility since they have not been licensed for storage and there is no effort underway to license them.

- Other storage and storage/transport casks for fuel storage

  In 1988, Oak Ridge National Laboratory compiled information on casks used in the U.S. for the storage and transport of commercially generated spent fuel.[4] A summary of storage and transportable storage casks is shown in Table 5. All of these casks are possible candidates for GTCC LLW if the inner cavity is redesigned. More detailed information about these and other casks is found in Appendices A.1, A.2, and B.4.

  Smaller waste containers could be used to transport activated metal. Large components would need to be sized to fit in the waste containers. All of the containers in Appendix B could be used for this purpose. However, the more standard the waste containers are, the more off-the-shelf equipment that is available for handling operations. For example, 55-gallon drums are used extensively throughout governmental and commercial sectors. There are many commercially available shipping packagings for 55-gallon drums, as can be seen in Tables 2 and 3. Waste containers that are not standard (a) may require special handling equipment, (b) may not fit into conventional transportation casks, or (c) may require special dunnage for transport.

4.2 Process Waste

Process wastes consist of the wet waste generated from the cleanup of liquids containing soluble and insoluble radioactive constituents. Those wastes are in the form of ion-exchange media, filter media, and cartridge filters, with GTCC LLW concentrations of ^{137}Cs and ^{90}Sr. The Class C limits of cartridge filters are also affected by the presence of ^{63}Ni.[1]

The waste containers for processed waste could be either self-contained filters or removable filters that must be placed into a storage container after being used. The Three Mile Island Unit 2 (TMI-2) accident produced several examples of self-contained filter processed waste used as part of the cleanup system following the TMI-2 accident. Those waste containers are the Submerged Demineralizer System (SDS) vessels, EPICOR-II prefilters, and TMI-2 filter canisters. Appendix B.3 provides a brief description and sketch of each of these filter containers. Generally, Type B transportation casks have been used to transport these filters. Examples of Type B casks used to transport this type of waste are CNSI 1-13C, NuPac 125-B, SEG's 3-82B, and CNS 8-120B. Filters have been stored in concrete overpacks and disposed of in vaults or high integrity containers (HICs). Examples of casks used to transport HICs are NuPac 10-142, NuPac 14/210L, CNSI 14/215H, LN 14/195, etc. Many cartridge filters are not self-contained. HICs and 55-gallon drums are the most commonly used. The multipurpose cask and canisters discussed in Section 4.1 may also be used to store filters.

One issue for transporting filters is gas generation from radiolytic decomposition of water into H_2 and O_2 gases that can reach a flammable gas mixture. DOT regulations prohibit shipment of radioactive material generating gas mixtures. In order to transport this type of waste, the gas generation rate must be controlled. Controlling gas generation can be done by equipping the containers with a catalyst for gas recombination. Other treatments are water removal by vacuum drying and filter vitrification.

4.3 Dry Contaminated Solids

Dry contaminated solids are routinely generated at most facilities in the nuclear industry and by other commercial users of radioactive materials. Those materials are in the form of

Table 5. Storage and storage/transport casks for spent fuel.[4]

	CASTOR-IC	CASTOR V/21	TN-24P	TN-24	TN-REG/ BRP	MC-10	REA-2023	NAC S/T	C-E Dry Cap	NUPAC CP-9D[h]	NUHOMS 0708
Type	Storage	Storage	Storage/ transport	Storage	Storage/ transport	Storage	Storage	Storage/ transport	Storage/ transport	Storage	Storage
Capacity (assemblies) Intact SF	16 BWR	21 PWR	24 PWR	24 PWR 52 BWR	40 PWR 85 BWR[b]	24 PWR	24 PWR 52 BWR	26 PWR[f]	24 PWR 60 BWR	9 PWR	7 PWR
Consolidated fuel rods	21 BWR	42 BWR	48 PWR	48 PWR 104 BWR	-	48 BWR	48 PWR 104 BWR	56 PWR 122 BWR	48 PWR 100 BWR	18 PWR	—
Weight-Loaded (tons)[a]	81	117	100	100	103/98	120	98	100	111/113	88	11[c]
Design heat Rejection (kW)[a]	14.4	28	20.6	24	5	13.5	44.6	26[g]	24	5.4	7
Peak Clad Temperature (°C)[a]	365	365	221	375	375	336	304	360	355	290	380
Materials of Construction Cask body	Nodular cast iron	Nodular cast iron	Forged steel	SA350, Gr. LFI	Forged steel	Forged steel	Pb/SS	Pb/SS	Steel	Concrete	Concrete[d]
Basket	Borated SS	SS/borated SS	A1/B	SS/B, Cu plate	SS/B	SS grid/ SS cell with boral plates	SS with boral inserts	A1	SS	Steel	SS/Pb in ends[e]
Neutron shield	Polyethylene	Polyethylene	Resin-sides; lid—poly-propylene	Polyester resin	None	BISCO N-3	Gylcol and water	BISCO NS4FR	BISCO	Concrete/ RX-227	Concrete[d]
Cavity Atmosphere	He	He	He	N or He	Inert	He	He	He	He	Inert	He
Licensing Status	Licensed	Licensed	Applied for—storage	Applied for	Applied for—transport	Licensed	Applied for	Applied for—storage	Applied for	Applied for	Licensed
Number in existence in U. S. (or on order in 1988)	1	6	1	0	2	1	1	1	0	0	3

a. For intact fuel assemblies.
b. Short assemblies, double stacked.
c. Weight of canister only — not concrete storage module.
d. Refers to NUHOMS concrete storage module.
e. Refers to NUHOMS canister.
f. 31 PWR with burnup credit.
g. 16 kW for burnup credit version.
h. Applies for CP-9W.

SS — stainless steel.

contaminated plastics, paper, metals, and wood, and are historically the largest volume of LLW generated. The routine generation of these waste forms is a result of surface contamination. Their specific activity is low, rarely exceeding Class A limits. For most facilities, it is unlikely that Class C limits for these waste forms will be exceeded. However, there are some fuel development and hot cell facilities that could generate GTCC LLW as a result of transuranic surface contamination.[1] (See Table 1 for examples of dry contaminated solid wastes.) Since hot cell facilities are usually small, with limited space and capability to handle large containers, contaminated materials are often bagged and/or loaded into 1-gallon paint buckets. The bags or paint buckets may then be loaded into larger containers. HICs and 55-gallon drums are most commonly used as a waste container for these wastes. There are numerous transportation casks available to transport these waste containers as shown in Tables 2 and 3. These wastes could also be loaded into the large capacity canisters discussed in Section 4.1, which would allow this type of waste to be transported and stored using the same equipment and storage facilities as the spent fuel.

4.4 Sealed Radiation Sources

Sealed radiation sources consist of small capsules, usually stainless steel, that encapsulate relatively high concentrations of a single nuclide. Sealed sources are used in a wide range of applications, including industrial and medical applications. The sealed sources are typically contained within a larger device. Two groups of those sources have been identified: (a) those containing transuranic radionuclides, and (b) those containing other radionuclides.[1] Table 6 summaries the range of sizes for individual source capsules along with the shielding, device, and transport package for each major sealed source identified by an NRC survey.[5]

Sealed sources are routinely handled throughout industry. In most cases, they have their own containers that are used for storage, shielding, and transport. Appendix C shows typical sealed sources, and examples of nonreturnable and returnable packaging. Appendix A.3 is a list of NRC-licensed transport packaging. Sources and containers could be placed into larger waste containers as is; however, that would be an inefficient use of the waste container. One vendor, Troxler Electronics, Inc., may develop a 55-gallon 7A drum that has special pipe sleeves and shielding for consolidating sources.[2] As identified in Reference 2, if the sources were dismantled, thereby removing all the electronics and support components so that only the shielded capsule remained, a significant volume reduction would result.

It should be noted that it is important to ensure that sealed sources meet the definition of special form radioactive materials, 49 CFR 173.469, if the A_1 values are used in determining the appropriate shipping packages. Failing to identify that a source no longer meets the definition of special form could result in it being shipped out of compliance with DOT and NRC regulations.

Table 6. Source and package size ranges.[2]

Moisture/Density Gauges (≈14,000)	
Source capsule size	0.75 cm^3 - 4.6 cm^3
Shield size	3,670 cm^3 - 4,140 cm^3
Gauge size	14,680 cm^3 - 20,700 cm^3
Package size	96,500 cm^3 - 104,950 cm^3
Fixed/Test Gauges (≈4,100 + 66,000+)	
Source capsule size	4.24 cm^3 - 13.5 cm^3
Shield size	198 cm^3 - 655 cm^3
Gauge/container size	5,678 cm^3 - 9,440 cm^3
Package size	20,600 cm^3 - 32,180 cm^3
Oil Well Logging Units (≈2,000)	
Source capsule size	14.3 cm^3 - 38.6 cm^3
Shield size	1,073 cm^3 - 1,442 cm^3
Gauge/container size	3,785 cm^3 - 5,680 cm^3
Package size	
Type A	20,600 cm^3 - 32,180 cm^3
Type B	71,800 cm^3 - 71,800 cm^3

5. CONCLUSIONS

There are a wide variety of shipping packages and waste containers that could be used to transport GTCC LLW. Transportation regulations do not address waste containers unless they are used as shipping packages or are specified as a component of a shipping package. In most cases, the waste container will be determined by the generator based on operations, handling, storage, and transportation capabilities. Unless acceptance criteria are developed for GTCC LLW accepted by DOE, there is a potential of receiving a wide variety of containers transported in various shipping packages.

This report does not try to identify the "best" package or container(s); however, there are shipping packages and containers that have attributes worthy of discussion. The TN-RAM cask and container system is currently being used throughout the commercial industry for transporting large volumes of radioactive LLW by truck. The GTCC LLW could be sized to fit into the TN-RAM container and transported in the TN-RAM cask. The NUHOMS, currently licensed by the NRC for storage, could be attractive if the transfer cask is licensed by the NRC for transport. The canister has a large capacity that could be modified to hold the GTCC LLW. Smaller containers like 55-gallon drums are attractive in that (a) the handling equipment is commercially available, (b) sophisticated facilities for handling are not required, (c) they are inexpensive, (d) a large selection of shipping packages are available for transport, (e) the GTCC LLW could be sized to fit into the drums, and (f) there are numerous commercially available casks for transporting 55-gallon drums.

The above are not the only casks and containers to be considered. A strong case can be made for using other casks and containers, or a combination of casks and containers, identified in this report. The final decision will be made based on a number of considerations, e.g., the waste form; the generators' capabilities; processing and repackaging, if any; transportation; and the storage and disposal facilities' capabilities and acceptance criteria. Once these considerations have been addressed, the program will need to decide whether to lease or buy shipping packages. It appears from the information contained in this report that a new shipping package design will not be necessary. However, there are several vendors in the commercial sector that have the technical capability to modify and design shipping packages and waste containers to meet the needs of the GTCC LLW transport program.

6. REFERENCES

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3. J. M. Cruse, *Test and Evaluation Document for DOT Specification 7A Type A Packaging*, WHC-EP-0558, June 1992.

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Appendix A

Shipping Packages/Casks

Appendix A.1

Standard Transportation Packaging/Casks

PACIFIC NUCLEAR

CASK DATA TABLE

CASK TYPE	CLASS	USNRC C OF C	PAY. VOL. CU.FT.	DRUM CAP.	CASK DIMENSIONS INNER DIA.	INNER HGT.	EXT. DIA.	EXT. HGT.
14-210L	A	9176	217	14	77.5	80.25	92.25	92.0
14-210H	A	9176	217	14	77.5	80.25	93.5	92.0
14-190M	A	9159	190	14	75.5	73.38	91.5	85.13
10-142B	B	9208	142	10	66.0	72.0	112.0	120.0

CASK TYPE	EMPTY (LBS.)	AUTHORIZED PAYLOAD (LBS.)	LOADED (LBS.)
14-210L	31,600	20,000	51,600
14-210H	38,400	20,000	58,400
14-190M	33,500	20,000	53,500
10-142B	58,100	10,000	68,100

CASK TYPE	CONTAINER TYPES	LEAD EQUIV. (INCHES)	MAX. RAD. LEVELS	INVENTORY
14-210L	ES-210 C.S EL-210 P.H.	2.00	7 R/hr.	7
14-210H	EL-210 C.S. EL-210 P.H.	2.73	20 R/hr.	8
14-190M	ES-190 C.S. EL-190 P.H.	2.25	10 R/hr.	1
10-142B	ES-142 C.S. EL-142 P.H.	4.25	350 R/hr.	3

C.S. = CARBON STEEL
P.H. = POLY HIC

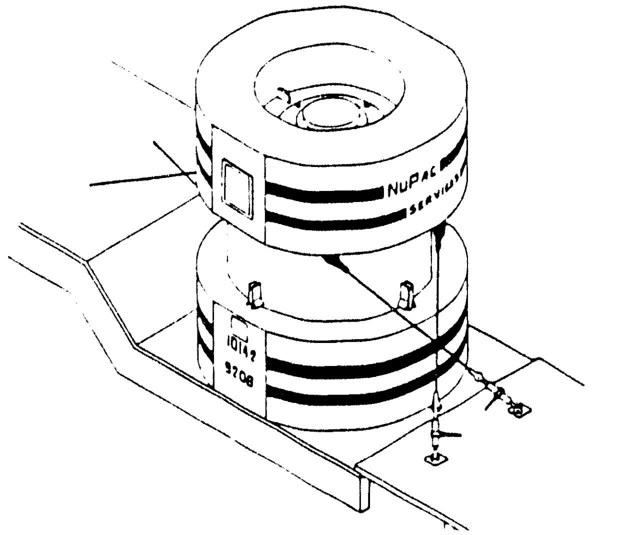
NuPac Cask No. 10-142

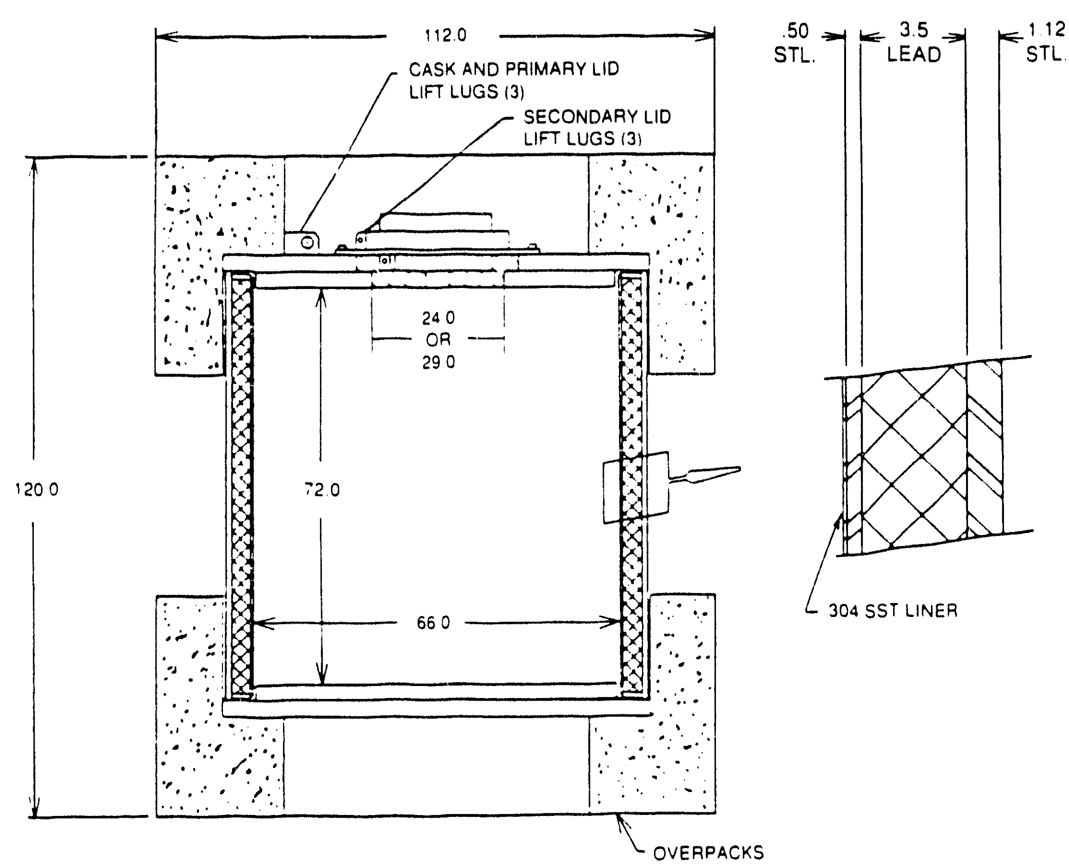
NRC CofC #9208

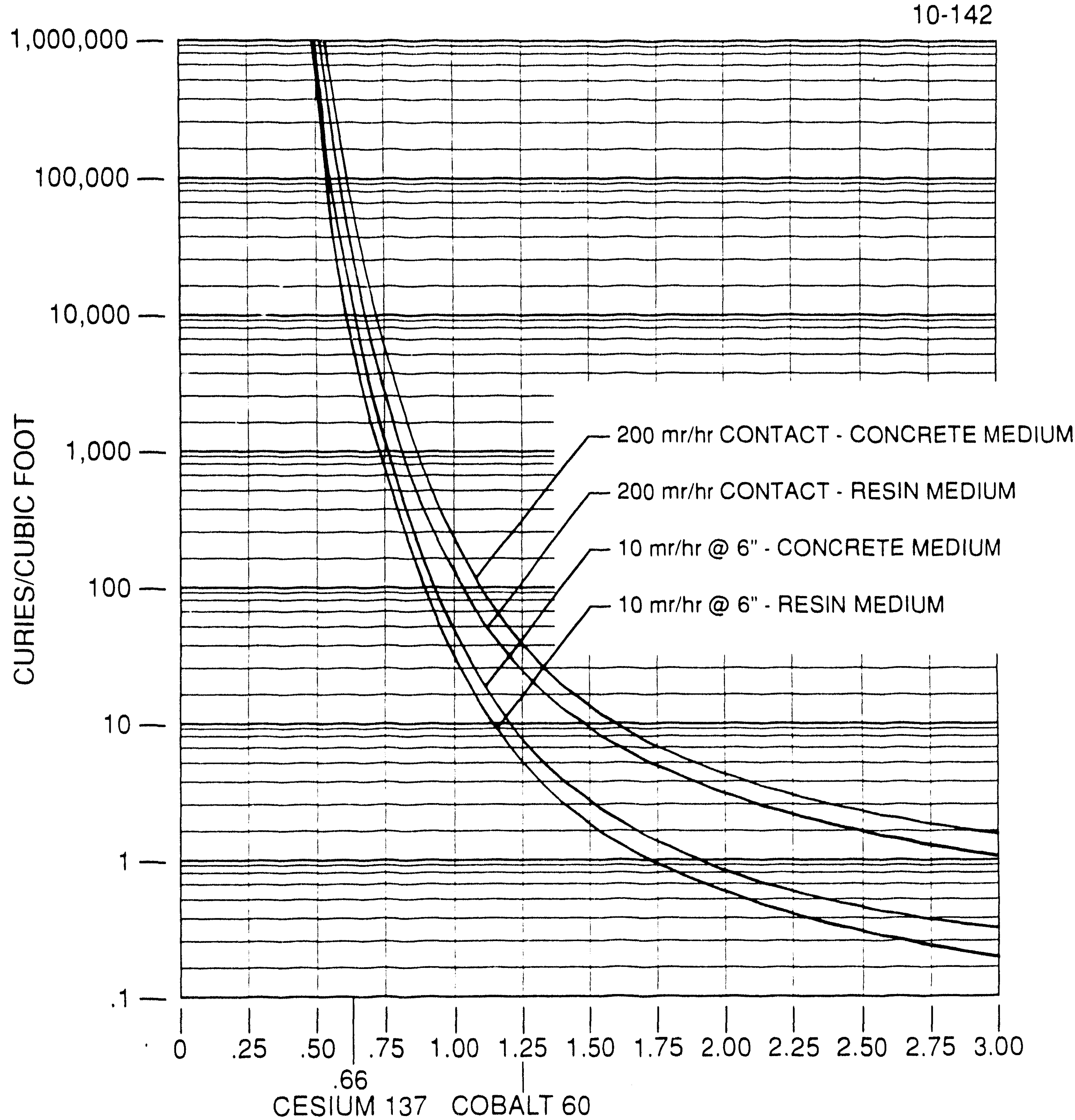
PACIFIC NUCLEAR SYSTEMS

Capacity: 10-55 gallon drums
1-142 cu. ft. liner
Shielding: 4.25" lead equivalent
Dose Rate: 350 R/hr approximate
(based on Cobalt 60)
Empty Package Weight (with lid): 54,000
Payload Weight: 10,000

The NuPac 10-142 is a lead and steel Type B shipping cask. The cask lid is secured to the cask body by 16 1-1/2" studs and nuts. This cask is top loading and has both a stainless steel liner and outer surface for ease of decontamination.






10-142
1,000,000
100,000
10,000
1,000
100
10
1
.1
CURIES/CUBIC FOOT
200 mr/hr CONTACT - CONCRETE MEDIUM
200 mr/hr CONTACT - RESIN MEDIUM
10 mr/hr @ 6" - CONCRETE MEDIUM
10 mr/hr @ 6" - RESIN MEDIUM
0
.25
.50
.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
.66
CESIUM 137
COBALT 60
GAMMA ENERGY (MEV)

NuPac Cask No. 14-210H

NRC C of C #9176

Capacity: 14 55-gallon drums
1 190-215 cu. ft. liner

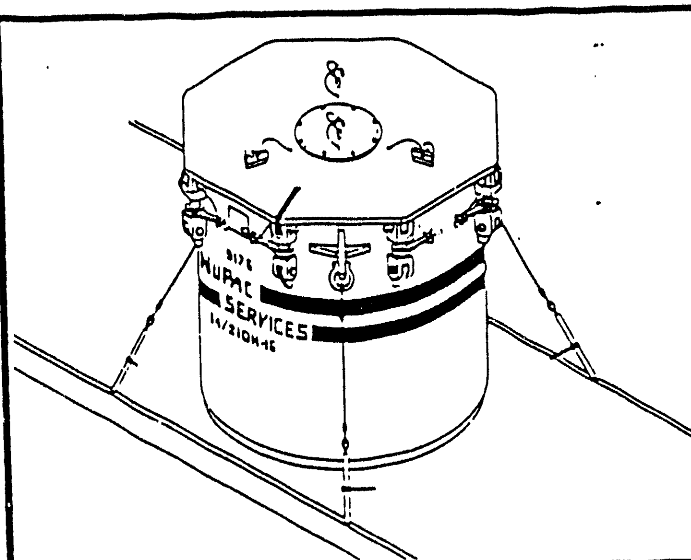
Shielding: 2.75 lead equivalent

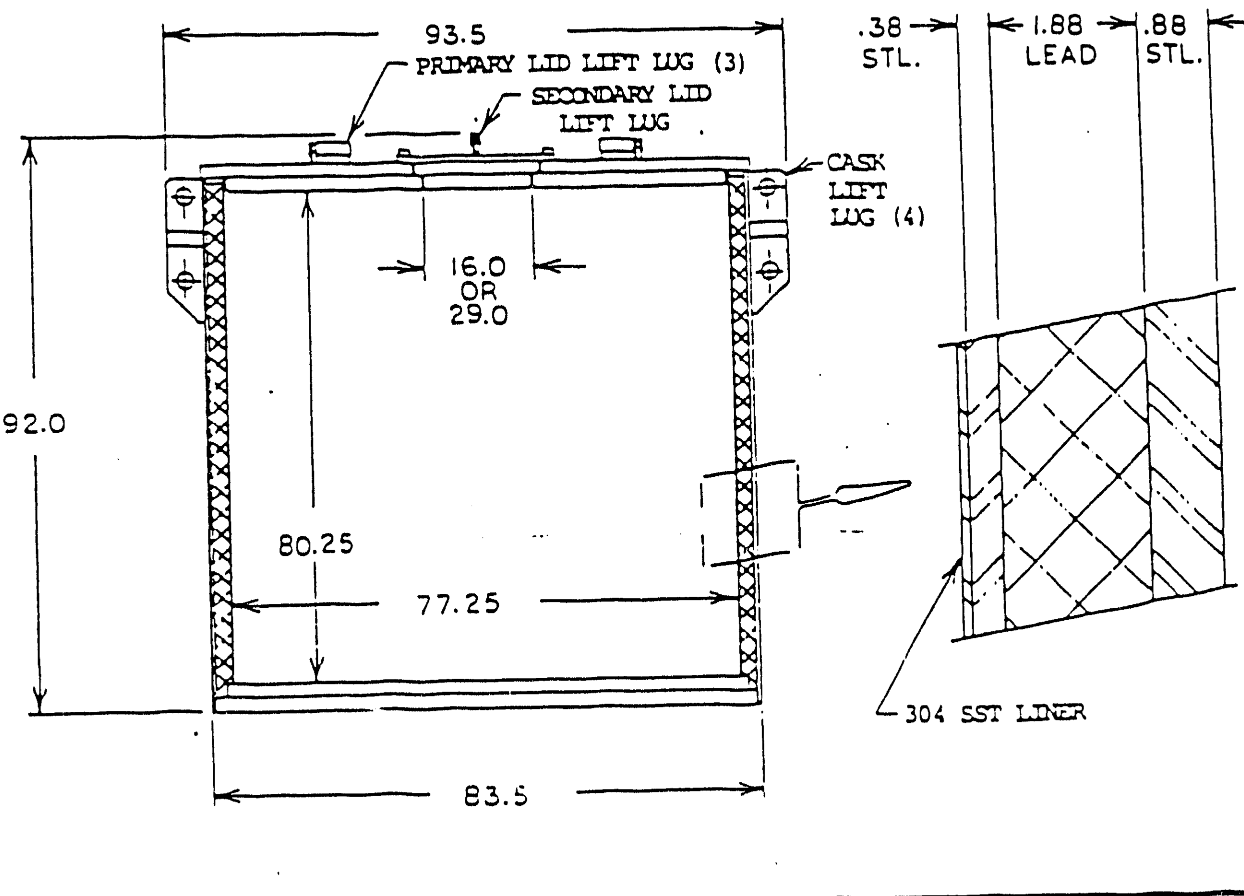
Dose Rate: 20 R/hr
(maximum based on Cobalt 60)

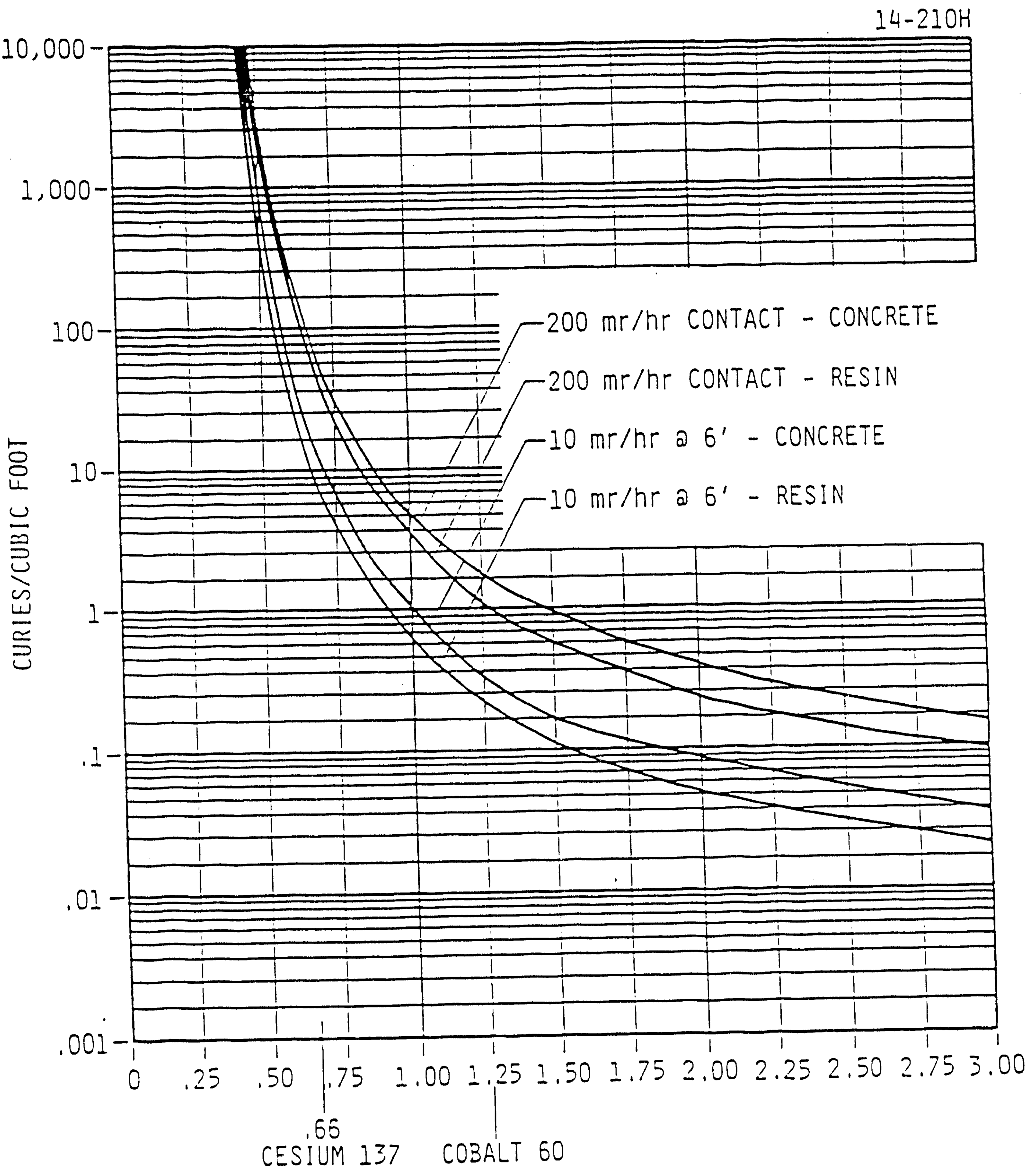
Empty Package Weight (with lid): 38,400

Payload Weight: 20,000

The NUPAC 14-210H is a lead and steel shipping cask for dewatered or solidified waste. Contents may be greater than Type A quantities meeting the requirements of low specific activity. The cask lid is secured to the cask body by eight 1 ¼ " ratchet binders.






14-210H
10,000
1,000
100
10
1
.1
.01
.001
CURIES/CUBIC FOOT
200 mr/hr CONTACT - CONCRETE
200 mr/hr CONTACT - RESIN
10 mr/hr @ 6' - CONCRETE
10 mr/hr @ 6' - RESIN
0
.25
.50
.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
.66
CESIUM 137
COBALT 60
GAMMA ENERGY (MEV)

NuPac Cask No. 14-210L

NRC C of C #9176

Capacity: 14 55-gallon drums
1 190-215 cu. ft. liner

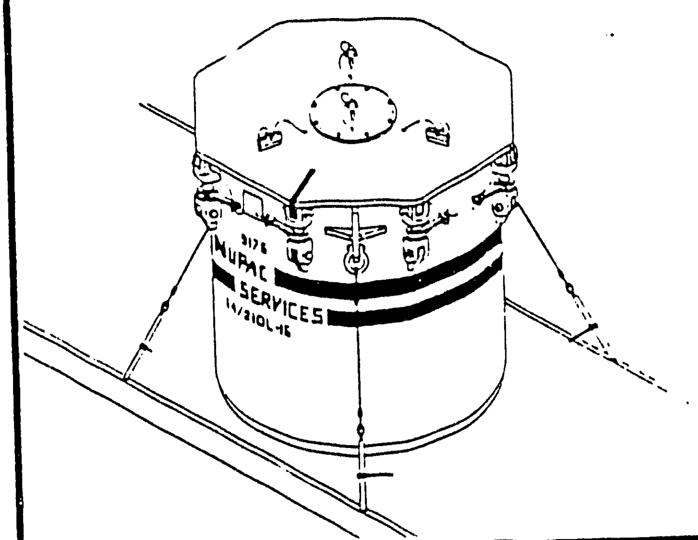
Shielding: 2.0" lead equivalent

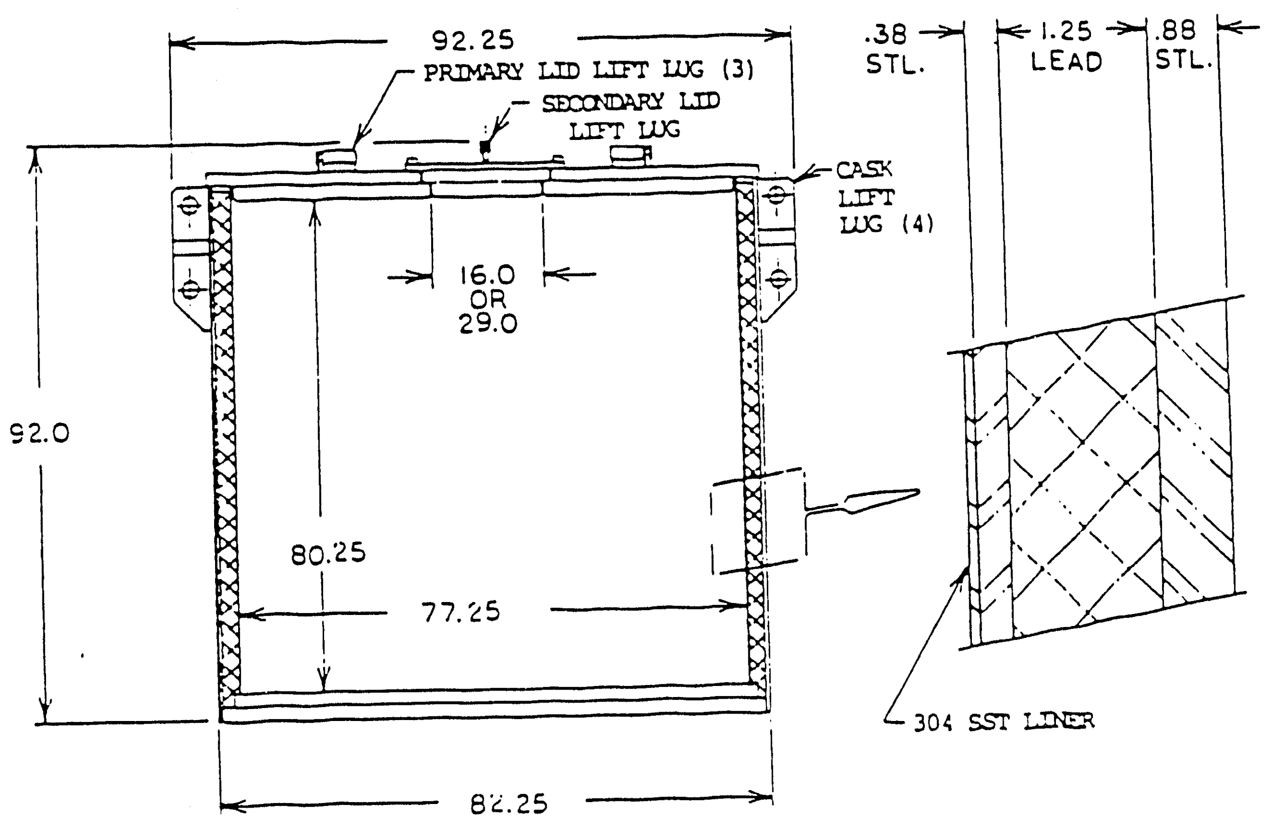
Dose Rate: 7 R/hr (approx)
(maximum based on Cobalt 60)

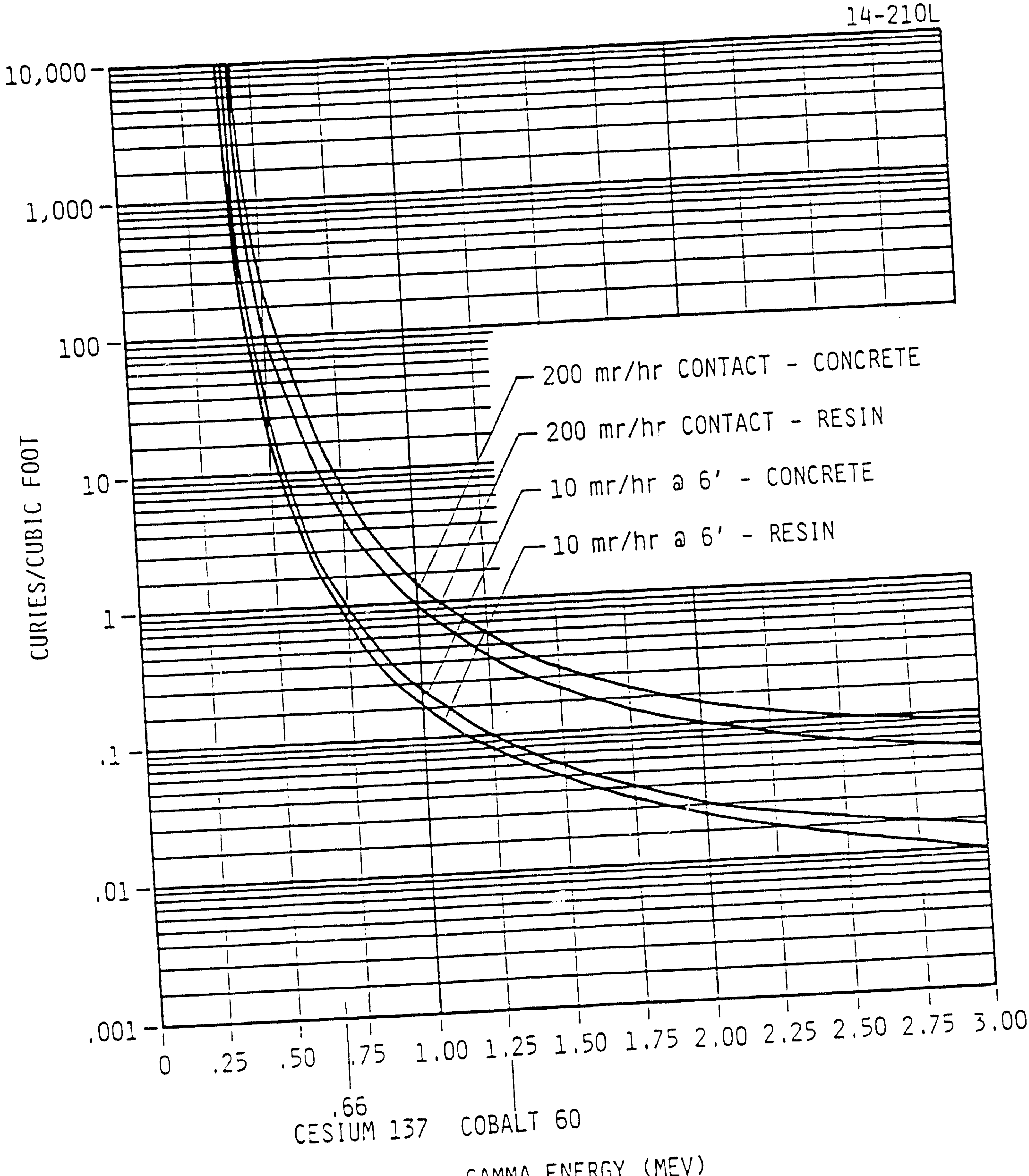
Empty Package Weight 28,600

Payload Weight: 20,000

The NUPAC 14-210L is a lead and steel shipping cask for dewatered or solidified waste. Contents may be greater than Type A quantities meeting the requirements of low specific activity. The cask lid is secured to the cask body by eight 1 ¼" ratchet binders.






14-210L
10,000
1,000
100
10
1
.1
.01
.001
CURIES/CUBIC FOOT
200 mr/hr CONTACT - CONCRETE
200 mr/hr CONTACT - RESIN
10 mr/hr @ 6' - CONCRETE
10 mr/hr @ 6' - RESIN
0
.25
.50
.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
.66
CESIUM 137
COBALT 60
GAMMA ENERGY (MEV)

NuPac Cask No. 14-190H

NRC C of C #9159

Capacity: 14 55-gallon drums
1 190 cu. ft. liner

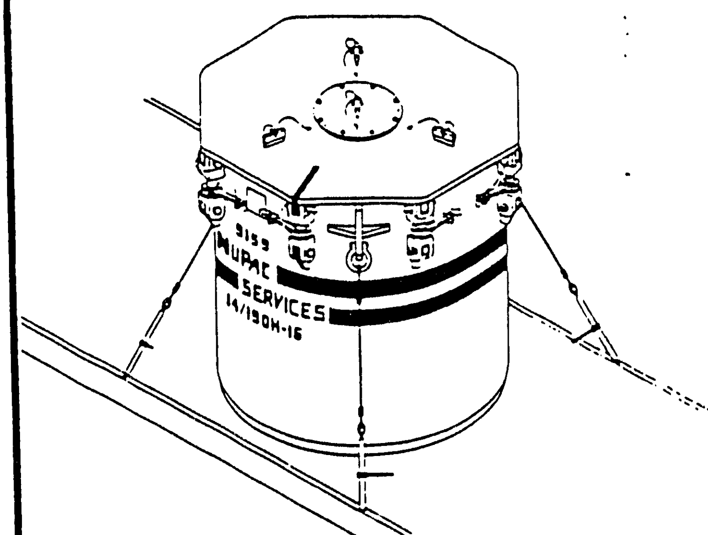
Shielding: 3.5" lead equivalent

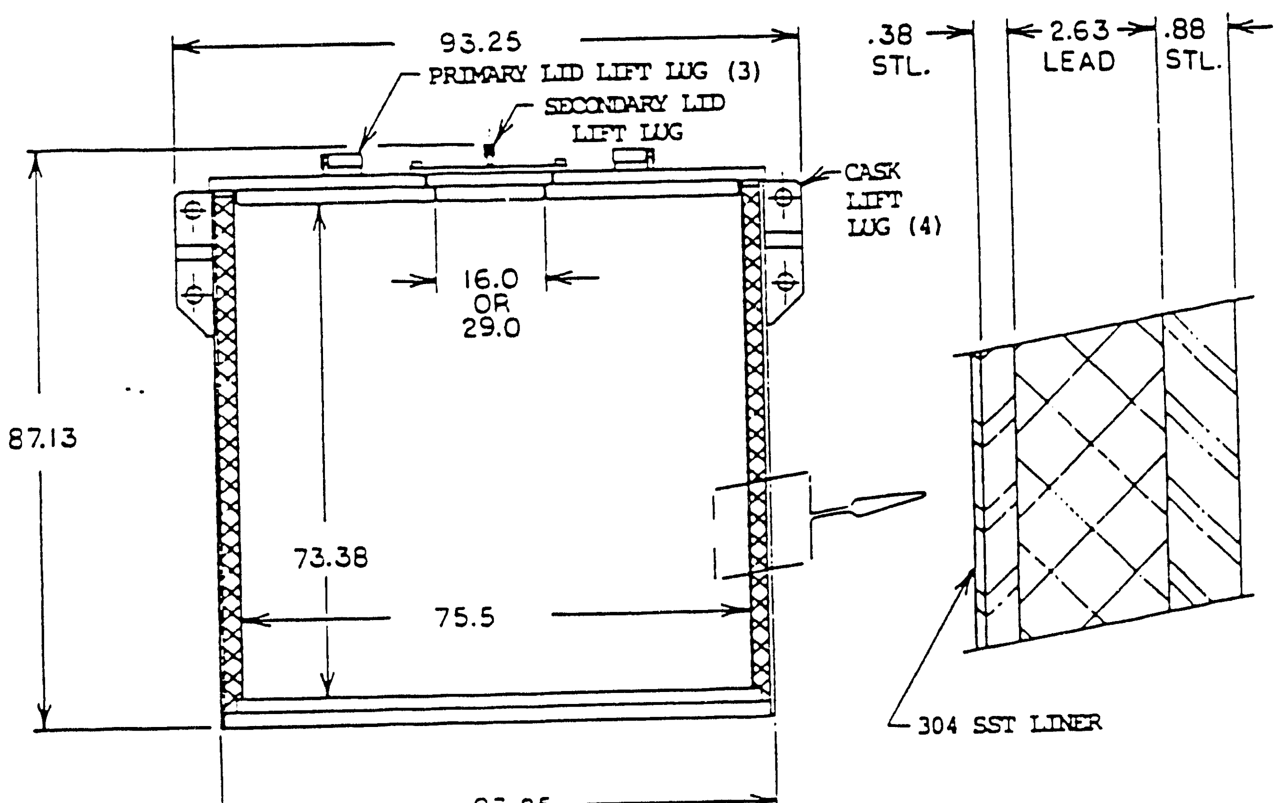
Dose Rate: 150 R/hr (approx)
(maximum based on Cobalt 60)

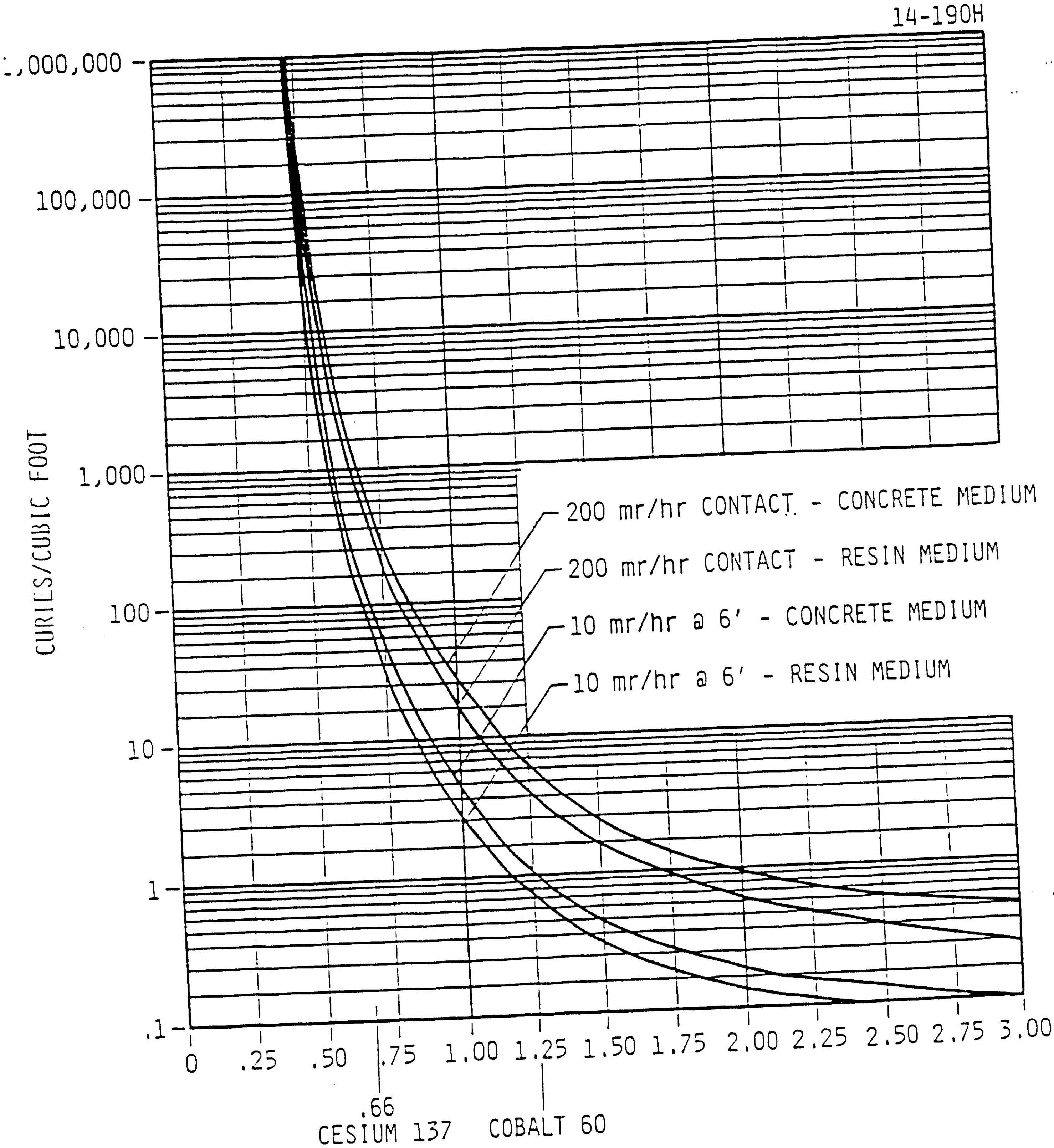
Empty Package Weight 45,200

Payload Weight: 20,000

The NUPAC 14-190H is a lead and steel shipping cask for dewatered or solidified waste. Contents may be greater than Type A quantities meeting the requirements of low specific activity. The cask lid is secured to the cask body by eight 1 ¼" ratchet binders.







14-190H
1,000,000
100,000
10,000
1,000
100
10
1
.1
CURIES/CUBIC FOOT
200 mr/hr CONTACT - CONCRETE MEDIUM
200 mr/hr CONTACT - RESIN MEDIUM
10 mr/hr @ 6' - CONCRETE MEDIUM
10 mr/hr @ 6' - RESIN MEDIUM
0
.25
.50
.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
.66
CESIUM 137
COBALT 60
GAMMA ENERGY (MEV)

FEATURES OF THE IF-300 IRRADIATED FUEL TRANSPORTATION SYSTEM

The IF-300 Irradiated Fuel Transportation System is designed to transport irradiated (spent) nuclear fuel in accordance with the requirements of the Nuclear Regulatory Commission (NRC), and the Department of Transportation.* The system is operational under Certificate of Compliance 9001, which was originally issued by the NRC (then Atomic Energy Commission) in 1973. At the present time, this Certificate permits shipment of all currently used Boiling (BWR) and Pressurized (PWR) Water Reactor fuel in a dry mode. Fuels of nominal burn-up can be shipped after approximately 2-1/2 years of cooling time. The cask is presently utilized in a "zero-release" configuration and uses a rupture disk device for overpressure protection rather than the original controlled-release valve.

The IF-300, which has a capacity of 7 PWR or 18 BWR bundles, was the first multi-bundle cask with the neutron shielding required for high exposure fuel. It is the only multi-bundle cask with actual operating experience and is noted for its relative compactness and ease of handling in currently operating nuclear stations.

Capacity, weight, and dimensional specifications of the IF-300 are as follows:

	BWR	PWR
Capacity		
Bundles	18	7
Approximate Maximum Loaded Weight (wet)**		
Cask only, pounds	140,000	136,000
Skid, enclosure, and cooling system, pounds	45,000	45,000
Rail Car	75,000	75,000
Total System, pounds	260,000	256,000
Cavity		
Length, inches	180	169
Diameter, inches	37.5	37.5
Cask Body		
Length, inches	208	198
Nominal Diameter, inches	64	64
Redundant Yoke		
Weight, pounds	15,000	15,000
Standard Yoke		
Weight, pounds	5,000	5,000
Skid		
Length, feet	37.5	37.5
Width, feet	8	8
Heat Dissipation		
Btu/hr	40,000	40,000

*U.S. Code of Federal Regulations, 10CFR71 and 49CFR17

**Weight of water in cask when removed from pool is approximately 4,000 pounds.

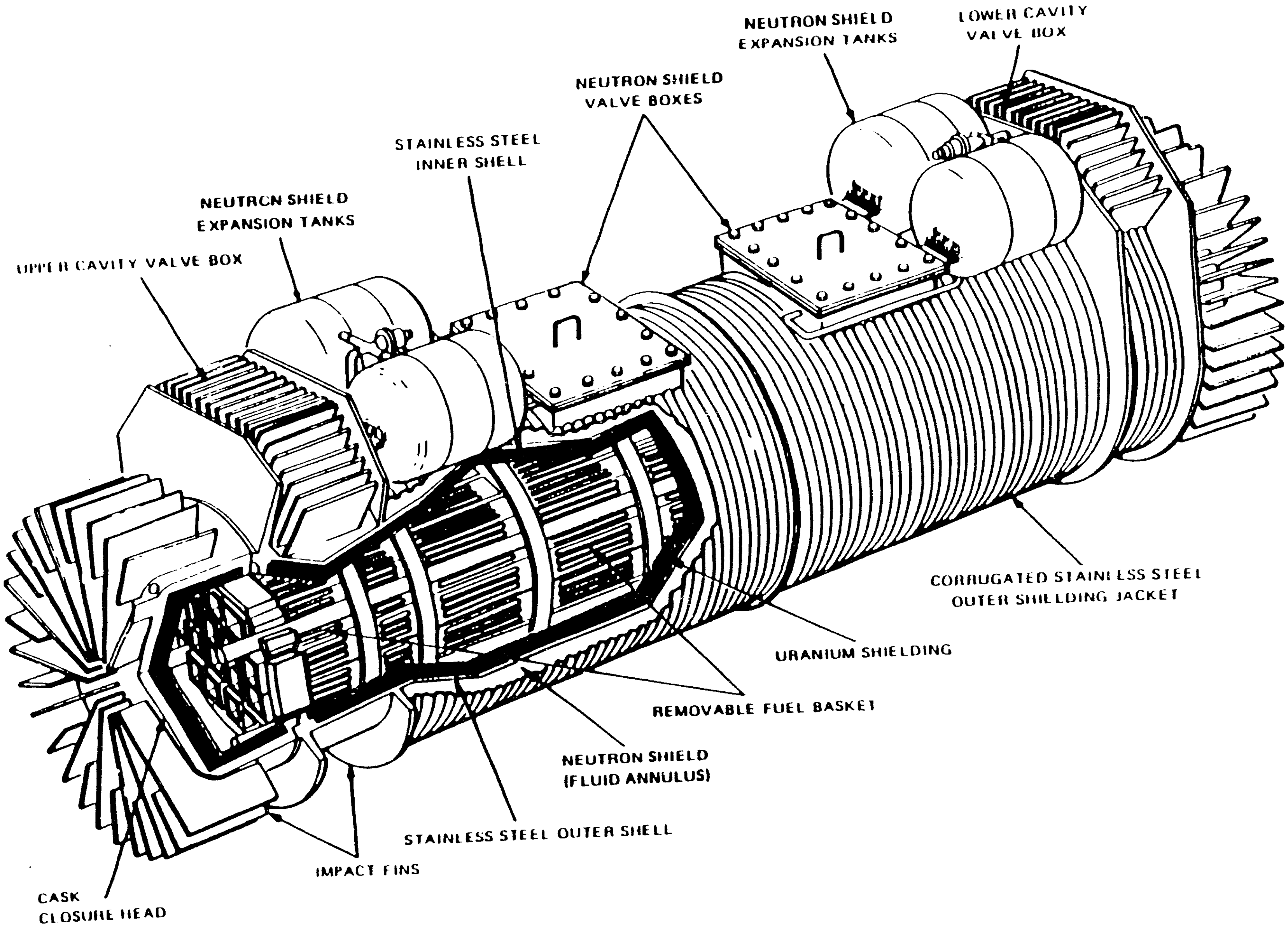
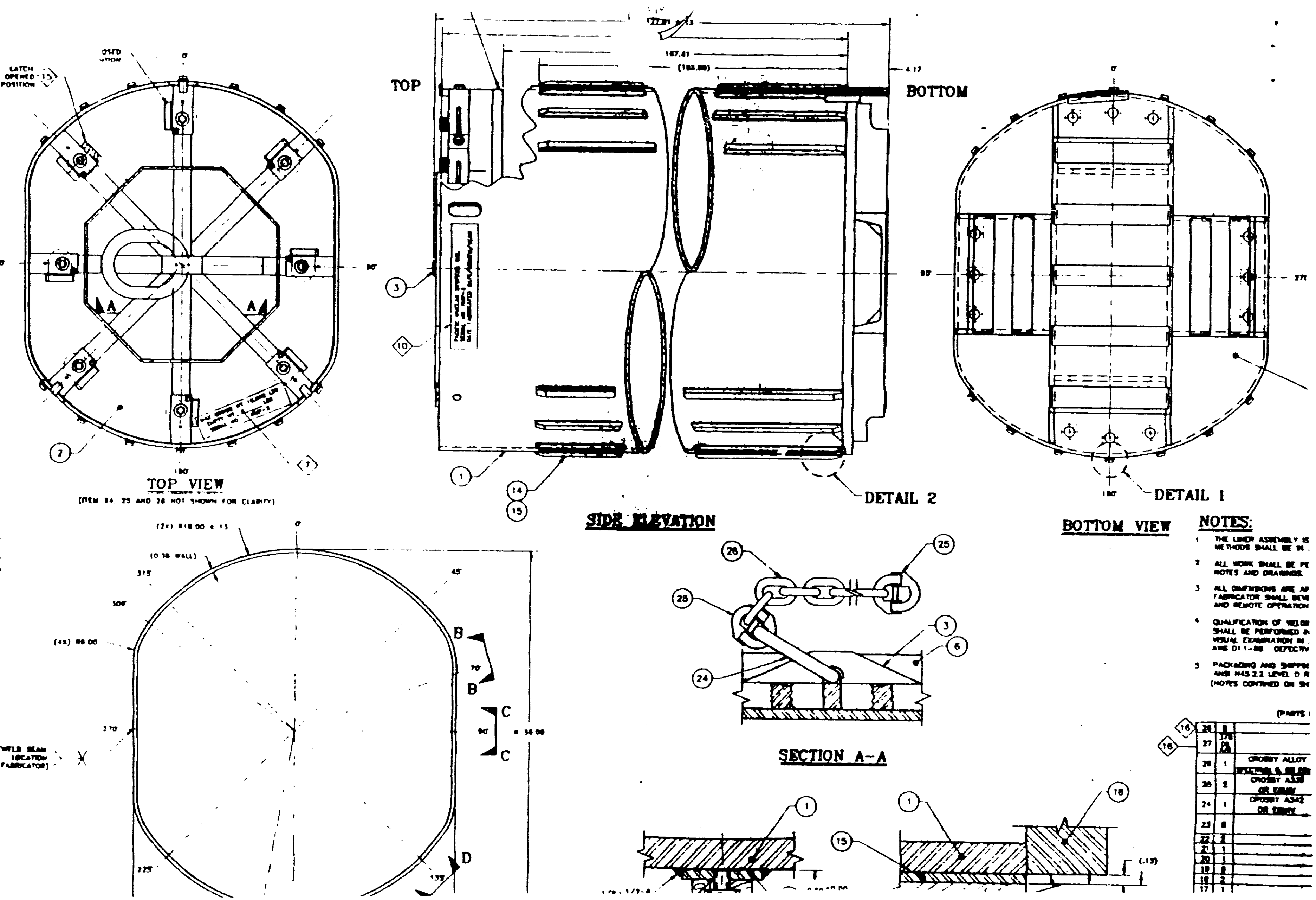
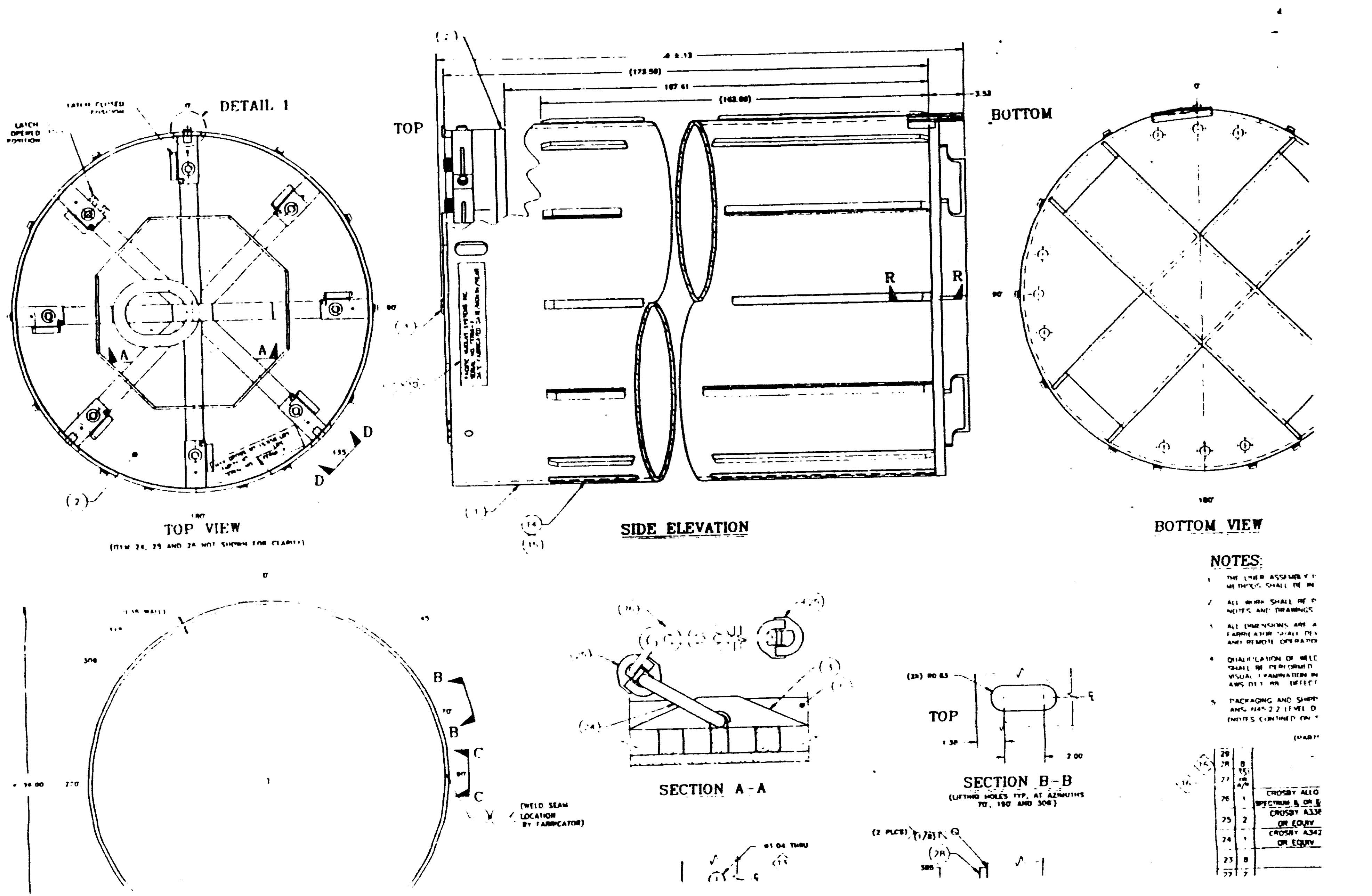


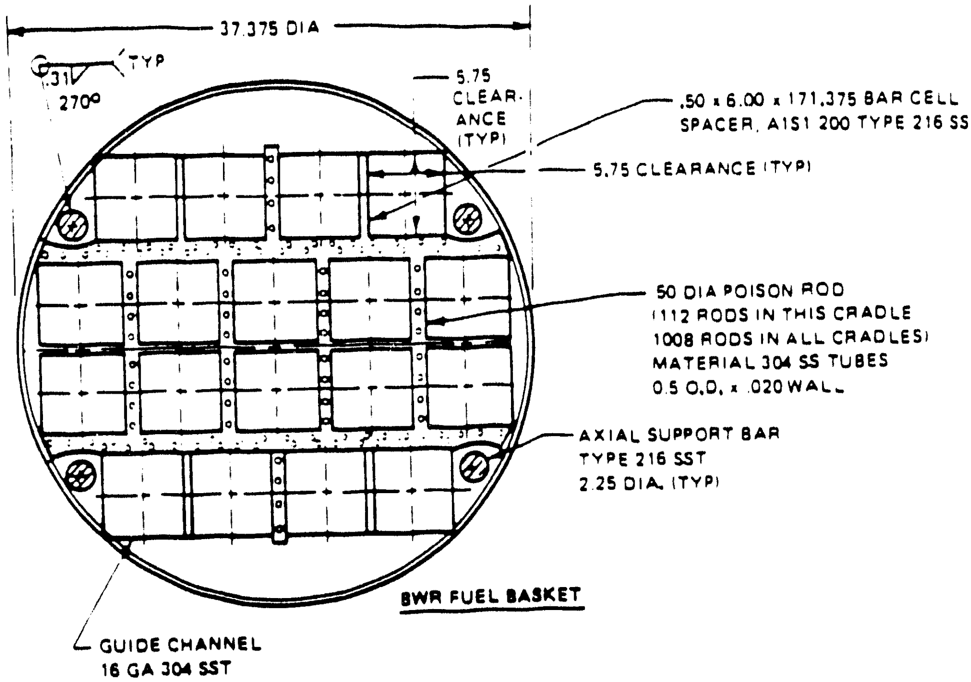
Figure 2 IF-300 Irradiated Fuel Shipping Cask

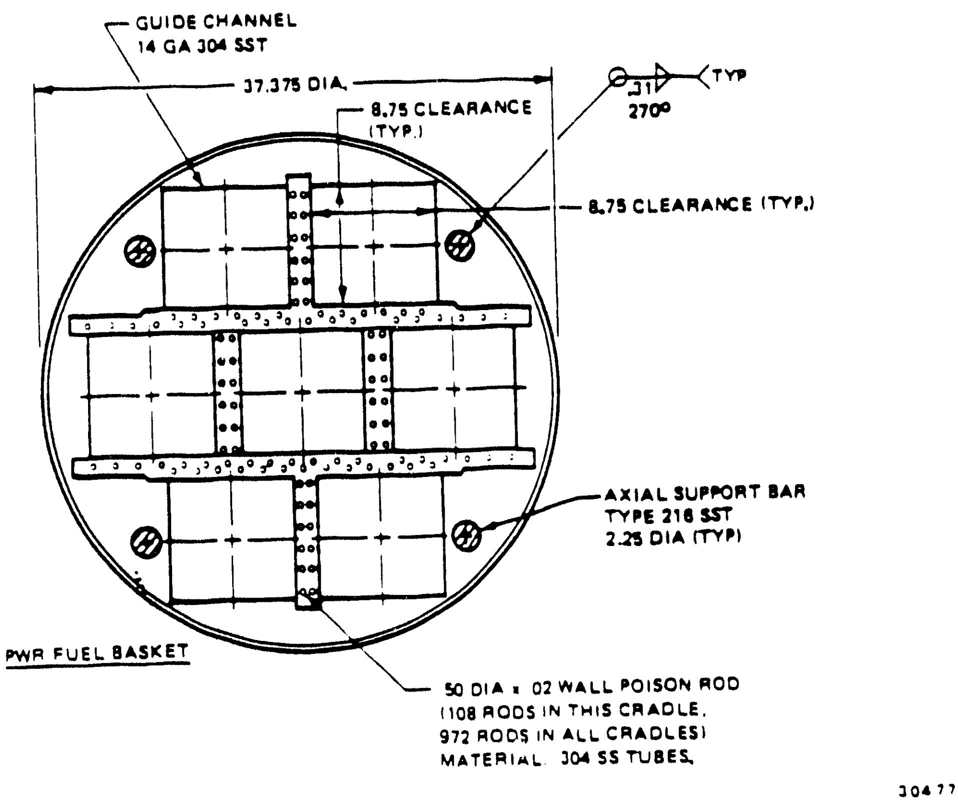


Inner container for the Pacific Nuclear Systems IF-300 shipping storage (1 of 3)



Inner container for the Pacific Nuclear Systems IF-300
shipping storage (2 of 3)





Inner container for the Pacific Nuclear Systems IF-300 shipping storage (3 of 3)

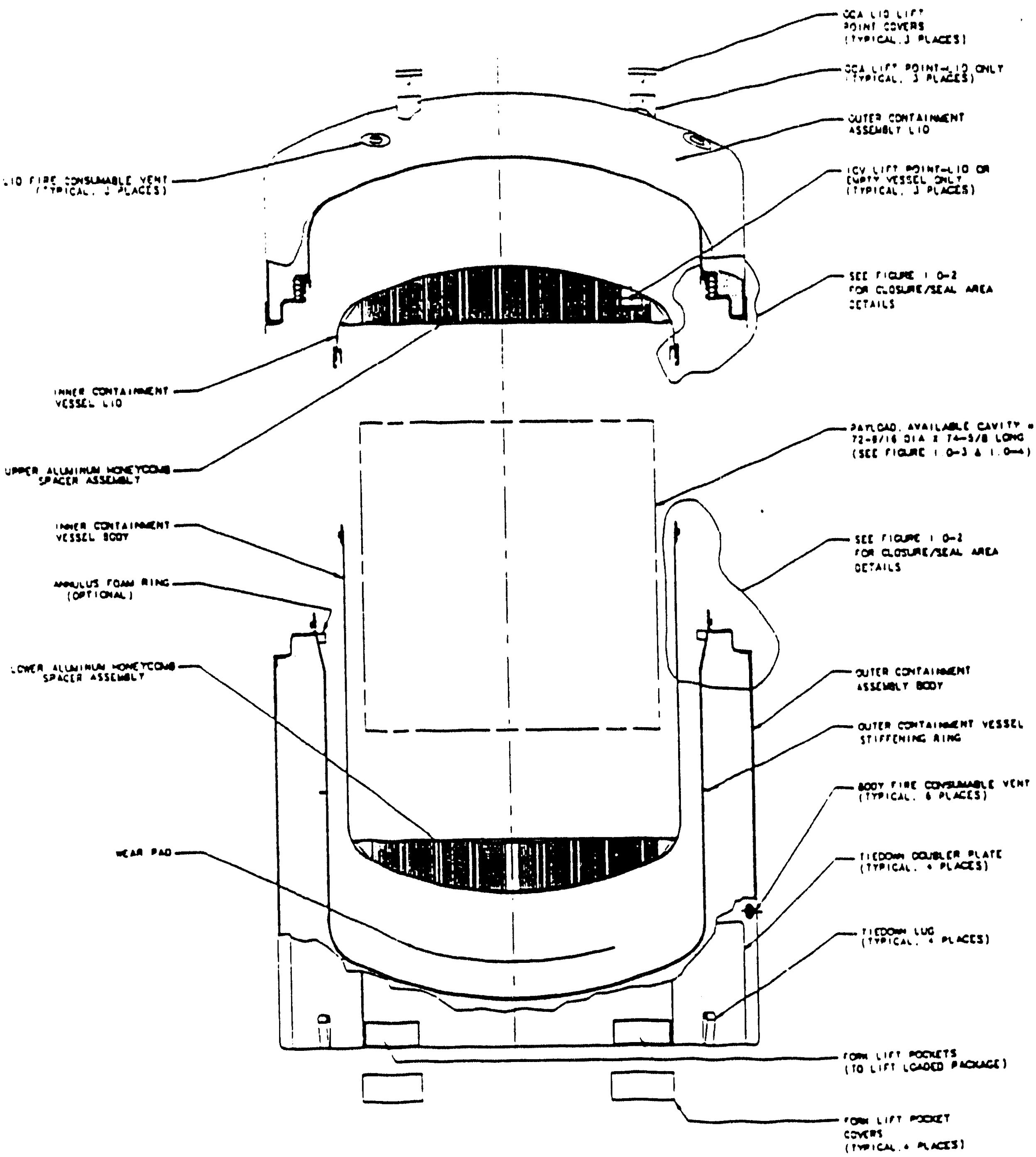
NUPAC TRUPACT-II SHIPPING CONTAINER

The TRUPACT-II package is a stainless steel and polyurethane foam shipping container designed to provide double containment for shipment of contact-handled transuranic wastes. The package is designed to ship up to fourteen 55-gallon drums or two standard waste boxes (SWB). The package weighs approximately 19,250 pounds when loaded with the maximum authorized contents of 7,265 pounds. Up to three TRUPACT-II shipping containers are transported on a trailer designed for that purpose.

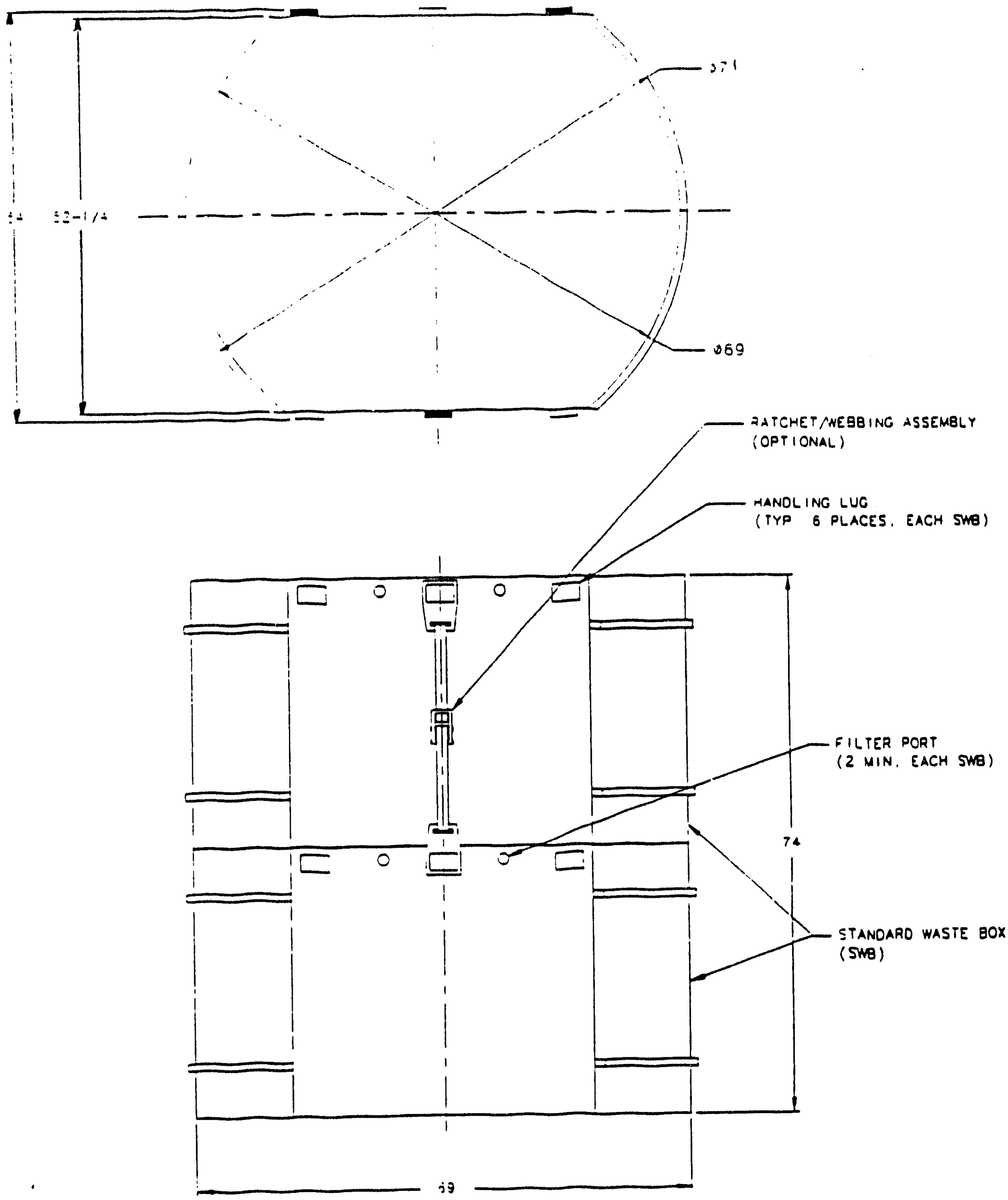
The TRUPACT-II package consists of a stainless steel inner containment vessel (ICV) housed inside a stainless steel-polyurethane foam outer containment assembly (OCA). The OCA is a right circular cylinder with a flat bottom and domed lid. It has outside dimensions of approximately 94 inches diameter and 122 inches height. The OCA body consists of a 10-inch thick layer of polyurethane foam sandwiched between a 1/4 to 3/8-inch thick outer stainless steel shell and a 3/16-inch thick inner stainless steel shell. The inner stainless steel shell of the OCA is designated as the outer containment vessel (OCV). The dome shaped lid of the OCA is filled with polyurethane foam and is secured to the OCA body by a locking ring. A butyl rubber O-ring is used for the containment seal for the OCV. A second O-ring, made of either neoprene or ethylene propylene, allows the OCV seal to be leak tested. The OCV is equipped with a seal test port and a vent port. The OCA lid is equipped with three pairs of equally spaced lift straps and guide pockets for lifting and handling the OCA lid.

The ICV is a 1/4-inch thick stainless steel shell with domed ends having inside dimensions of approximately 73 inches diameter and 98 inches height. A butyl rubber O-ring is used for the containment seal. A second O-ring, made of either neoprene or ethylene propylene, allows the ICV seal to be leak tested. The ICV is equipped with a seal test port and vent port. Aluminum spacers are placed in the top and bottom domed ends of the ICV during shipping. The cavity available for contents is a cylinder with approximate dimensions of 73 inches diameter and 75 inches height.

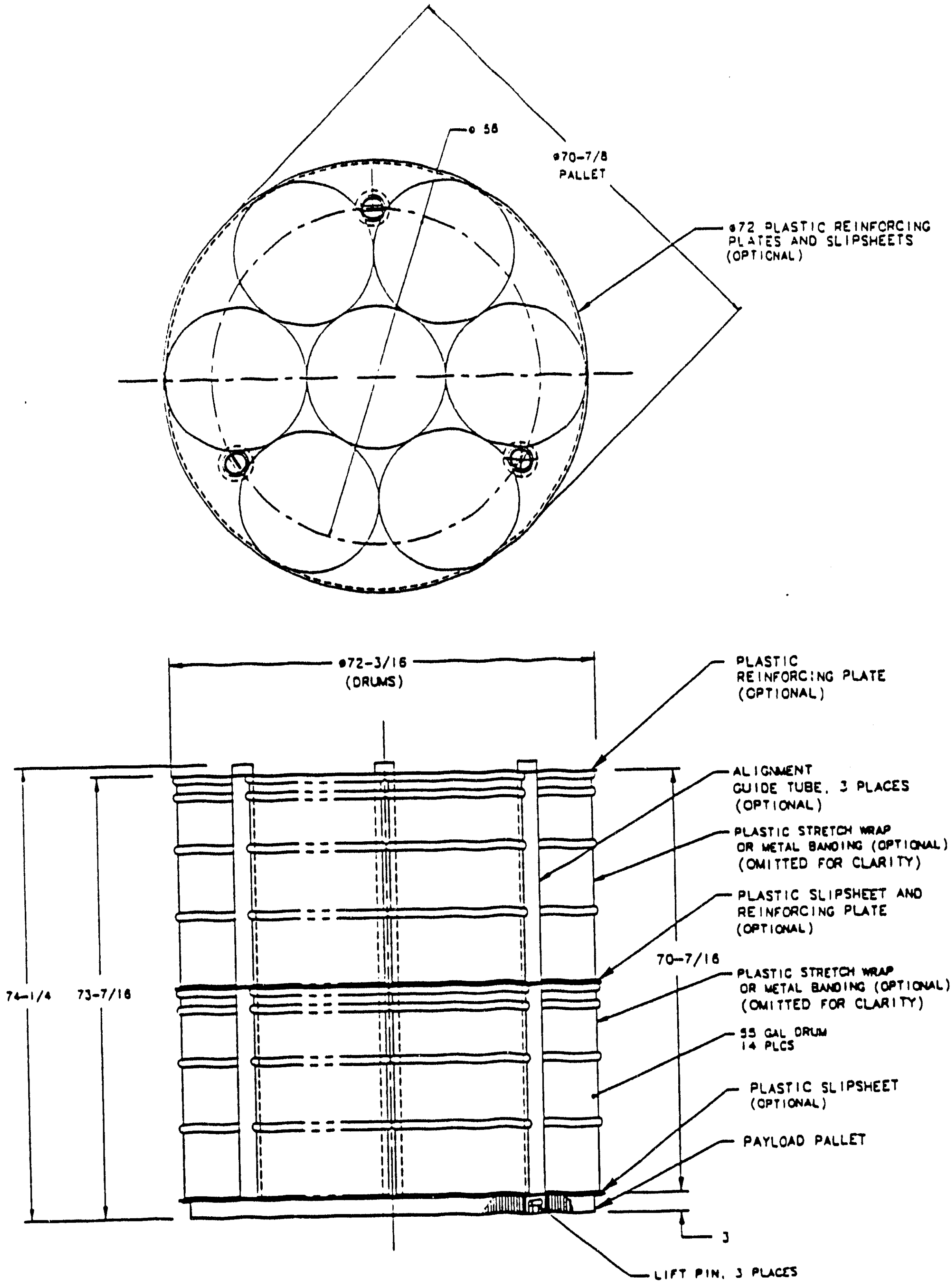
The TRUPACT-II package is secured to a special trailer using four sets of doubler plates and tie-down lugs. Fork pockets are located at the base of the OCA for lifting and handling the package.



TRUPACT-II Packaging Components



Representative TRUPACT-II 2-SWB Payload Configuration



Representative TRUPACT-II 14-Drum Payload Configuration

NFS-4 (NAC-1)

(1) Type	Legal Weight Truck Shipping Cask
(2) Manufacturer/Vendor	Nuclear Assurance Corporation
(3) Capacity	
(a) Intact SF (Assys)	1 PWR; 2 BWR
(b) Cans Consolidated Fuel Rods	1 PWR; 2 BWR
(4) Weight (tons)	
(a) Loaded	23
(b) Empty	22
(5) Design Heat Rejection (kW)	11.5
(6) Shape	Cylindrical
(7) Dimensions	
(a) Overall Length (in)	214
(b) Overall Diameter (in)	38
(c) Cavity Length (in)	178
(d) Cavity Width (in)	13.5
(e) Inner Shell Wall Thickness (in)	0.31
(f) Lead Shield Wall Thickness (in)	6.62
(g) Outer Shell Wall Thickness (in)	1.25
(h) Neutron Shield Tank Thickness (in)	4.5
(8) Materials of Construction	
(a) Cask Body	SS/Lead
(b) Neutron Shield	
Sides	Borated Water/Antifreeze
Ends	None
(c) Basket	SS
(9) Cooling Fins	None - Smooth Surface
(10) Operating Temperature (^{o}F)	345 max.
(11) Operating Pressure (psig)	5 (984 max.)
(12) Outside Surface Dose (mR/hr)	200 max.
(13) Cavity Atmosphere	Air

(14) Licensing Status Originally licensed by AEC and NRC. NRC would not recertify the cask due to the fact that the inside cavity was constructed of 5/16-inch SS plate which was rolled and welded. There was some distortion in the inner cavity as a result of this. After the cask had been used some time NRC required documentation to show that the distortion wasn't due to shipping operations; however, these types of records were not available. Hence the cask has had limited use in transporting non-LWR fuel and can only be used for on-site transfers of LWR fuel.

(15) Comments NAC obtained license for NFS-4 cask design -- to have NAC-1 manufactured; NAC later took possession of NFS-4 casks and has rights to lease them.

A total of seven casks are in existence, one of which is owned by Duke Power Co. and the others are available for lease from NAC. Casks have interchangeable baskets for PWR and BWR fuel.

References

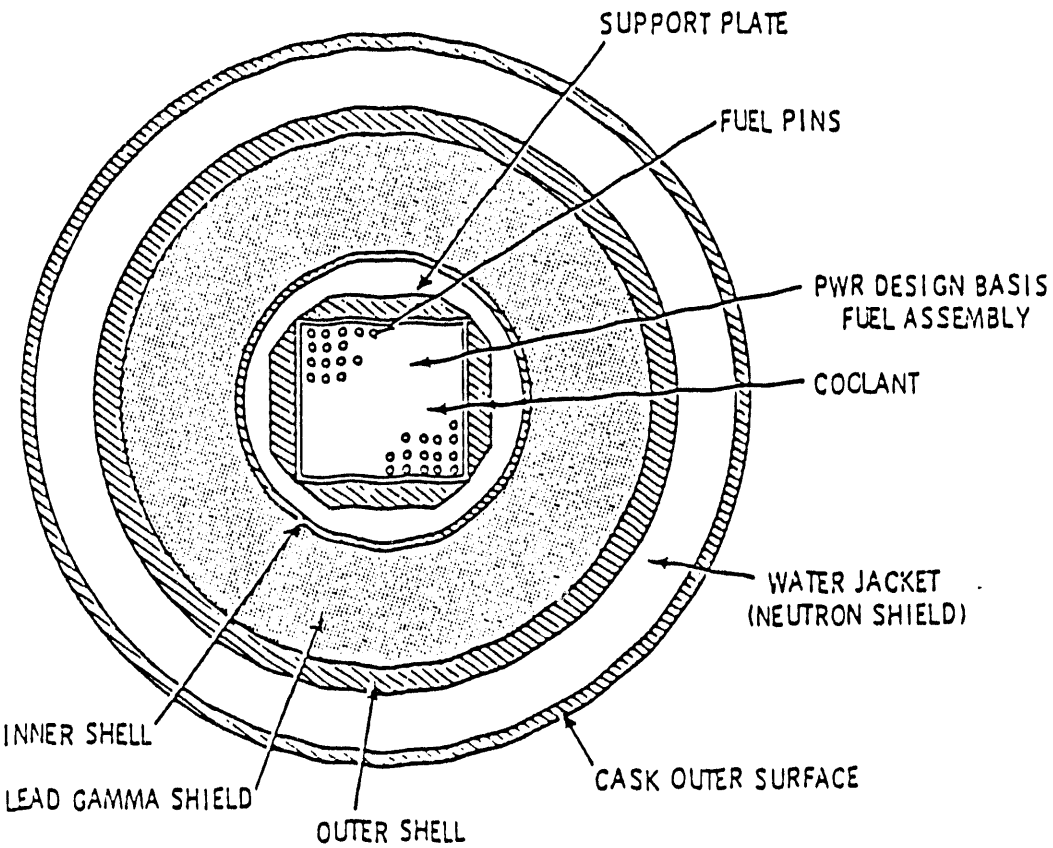
(1) K. H. Dufrane, Design, Manufacturing and Operational Experience with the NFS-4 Spent Fuel Shipping Cask, Proceedings of the 4th International Symposium on Packaging and Transportation of Radioactive Materials, Miami Beach, FL, September 1974.

(2) Letter W. J. Lee (NAC) to W. Etz (JAI), July 29, 1987

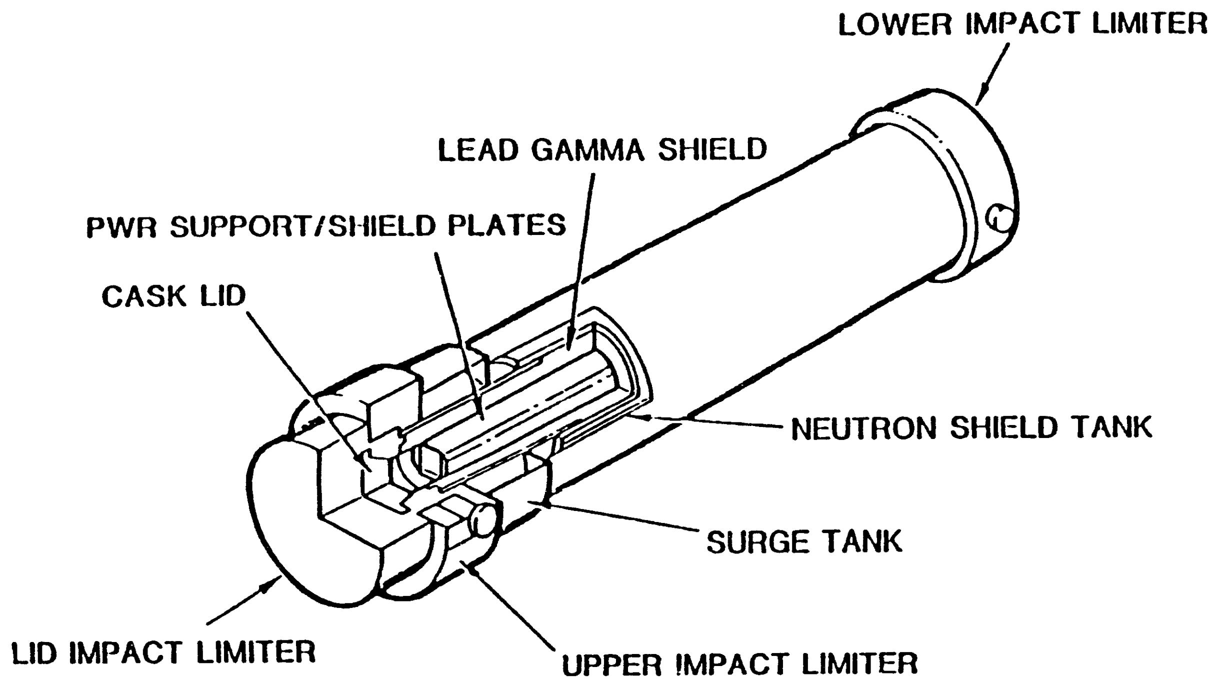
(3) U. S. Department of Energy, Technology for Commercial Radioactive Waste Management, Vol. 4, DOE-ET-0028, May 1979

(4) P. M. Daling and R. L. Engel, Analysis of Near-Term Spent Fuel Transportation Hardware Requirements and Transportation Costs, PNL-4575, January 1983

(5) Letter W. J. Lee (NAC) to E. R. Johnson (JAI), February 8, 1988



CROSS-SECTION OF NFS-4 (NAC-1) LEGAL WEIGHT TRUCK CASK



NFS-4 (NAC-1) LEGAL WEIGHT TRUCK CASK

NLI 1/2

(1) Type	Legal Weight Truck Shipping Cask
(2) Manufacturer/Vendor	NL Industries Inc.
(3) Capacity	
(a) Intact SF Assys	1 PWR; 2 BWR
(b) Cans Consolidated Fuel Rods	2 PWR; 4 BWR
(4) Weight (tons)	
(a) Loaded	23.1
(b) Empty	22.3
(5) Design Heat Rejection (kW)	10.6
(6) Shape	Cylindrical
(7) Dimensions	
(a) Overall Length (in)	195.25
(b) Overall Diameter (in)	47.12
(c) Cavity Length (in)	178
(d) Cavity Diameter (in)	13.38
(e) Inner Shell Wall Thickness (in)	0.5
(f) Lead Shield Wall Thickness (in)	2.12
(g) Depleted U Wall Thickness (in)	2.75
(h) Outer Shell Wall Thickness (in)	0.88
(i) Neutron Shield Tank Thickness (in)	5.25
(j) Inner Container Wall Thickness (in)	0.25
(8) Materials of Construction	
(a) Cask Body	SS/Lead/Depleted U
(b) Neutron Shield	
Sides	Water & Ethylene Glycol
End	None
(c) Basket	SS and Aluminum
(9) Cooling Fins	Yes
(10) Cavity Atmosphere	He; air if heat is less than 2.5 kw
(11) Operating Temperature (^{o}F)	900 (Fuel Clad)
(12) Operating Pressure (psig)	310 max.
(13) Outside Surface Dose (mR/hr)	100 max.

(14) Licensing Status Licensed by NRC in 1980; can be used to ship either intact or consolidated LWR fuel.

(15) Comments Casks have separate baskets for PWR and BWR fuel. There are a total of 5 casks currently in existence.

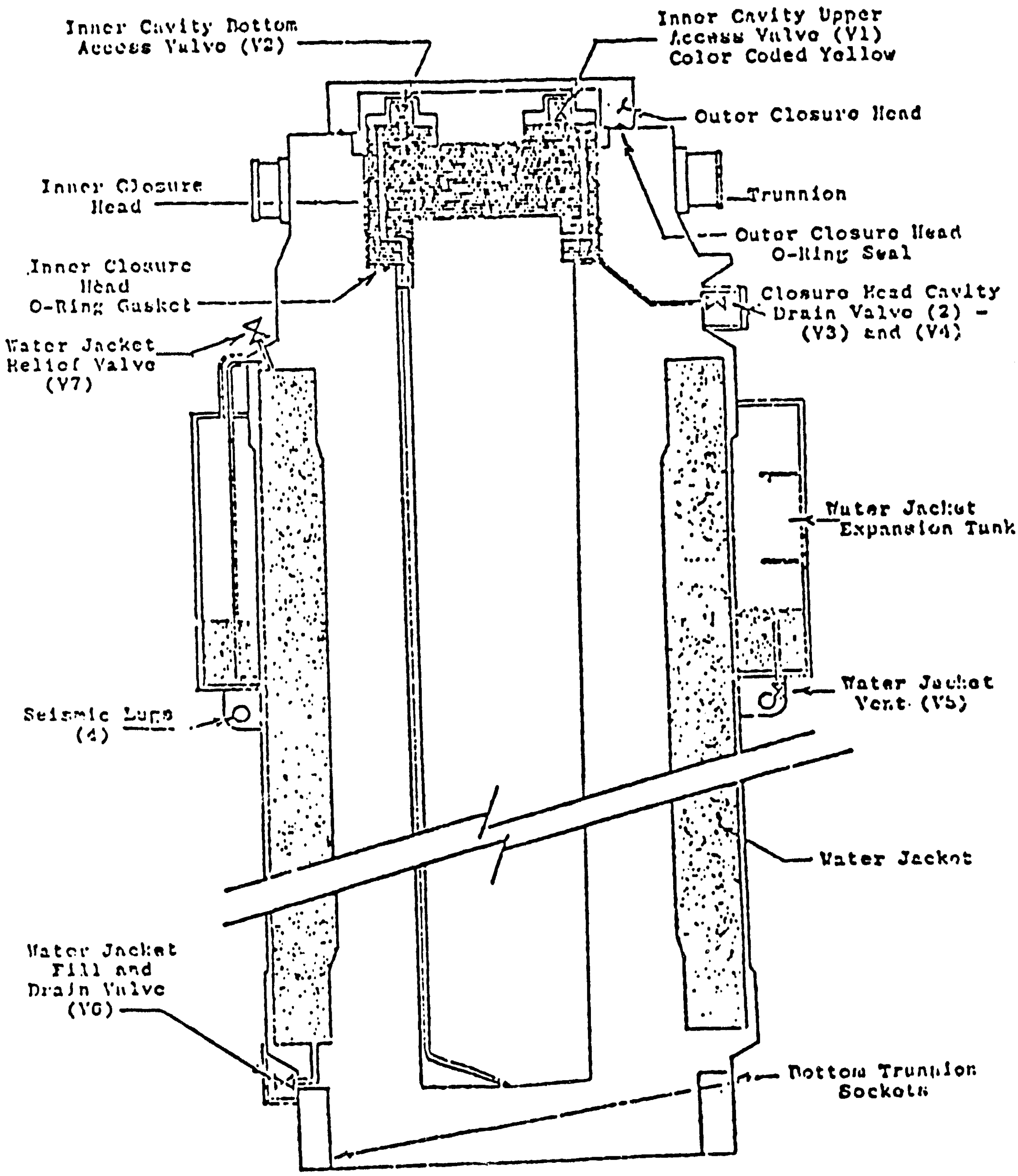
Casks are currently in the possession of Nuclear Assurance Corporation who has the rights to lease them.

References

(1) USNRC Certificate of Compliance No. 9010, July 16, 1980

(2) Letter W. J. Lee (NAC) to W. Etz (JAI), July 29, 1987

(3) Letter W. J. Lee (NAC) to E. R. Johnson (JAI), February 8, 1988



NLI 1/2 LEGAL WEIGHT TRUCK CASK

NLI 10/24

(1) Type	Rail Shipping Cask
(2) Manufacturer/Vendor	NL Industries Inc.
(3) Capacity	
(a) Intact SF Assys	10 PWR; 24 BWR
(4) Weight (tons)	
(a) Loaded	96.5
(b) Empty	89
(5) Design Heat Rejection (kW)	70
(6) Shape	Cylindrical
(7) Dimensions	
(a) Overall Length (in)	204.5
(b) Overall Diameter (in)	88
(c) Cavity Length (in)	179.5
(d) Cavity Diameter (in)	45
(e) Inner Shell Thickness (in)	0.75
(f) Outer Shell Thickness (in)	2
(g) Lead Shield Wall Thickness (in)	6
(h) Neutron Shield Tank Thickness (in)	9.75
(i) Outer Closure Head Thickness (in)	2.5
(8) Materials of Construction	
(a) Cask Body	SS/Lead
(b) Neutron Shield	
Sides	Water
Ends & Strategic Wall Locations	Ricorad
(c) Basket	Aluminum Lined with Ag-In-Cd plates in SS
(9) Cooling Fins	Concentric (forced water circulation cooling from separate cooling circuit)
(10) Dry Shipment	
(a) Atmosphere	He
(b) Cavity Pressure (psig)	23.1 (normal); 500 (max.)
(11) Wet Shipment	
(a) Medium	Water
(b) Cavity Pressure (psig)	500 (max.)
(12) Normal Operating Temperatures (w/only one of two cooling systems operative)	
(a) Outer Surface (°F)	227
(b) Inner Seal (°F)	268
(c) Basket (°F)	451 (max.)
(d) Fuel Assembly (°F)	690 (avg.)
(13) Outside Surface Dose (mR/hr)	200 max.

(14) Licensing Status Licensed by NRC for shipment using Ag-In-Cd basket. Certificate has expired and no renewal has been applied for.

(15) Comments Cask has two separate baskets, one for PWR and one for BWR. Due to no demand for the use of this cask, owner recovered silver from the baskets in the late 1970s thus no baskets exist for the cask at present. There are a total of 2 casks currently in existence.

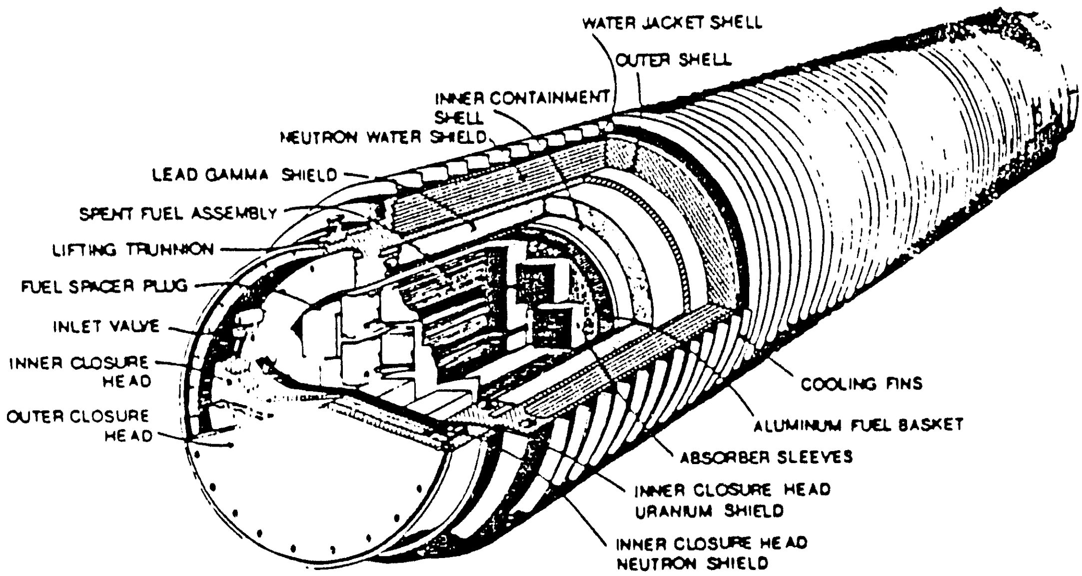
Casks are currently in the possession of Nuclear Assurance Corporation who has the rights to lease them.

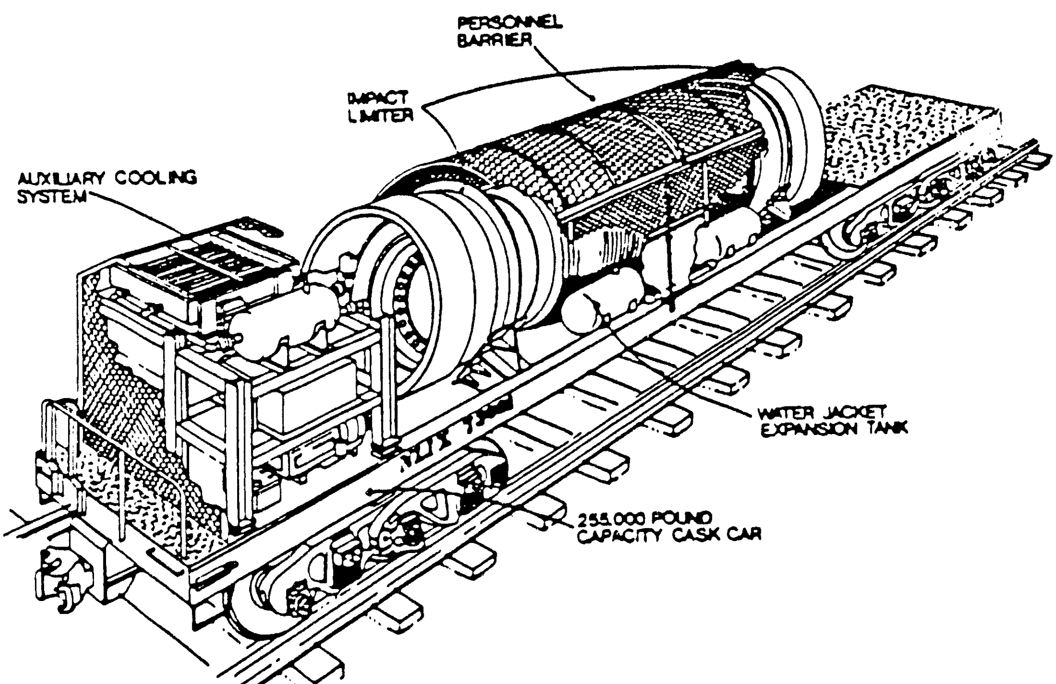
References

(1) C. E. Williams, et al, Design and Licensing Considerations of the NLI 10/24 Rail Transportation System for Shipping Spent Nuclear Fuel, Proceedings of the 4th International Symposium on Packaging and Transportation of Radioactive Materials, Miami Beach, FL, September 1974

(2) Letter W. J. Lee (NAC) to W. Etz (JAI), July 29, 1987

(3) Letter W. J. Lee (NAC) to E. R. Johnson (JAI), February 8, 1988





NLI 10/24 RAIL CASK

THE TN-RAM - A NEW CASK FOR SHIPPING HIGH ACTIVITY IRRADIATED HARDWARE

PACKAGE DESCRIPTION

Specifications for the TN-RAM were developed in conjunction with WasteChem to meet demand for a high capacity packaging to serve the irradiated hardware market. It was decided that an Over-Weight Truck (OWT) cask would be required to meet this goal. Transnuclear already operated a fleet of TN-8 and TN-9 OWT casks for spent fuel, and therefore it was decided to design the TN-RAM to mate with existing lifting equipment and auxiliary equipment to minimize the investment needed. An optimization study led to the following key design parameters:

Payload: 9500 lbs (4310 kg) including the weight of secondary liner
Heat Load: 300 watts
Source Term: 2000 times the A2 quantity for Co-60, 14,000 Curies (5.18E14 Bequerels)

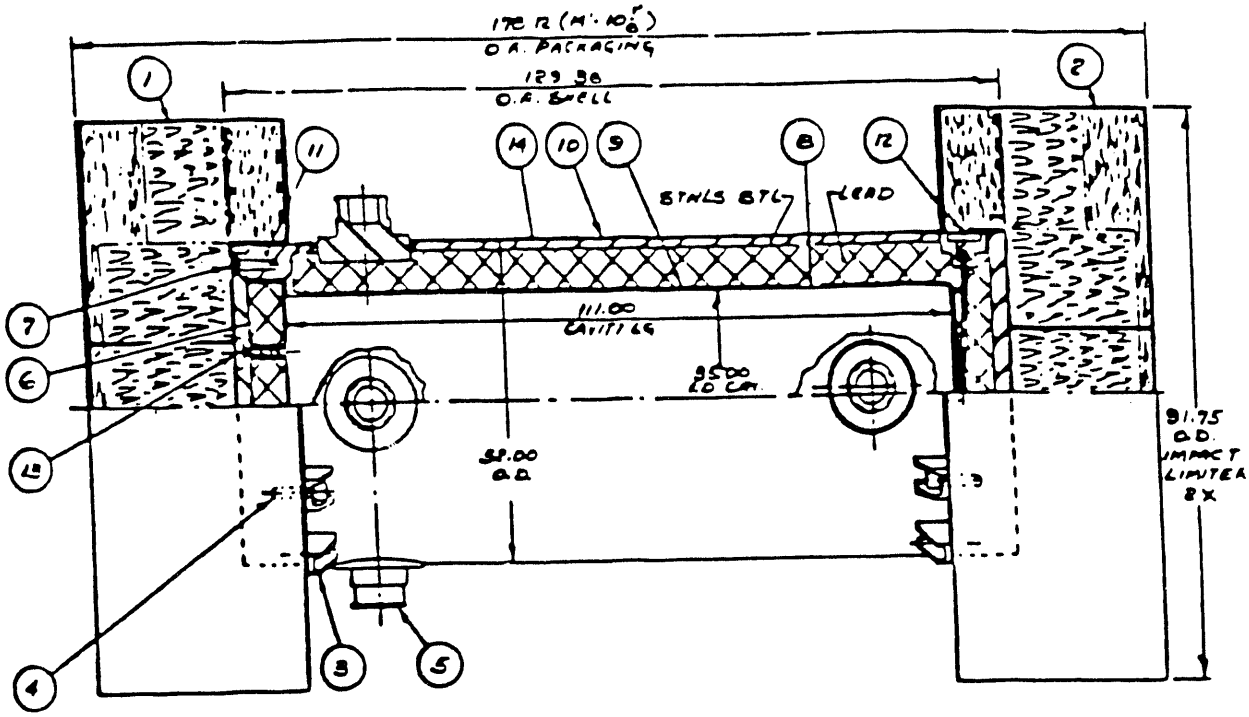
With these parameters set, intensive design efforts got under way in the spring of 1988.

A schematic of the cask is shown in Figure 1. The TN-RAM transport cask has the configuration of a right circular cylinder. It is fabricated from lead and stainless steel, with wood-filled impact limiters attached at both ends. The lead and steel construction of the lid, walls, and bottom provides a shielding effectiveness of 7.1 inches (18 cm) lead equivalent. The overall dimensions of the packaging are 178.12 inches (452 cm) long and 91.75 inches (233 cm) in diameter with the impact limiters installed. The cask is 129.38 inches (329 cm) long and 52.00 inches (132 cm) in diameter. The cask cavity has a length of 111 inches (282 cm) and a diameter of 35 inches (89 cm).

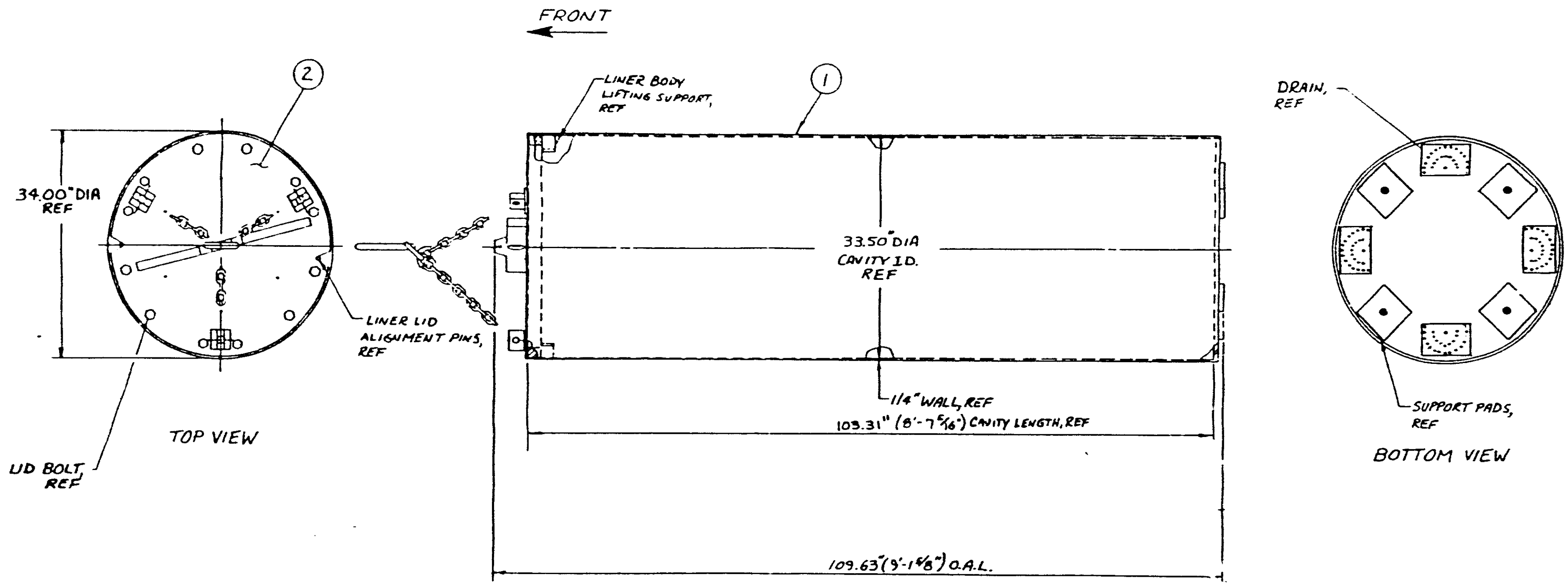
The basic components of the TN-RAM packaging are the cask body, closure lid, lid bolts, and impact limiters. The cask body consists of the cylindrical shell assembly and bottom assembly. The closure lid is attached to the cask body with sixteen 1.5 inch (3.81 cm) diameter bolts. Six trunnions are welded to the cask body with four located at 90° intervals near the lid end and two located with a 180° spacing near the bottom end. Two penetrations into the containment are provided to support cask operations. One is located in the lid and one is located in the cask body near the bottom end. The maximum gross weight of the loaded package is 80,000 pounds (36,288 kg) including payload. The TN-RAM is transported horizontally on a dedicated trailer with the lid end facing the tractor. During transport, the packaging is supported in a transport cradle by two top and two bottom trunnions.

FIGURE 1

TN-RAM PACKAGING



ITEM NO.	DESCRIPTION
1	Upper (front) Impact Limiter
2	Lower (rear) Impact Limiter
3	Impact Limiter Attachment Lugs
4	Impact Limiter Attachment Bolts
5	Lifting/Tiedown Trunnions
6	Closure Lid
7	Lid Bolts
8	Cask Body
9	Inner Shell
10	Outer Shell
11	Bolting Flange
12	Drain Port
13	Vent Port
14	Thermal Barrier

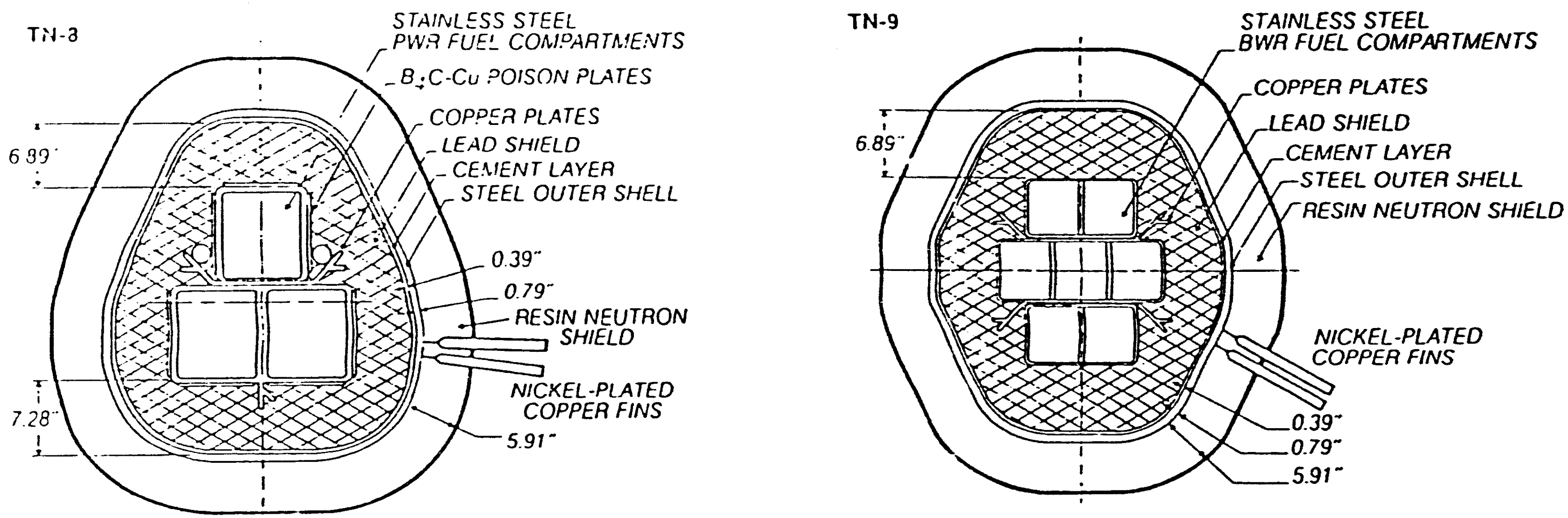


TRANSNUCLEAR, INC.
HAWTHORNE, N.Y.

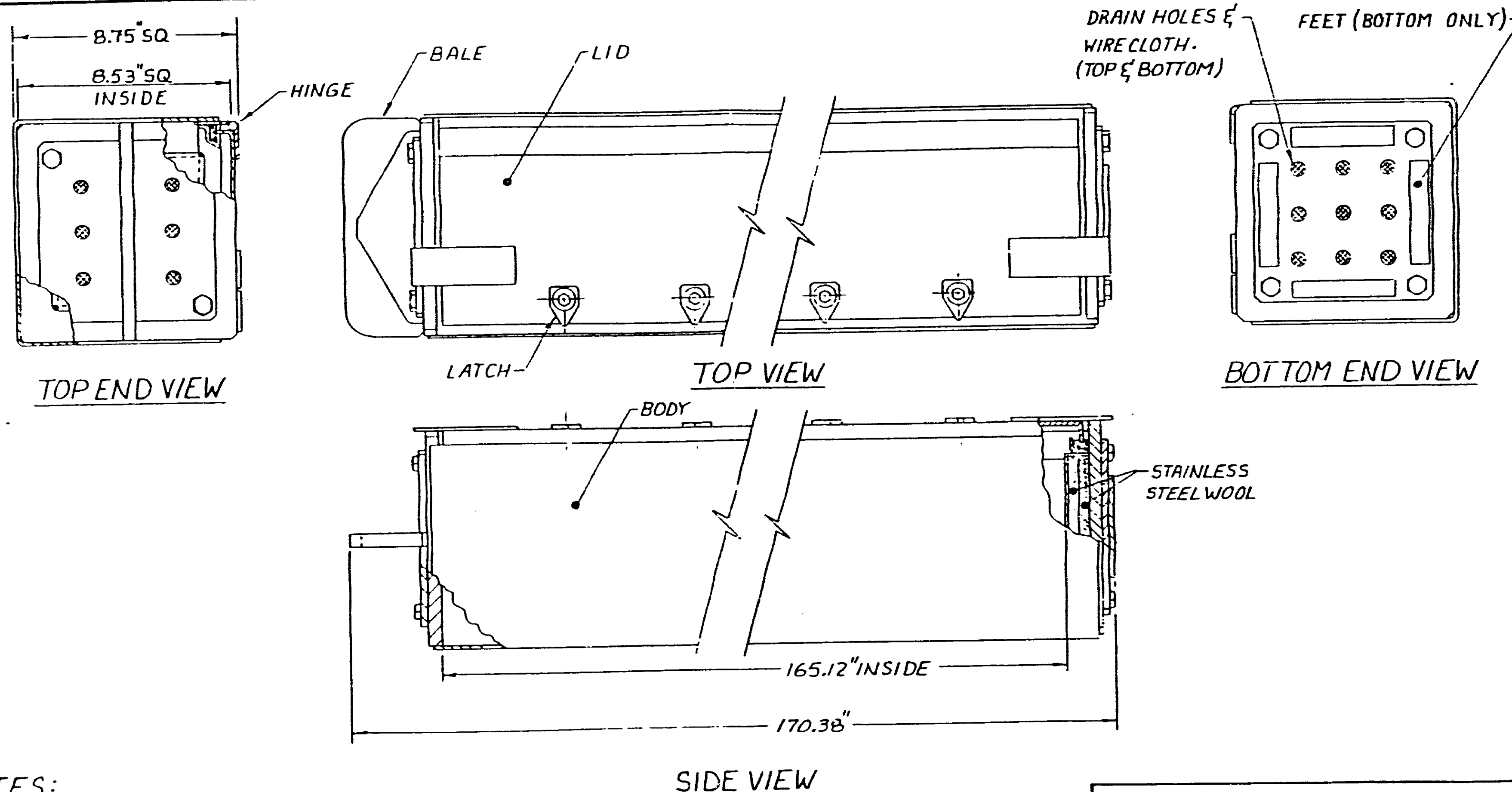
TN-RAM LINER

Design Characteristics of Transnuclear Spent Fuel Casks

	TN-8	TN-9	TN-12Y
Fuel			
Type of Fuel	PWR	BWR	PWR/BWR
Number of Assemblies	3	7	12/32
Cavity			
Cavity length	14'	14' 10"	14' 10"
Fluid during transport	Air	Air	Air
Pressure during transport (psia)	<14.7	<14.7	<14.7
Design pressure (psia)	125	125	750
Shielding			
Gamma shield material	Lead	Lead	Lead
Gamma dose rate 2m from surface (mrem/hr)	6.5	6.5	<8
Neutron shield material	Borated Solid Resin		
Neutron dose rate 2m from surface (mrem/hr)	2	2	2
Heat Rejection			
Mode	Natural convection and radiation		
Surface	Nickel-chrome plated copper fins		Smooth outer surface
Overall Dimensions			
Outside diameter	5' 8"	5' 8"	7' 6"
Length with covers	18' 1"	18' 11"	18' 11"
Length without covers	16'	16' 10"	17' 2"
Weight			
Maximum loaded weight (lbs.)	78,600	78,200	172,000
Empty weight (lbs.)	73,800	73,600	153,000
Cover weight (2) (lbs.)	1,820	1,820	8,000
Lid weight (lbs.)	1,870	1,510	9,000



CROSS-SECTIONS OF TN-8 AND TN-9 OVERWEIGHT TRUCK SHIPPING CASKS



NOTES:

1. USEABLE VOLUME $\cong$ 6.8 FT^3.
2. SIDE LOADING
3. APPROVED BY C.N.S.I. AND STATE OF SOUTH CAROLINA FOR USE AT BARNWELL BURIAL SITE.
4. MATERIAL - STAINLESS STEEL
5. HANDLING AND LOADING TOOLS ALSO AVAILABLE.

TRANSNUCLEAR, INC. HAWTHORNE, N.Y.
TN-8L WASTE LINER

PHOTOGRAPH OF TN-8 SHIPPING CASK

PHOTOGRAPH OF TN-9 SHIPPING CASK

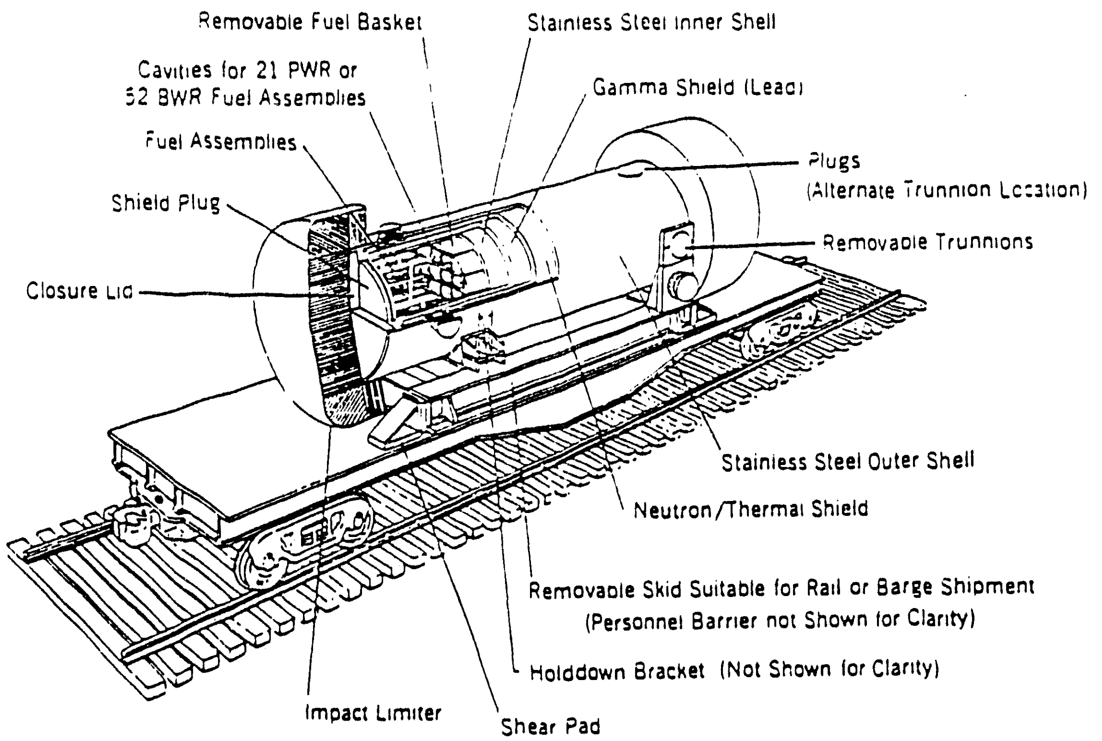


Figure 1. B&W BR-100 rail barge cask.

selected for their energy-absorbing abilities, ultimately reducing impact loads on the container during an accident. The fuel baskets are assemblies of individual fuel storage cells made primarily of anodized aluminum for structural and thermal reasons and a boron-aluminum sheet material for criticality control. A separate shield plug of lead encased in stainless steel is located between the fuel and the closure lid.

Table 1. BR-100 component weights (lb)

	Pool Lifting Configuration		Transportation Configuration	
Component	PWR	BWR	PWR	BWR
Cask body	139,000	139,000	139,000	139,000
Shield plug	5,200	5,200	5,200	5,200
Main closure lid	–	–	7,700	7,700
Basket assembly	9,000	10,000	9,000	10,000
Payload	32,800	33,800	32,800	33,800
Dewatering tool	1,000	1,000	–	–
Handling equipment	2,500	2,500	–	–
Water (before drain)	10,000	8,500	–	–
Impact limiters	–	–	8,000	8,000
Package and Contents	199,500	200,000	201,700	203,700
Railcar	–	–	45,000	45,000
Skid	–	–	11,500	11,500
Personnel Barrier	–	–	500	500
Gross Vehicle Weight	--	--	258,700	260,700

Table 1 summarizes the cask weights and key dimensions.

The cask components that retain the radioactive contents are called the containment boundary and consist of the cask body sidewall, closure, closure seal, closure bolts, bottom head, and penetrations with seals for draining and gas sampling.

Table 1. Weights and dimensions

	GA-4	GA-9
Weight	52,600 lb	52,900 lb
Cask length		
without impact limiters	187.75 in.	198.00 in.
with impact limiters	233.75 in.	244.00 in.
Trunnion-to-trunnion width	48.00 in.	47.73 in.
Impact limiter diameter	90.00 in.	90.00 in.
Cavity depth	167.25 in.	178.00 in.
Cavity width/height	18.06 in.	18.21 in.

The noncircular cross section of the cask body (Figure 3) was selected over the traditional circular cross section because it results in a weight-efficient design that maximizes the capacity of the legal weight truck casks. By increasing the capacity of the casks, the number of trips the cask must make from the reactor site to a monitored retrievable storage facility or to a repository is reduced. This reduces the risk of a cask being involved in an accident, reduces the dose to the public and occupational workers, and reduces the total cost of shipping the spent fuel.

A unique feature of the cask designs is the removable and interchangeable aluminum honeycomb impact limiters. The impact limiter design is identical for both top and bottom impact limiters and for both the GA-4 and GA-9 casks. General Atomics selected aluminum honeycomb for the impact limiters because it is lightweight, is of uniform density, is available in a wide variety of strengths, has a well-defined uniform crush strength, and does not burn when subjected to intense heat. By designing the impact limiters with sections of honeycomb of different strengths and aligned in different directions, the impact limiters are highly efficient, reliable, and lightweight.

The fuel support structure in each cask is removable. This feature facilitates making repairs to the fuel support structures in case of damage, facilitates decontaminating the cask, and allows the most flexibility in carrying other payloads such as fuel with nonstandard dimensions and nonfuel-bearing components.

All major cask components are stainless steel except the neutron shield, which is polyethylene-boron; the gamma shield, which is depleted uranium; and the boron-carbide neutron-poison rods contained in the fuel support structure. The solid polyethylene-boron used for neutron shielding contains 1% (by weight) natural boron to minimize secondary gamma production within the material. The metallic components in the ports are fabricated from 304 stainless steel. All of the other stainless steel components are fabricated from XM-19 stainless steel, which is an austenitic stainless steel with high strength, excellent corrosion resistance, ductility, and low-temperature impact resistance. The closure and impact limiter bolts, threaded inserts, and shear pins are fabricated from Inconel 718. All O-rings are made of Parker V835-75 compound, which is a fluorocarbon elastomer.

The impact limiters are fabricated of aluminum honeycomb and are totally enclosed with Inconel 625. Inconel 625 is a high-strength, high-nickel steel alloy with excellent low-temperature impact resistance, corrosion resistance, and ductility.

The cask interior surfaces are smooth and free of any projections that could interfere with fuel loading or removal. All components that could come in contact with the fuel assemblies are fabricated from XM-19 stainless steel, which has excellent resistance to galvanic corrosion.

STRUCTURAL EVALUATION

Structural analysis of the GA-4 and GA-9 cask designs shows that the cask designs meet all applicable criteria. The casks are designed for the loading and environmental conditions defined in Title 10 of the Code of Federal Regulations, Part 71 (10 CFR Part 71) and meet the elastic analysis stress allowables presented in U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 7.6, "Design Guide for the Structural Analysis of Shipping Cask Containment Vessels." In addition, the designs meet all applicable criteria from the "American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code."

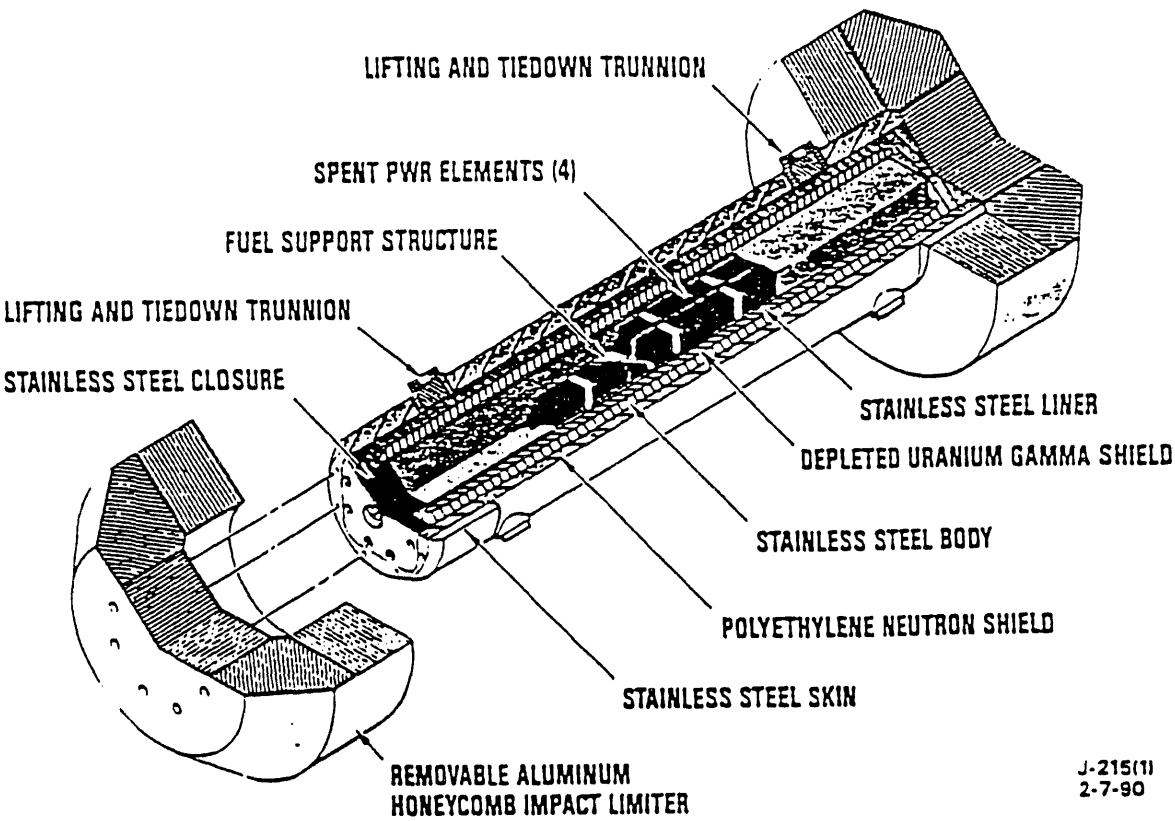


Figure 1. GA-4 legal weight truck cask.

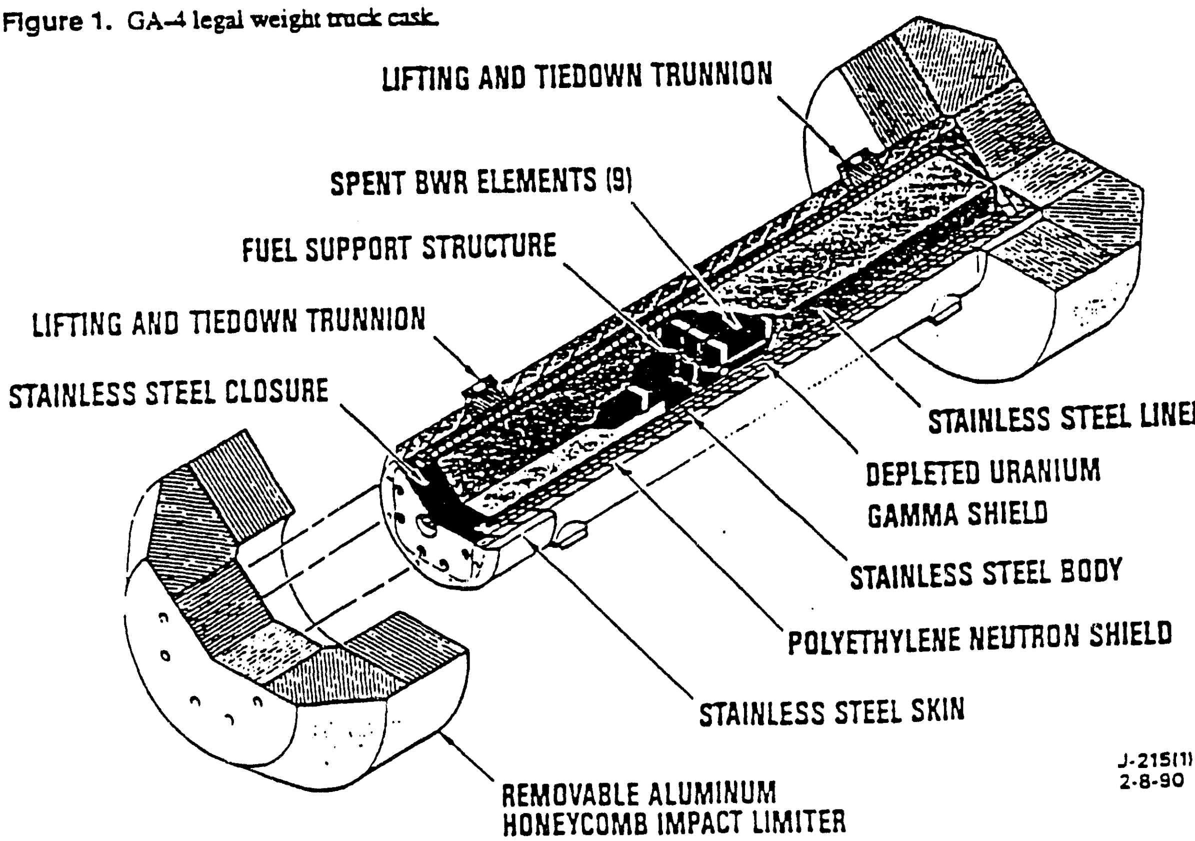


Figure 2. GA-9 legal weight truck cask.

CNS 14-170 TYPE A TRANSPORT CASK - SERIES II

The top-loading CNS 14-170 Transport Cask is designed to contain fourteen drums or one 185 ft^3 liner with radiation levels up to approximately 15 R/hr at the surface. This cask uses ratchet binders for easy loading and unloading characteristics. This Series II type allows a payload of 14,000 pounds. Approximately 2.13 inches of lead equivalent shielding is provided.

CNS 14-170 TYPE A TRANSPORT CASK - SERIES III

The CNS 14-170 Series III Cask is a steel encased, lead shielded cask for low specific activity material. The Series III cask is essentially the same as the Series II cask except that it has an increased maximum payload of 17,800 pounds versus 14,000 pounds for the Series II.

CNS 14-190H TYPE A TRANSPORT CASK

The CNS 14-190H Cask is a top-loading lead and steel cask for transporting dewatered and solidified low specific activity material. This cask has an empty weight of 45,200 pounds and a maximum payload weight of 20,000 pounds. It also provides a lead equivalence of 3.5 inches.

CNS 14-195L STRONG, TIGHT TRANSPORT CASK

The CNS 14-195L Cask is a top-loading lead and steel cask specifically designed for transporting Type A quantities of radioactive material meeting low-specific activity criteria. This cask can accommodate one 215 ft^3 container or fourteen 55-gallon drums. It has a lead equivalent of 2.0 inches and a maximum payload of 17,700 pounds.

CNS 14-195H TRANSPORT CASK

The top-loading CNS 14-195H Transport Cask is designed to contain fourteen drums or one 215 ft^3 liner with radiation levels up to approximately 18 R/hr at the surface. By strategically locating drums with lower surface radiation levels within the CNS 14-195H cask, drums radiating up to 80 R/hr may be readily shielded. Approximately 2.75 inches of lead equivalent shielding is provided. Maximum payload is 17,700 pounds.

CNS 14-215H TYPE A TRANSPORT CASK

The CNS 14-215H Transport Cask is designed to transport fourteen drums or one 215 ft^3 liner with radiation levels of up to approximately 20 R/hr. Approximately 2.73 inches of lead equivalent is provided. The cask has a maximum payload volume of 217 ft^3. This cask has a maximum payload of 20,000 pounds.

CNS 15-160B TYPE B TRANSPORT CASK

The top-loading CNS 15-160B Transport Cask is designed to transport fifteen 55-gallon DOT Type A drums or two 80 ft^3 containers with radiation levels up to 1.9 R/hr. 1.5 inches of lead shielding is provided. The cask has a maximum payload of 5,000 pounds.

CNS 18-450 TRANSPORT CASK

The top-loading CNS 18-450 Cask is designed to transport one 380 ft^3 liner or eighteen 55-gallon drums reading 1 to 5 R/hr at contact. One inch of lead equivalence is provided in the cask with supplemental shield plates located on the cask's exterior with an additional 1 inch of lead equivalence.

CNS 21-300 TYPE A TRANSPORT CASK

The top-loading CNS 21-300 Cask is designed to transport twenty-one 55-gallon drums or one 340 ft^3 liner. The cask provides approximately 1.5 inches of lead equivalent shielding with radiation levels of 3 R/hr being readily shielded. The maximum payload for this cask is 27,250 pounds.

SHIELDED VANS

The CNS standard 40-foot, closed trailers are provided for very low-level radwaste. Approximately 26,000 pounds of drummed or otherwise properly packaged radwaste may be transported per shipment. Radwaste radiating up to approximately 750 mR/hr can be readily shielded by strategically placing drums in the center of van. Average radiation levels of material should be about 200-400 mR/hr.

CNS 27-415 SHIELDED SHIPPING BOX

The CNS 27-415 shielded shipping box is a container which can be used to transport twenty-seven 55-gallon drums radiating up to approximately 750 mR/hr. This container has a maximum internal volume of 415 ft^3.

REGULAR VANS

Standard 40-foot, closed trailers are provided for very low-level radwaste. Approximately 45,000 pounds of drummed or otherwise properly packaged radwaste may be transported per shipment. Radwaste radiating up to about 200 mR/hr can be readily shielded.

CNS BTC-C TRANSPORT VEHICLE

The top-loading CNS BTC-C containers are dump-type vehicles which may be utilized for the transport of bulk radioactive wastes. Each vehicle has an available internal volume of 620 ft^3. It can transport a payload of approximately 40,000 pounds.

CNS BTC-S TRANSPORT VEHICLE

The top-loading CNS BTC-S strong, tight container may be utilized in the shipment of bulk or LSA radioactive wastes. Each container consists of an outer shell with 3 removable steel boxes therein, each of 120 ft^3 capacity. Three CNS BTC-S containers are available. This container has an internal capacity of 360 ft^3. It can transport a payload of approximately 40,000 pounds.

SPECIAL CONTAINERS

Numerous one-time and specialty use casks and containers have been designed and fabricated by Chem-Nuclear Systems, Inc. Such containers are frequently required to accommodate odd-shaped or weighty objects. Contact your CNSI Marketing Representative for further information.

***The dose rates given for each cask are based on 10% Cobalt-60 concentration.*

CHEM-NUCLEAR SYSTEMS, INC.

TRANSPORT EQUIPMENT DESCRIPTION

CNS 1-8 TYPE B TRANSPORT CASK

The CNS 1-8 Cask is a steel and polyurethane foam shipping container certified for Type "B" shipments. The CNS 1-8 provides essentially no shielding and can accommodate one 55-gallon drum or approximately 9 ft^3 of properly packaged solid radwaste. This cask is designed, but not limited, for alpha and beta radionuclides, including fissile material. Rad levels should not exceed 200 mR/hr. This cask has a maximum payload of 550 pounds.

CNS 1-13G TYPE B TRANSPORT CASK

The top-loading CNS 1-13G Cask is designed to transport one 55-gallon drum or one 17 ft3 liner. This Cask provides 6.2 inches of lead equivalent shielding, with radiation levels of 6000 R/hr being readily shielded. Underwater loading capabilities are designed therein.

AUXILIARY SHIELD CONTAINER FOR THE CNS 1-13G CASK

The CNS auxiliary shield container is a cylindrical shaped sealed container constructed of welded steel and lead. The lead shield thickness is equivalent to 7 3/4 inches. The body external dimensions are 30.5 inches in height by 24 inches in diameter. The internal cavity formed by the lid and body is 14 inches high with a 7.62 inch diameter. This container also utilizes a drain plug which makes it suitable for underwater loading. Various types of irradiated components can be shipped in this configuration. The radioactive contents of the material must not exceed 39,000 curies of Cobalt-60 or equivalent radioactive content. This container has an empty body weight of 4,900 pounds, with a lid weight of 200 pounds. Maximum contents weight should not exceed 250 pounds.

CNS 1-13C TYPE B TRANSPORT CASK

The top-loading CNS 1-13C Cask is similar to the 1-13G except that the thermal shield is integral to the 1-13C Cask body. Since no additional overpack is provided, shielding is reduced to approximately 5.7 inches of lead equivalence. Rad levels should not exceed 4,500 R/hr. This cask also has underwater loading capabilities. Maximum payload is 5,000 pounds.

CNS 3-55 TYPE B TRANSPORT CASK

The CNS 3-55 Cask is a lead and steel cask certified for shipments of Type B Quantity, with inside dimensions of 36 inches in diameter and 110.5 inches in height. This underwater loading cask can accommodate three (3) standard 55-gallon drums or a 60 ft^3 capacity disposable liner. The cask provides the equivalent shielding of 7 inches of lead. The CNS 3-55 Cask is suitable for use with either the redundant crane or dashpot type of cask drop protection system. This cask is also ideal for the transport of irradiated metals. Rad levels should not exceed 15,000 R/hr. This cask also has a shielded personnel barrier designed especially for this cask. Maximum payload is 9,220 .

CNS 4-85 TYPE B TRANSPORT CASK

The top-loading CNS 4-85 Cask is designed to transport four 55-gallon drums or one 88 ft^3 liner. This cask provides 3.38 inches of lead equivalent shielding. Rad levels should not exceed 35 R/hr. The maximum payload for this cask is 5,700 pounds.

CNS 6-75 TYPE A TRANSPORT CASK

The CNS 6-75 Cask is a lead and steel cask for shipping solid low-level radioactive waste. The cask weighs 31,000 pounds empty and provides the equivalent shielding of 4 inches of lead. This cask can accommodate six (6) standard 55-gallon drums in two palletized tiers of three, or a 85 ft^3 capacity disposable liner. Approved for LSA material in greater than Type "A" quantities. Rad levels should not exceed 235 R/hr. The cask is sized such that (3) 24" x 72" pressure vessels will fit inside. Maximum payload is 10,300 pounds.

CNS 6-80-2 TYPE A TRANSPORT CASK

The top-loading CNS 6-80-2 Transport Cask is designed to transport radwaste radiating up to about 1,860 R/hr and can readily accommodate underwater loading. Four (4) 55-gallon drums of radwaste may be readily transported therein. Also, one (1) 91 ft^3 disposable liner may be placed therein. This cask has a lead equivalent of 5.00 inches. This cask has a maximum payload of 7,500 pounds.

CNS 7-100 TYPE A TRANSPORT CASK

The top-loading CNS 7-100 Transport Cask is designed to contain seven drums or one 100 ft^3 liner with radiation levels up to 190 R/hr contact. By strategically locating drums with lower surface radiation levels within the CNS 7-100 Cask, drums radiating up to between 125 and 150 R/hr may be shielded. Approximately 3.5 inches of lead shielding is provided. Maximum payload is 13,000 pounds.

CNS 8-120A TYPE A TRANSPORT CASK

The CNS 8-120A Cask is a lead and steel cask certified for shipping greater than Type A quantities of radioactive material, meeting the requirements for low specific activity. This cask provides the equivalent shielding of 4.50 inches of lead. With internal dimensions of 62 inches in diameter and 75 inches in height, this cask can accommodate eight standard 55-gallon drums or a 130 ft^3 capacity disposable liner. This cask is suitable for underwater loading. Dose rates of approximately 880 R/hr can be readily shielded for transport utilizing this cask. Maximum payload is 20,000 pounds.

CNS 8-120B TYPE B TRANSPORT CASK

The CNS 8-120B Cask is a lead and steel cask certified for shipments of Type "B" and large quantities of radioactive materials. The cask weighs 58,000 pounds and provides the equivalent shielding of 4.5 inches of lead. With internal dimensions of 62 inches in diameter and 75 inches in height, the cask can accommodate eight (8) standard 55-gallon drums or a 130 ft^3 capacity disposable liner. Additionally, the cask is suitable for underwater loading. Dose rates of approximately 880 R/hr can be readily shielded for transport utilizing this cask. Maximum payload is 14,680 pounds.

CNS 12-180 STRONG, TIGHT TRANSPORT CASK

The CNS 12-180 Cask is a lead and steel rectangular cask designed to accommodate twelve (12) standard 55-gallon DOT Type A drums of Type "A" quantities of radwaste material. This cask is of the end-loading type equipped with roller conveyors compatible with most PWR and BWR drum loadout facilities. The cask weighs 31,000 pounds empty and provides the equivalent of 2 inches of lead shielding. Rad levels should not exceed 1 R/hr contact.

CHEM-NUCLEAR SYSTEMS, INC. TRANSPORT CASK INVENTORY

CNSI TRANSPORT CONTAINER	NO.	CLASSIFICATION C OF C**	INTERNAL DIMENSIONS DIA. X HEIGHT	PB SHIELDING EQUIVALENCE (INCHES)	APPROXIMATE MAXIMUM RAD-LEVELS (R/HR) *BASED ON 10% Co-60	LINER CAPACITY (FT^3)	DRUM (55-GAL) CAPACITY	APPROXIMATE MAXIMUM EMPTY WEIGHT (LBS)	NO LIMIT MAXIMUM PAYLOAD (LBS)
CNS 14-195H	11	Type A USA/9094/A	77.00" x 80.13"	2.63	21	215	14	39,650	17,700
CNS 14-215H	8	Type A USA/9176/A	77.00" x 80.25"	2.73	20	215	14	38,400	20,000
CNS 15-160B	1	Type B USA/6144/B	126" x 36" x 75"	1.50	1.9	2 @ 80	15	37,000	5,000
CNS 18-450	1	Strong, Tight Container	86.00" x 86.00" x 100.00"	1.50	No More Than 1 R/hr on Contact	450	18	37,000	No Limit
CNS 21-300	12	Type A USA/9096/A	83.00" x 109.25"	1.50	3	340	21	30,200	27,250
CNS 21-300 W/ Shield Insert	3	Type A USA/9096/A	76" x 106-1/2"	2.00	3.00	170	8	39,310	27,250
CNS 27-415	1	Shielded Shipping Box	39" H x 78" W x 233-3/4" L	0.66 - 1.15	0.75	415	27	26,725	No Limit
Flatbed		N/A	8' W x 40' L 8' W x 45' L	N/A	0.080	N/A	N/A	14,000	48,000
Regular Van		N/A	13' 6" H x 40' L 13' 6" H x 45' L	N/A	0.200	N/A	N/A	17,500	45,000
Shielded Van		Closed, Transport Vehicle	7' 5" x 40" x 9'	0.50	0.750	N/A	N/A	33,000	26,000
CNS BTC-C		Bulk Shipment Only	Dump type vehicles for the transport of bulk LSA, radioactive wastes - 620 ft^3 capacity, 36,000+ lb. payload capacity (depending on various state limits). (Dimensions 18' x 52" x 84")						
CNS BTC-S		Strong, Tight Container	Closed box-type containers for the shipment of bulk, LSA, radioactive wastes - 360 ft^3 capacity, 40,000+ lb. payload capacity (depending on various state limits). (Dimensions without inserts - 78" x 180" x 52")						

* Based on Cobalt-60 gamma energy, these Rad levels are generally found to be conservative, however, equivalent shielding should be carefully evaluated in relation to the specific isotopes involved. Reference the individual cask's <u>Maximum Allowable Activity Concentration Curves</u> to determine your specific case.

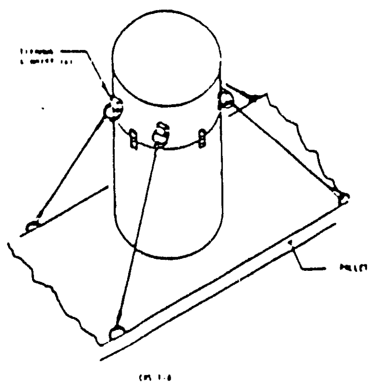
**All NRC-approved casks can be used as DOT 7A - Type A containers with minor modifications.

CHEM-NUCLEAR SYSTEMS, INC. TRANSPORT CASK INVENTORY

CNSI TRANSPORT CONTAINER	NO.	CLASSIFICATION C OF C**	INTERNAL DIMENSIONS DIA. X HEIGHT	PB SHIELDING EQUIVALENCE (INCHES)	APPROXIMATE MAXIMUM RAD-LEVELS (R/HR) *BASED ON 10% Co-60	LINER CAPACITY (FT 3)	DRUM (55-GAL) CAPACITY	APPROXIMATE MAXIMUM EMPTY WEIGHT (LBS)	NO LIMIT MAXIMUM PAYLOAD (LBS)
CNS 1-8	1	Type B USA/9070/B	24.00" x 34.50"	Nil	0.200	9	1	200	550
CNS 1-13G	1	Type B USA/9216/B	26.50" x 54.00"	6.20	6,000	17	1	25,500	No Limit
CNS 1-13C	1	Type B USA/9081/B	26.50" X 54.00"	5.70	4,500	17	1	20,950	5,000
CNS 3-55	2	Type B USA/5805/B	36.00" X 116.75"	7.00	15,000	60	3	64,980	9,220
CNS 4-85	1	Type B USA/6244/B	46.00" X 100.00"	3.38	35	88	4	40,300	5,700
CNS 6-75	1	Type A USA/9108/A	53.00" X 74.50"	4.00	235	85	6	31,000	10,300
CNS 6-80-2	5	Type A USA/9111/A	59.00" X 58.00"	5.00	1,860	91	4	44,000	7,500
CNS 7-100	2	Type A USA/9080/A	75.50" X 40.75"	3.50	190	100	7	35,500	13,000
CNS 8-120B	2	Type B USA/9168/B	62.00" X 75.00"	4.50	880	130	8	49,300	14,680
CNS 8-120A	5	Type A USA/6601/A	62.00" X 75.00"	4.50	880	130	8	49,300	20,000
CNS 14-170 Series II	6	Type A USA/9079/A	75.50" X 73.25"	2.13	15	185	14	33,800	14,000
CNS 14-170 Series III	5	Type A USA/9151/A	75.50" X 73.25"	2.13	15	185	14	35,200	17,800
CNS 14-190H	1	Type A USA/9159/A	75.25" X 73.38"	3.50	50	185	14	45,200	20,000
CNS 14-195L	2	Strong, Tight Container, LSA Type A Quantity Only	77.00" X 80.00"	2.00	No More Than 1 R/hr on Contact	215	14	31,550	17,700

CHEM-NUCLEAR SYSTEMS, INC.

CNS 1-8

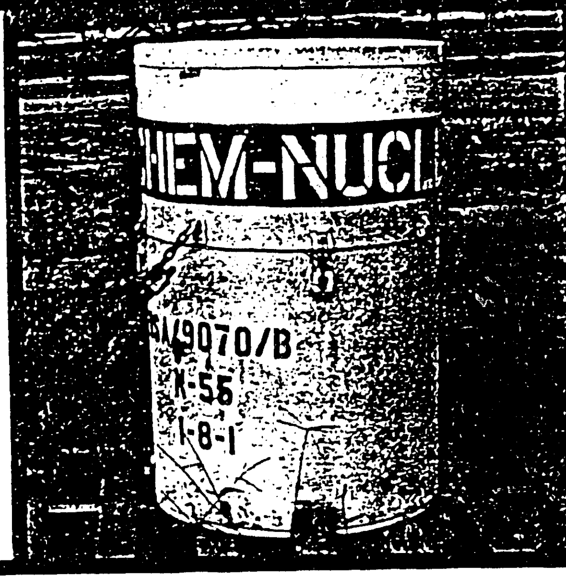


CNS 1-8

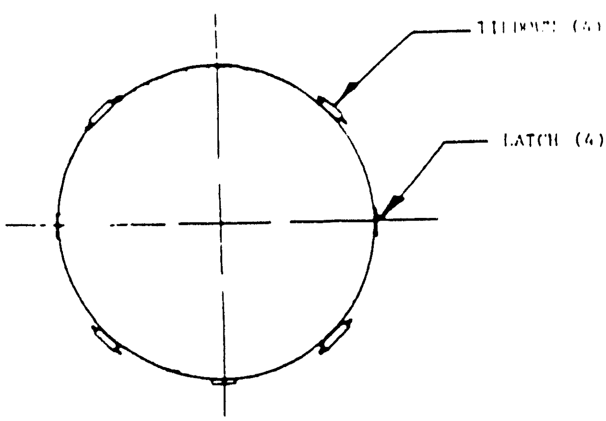
NRC Certificate No. USA/9070/B( )F

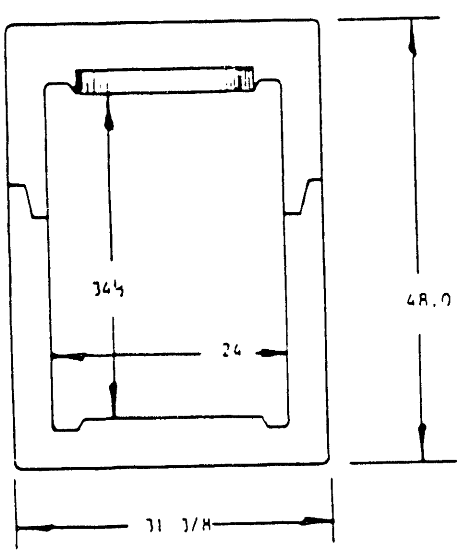
Capacity: (1) 55-gallon drum
Shielding: NIL
Dose Rate: 0.200 R/hr
(Maximum based on Cobalt 60)

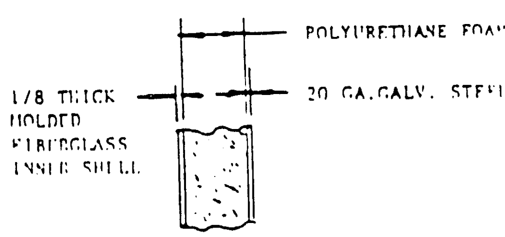
Empty Package Weight (with lids, empty):	200#
Payload Weight:	550#



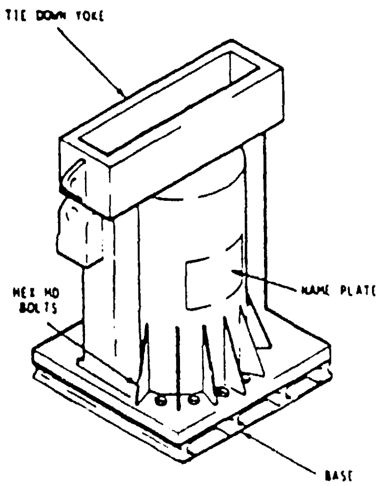
The CNS 1-8 is a specially designed low carbon steel overpack filled with rigid polyurethane foam used for shipping greater than Type A quantities for radioactive material. The containment vessel is a 55-gallon drum, meeting the requirements of DOT Specification 17H or 17C.







The CNS 1-8 is a reusable insulated and shock absorbing packaging designed to protect a standard 55-gallon drum from normal conditions of transport and hypothetical accident conditions.



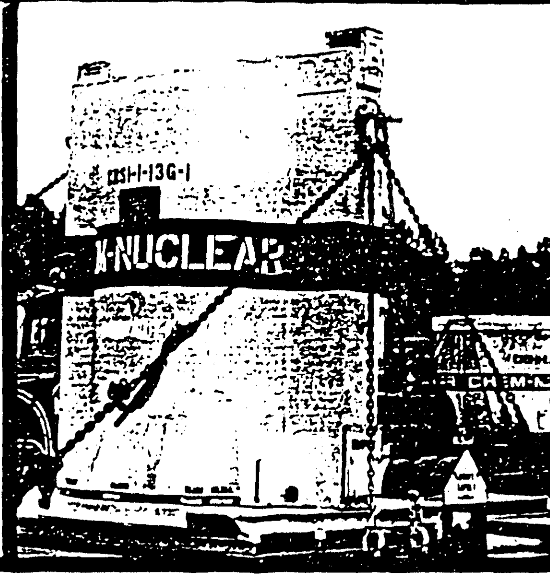
CNS 1-13G

NRC Certificate No. USA/9216/B ( ) F

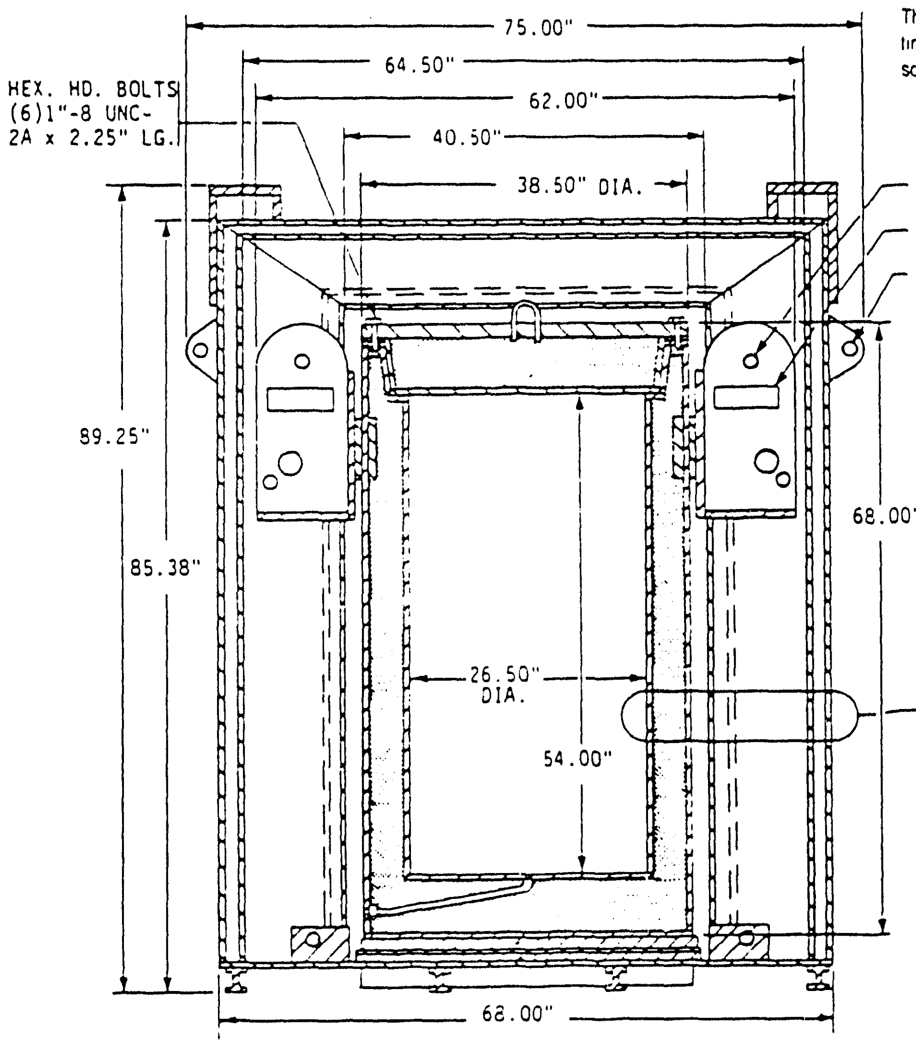
Capacity (1) 55-gallon drum
(1) 8-17 ft^3 liner
Shielding: 6.20" lead equivalent
Dose Rate: 6000 R/hr (approx.)
(Maximum based on Cobalt 60)

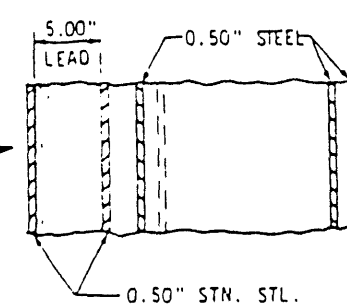
Total Empty Package Weight:	25,500#
Empty Cask Weight (with lid):	19,100#
Cask Lid Weight:	2,000#
Overpack with Baseplate.	6,400#

Payload weight not restricted



The CNS 1-13G cask is specially designed for transporting activated reactor components and nuclear therapy sources.

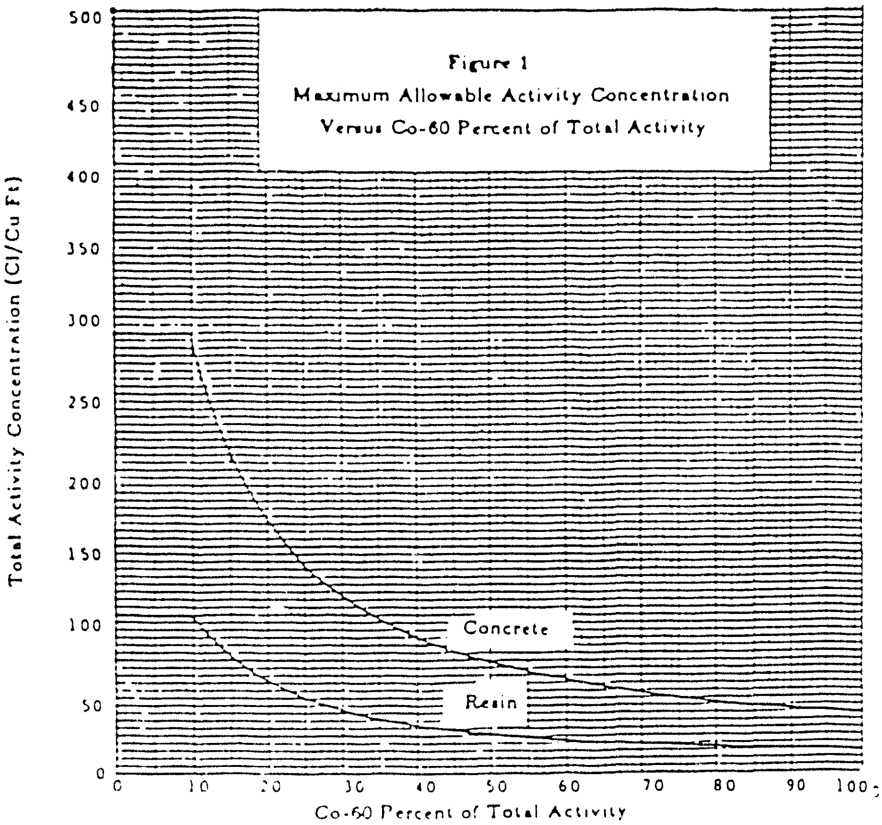


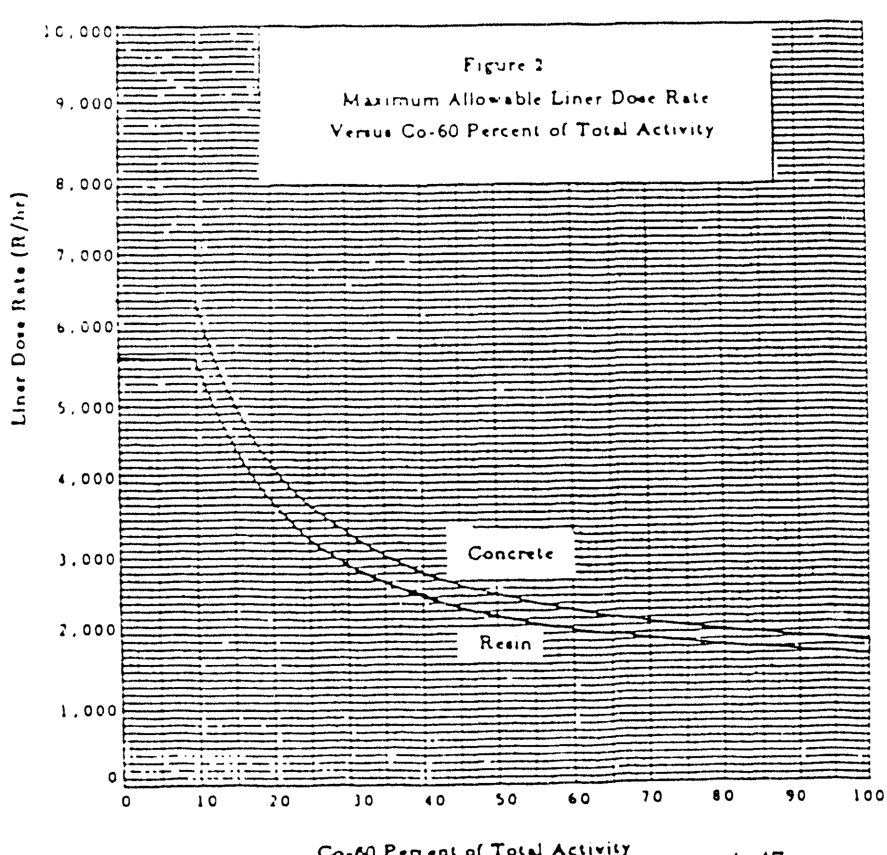


The CNS 1-13G cask is a lead and steel shipping cask for fissile, solid metal, or metal oxides by-product material. The decay heat of the contents must not exceed 600 watts (38,800 curies of Cobalt-60)

Loading: (A) One drum with appropriate lifting sling may be lowered into the cask. (B) A disposable liner may be lowered into the cask while mounted on the transport trailer. (C) Activated reactor components contained in a disposable liner may be loaded into the cask underwater

Rev. 2





The curves shown at left may be used to determine the maximum activity concentration (Figure 1) and the maximum liner dose rate (Figure 2) which can be shipped in this cask. For a well mixed, uniform concentration of waste, use of these figures will result in compliance with legal dose rates on the cask surface and at a distance of 2 meters from the surface (See Cautionary Note)

These curves are related to the relative concentration of Co-60 in the waste The Co-60 concentration is obtained from a representative sample of the waste prior to filling a drum or liner Practical experience shows that Co-60 is a dominant isotope in most mixtures and is the most significant from a shielding standpoint. The conservative assumption is made that the remaining isotopes (other than Co-60) emit one gamma per disintegration with an energy of 1 0 MEV

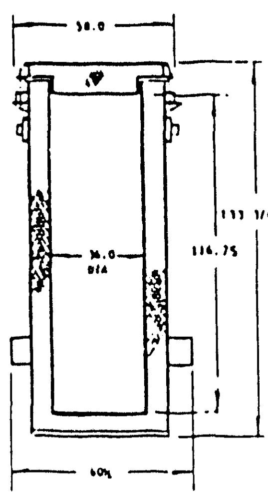
Two general types of waste forms are normally shipped, concreted or dewatered resins and filter media. A nominal average density of 2.0 g/cc for concreted wastes and 0 6 g/cc for resins was used in developing the curves

CAUTIONARY NOTE

The curves include a safety factor (peak-to-average factor) of 2 0 which relates field measurements to shielding calculations assuming uniform waste mixtures The calculations were made using a comprehensive computer analysis The field measurements are based on a statistical analysis of a large number of cask shipments However, due to variations in waste materials, tolerance in measurement instruments, and other real world factors, there is still a large scatter in the peak-to-average factor. Statistically, these curves yield compliance in about 60% of the shipments To obtain compliance in about 95% of the shipments, multiply the maximum allowable activity concentration and the maximum allowable liner dose rate by 0 6

CHEM-NUCLEAR SYSTEMS, INC.

CNS 3-55



CNS 3-55

NRC Certificate No. USA/5805/B()

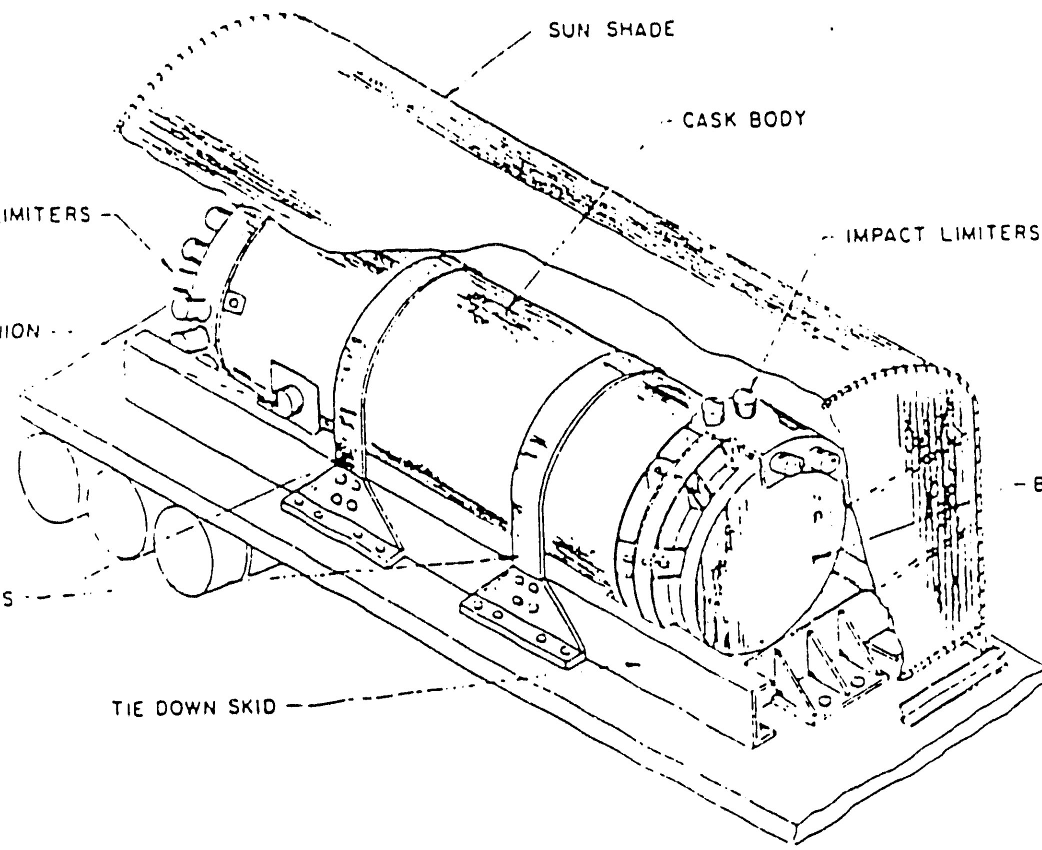
Capacity: (3) 55-gallon drums
(1) 60 ft^3 liner

Shielding: 7.0" lead equivalent

Dose Rate: 15,000 R/hr
(Maximum based on Cobalt 60)

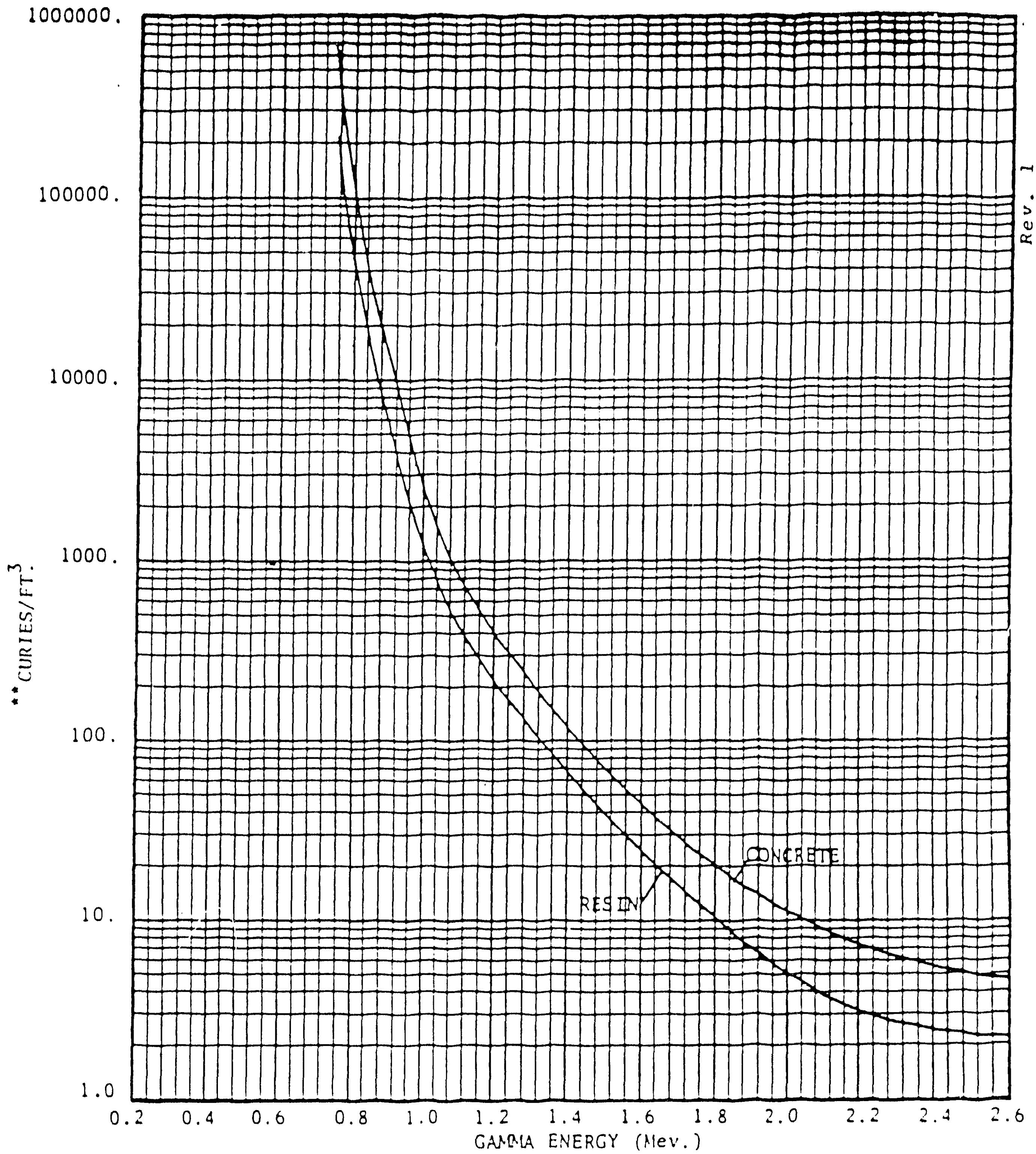
Empty Package Weight (with lid):	56,912#
Cask lid (with slump ring)	6,265#
Payload Weight:	9,220#

The CNS 3-55 cask is specially designed for transporting irradiated metal components packaged in secondary containers.



The CNS 3-55 cask is a steel-encased, lead-shielded cask with crushable impact limiters used for transporting miscellaneous nonfissile irradiated components packaged in secondary containers. Maximum decay heat load should not exceed 250 watts.

Loading: This underwater loading cask can accommodate three (3) standard 55-gallon drums or a 60 ft^3 capacity disposable liner



CHEM-NUCLEAR SYSTEMS, INC.

CASK CNS 3-55
(CASK LL-57-65) ¼ INCH STEEL, 6 INCHES LEAD
¼ INCH STEEL

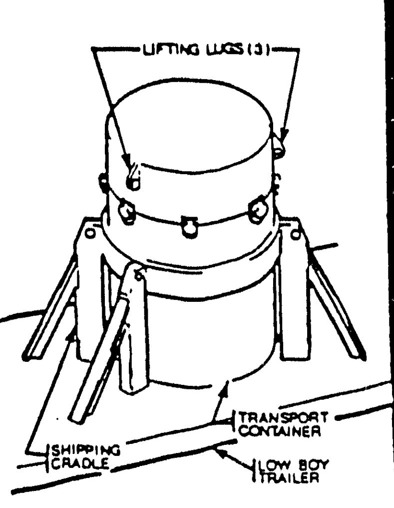
**BASED ON HOMOGENEOUS MIX

DOSE RATE AT 6 FEET
FROM CASK IS 10 MR/HR

REV.	DATE	SHEET

CHEM-NUCLEAR SYSTEMS, INC.

CNS 4-85

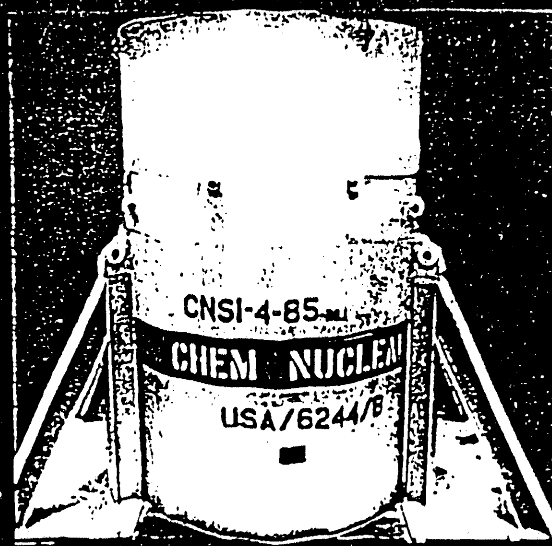


CNS 4-85

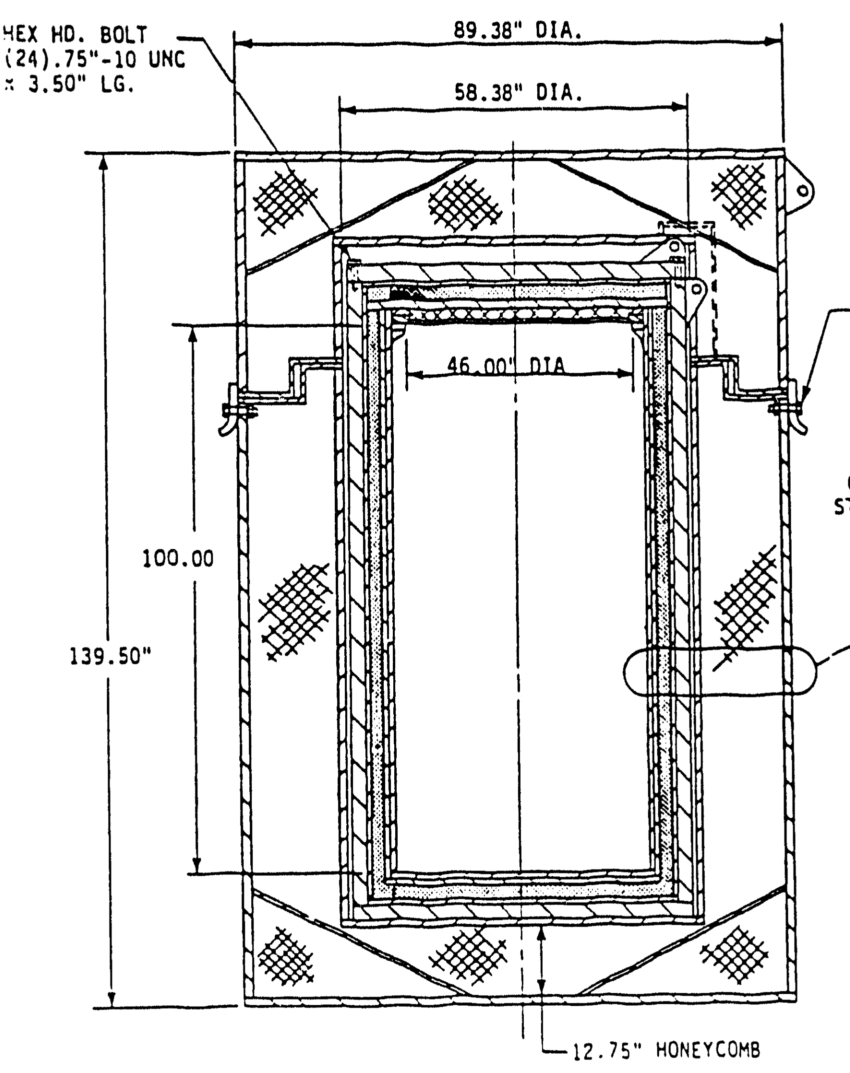
NRC Certificate No. USA/6244/B( )

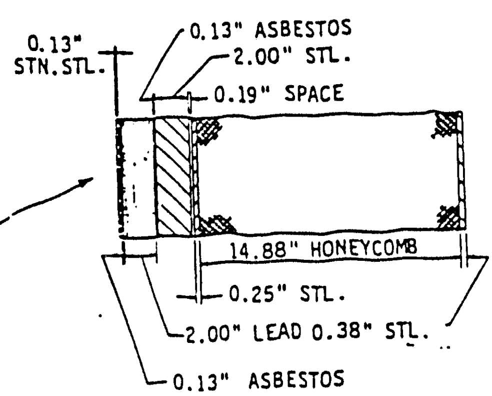
Capacity: (1) 85-96 ft^3 liner
Shielding: 3.38" lead equivalent
Dose Rate: 80 R/hr (approx.)
(Maximum based on Cobalt 60)

Empty Package Weight (w/lid & overpack):	40,300#
Top overpack:	1,750#
Cask lid:	3,500#
Payload weight:	5,700#



The CNS 4-85 cask is specially designed for transporting type B quantities of radioactive dewatered resin.

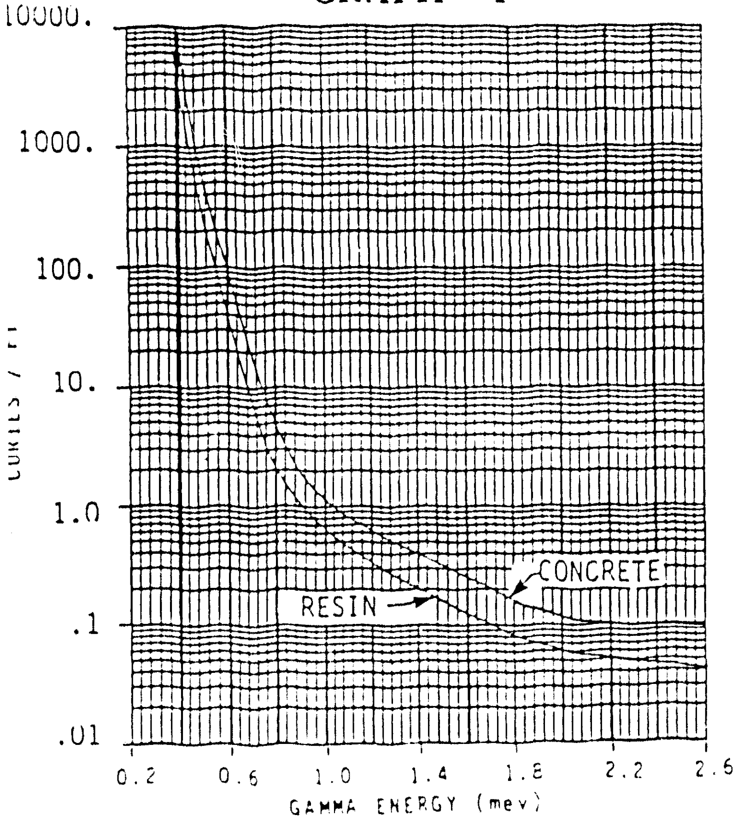




The CNS 4-85 cask is an aluminum honeycomb, lead, and steel shipping cask for dewatered or solidified waste material. The contents may contain greater than Type A quantities of radioactive material. The decay heat of the contents must not exceed 10 watts (640 curies of Cobalt 60).

Loading: The disposable liner may be loaded while in the cask or placed in the cask after filling.

GRAPH I

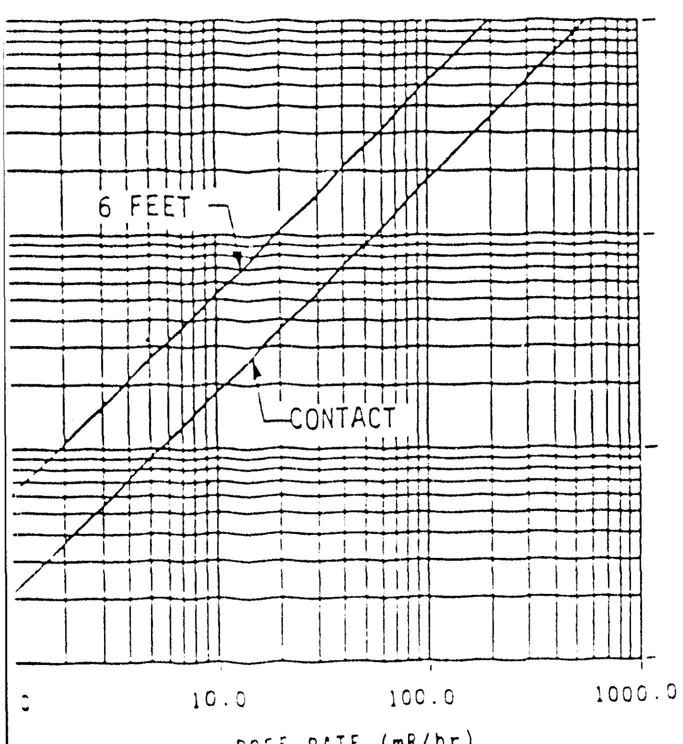


Graph I shows the maximum curie concentration (curies/ft^3) for various gamma emitting radionuclides (MeV) to produce a dose rate of 10 millirem/hour at a distance of six feet from the cask side.

Graphs II and III show the dose rate (millirem/hour) at a distance of six feet from the cask side and at contact with the cask based only on Cobalt-60 radionuclides. (1.25 MeV Average).

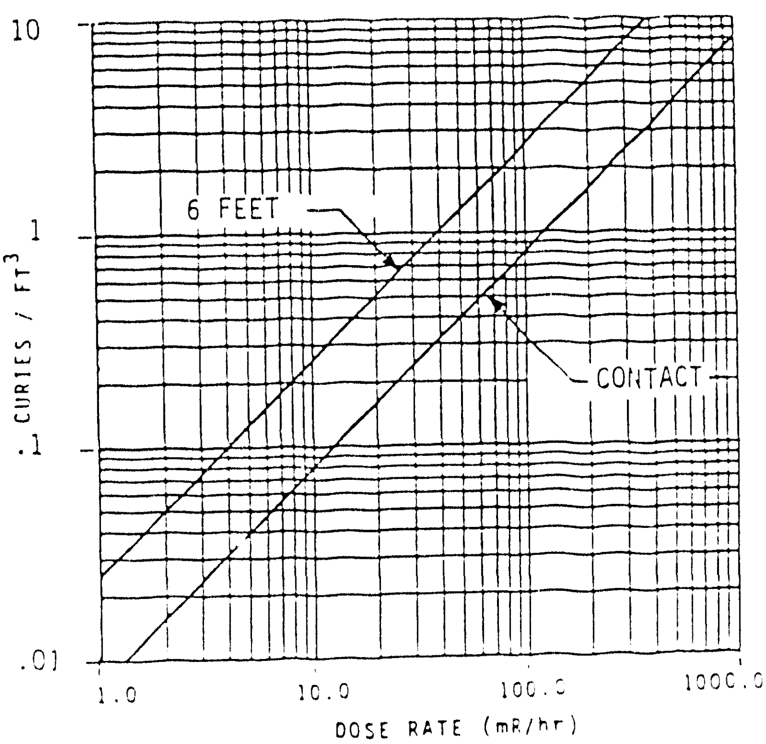
Radiation self absorbtion factors were considered for all graphs. The graphs were based on a resin content density of 1.0 gm/cc and a concrete density of 2.4 gm/cc.

GRAPH II



CONCRETE

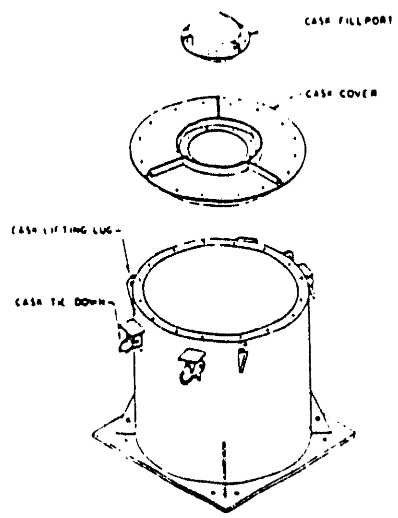
GRAPH III



RESIN

CHEM-NUCLEAR SYSTEMS, INC.

CNS 6-75



CNS 6-75

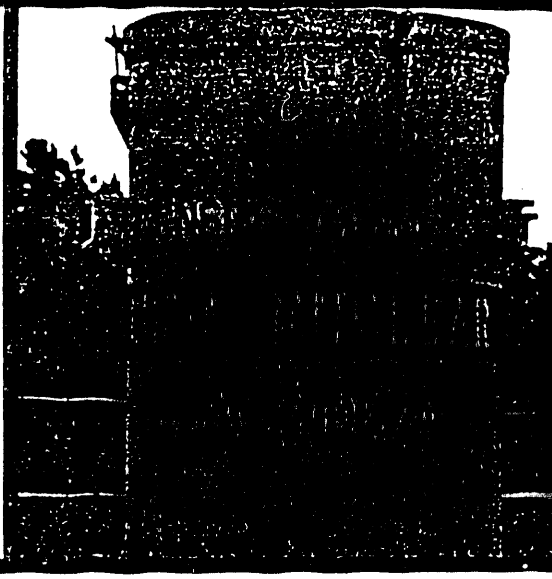
NRC Certificate No. USA/9108/A

Capacity: (6) 55-gallon drums
(1) 85 ft^3 liner
(3) 24" x 72" pressure vessels

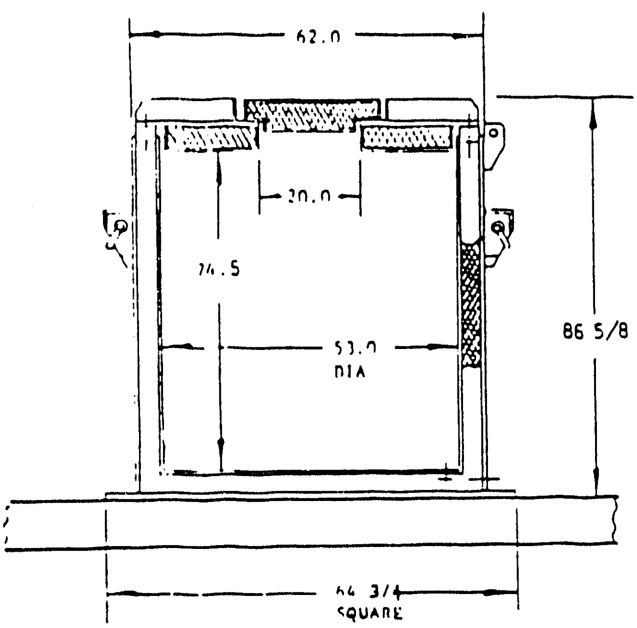
Shielding: 4.0" lead equivalent

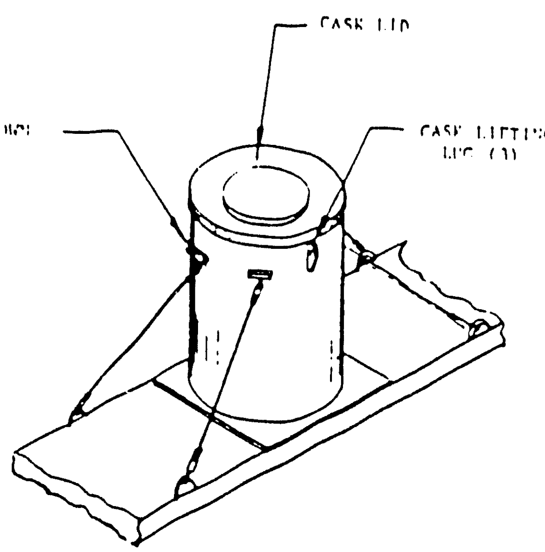
Dose Rate: 235 R/hr
(Maximum based on 10% Cobalt 60)

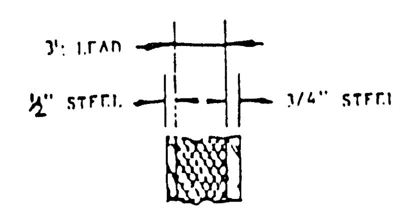
Empty Package Weight (with lids):	31,00#
Cask Lid:	3,800#
Payload Weight:	10,300#



The CNS 6-75 cask is specially designed for transporting greater than Type A quantities of radioactive material.



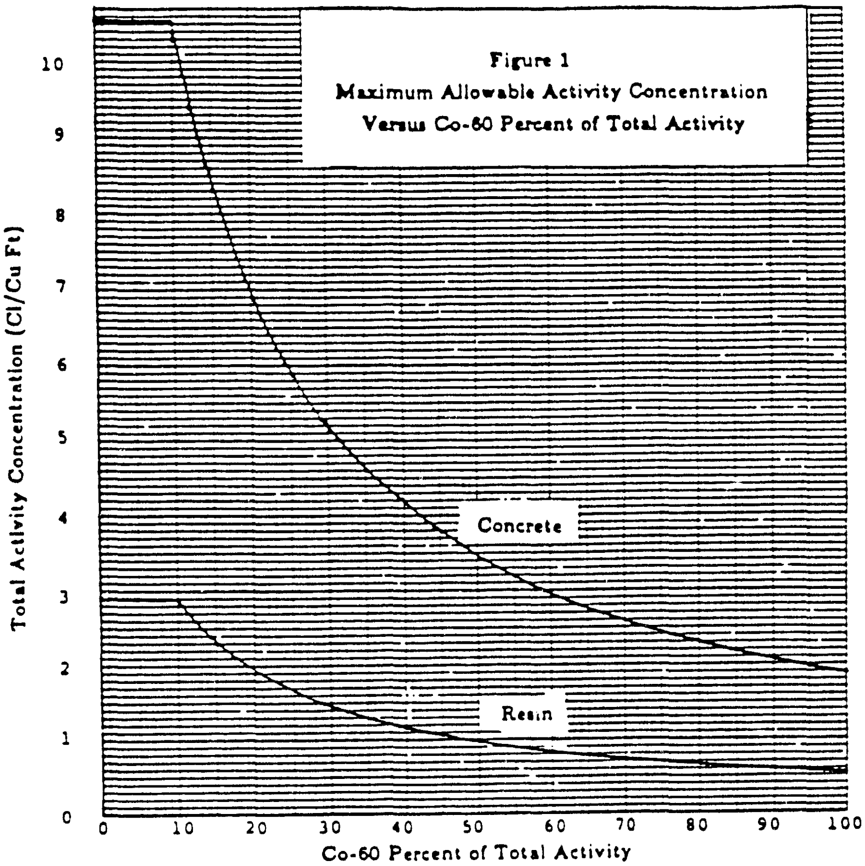


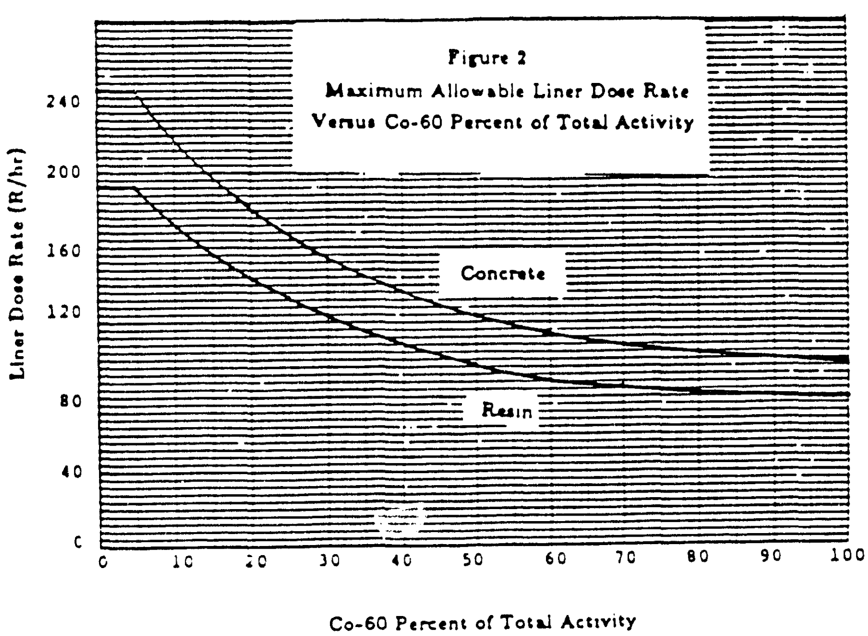


TYP. WALL SECTION

The CNS 6-75 cask is a steel-encased, lead-shielded cylindrical cask for transporting dewatered or solidified waste meeting the requirements of low specific activity material in secondary containers.

Loading: This cask accommodate six (6) standard 55-gallon drums in two (2) tiers of three, or one 85 ft capacity[3] disposable liner.





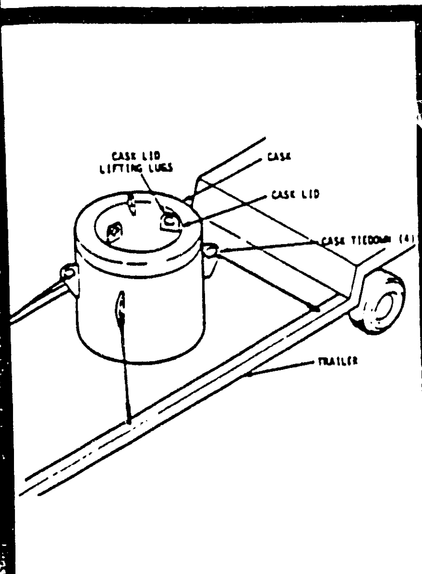
The curves shown at left may be used to determine the maximum activity concentration (Figure 1) and the maximum liner dose rate (Figure 2) which can be shipped in this cask. For a well mixed, uniform concentration of waste, use of these figures will result in compliance with legal dose rates on the cask surface and at a distance of 2 meters from the surface (See Cautionary Note).

These curves are related to the relative concentration of Co-60 in the waste. The Co-60 concentration is obtained from a representative sample of the waste prior to filling a drum or liner. Practical experience shows that Co-60 is a dominant isotope in most mixtures and is the most significant from a shielding standpoint. The conservative assumption is made that the remaining isotopes (other than Co-60) emit one gamma per disintegration with an energy of 1.0 MEV.

Two general types of waste forms are normally shipped, concreted or dewatered resins and filter media. A nominal average density of 2.0 g/cc for concreted wastes and 0.6 g/cc for resins was used in developing the curves.

CAUTIONARY NOTE

The curves include a safety factor (peak-to-average factor) of 2.0 which relates field measurements to shielding calculations assuming uniform waste mixtures. The calculations were made using a comprehensive computer analysis. The field measurements are based on a statistical analysis of a large number of cask shipments. However, due to variations in waste materials, tolerance in measurement instruments, and other real world factors, there is still a large scatter in the peak-to-average factor. Statistically, these curves yield compliance in about 60% of the shipments. To obtain compliance in about 95% of the shipments, multiply the maximum allowable activity concentration and the maximum allowable liner dose rate by 0.6.



CNS 6-80-2

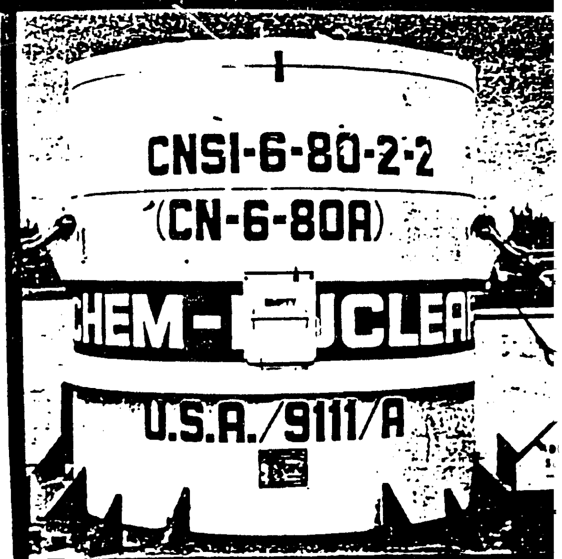
NRC Certificate No. USA/9111/A

Capacity: (4) 55-gallon drums
(1) 80-91 ft^3 liner

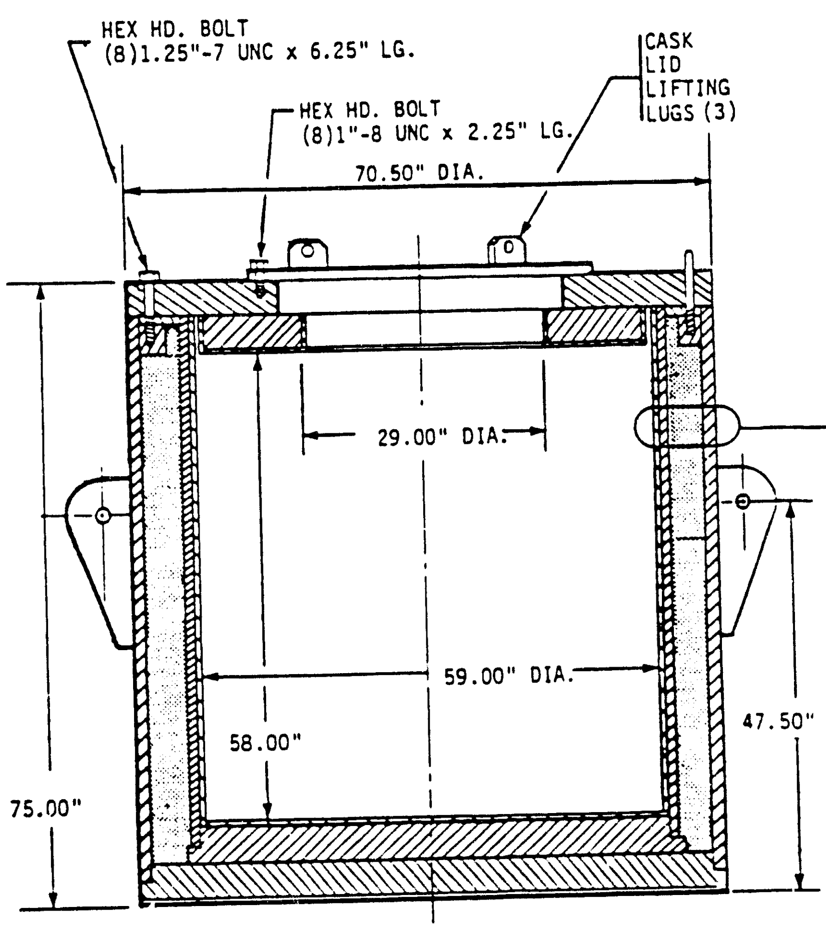
Shielding: 5.00" lead equivalent

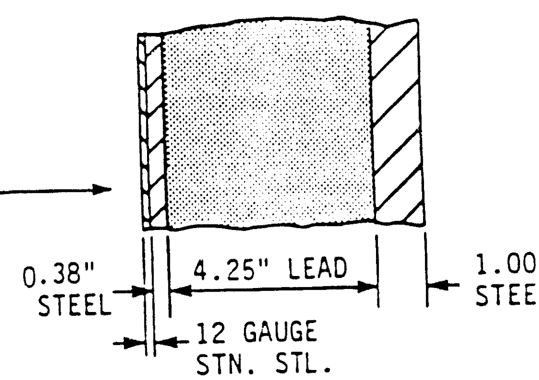
Dose Rate: 1000 R/hr
(Maximum based on Cobalt 60)

Empty Package Weight (with lids):	44,000#
Prim. & sec. lids:	6,100#
Secondary lid:	2,200#
Payload weight:	7,500#



The CNS 6-80-2 cask is specially designed for transporting dewatered and solidified highly radioactive resin.

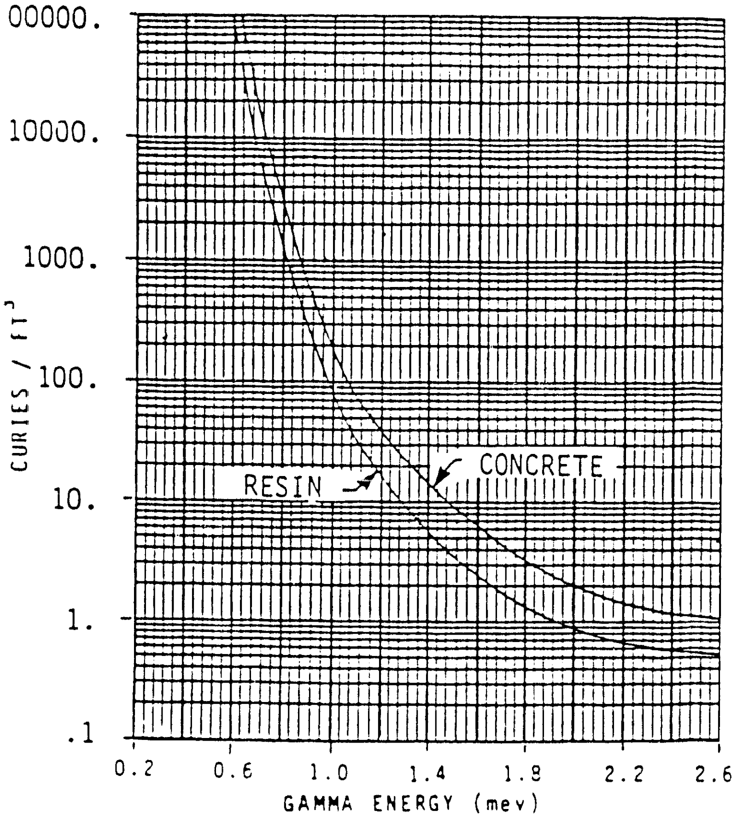




The CNS 6-80-2 cask is a lead and steel shipping cask for dewatered or solidified waste material. The contents may contain greater than Type A quantities of radioactive material but must meet the requirements of low specific activity. The decay heat of the load must not exceed 400 watts (25,000 curies of Cobalt 60).

Loading: (A) Four drums are placed on one pallet located outside of the cask. The pallet is then lowered into the cask. (B) A liner may be loaded while in the cask through the 29 inch diameter access port or placed in the cask after filling. The upright cyclinder cask may also be loaded while mounted on the transport trailer.

GRAPH I

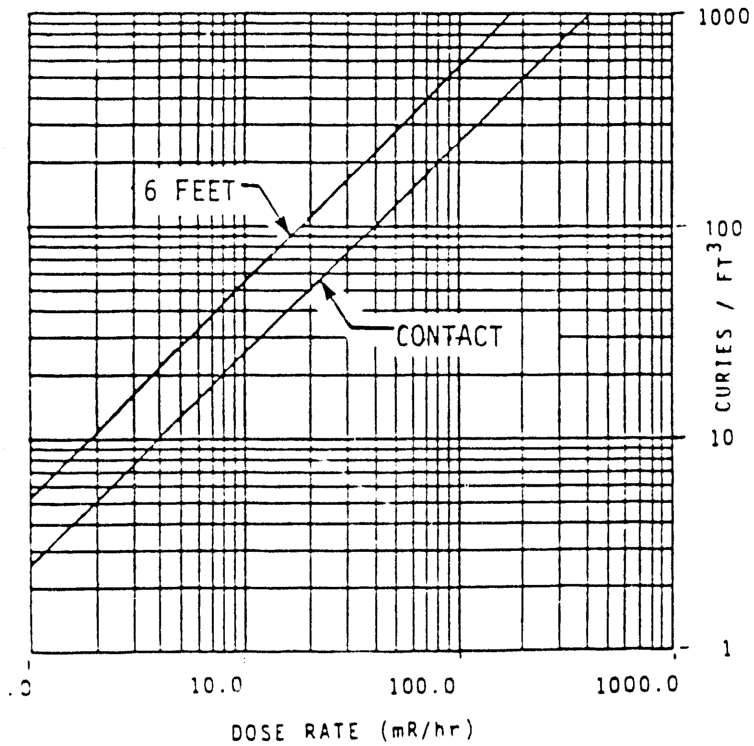


Graph I shows the maximum curie concentration (curies/ft^3) for various gamma emitting radionuclides (MeV) to produce a dose rate of 10 millirem/hour at a distance of six feet from the cask side.

Graphs II and III show the dose rate (millirem/hour) at a distance of six feet from the cask side and at contact with the cask based only on Cobalt-60 radionuclides. (1.25 MeV Average).

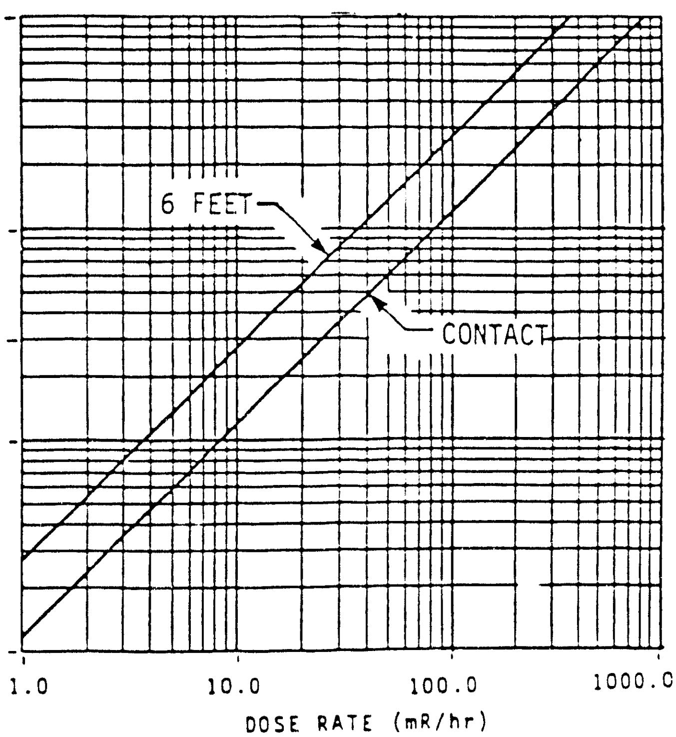
Radiation self absorbtion factors were considered for all graphs. The graphs were based on a resin content density of 1.0 gm/cc and a concrete density of 2.4 gm/cc.

GRAPH II



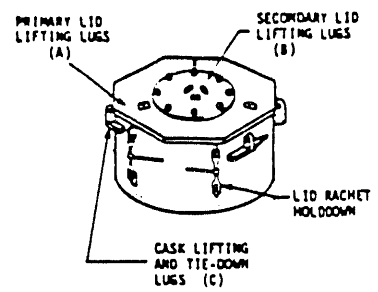
CONCRETE

GRAPH III



RESIN

CHEM-NUCLEAR SYSTEMS, INC. — CNS 7-100



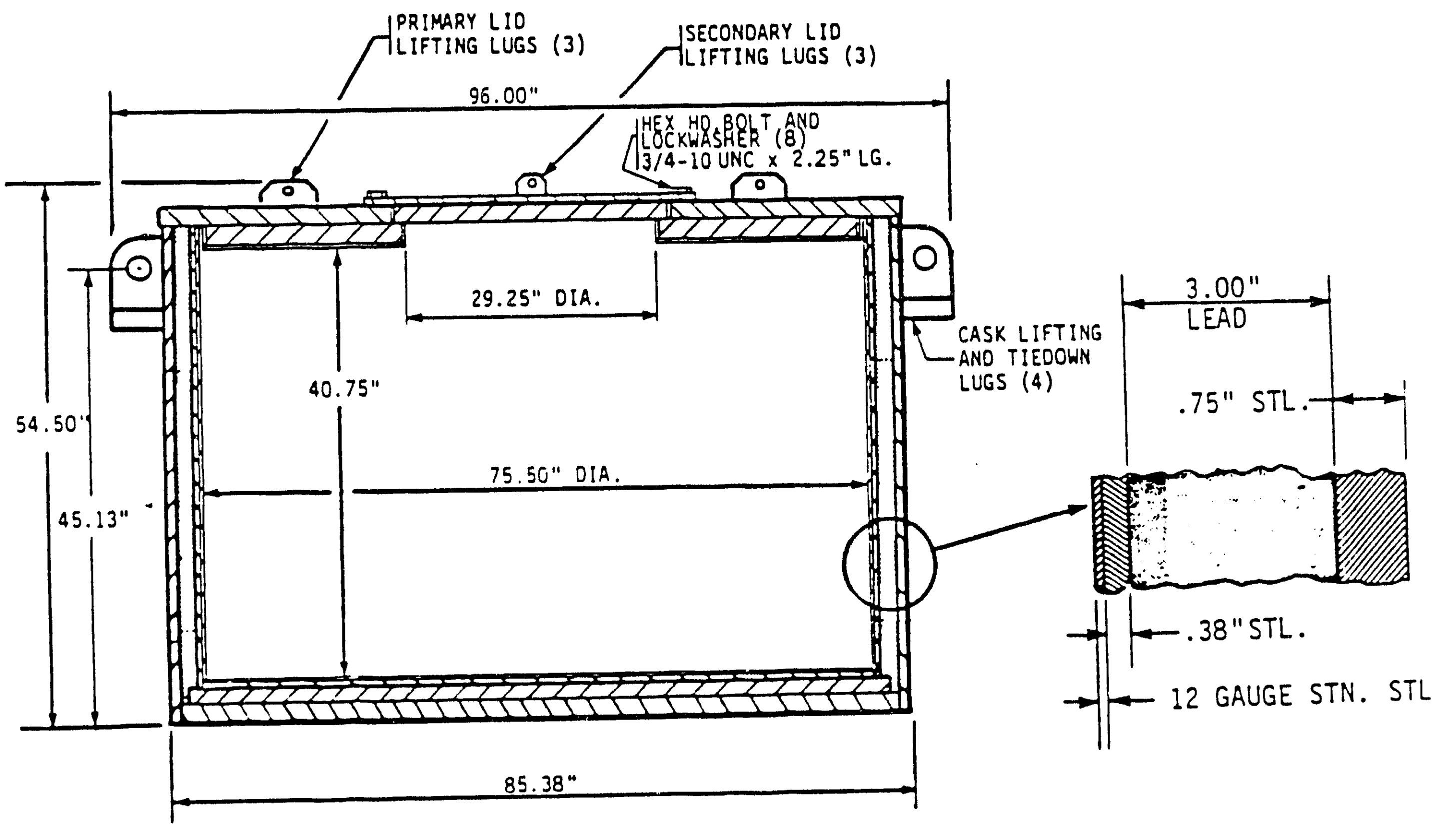
CNS 7-100

NRC Certificate No. USA/9080/A

Capacity:	(7) 55-gallon drums
	(1) 85-100 ft^3 liner
Shielding:	3.50" lead equivalent
Dose Rate:	190 R/hr (approx.)
	(Maximum based on 10% Cobalt 60)

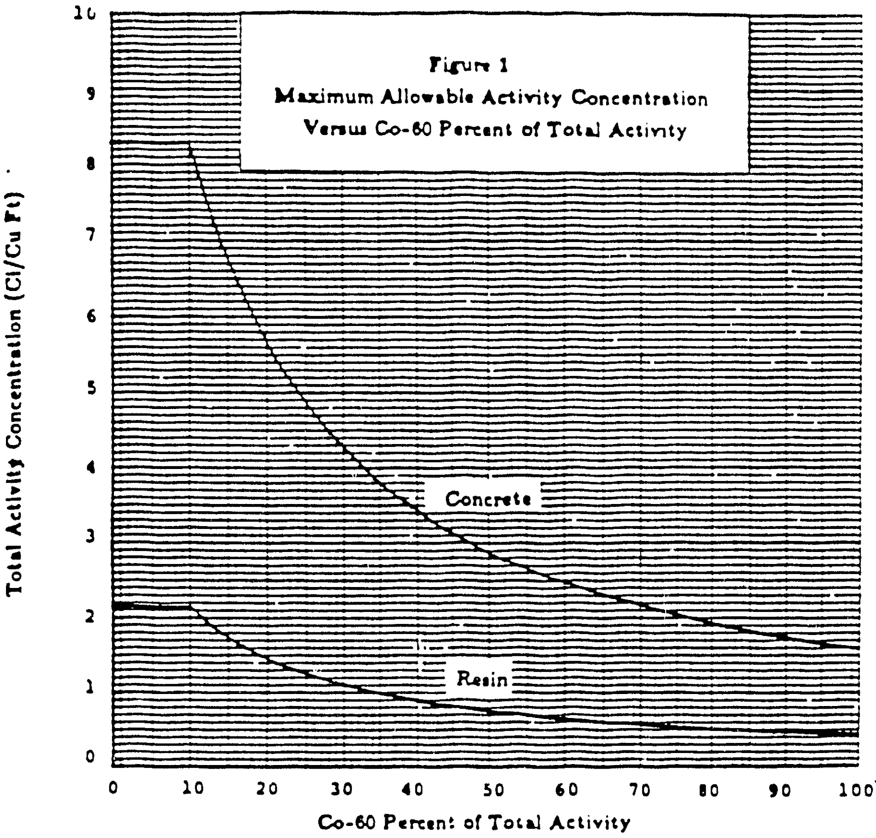
Empty Package Weight (with lids):	35,500#
Primary and Secondary lids:	15,750#
Secondary lid:	850#
Payload Weight:	13,000#

The CNS 7-100 cask is specially designed for transporting solidified radioactive waste material.



The CNS 7-100 cask is a lead and steel shipping cask for dewatered or solidified waste material. The contents may contain greater than Type A quantities of radioactive material but must meet the requirements of low specific activity.

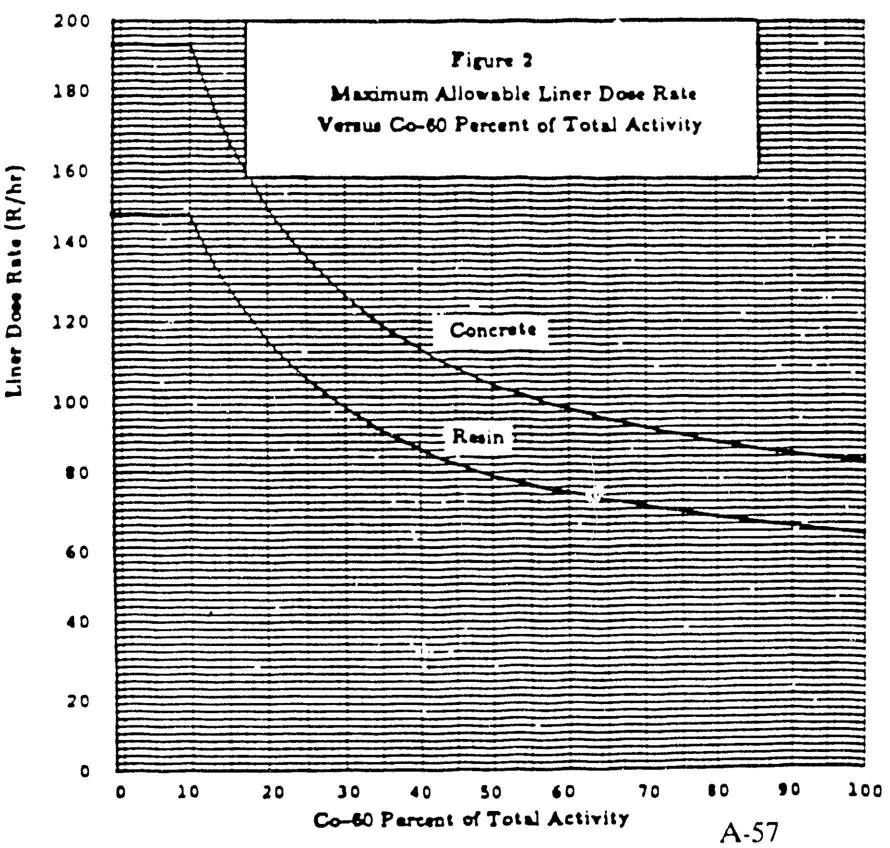
Loading: (A) Seven drums are placed on one pallet located outside the cask. The pallet is then lowered into the cask. (B) A liner may be loaded while in the cask through the 29 inch diameter access port or placed in the cask after filling. The upright cylinder cask may also be loaded while amounted on the transport trailer.



The curves shown at left may be used to determine the maximum activity concentration (Figure 1) and the maximum liner dose rate (Figure 2) which can be shipped in this cask. For a well mixed, uniform concentration of waste, use of these figures will result in compliance with legal dose rates on the cask surface and at a distance of 2 meters from the surface (See Cautionary Note).

These curves are related to the relative concentration of Co-60 in the waste. The Co-60 concentration is obtained from a representative sample of the waste prior to filling a drum or liner. Practical experience shows that Co-60 is a dominant isotope in most mixtures and is the most significant from a shielding standpoint. The conservative assumption is made that the remaining isotopes (other than Co-60) emit one gamma per disintegration with an energy of 1.0 MEV

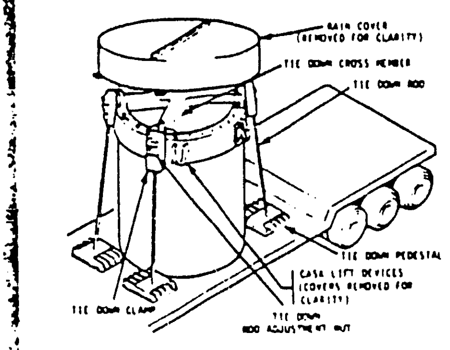
Two general types of waste forms are normally shipped, concreted or dewatered resins and filter media. A nominal average density of 2.0 g/cc for concreted wastes and 0.6 g/cc for resins was used in developing the curves



CAUTIONARY NOTE

The curves include a safety factor (peak-to-average factor) of 2.0 which relates field measurements to shielding calculations assuming uniform waste mixtures. The calculations were made using a comprehensive computer analysis The field measurements are based on a statistical analysis of a large number of cask shipments. However, due to variations in waste materials, tolerance in measurement instruments, and other real world factors, there is still a large scatter in the peak-to-average factor. Statistically, these curves yield compliance in about 60% of the shipments. To obtain compliance in about 95% of the shipments, multiply the maximum allowable activity concentration and the maximum allowable liner dose rate by 0 6.

CHEM-NUCLEAR SYSTEMS, INC. — CNS 8-120A

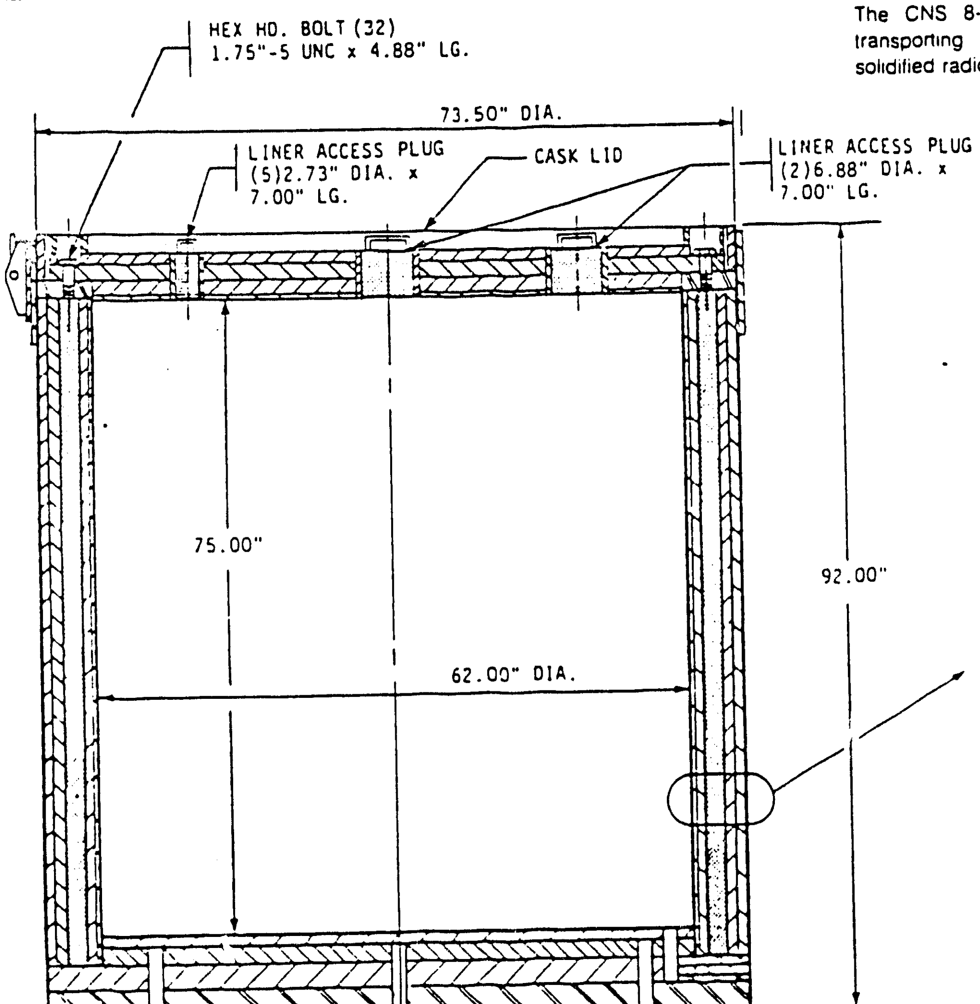


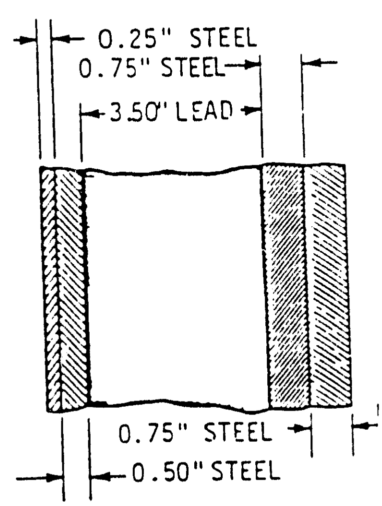
CNS 8-120A

NRC Certificate No. USA/6601/A( )

Capacity:	(8) 55-gallon drums
	(1) 120-130 ft^3 liner
Shielding:	4.50" lead equivalent
Dose Rate:	880 R/hr (approx.) (Maximum based on 10% Cobalt 60)
Empty Package Weight (with lids):	54,000#
Cask lid weight:	8,450#
Payload Weight:	20,000#

The CNS 8-120A cask is specially designed for transporting Type A quantities of dewatered or solidified radioactive waste.





The CNS 8-120 cask is a lead and steel shipping cask for dewatered or solidified waste material or activated reactor components. The contents may contain Type A quantities of low specific activity material. The decay heat of the content must not exceed 40 watts.

Loading: (A) Four drums are placed on each of the two pallets located outside of the cask. The pallets are then lowered into the cask. (B) Activated reactor components contained in a disposable liner may be loaded into this cask underwater. (C) A liner may be loaded while in the cask through the 7.5 inch diameter access port or placed in the cask after filling. The upright cylinder cask may also be loaded while mounted on the transport trailer

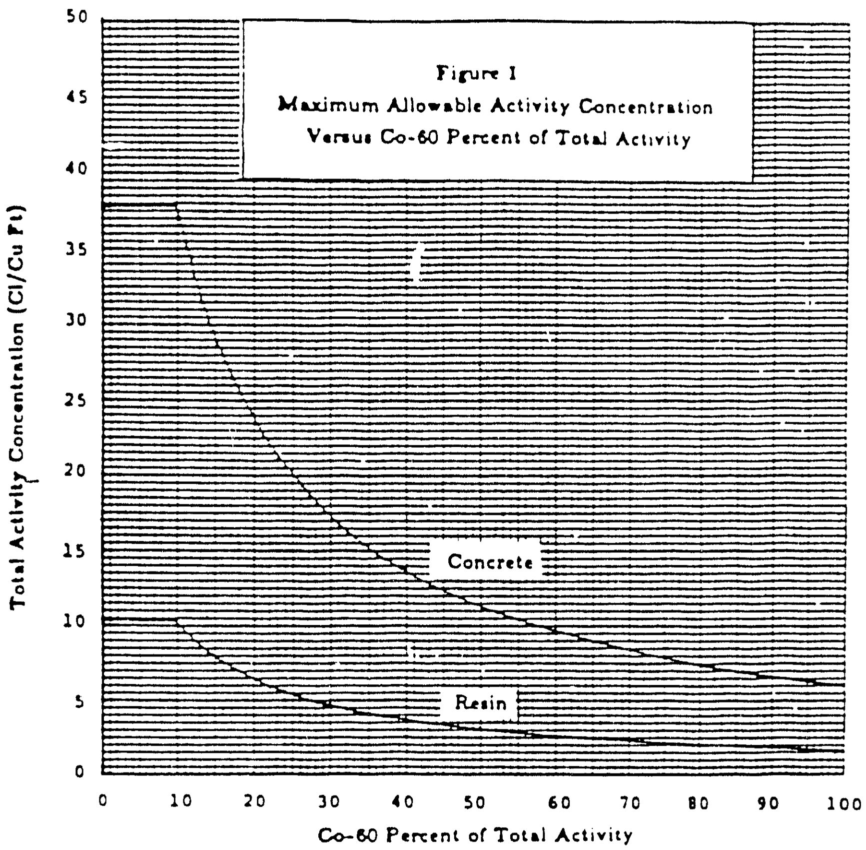


Figure 1
Maximum Allowable Activity Concentration Versus Co-60 Percent of Total Activity

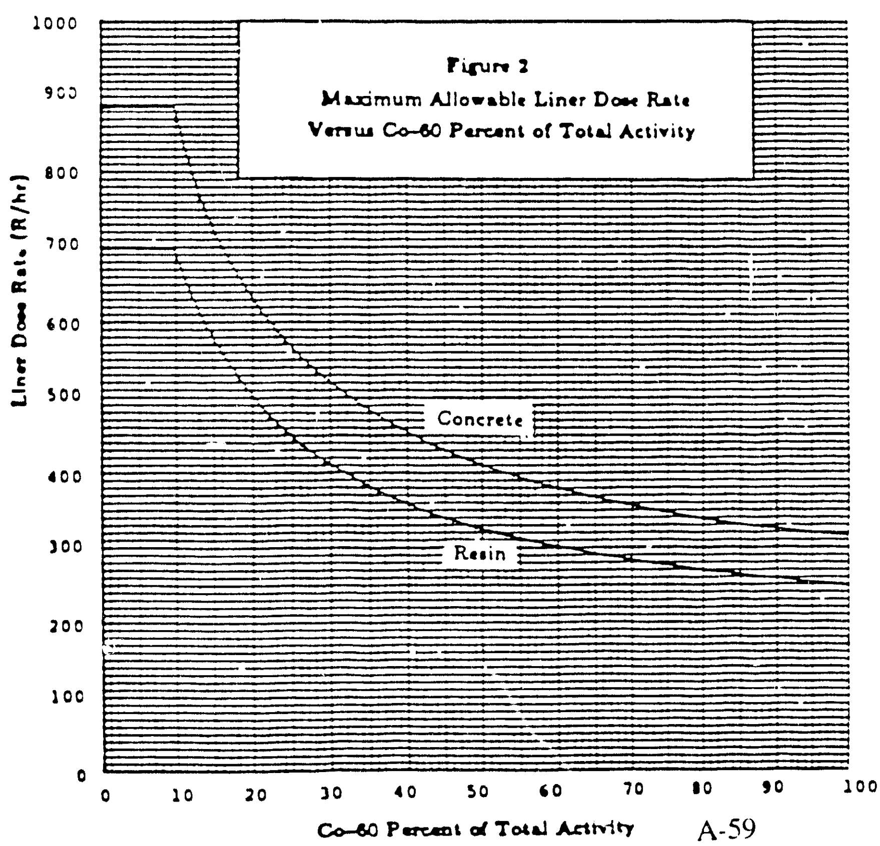


Figure 2
Maximum Allowable Liner Dose Rate Versus Co-60 Percent of Total Activity

The curves shown at left may be used to determine the maximum activity concentration (Figure 1) and the maximum liner dose rate (Figure 2) which can be shipped in this cask. For a well mixed, uniform concentration of waste, use of these figures will result in compliance with legal dose rates on the cask surface and at a distance of 2 meters from the surface (See Cautionary Note)

These curves are related to the relative concentration of Co-60 in the waste. The Co-60 concentration is obtained from a representative sample of the waste prior to filling a drum or liner. Practical experience shows that Co-60 is a dominant isotope in most mixtures and is the most significant from a shielding standpoint. The conservative assumption is made that the remaining isotopes (other than Co-60) emit one gamma per disintegration with an energy of 1.0 MEV.

Two general types of waste forms are normally shipped, concreted or dewatered resins and filter media. A nominal average density of 2.0 g/cc for concreted wastes and 0.6 g/cc for resins was used in developing the curves

CAUTIONARY NOTE

The curves include a safety factor (peak-to-average factor) of 2.0 which relates field measurements to shielding calculations assuming uniform waste mixtures. The calculations were made using a comprehensive computer analysis. The field measurements are based on a statistical analysis of a large number of cask shipments. However, due to variations in waste materials, tolerance in measurement instruments, and other real world factors, there is still a large scatter in the peak-to-average factor. Statistically, these curves yield compliance in about 60% of the shipments. To obtain compliance in about 95% of the shipments, multiply the maximum allowable activity concentration and the maximum allowable liner dose rate by 0.6

CHEM-NUCLEAR SYSTEMS, INC.

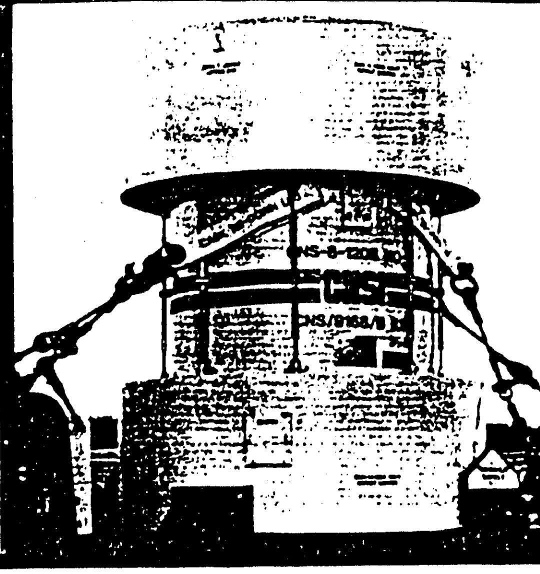
CNS 8-120B

CNS 8-120B

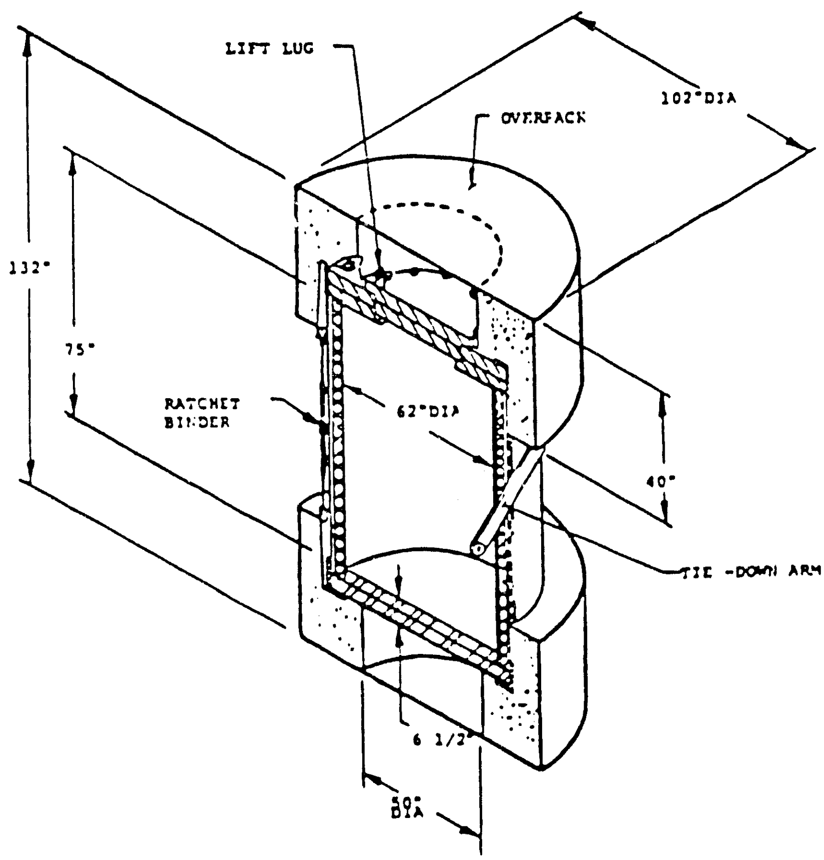
NRC Certificate No. USA/9168/B(U)

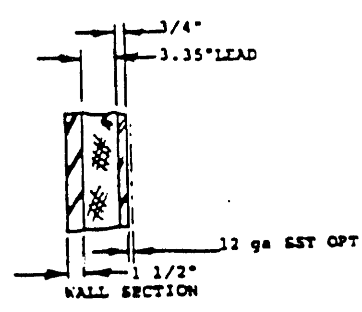
Capacity:	(8) 55-gallon drums (1) 120-130 ft^3 liner (4) 24" x 72" pressure vessels
Shielding:	4.5" lead equivalent
Dose Rate:	880 R/hr (Maximum based on 10% Cobalt 60)

Empty Package Weight (with lids):	49,300#
Primary and Secondary lids:	7,080#
Secondary lid:	1,890#
Payload Weight:	14,680#



The CNS 8-120B cask is specially designed for transporting Type B quantities of dewatered and solidified highly radioactive resin.





The CNS 8-120B cask is a lead and steel shipping cask for dewatered or solidified waste material or activated reactor components contained within secondary container(s). The contents may contain greater than Type A quantities of radioactive material.

Loading: (A) Four drums are placed on each of the two pallets located outside the cask. The pallets are then lowered into the cask. (B) Activated reactor components contained in a disposable liner may be loaded into this cask underwater. The upper right cylinder cask may be loaded while mounted on the transport trailer.

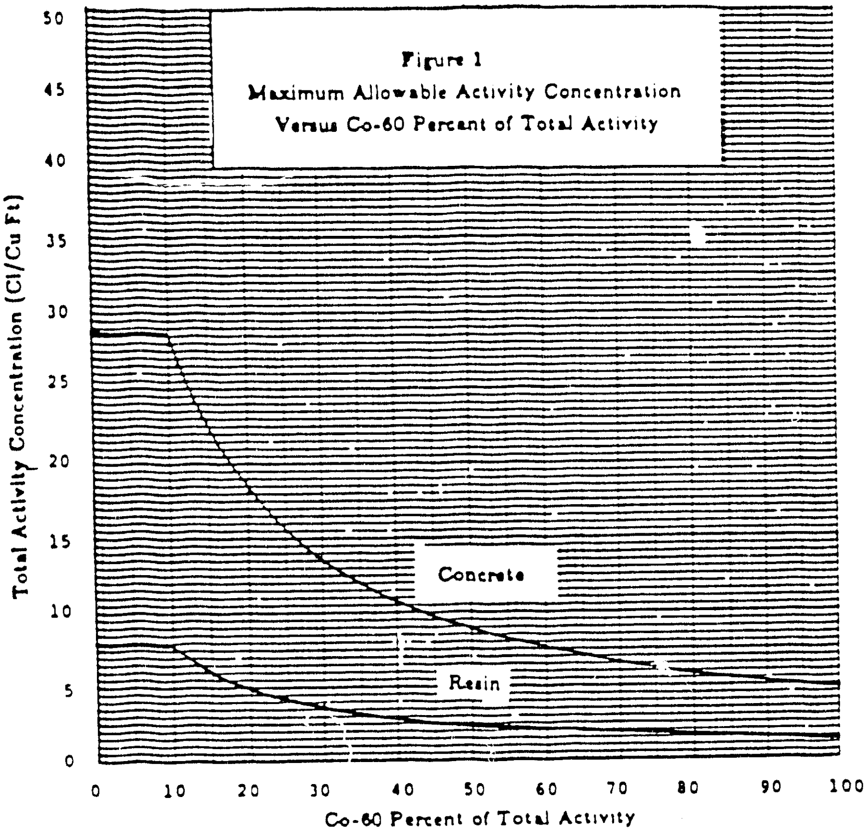


Figure 1
Maximum Allowable Activity Concentration
Versus Co-60 Percent of Total Activity

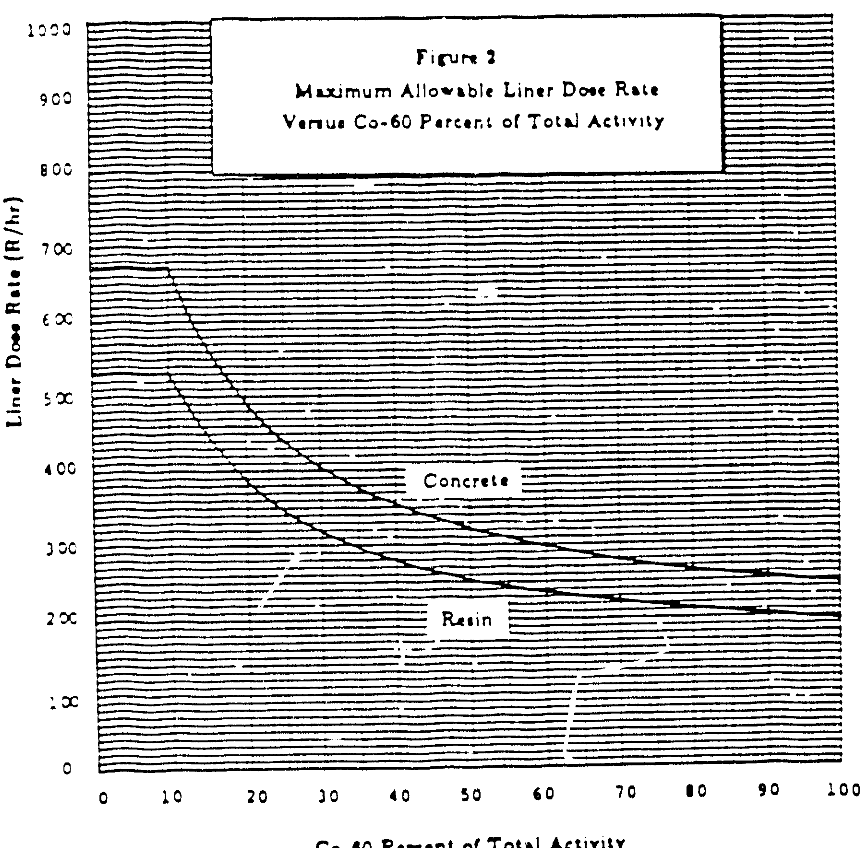


Figure 2
Maximum Allowable Liner Dose Rate
Versus Co-60 Percent of Total Activity

The curves shown at left may be used to determine the maximum activity concentration (Figure 1) and the maximum liner dose rate (Figure 2) which can be shipped in this cask. For a well mixed, uniform concentration of waste, use of these figures will result in compliance with legal dose rates on the cask surface and at a distance of 2 meters from the surface (See Cautionary Note)

These curves are related to the relative concentration of Co-60 in the waste. The Co-60 concentration is obtained from a representative sample of the waste prior to filling a drum or liner. Practical experience shows that Co-60 is a dominant isotope in most mixtures and is the most significant from a shielding standpoint. The conservative assumption is made that the remaining isotopes (other than Co-60) emit one gamma per disintegration with an energy of 1.0 MEV

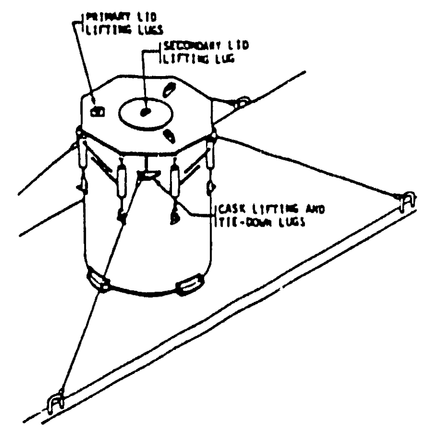
Two general types of waste forms are normally shipped, concreted or dewatered resins and filter media. A nominal average density of 2.0 g/cc for concreted wastes and 0.6 g/cc for resins was used in developing the curves

CAUTIONARY NOTE

The curves include a safety factor (peak-to-average factor) of 2.0 which relates field measurements to shielding calculations assuming uniform waste mixtures. The calculations were made using a comprehensive computer analysis. The field measurements are based on a statistical analysis of a large number of cask shipments. However, due to variations in waste materials, tolerance in measurement instruments, and other real world factors, there is still a large scatter in the peak-to-average factor. Statistically, these curves yield compliance in about 60% of the shipments. To obtain compliance in about 95% of the shipments, multiply the maximum allowable activity concentration and the maximum allowable liner dose rate by 0.6

CHEM-NUCLEAR SYSTEMS, INC.

CNS 14-170
SERIES II

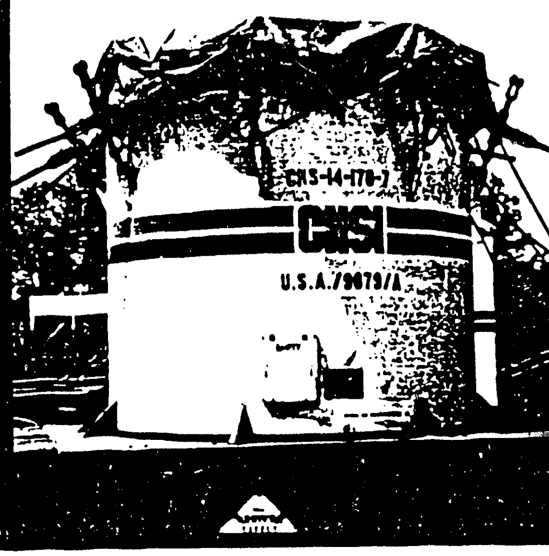


CNS 14-170

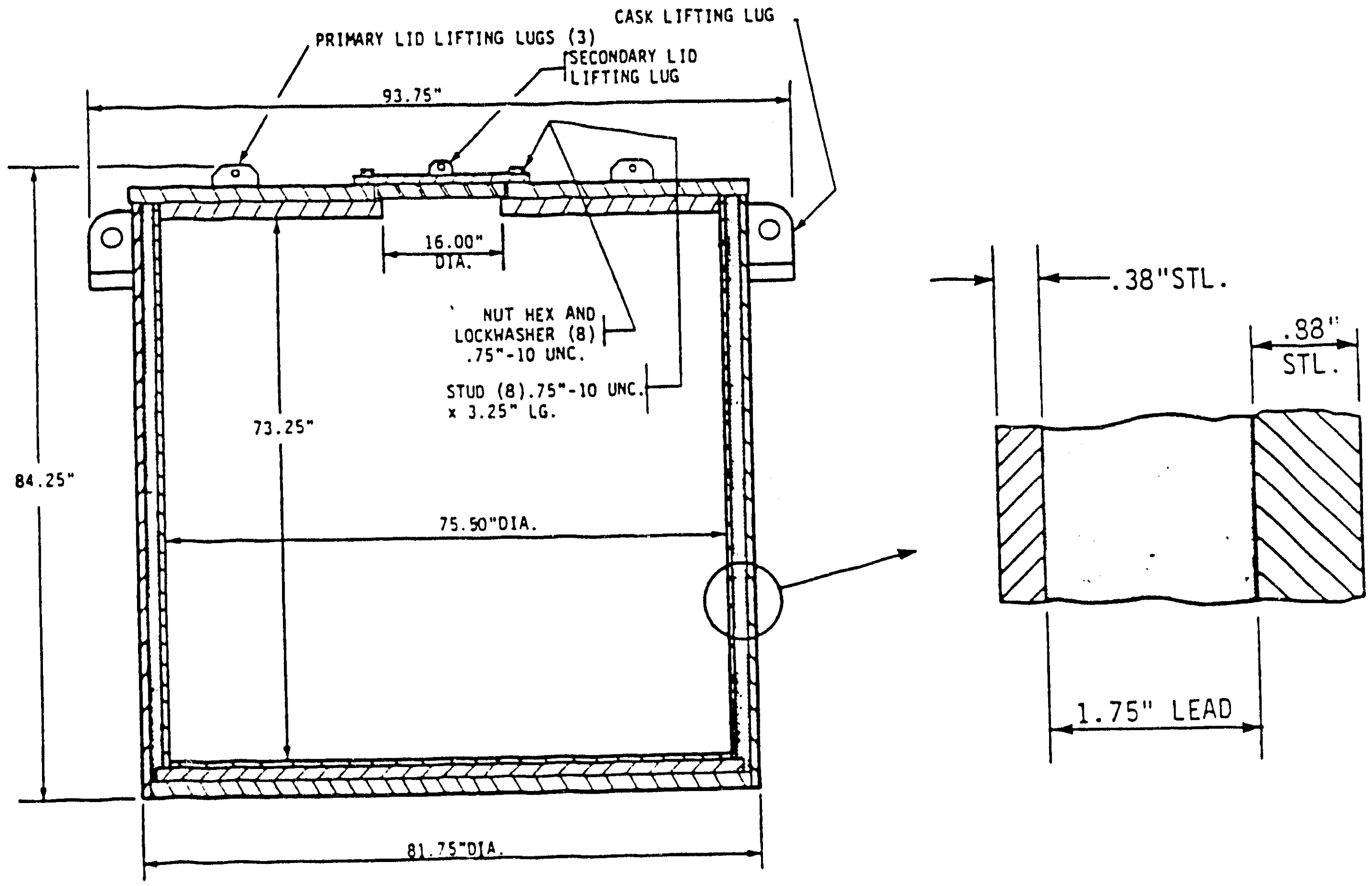
NRC Certificate No. USA/9079/A

Capacity:	(14) 55-gallon drums
	(1) 170-185 ft^3 liner
Shielding:	2.13" lead equivalent
Dose Rate:	15 R/hr (approx.)
	(Maximum based on 10% Cobalt 60)

Empty Package Weight (with lids):	33,800#
Primary and Secondary lids:	5,600#
Secondary lid:	400#
Payload Weight:	14,000#



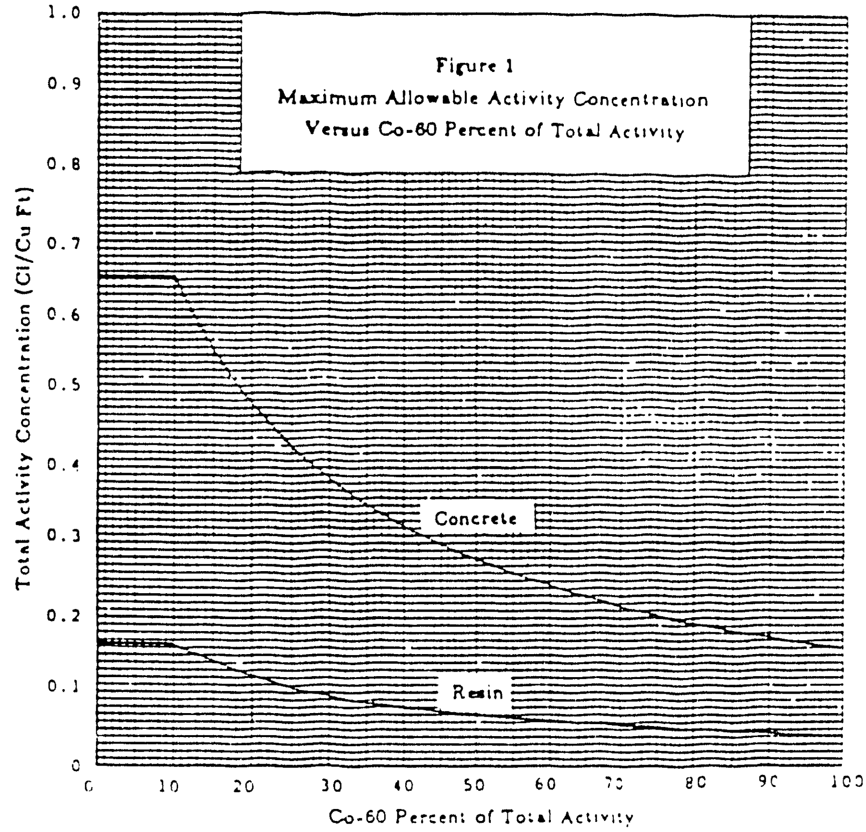
The CNS 14-170 cask is specially designed for transporting solidified drums of low level radioactive waste material.

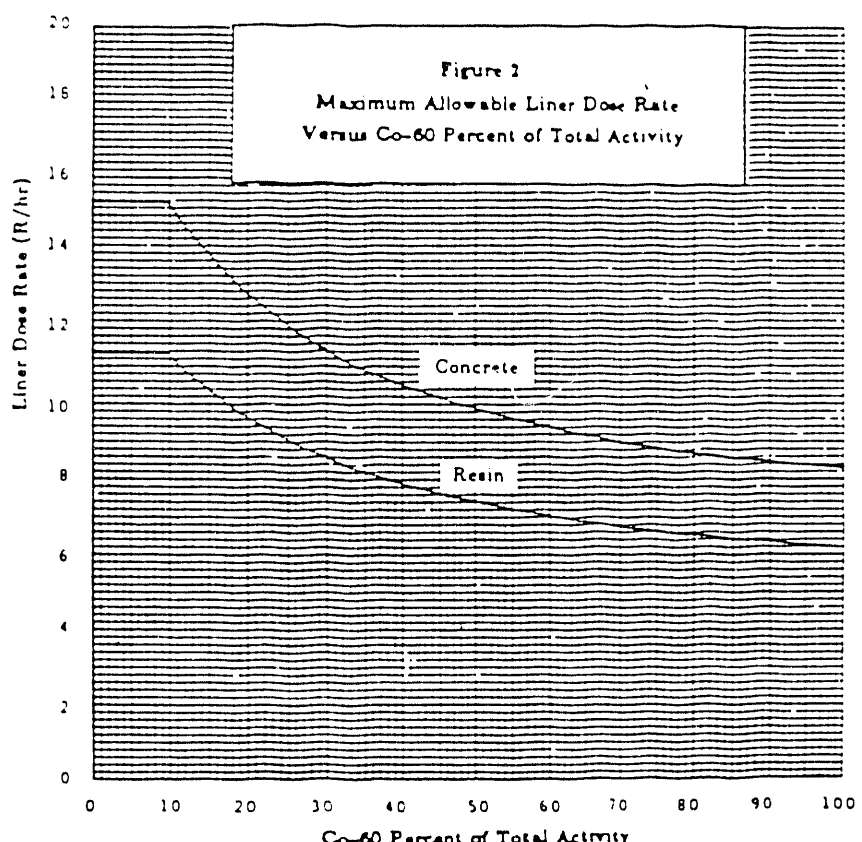


The CNS 14-170 cask is a lead and steel cask for dewatered or solidified waste material. The contents may contain greater than Type A quantities of radioactive material but must meet the requirements of low specific activity. Maximum decay heat load must not exceed 7 watts.

Loading: (A) Seven drums are placed on each of the two pallets located outside of the cask. The pallets are then lowered into the cask. (B) A liner may be loaded while in the cask through the 16 inch diameter access port or placed in the cask after filling. The upright cylinder cask may also be loaded while mounted on the transport trailer.

Rev 1





The curves shown at left may be used to determine the maximum activity concentration (Figure 1) and the maximum liner dose rate (Figure 2) which can be shipped in this cask. For a well mixed, uniform concentration of waste, use of these figures will result in compliance with legal dose rates on the cask surface and at a distance of 2 meters from the surface (See Cautionary Note).

These curves are related to the relative concentration of Co-60 in the waste. The Co-60 concentration is obtained from a representative sample of the waste prior to filling a drum or liner. Practical experience shows that Co-60 is a dominant isotope in most mixtures and is the most significant from a shielding standpoint. The conservative assumption is made that the remaining isotopes (other than Co-60) emit one gamma per disintegration with an energy of 1.0 MEV.

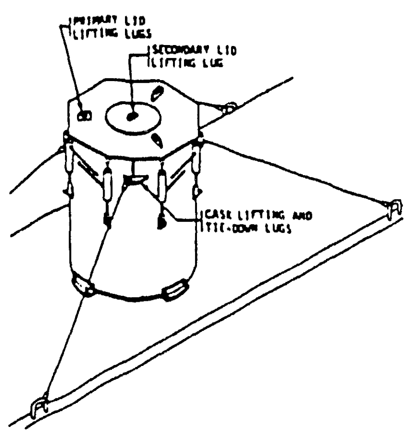
Two general types of waste forms are normally shipped, concreted or dewatered resins and filter media. A nominal average density of 2.0 g/cc for concreted wastes and 0.6 g/cc for resins was used in developing the curves.

CAUTIONARY NOTE

The curves include a safety factor (peak-to-average factor) of 2.0 which relates field measurements to shielding calculations assuming uniform waste mixtures. The calculations were made using a comprehensive computer analysis. The field measurements are based on a statistical analysis of a large number of cask shipments. However, due to variations in waste materials, tolerance in measurement instruments, and other real world factors, there is still a large scatter in the peak-to-average factor. Statistically, these curves yield compliance in about 60% of the shipments. To obtain compliance in about 95% of the shipments, multiply the maximum allowable activity concentration and the maximum allowable liner dose rate by 0.6.

CHEM-NUCLEAR SYSTEMS, INC.

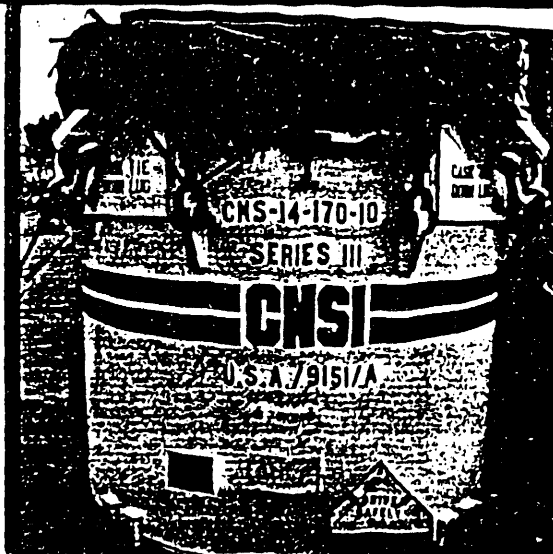
CNS 14-170
SERIES III



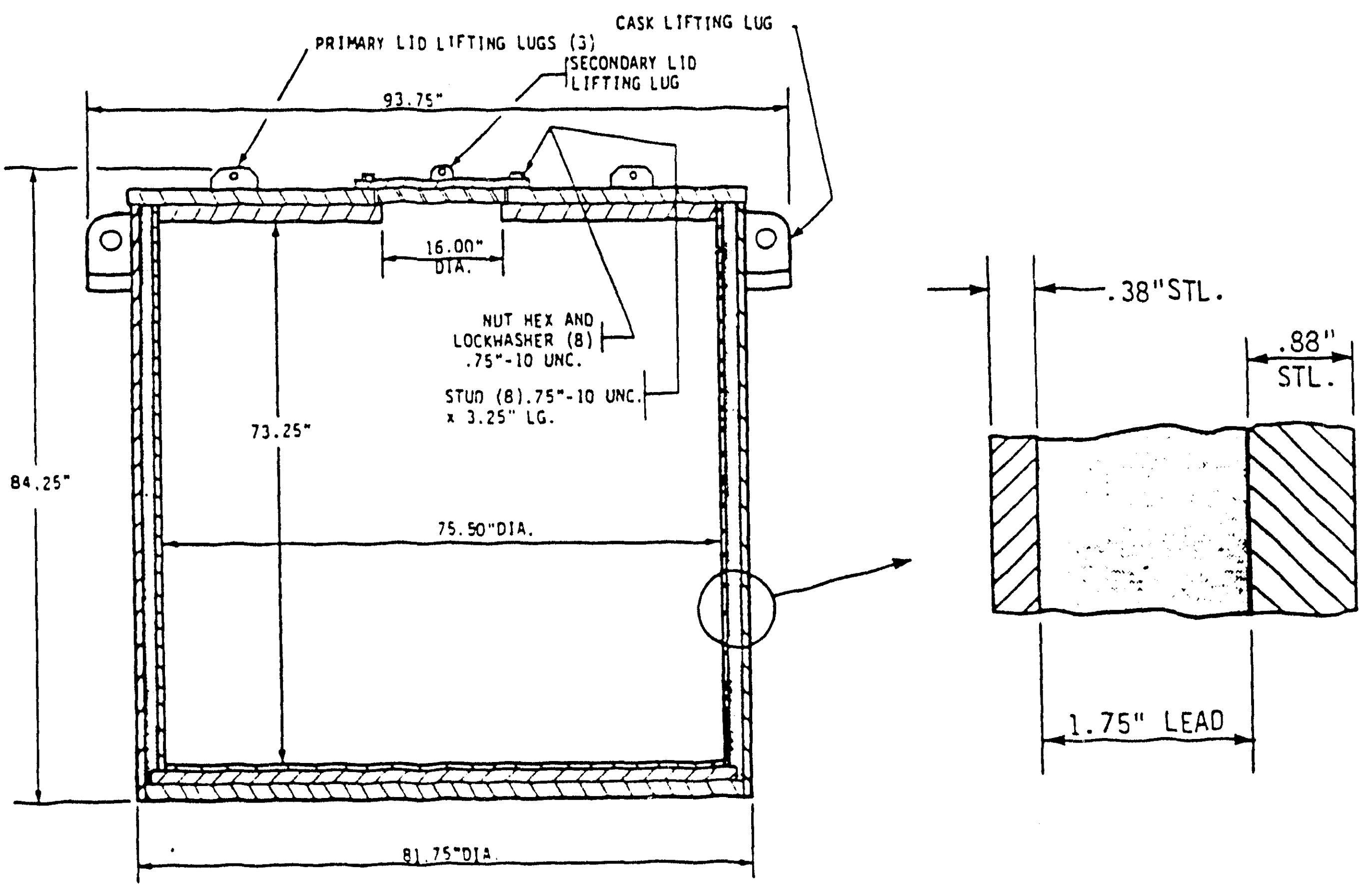
CNS 14-170

NRC Certificate No. USA/9151/A

Capacity:	(14) 55-gallon drums	
	(1) 170-185 ft^3 liner	
Shielding:	2.13" lead equivalent	
Dose Rate:	15 R/hr (approx.)	
(Maximum based on 10% Cobalt 60)		
Empty Package Weight (with lids):		33,800#
Primary and Secondary lids:		5,550#
Secondary lid:		375#
Payload Weight:		19,205#



The CNS 14-170 cask is specially designed for transporting solidified drums of low level radioactive waste material.



The CNS 14-170 cask is a lead and steel cask for dewatered or solidified waste material. The contents may contain greater than Type A quantities of radioactive material but must meet the requirements of low specific activity. Maximum decay heat load must not exceed 7 watts.

Loading: (A) Seven drums are placed on each of the two pallets located outside of the cask. The pallets are then lowered into the cask. (B) A liner may be loaded while in the cask through the 16 inch diameter access port or placed in the cask after filling. The upright cylinder cask may also be loaded while mounted on the transport trailer.

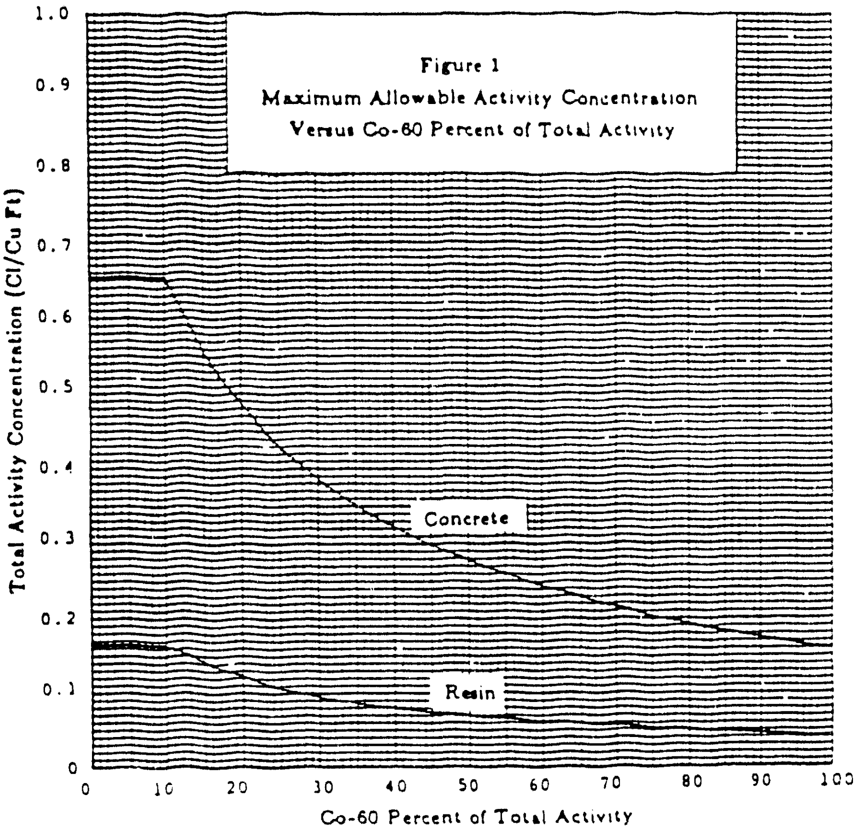


Figure 1
Maximum Allowable Activity Concentration
Versus Co-60 Percent of Total Activity

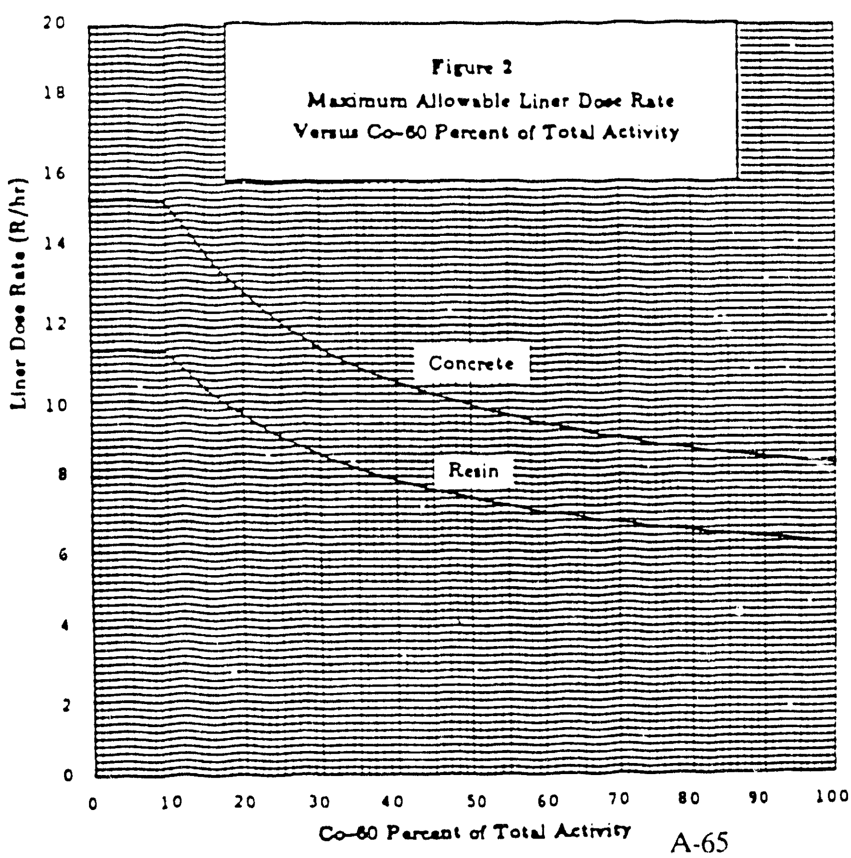


Figure 2
Maximum Allowable Liner Dose Rate
Versus Co-60 Percent of Total Activity

The curves shown at left may be used to determine the maximum activity concentration (Figure 1) and the maximum liner dose rate (Figure 2) which can be shipped in this cask. For a well mixed, uniform concentration of waste, use of these figures will result in compliance with legal dose rates on the cask surface and at a distance of 2 meters from the surface (See Cautionary Note)

These curves are related to the relative concentration of Co-60 in the waste. The Co-60 concentration is obtained from a representative sample of the waste prior to filling a drum or liner. Practical experience shows that Co-60 is a dominant isotope in most mixtures and is the most significant from a shielding standpoint. The conservative assumption is made that the remaining isotopes (other than Co-60) emit one gamma per disintegration with an energy of 1.0 MEV

Two general types of waste forms are normally shipped, concreted or dewatered resins and filter media. A nominal average density of 2.0 g/cc for concreted wastes and 0.6 g/cc for resins was used in developing the curves.

CAUTIONARY NOTE

The curves include a safety factor (peak-to-average factor) of 2.0 which relates field measurements to shielding calculations assuming uniform waste mixtures. The calculations were made using a comprehensive computer analysis. The field measurements are based on a statistical analysis of a large number of cask shipments. However, due to variations in waste materials, tolerance in measurement instruments, and other real world factors, there is still a large scatter in the peak-to-average factor. Statistically, these curves yield compliance in about 60% of the shipments. To obtain compliance in about 95% of the shipments, multiply the maximum allowable activity concentration and the maximum allowable liner dose rate by 0.6

CHEM-NUCLEAR SYSTEMS, INC.

CNS 14-190H

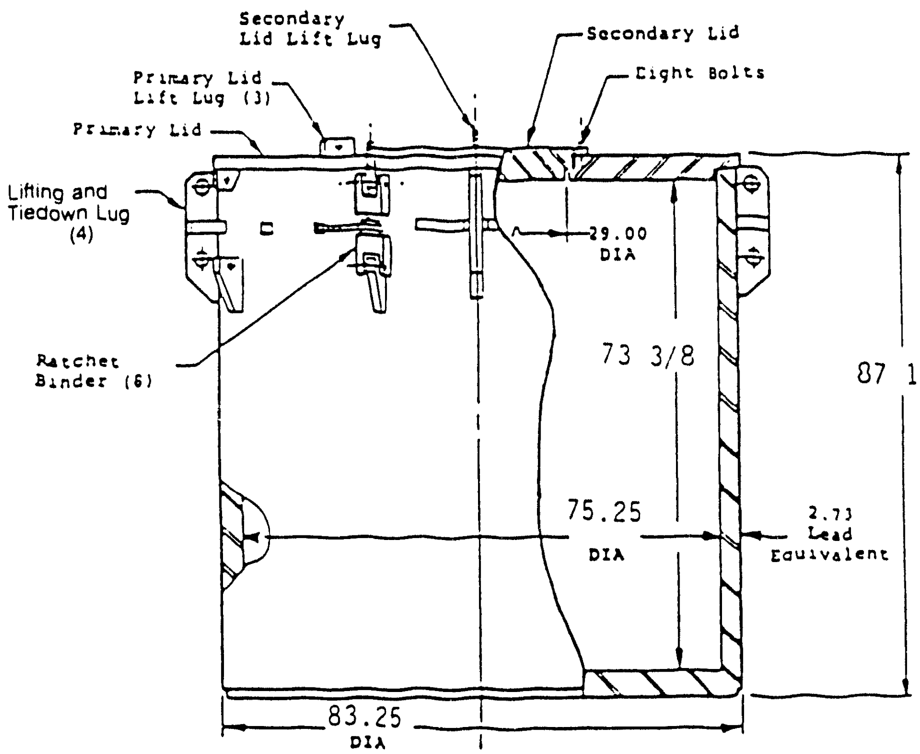
CNS 14-190H

NRC Certificate No. USA/9159/A

Capacity: (14) 55-gallon drums
(1) $170 ft^3$ container
Shielding: 3.5" lead equivalent
Dose Rate: 80 R/hr
(Maximum based on 10% Cobalt 60)

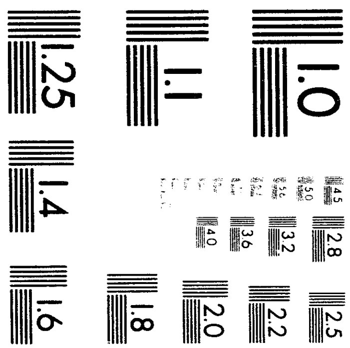
Empty Package Weight (with lids):	45,200#
Primary and secondary lids:	7,520#
Secondary lid:	550#
Payload Weight:	20,000#

The CNS 14-190H cask is designed for transporting dewatered and solidified low specific activity material.



The CNS 14-190H cask is a lead and steel cask for dewatered, solids, or solidified waste meeting the requirements for low specific activity material, in secondary containers. The contents may contain greater than Type A quantities of radioactive material, but must meet the requirements of low specific activity.

Loading: (A) Seven drums are placed on each of the two pallets located outside the cask. The pallets are then lowered into the cask. The upright cylinder may also be loaded while mounted on the transport trailer


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0

2 of 5

Figure 1
Maximum Allowable Activity Concentration Versus Co-60 Percent of Total Activity

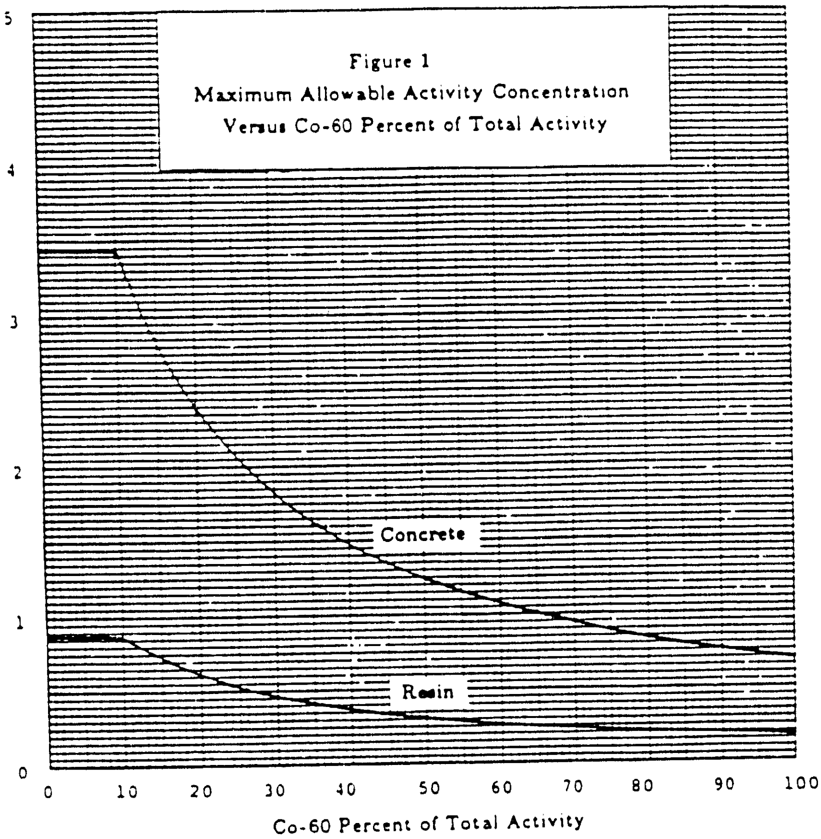
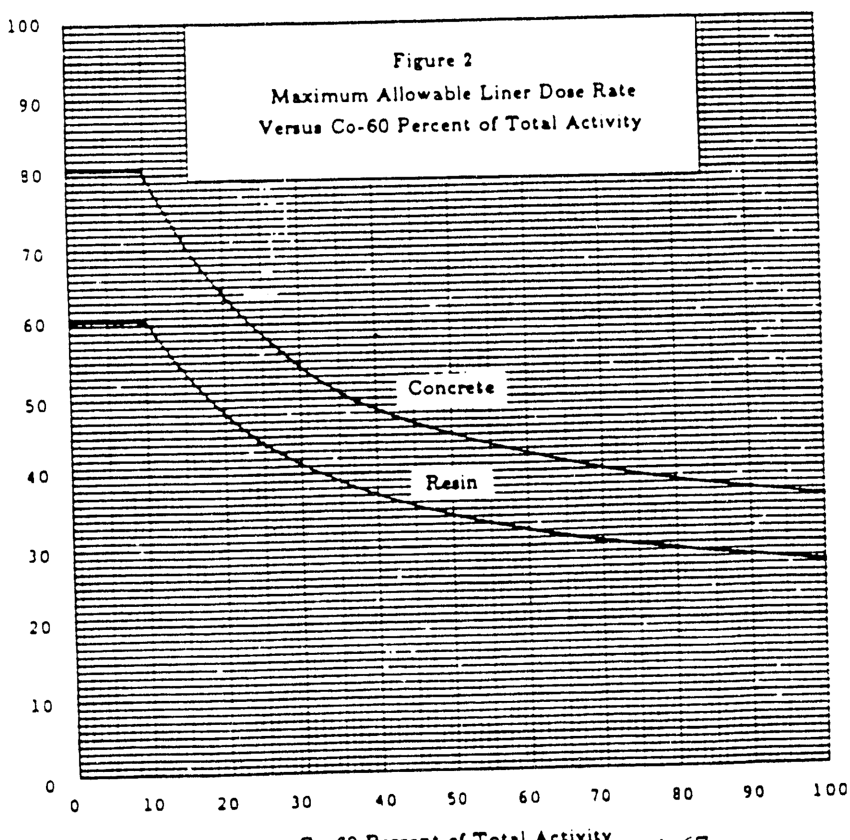


Figure 2
Maximum Allowable Liner Dose Rate Versus Co-60 Percent of Total Activity



The curves shown at left may be used to determine the maximum activity concentration (Figure 1) and the maximum liner dose rate (Figure 2) which can be shipped in this cask. For a well mixed, uniform concentration of waste, use of these figures will result in compliance with legal dose rates on the cask surface and at a distance of 2 meters from the surface (See Cautionary Note)

These curves are related to the relative concentration of Co-60 in the waste. The Co-60 concentration is obtained from a representative sample of the waste prior to filling a drum or liner. Practical experience shows that Co-60 is a dominant isotope in most mixtures and is the most significant from a shielding standpoint. The conservative assumption is made that the remaining isotopes (other than Co-60) emit one gamma per disintegration with an energy of 1.0 MEV

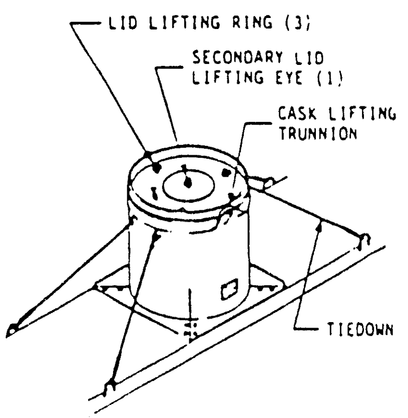
Two general types of waste forms are normally shipped, concreted or dewatered resins and filter media. A nominal average density of 2.0 g/cc for concreted wastes and 0.6 g/cc for resins was used in developing the curves.

CAUTIONARY NOTE

The curves include a safety factor (peak-to-average factor) of 2.0 which relates field measurements to shielding calculations assuming uniform waste mixtures. The calculations were made using a comprehensive computer analysis. The field measurements are based on a statistical analysis of a large number of cask shipments. However, due to variations in waste materials, tolerance in measurement instruments, and other real world factors, there is still a large scatter in the peak-to-average factor. Statistically, these curves yield compliance in about 60% of the shipments. To obtain compliance in about 95% of the shipments, multiply the maximum allowable activity concentration and the maximum allowable liner dose rate by 0.6.

CHEM-NUCLEAR SYSTEMS, INC.

CNS 14-195L



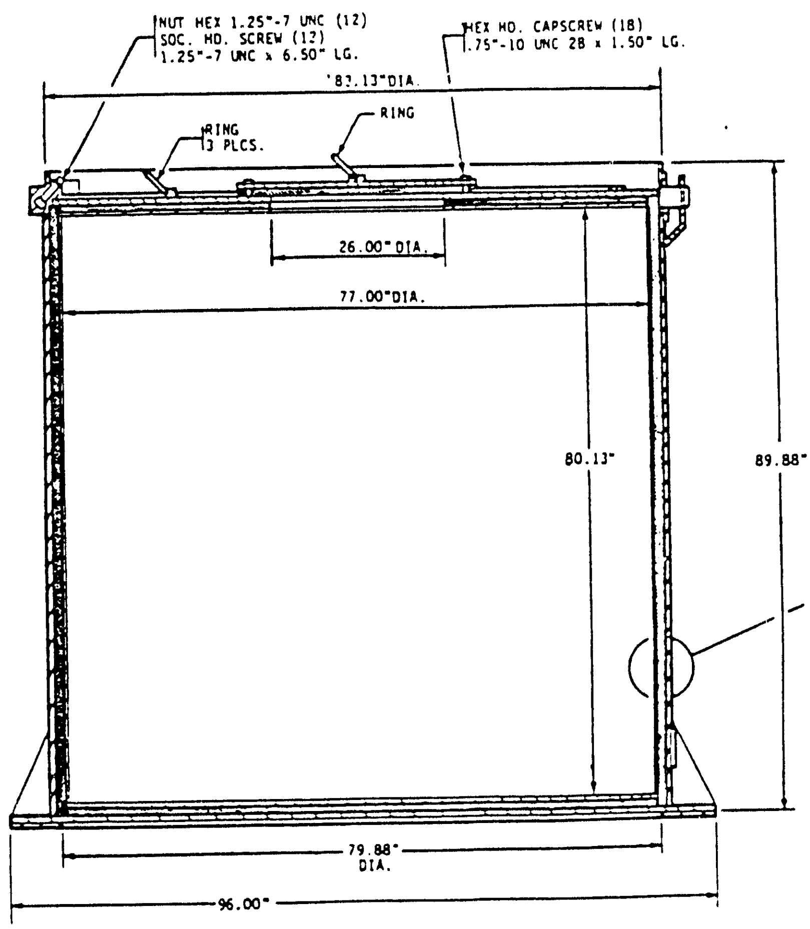
CNS 14-195L

Strong, tight container, Type A quantities only

Capacity:	(14) 55-gallon drums (1) 190-215 ft^3 liner
Shielding:	2.00" lead equivalent
Dose Rate:	Less than 1 R/hr on contact (based on Cobalt 60)

Empty Package Weight (with lids):	31,550#
Payload Weight:	17,700#

The CNS 14-195L cask is specially designed for transporting Type A quantities of radioactive material.

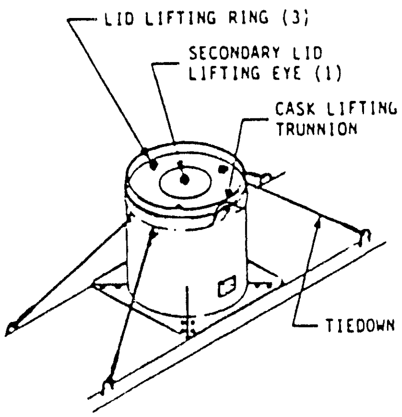


The CNS 14-195L cask is a lead and steel shipping cask for transporting dewatered or solidified waste material, but must meet the requirements of low specific activity

Loading (A) Seven drums are placed on each of two pallets located outside of the cask. The pallets are then lowered into the cask. (B) A liner may be loaded while in the cask through a 26 inch diameter access port or placed in the cask after filling. The upright cylinder may also be loaded while mounted on the transport trailer.

CHEM-NUCLEAR SYSTEMS, INC.

CNS 14-195H



CNS 14-195H

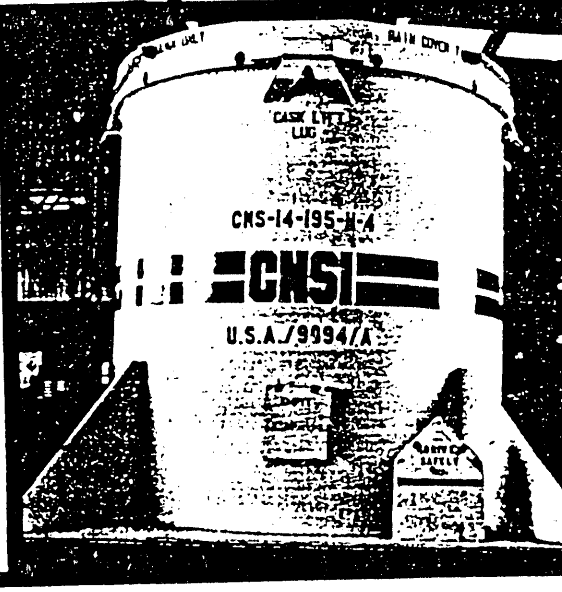
NRC Certificate No. USA/9094/A

Capacity: (14) 55-gallon drums
(1) 190-215 ft^3 liner

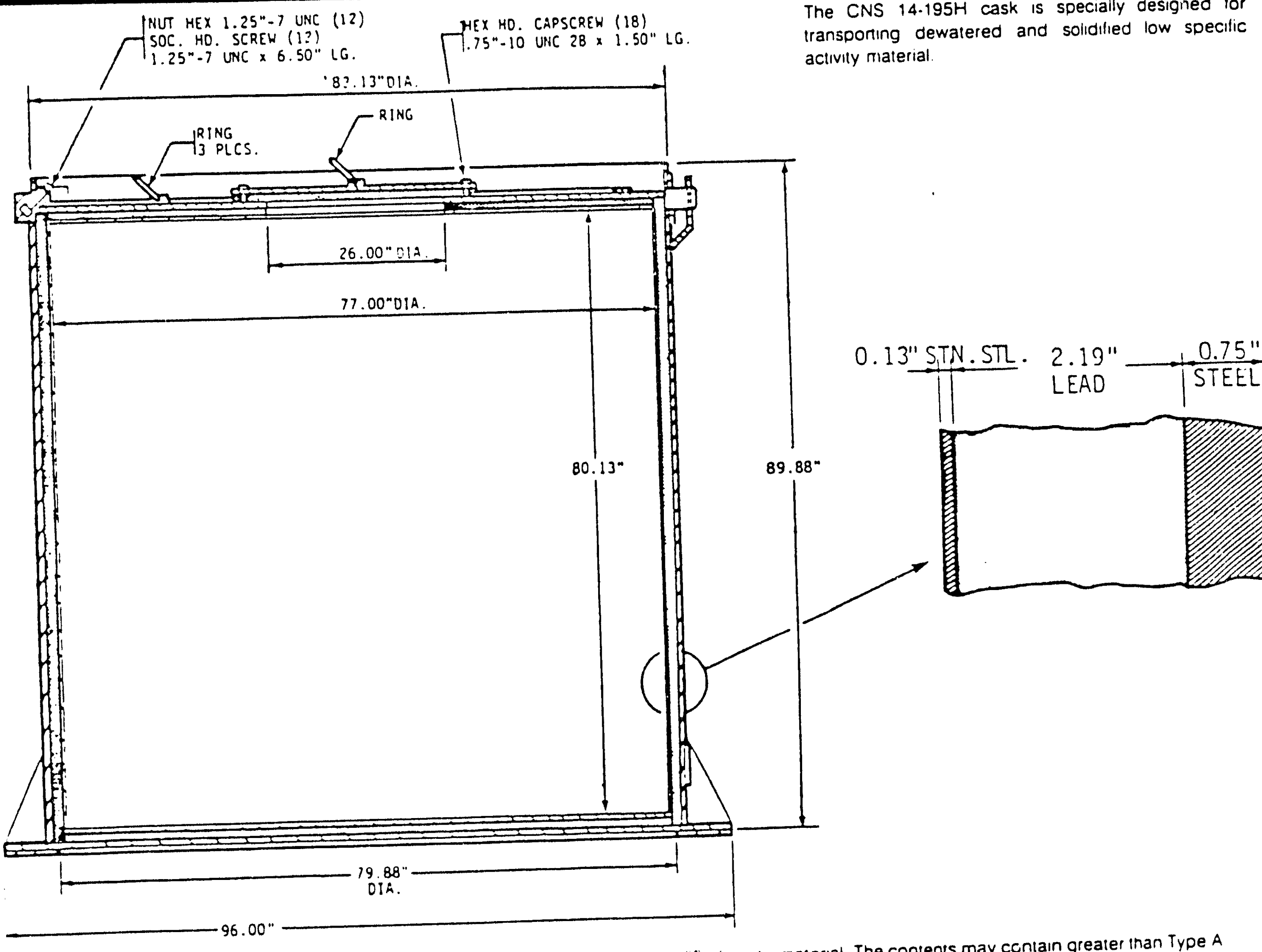
Shielding: 2.63" lead equivalent

Dose Rate: 21 R/hr (approx.)
(Maximum based on 10% Cobalt 60)

Empty Package Weight (with lids)	39,650#
Primary and secondary lids:	5,450#
Secondary lid:	850#
Payload weight:	17,700#



The CNS 14-195H cask is specially designed for transporting dewatered and solidified low specific activity material.



The CNS 14-195H cask is a lead and steel shipping cask for dewatered or solidified waste material. The contents may contain greater than Type A quantities of radioactive material but must meet the requirements of low specific activity.

Loading: (A) Seven drums are placed on each of the two pallets located outside of the cask. The pallets are then lowered into the cask. (B) A liner may be loaded while in the cask through the 26-inch diameter access port or placed in the cask after filling. The upright cyclinder cask may also be loaded while mounted on the transport trailer.

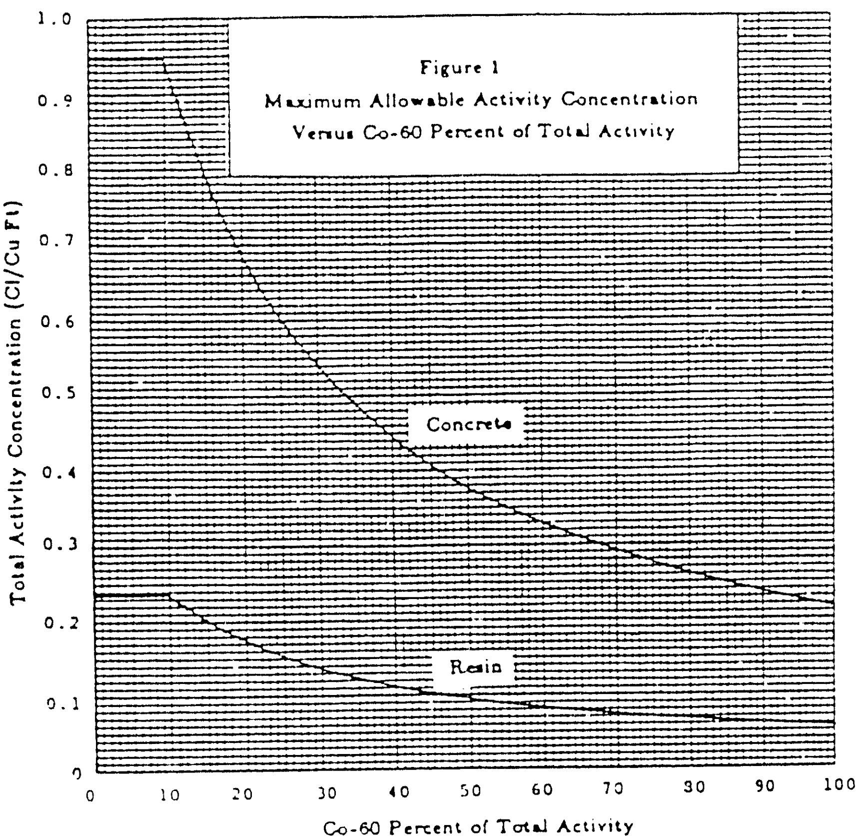


Figure 1
Maximum Allowable Activity Concentration
Versus Co-60 Percent of Total Activity

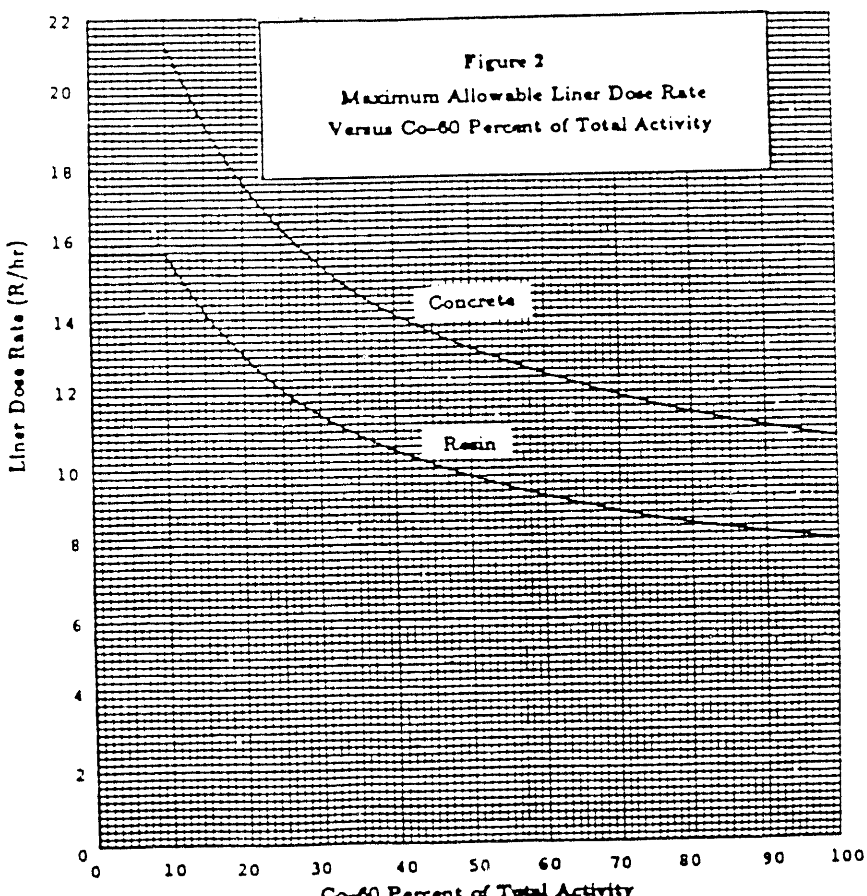


Figure 2
Maximum Allowable Liner Dose Rate
Versus Co-60 Percent of Total Activity

The curves shown at left may be used to determine the maximum activity concentration (Figure 1) and the maximum liner dose rate (Figure 2) which can be shipped in this cask. For a well mixed, uniform concentration of waste, use of these figures will result in compliance with legal dose rates on the cask surface and at a distance of 2 meters from the surface (See Cautionary Note).

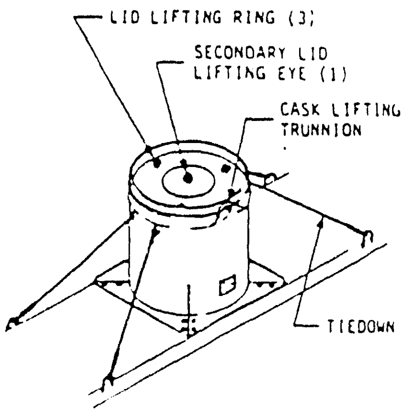
These curves are related to the relative concentration of Co-60 in the waste. The Co-60 concentration is obtained from a representative sample of the waste prior to filling a drum or liner. Practical experience shows that Co-60 is a dominant isotope in most mixtures and is the most significant from a shielding standpoint. The conservative assumption is made that the remaining isotopes (other than Co-60) emit one gamma per disintegration with an energy of 1.0 MEV.

Two general types of waste forms are normally shipped, concreted or dewatered resins and filter media. A nominal average density of 2.0 g/cc for concreted wastes and 0.6 g/cc for resins was used in developing the curves.

CAUTIONARY NOTE
The curves include a safety factor (peak-to-average factor) of 2.0 which relates field measurements to shielding calculations assuming uniform waste mixtures. The calculations were made using a comprehensive computer analysis. The field measurements are based on a statistical analysis of a large number of cask shipments. However, due to variations in waste materials, tolerance in measurement instruments, and other real world factors, there is still a large scatter in the peak-to-average factor. Statistically, these curves yield compliance in about 60% of the shipments. To obtain compliance in about 95% of the shipments, multiply the maximum allowable activity concentration and the maximum allowable liner dose rate by 0.6.

CHEM-NUCLEAR SYSTEMS, INC.

CNS 14-215H



CNS 14-215H

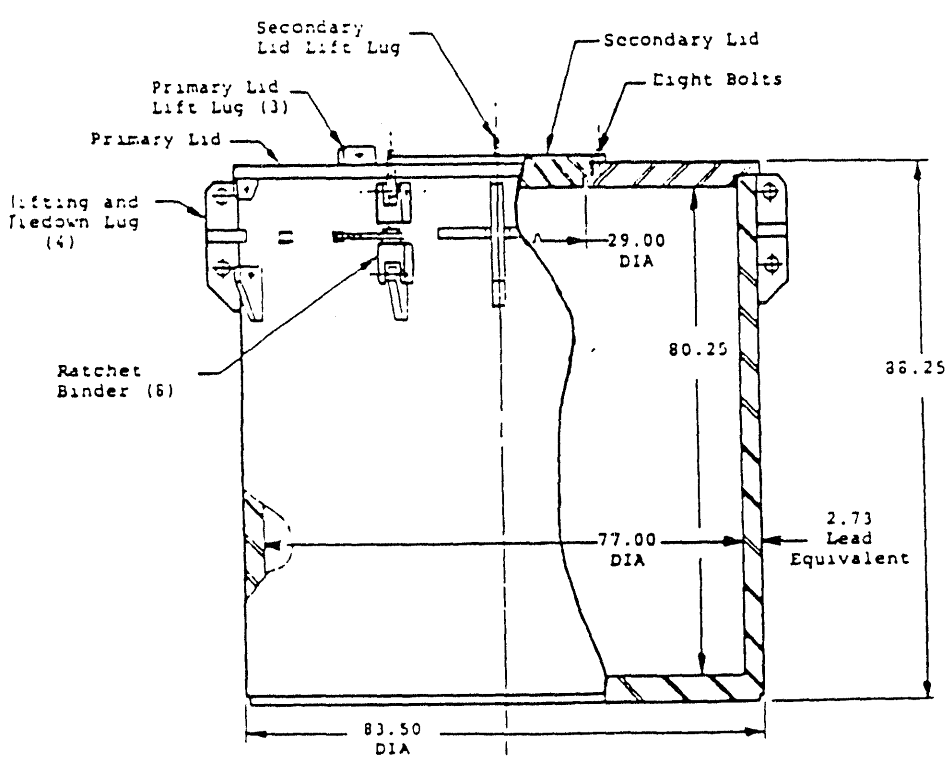
NRC Certificate No. USA/9176/A

Capacity:	(14) 55-gallon drums (1) 215 ft^3 liner (7) 24" x 72" pressure vessels
Shielding:	2.73" lead equivalent
Dose Rate:	20 R/hr

(maximum based on 10% Cobalt 60)

Empty Package Weight: (with lids):	38,400#
Primary and Secondary lids:	6,380#
Secondary lid:	1,140#
Payload Weight:	20,000#

The CNS 14-215H cask is specially designed for transporting dewatered and solidified low specific activity material.



The CNS 14-215H cask is a lead and steel encased shipping cask for transporting dewatered or solidified waste material. The contents may contain greater than Type A quantities of radioactive material, but must meet the requirements of low specific activity.

Loading: (A) Seven drums are placed on each of the two pallets located outside the cask. The pallets are then lowered into the cask. (B) A 190-215 ft^3 liner can be loaded while the cask is mounted on the transport trailer.

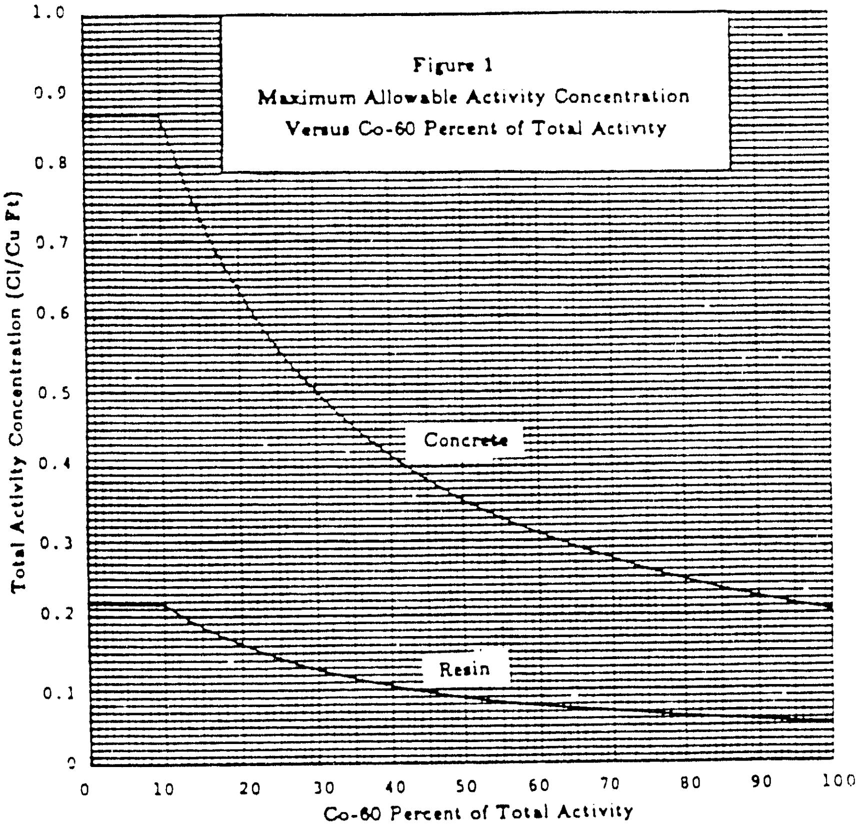


Figure 1
Maximum Allowable Activity Concentration
Versus Co-60 Percent of Total Activity

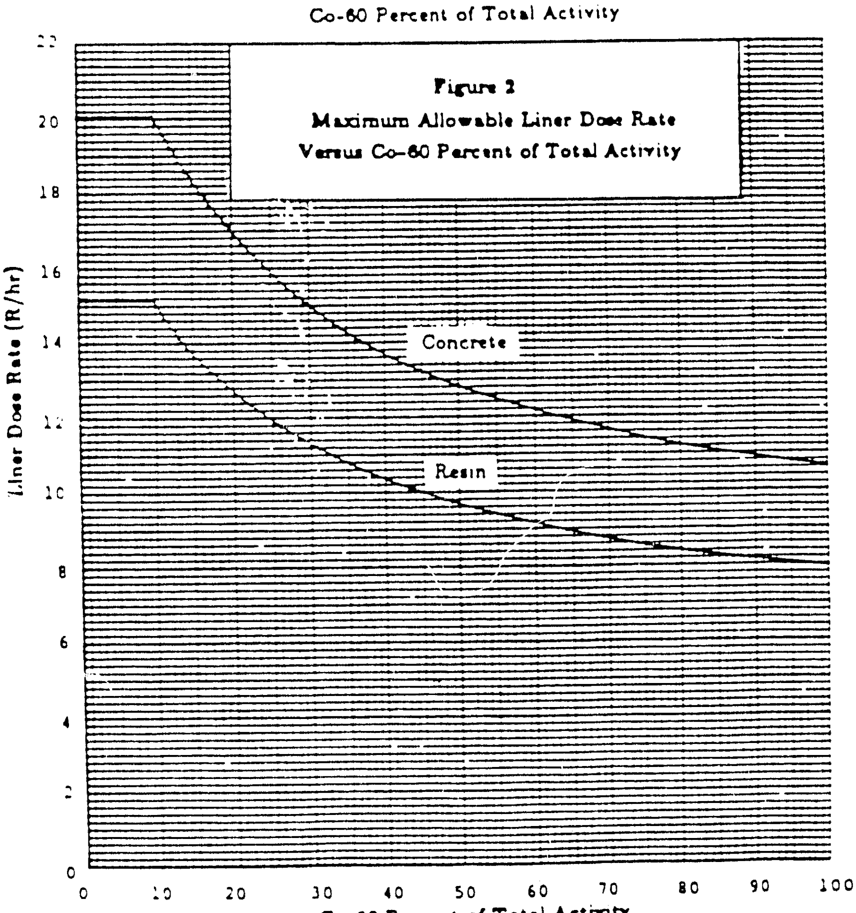


Figure 2
Maximum Allowable Liner Dose Rate
Versus Co-60 Percent of Total Activity

The curves shown at left may be used to determine the maximum activity concentration (Figure 1) and the maximum liner dose rate (Figure 2) which can be shipped in this cask. For a well mixed, uniform concentration of waste, use of these figures will result in compliance with legal dose rates on the cask surface and at a distance of 2 meters from the surface (See Cautionary Note)

These curves are related to the relative concentration of Co-60 in the waste. The Co-60 concentration is obtained from a representative sample of the waste prior to filling a drum or liner. Practical experience shows that Co-60 is a dominant isotope in most mixtures and is the most significant from a shielding standpoint. The conservative assumption is made that the remaining isotopes (other than Co-60) emit one gamma per disintegration with an energy of 1.0 MEV.

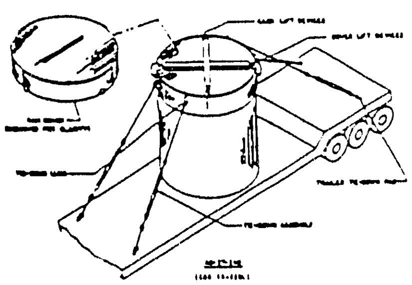
Two general types of waste forms are normally shipped, concreted or dewatered resins and filter media. A nominal average density of 2.0 g/cc for concreted wastes and 0.6 g/cc for resins was used in developing the curves.

CAUTIONARY NOTE

The curves include a safety factor (peak-to-average factor) of 2.0 which relates field measurements to shielding calculations assuming uniform waste mixtures. The calculations were made using a comprehensive computer analysis. The field measurements are based on a statistical analysis of a large number of cask shipments. However, due to variations in waste materials, tolerance in measurement instruments, and other real world factors, there is still a large scatter in the peak-to-average factor. Statistically, these curves yield compliance in about 60% of the shipments. To obtain compliance in about 95% of the shipments, multiply the maximum allowable activity concentration and the maximum allowable liner dose rate by 0.6

CHEM-NUCLEAR SYSTEMS, INC.

CNS 14-220L

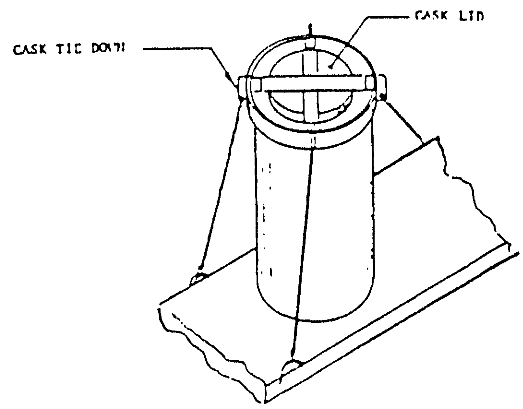


CNS 14-220L

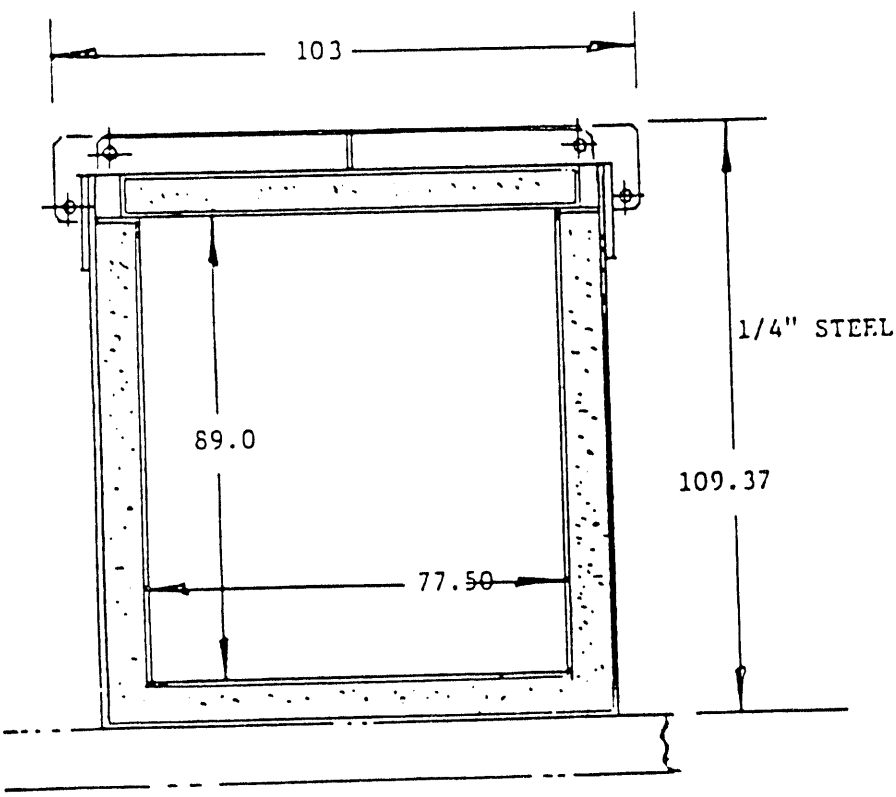
Strong, tight container,
Type A quantitites only

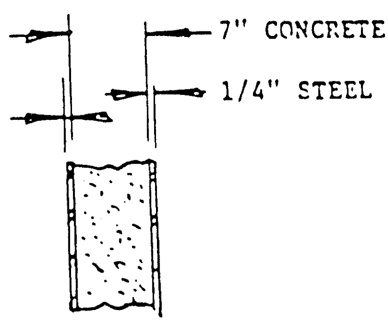
Capacity: (14) 55-gallon drums
(1) 200 ft^3 liner
Shielding: 1.75" lead equivalent
Dose Rate: Less than 1 R/hr contact
(Maximum based on Cobalt 60)

Empty Package Weight	33,200#
Payload Weight:	No limit



The CNS 14-220L is specially designed for transporting Type A quantitites of radioactive material.



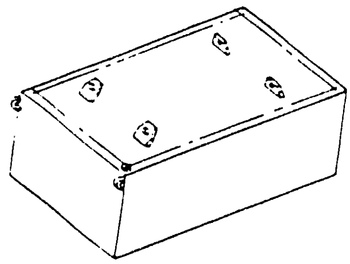


TYP. WALL SECTION

The CNS 14-220L cask is a steel and concrete shipping cask for transporting dewatered or solidified waste material. Loading: (A) Seven drums are placed on each of two pallets located outside the cask. The pallets are then lowered into the cask. (B) A liner may be loaded while in the cask through a 26-inch diameter access port or placed in the cask after filling. The upright cylinder may also be loaded while mounted on the transport trailer.

CHEM-NUCLEAR SYSTEMS, INC.

CNS 15-160B

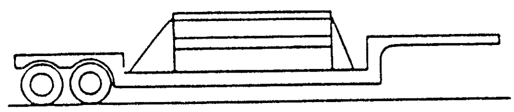


CNS 15-160B

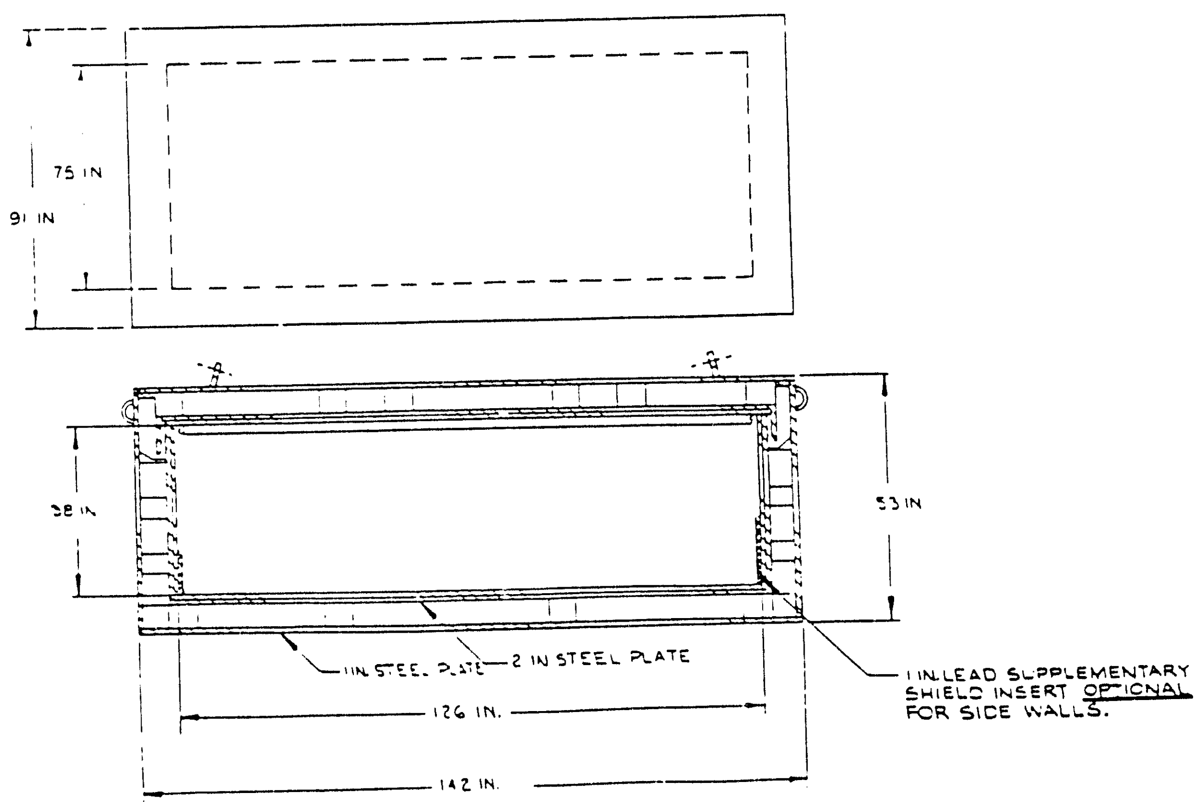
NRC Certificate No. USA/6144/B

Capacity:	(15) 55-gallon drums
	(2) 80 ft^3 liners
Shielding:	1.5" lead equivalent
Dose Rate:	1.9 R/hr
	(Maximum based on Cobalt 60)

Empty Package Weight:	37,000#
Cask Lid Weight:	12,000#
Payload Weight:	5,000#



The CNS 15-160B cask is designed for transporting greater than Type A quantity of radioactive material.

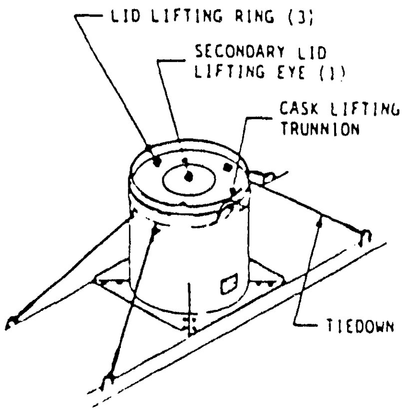


The CNS 15-160B cask consists of rectangular, double-walled welded mild steel designed to transport greater than Type A quantities of radioactive material, not to exceed 5 watts.

Loading: This cask is designed to transport fifteen (15) 55-gallon drums or two 80 ft^3 liners. One and one-half inches of lead equivalence is provided.

CHEM-NUCLEAR SYSTEMS, INC.

CNS 21-300

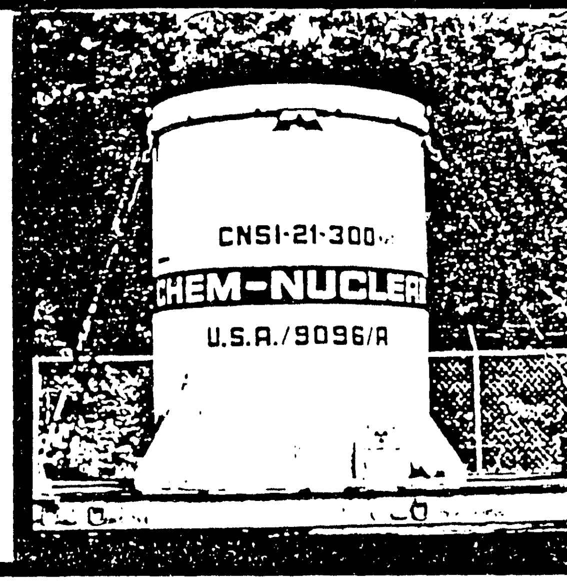


CNS 21-300

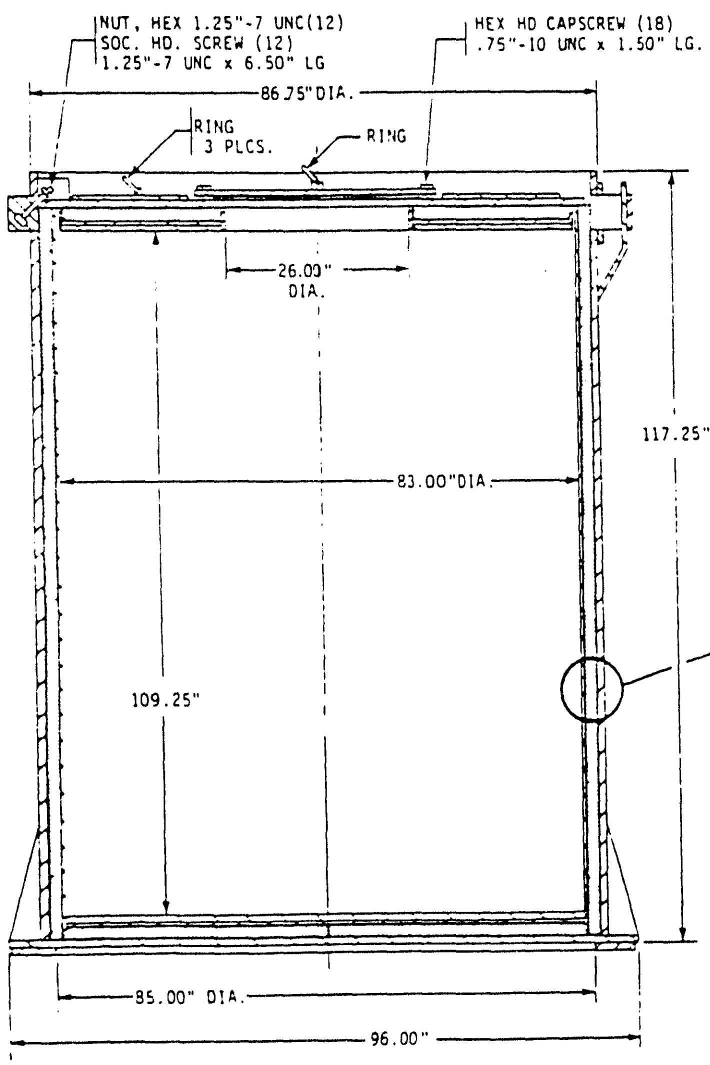
NRC Certificate No. USA/9096/A

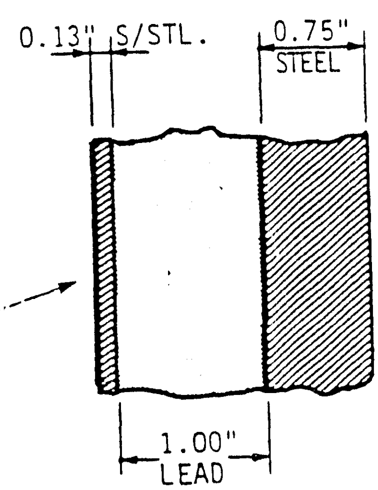
Capacity:	(21) 55-gallon drums
	(1) 315-340 ft^3 liner
Shielding:	1.50" lead equivalent
Dose Rate:	3 R/hr (approx.) (Maximum based on Cobalt 60)

Empty Package Weight (with lids):	30,200#
Primary and Secondary lids:	3,450#
Secondary lid:	550#
Payload Weight:	27,250#



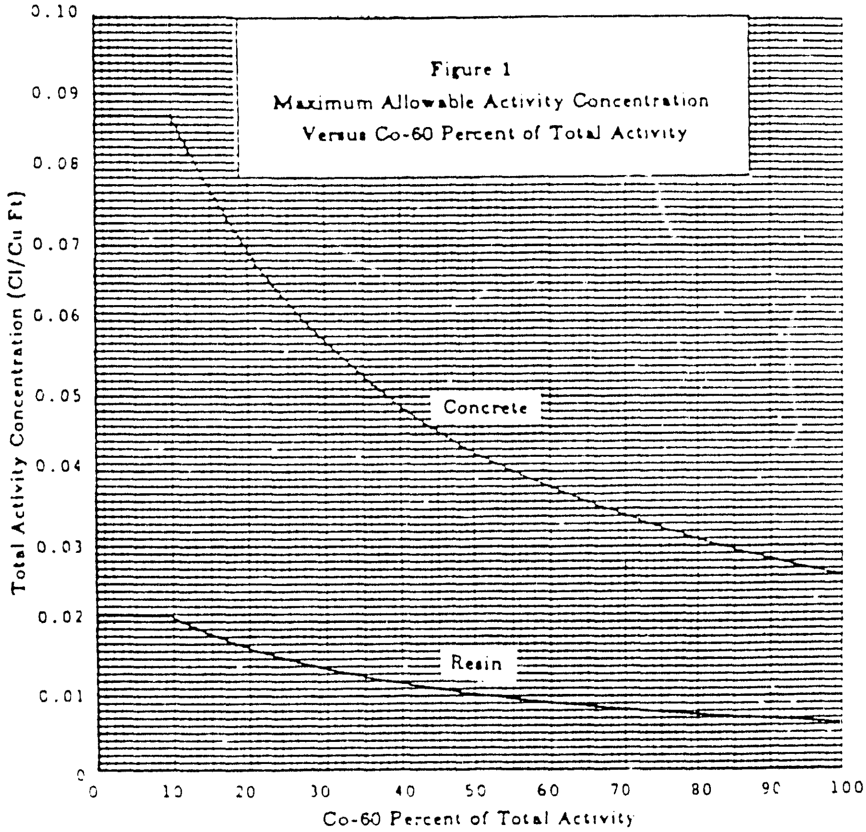
The CNS 21-300 cask is specially designed for transporting large volumes of low level radioactive waste material.

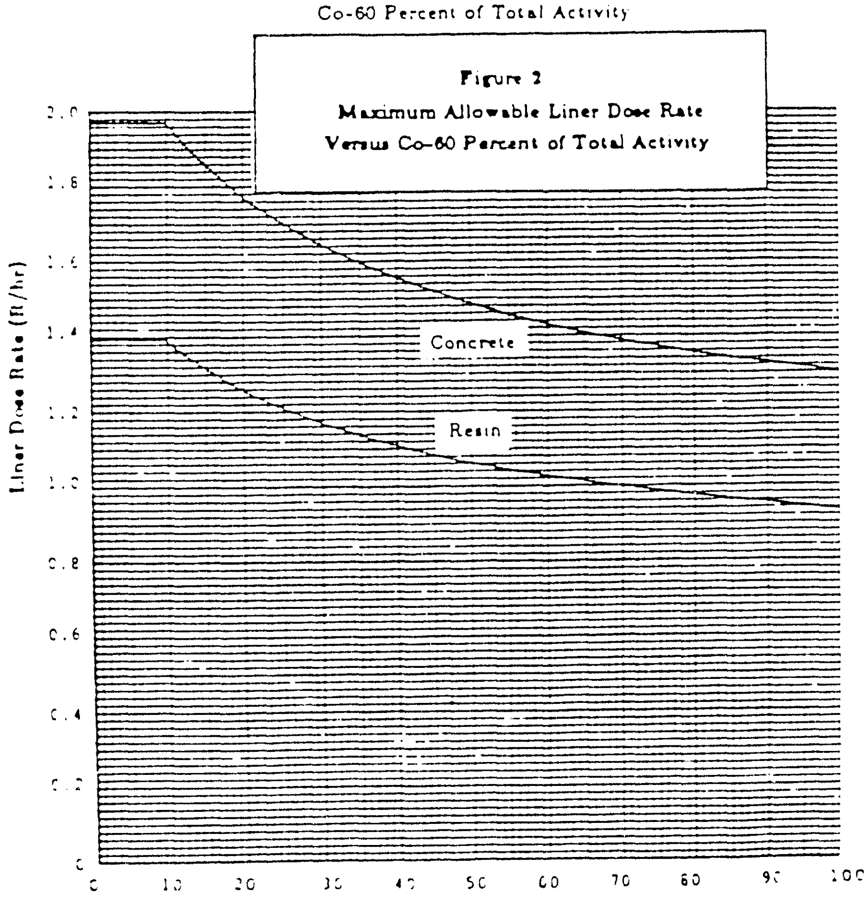




The CNS 21-300 cask is a lead and steel shipping cask for dewatered or solidified waste material. The contents may contain greater than Type A quantities of radioactive material but must meet the requirements of low specific activity.

Loading: (A) Seven drums are placed on each of the three pallets located outside of the cask. The pallets are then lowered into the cask. (B) A liner may be loaded inside the cask through the 26 inch diameter access port or placed in the cask after filling. The upright cylinder cask may also be loaded while mounted on the transport trailer.





The curves shown at left may be used to determine the maximum activity concentration (Figure 1) and the maximum liner dose rate (Figure 2) which can be shipped in this cask. For a well mixed, uniform concentration of waste, use of these figures will result in compliance with legal dose rates on the cask surface and at a distance of 2 meters from the surface (See Cautionary Note)

These curves are related to the relative concentration of Co-60 in the waste. The Co-60 concentration is obtained from a representative sample of the waste prior to filling a drum or liner. Practical experience shows that Co-60 is a dominant isotope in most mixtures and is the most significant from a shielding standpoint. The conservative assumption is made that the remaining isotopes (other than Co-60) emit one gamma per disintegration with an energy of 1.0 MEV

Two general types of waste forms are normally shipped, concreted or dewatered resins and filter media. A nominal average density of 2.0 g/cc for concreted wastes and 0.6 g/cc for resins was used in developing the curves

CAUTIONARY NOTE

The curves include a safety factor (peak-to-average factor) of 2.0 which relates field measurements to shielding calculations assuming uniform waste mixtures. The calculations were made using a comprehensive computer analysis. The field measurements are based on a statistical analysis of a large number of cask shipments. However, due to variations in waste materials, tolerance in measurement instruments, and other real world factors there is still a large scatter in the peak-to-average factor. Statistically, these curves yield compliance in about 60% of the shipments. To obtain compliance in about 95% of the shipments, multiply the maximum allowable activity concentration and the maximum allowable liner dose rate by 0.6

CHEM-NUCLEAR SYSTEMS, INC.
P.O. Box 726 . Barnwell, South Carolina 29812 . (803) 259-1781

December 19, 1978
SEO-618

In order to attain full compliance with Chem-Nuclear Systems, Inc. (CNSI) licensed casks' Certificates of Compliance, the following information is provided to convert curie contents to thermal watts. This is to be utilized to insure that CNSI shipping casks' thermal watt limitations are not exceeded. We have included sample calculations for the 600 watt limit as defined for our CNSI 1-13 shipping cask, Certificate of Compliance, USA/9044/B( )F, to assist you in documenting your shipment.

I] Curies to Thermal Watts Conversion Equation

$$\text{Kilowatts} = (\text{total curies}) \quad \frac{(\text{Total MEV})}{(\text{Disintegration})} \times \frac{\text{Kilowatt} - \text{Second}}{6.243 \times 10^{15}\ \text{MEV}}$$

$$\times \quad \frac{3.7 \times 10^{10}\ \text{Disintegration} - \text{Second}}{1\ \text{Curie}}$$

II] The following example is provided determining the maximum allowable curie content for CNSI's 1-13 cask, (USA/9044/B( )F), which has an upper limit of 600 watts:

Radioisotope: Cobalt 60

$$\frac{0.314\ \text{MEV Beta Max}}{3} = 0.105\ \text{MEV Beta Average}$$

1.173 MEV Gamma
1.332 MEV Gamma
0.105 MEV Beta Average
2.610 MEV

Total MEV per disintegration: 2.610

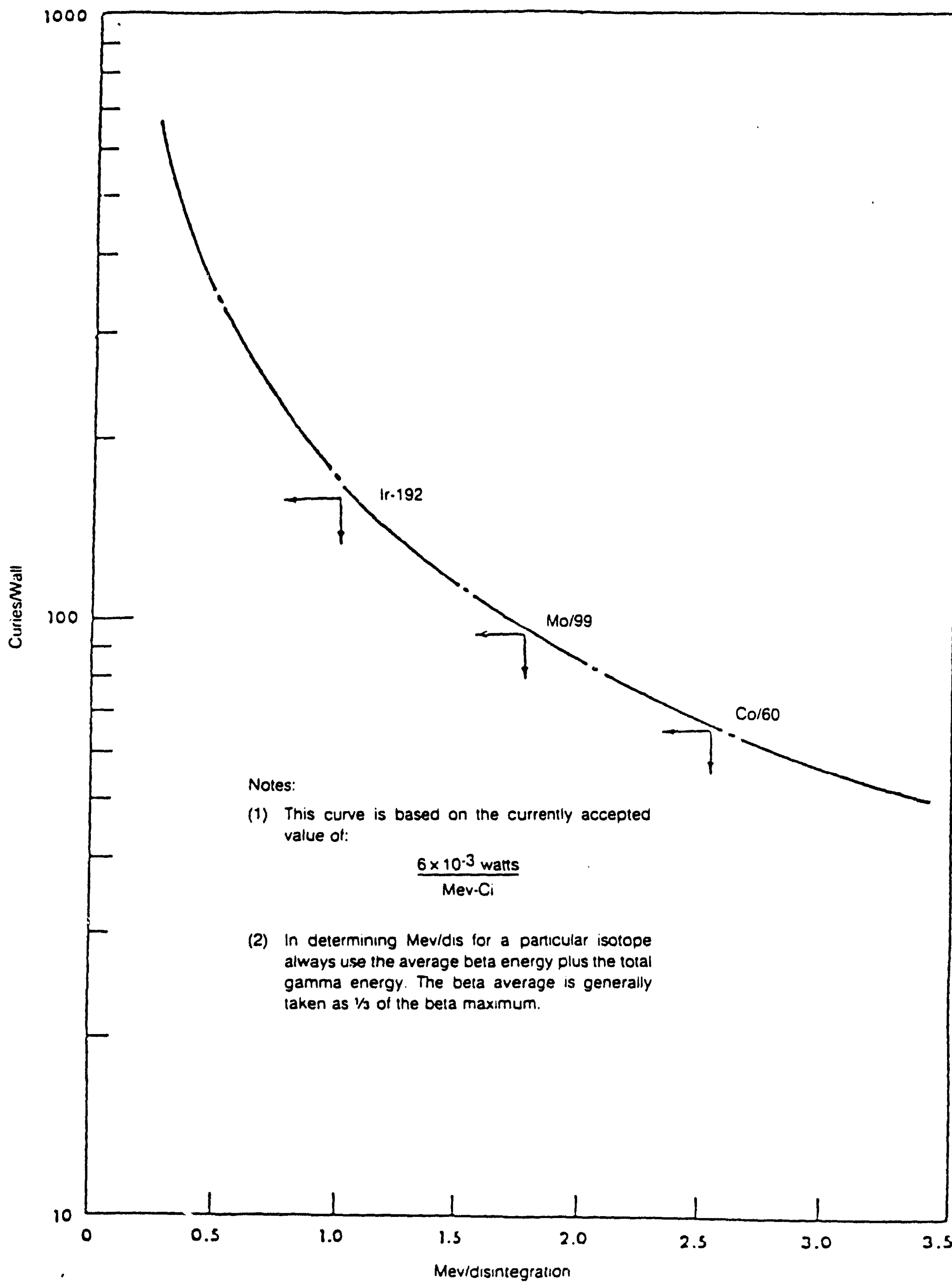


FIGURE A-1. ISOTOPE HEAT RATING

Figure 1
Concrete Waste
Maximum Allowable Activity Concentration
Versus Co-60 Percent of Total Activity

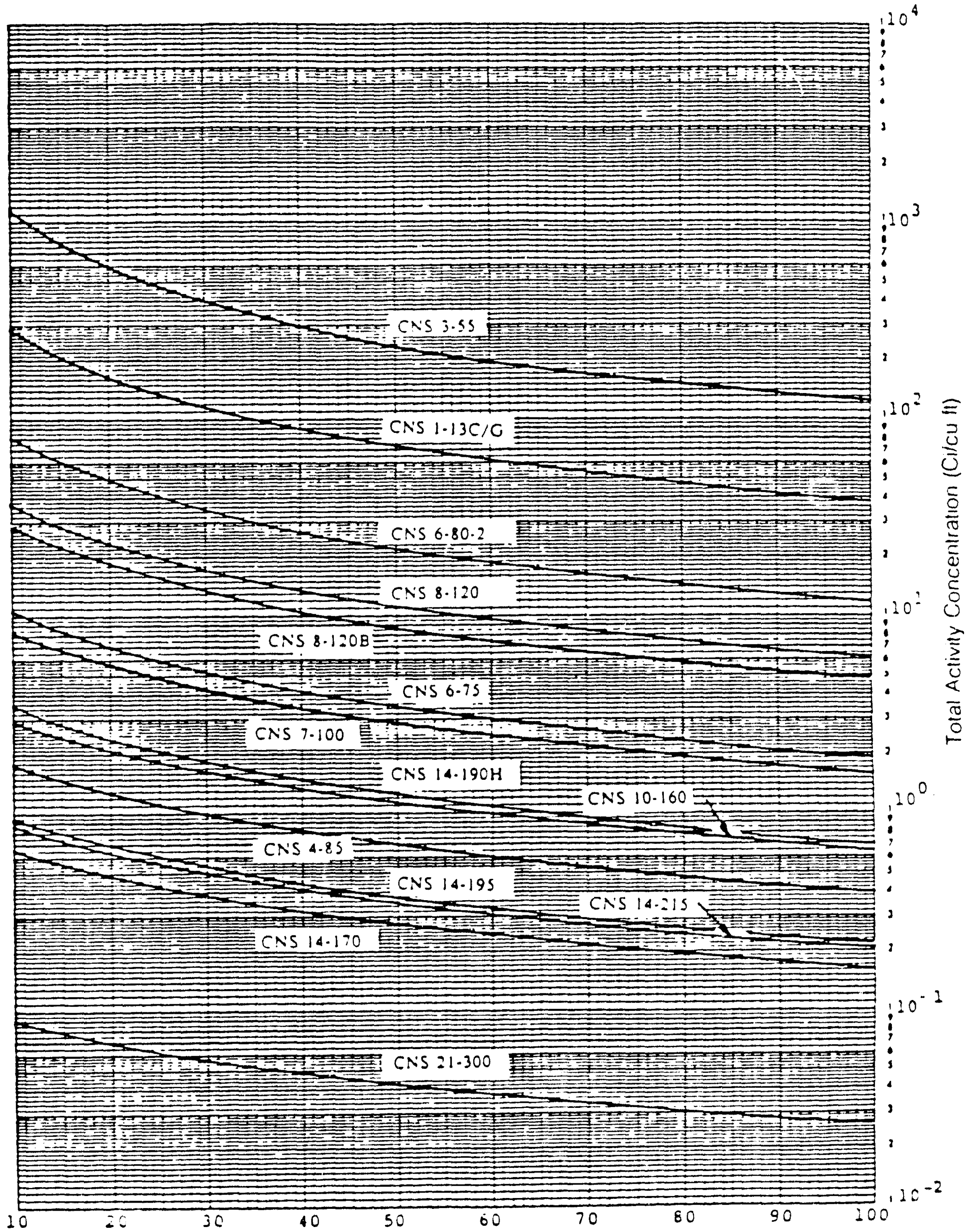


Figure 2
Concrete Waste
Maximum Allowable Liner Dose Rate
Versus Co-60 Percent of Total Activity

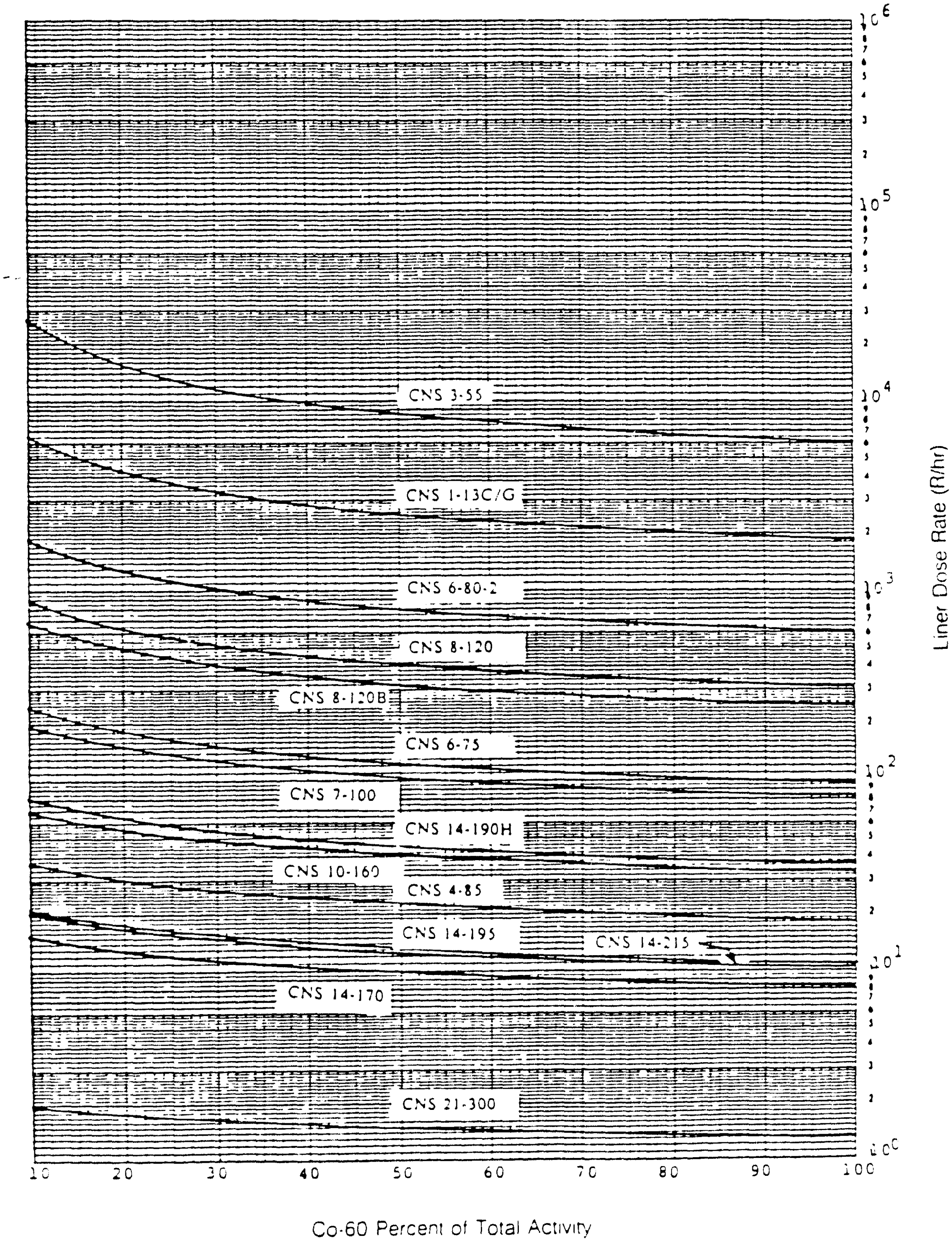


Figure 3
Resin Waste
Maximum Allowable Activity Concentration
Versus Co-60 Percent of Total Activity

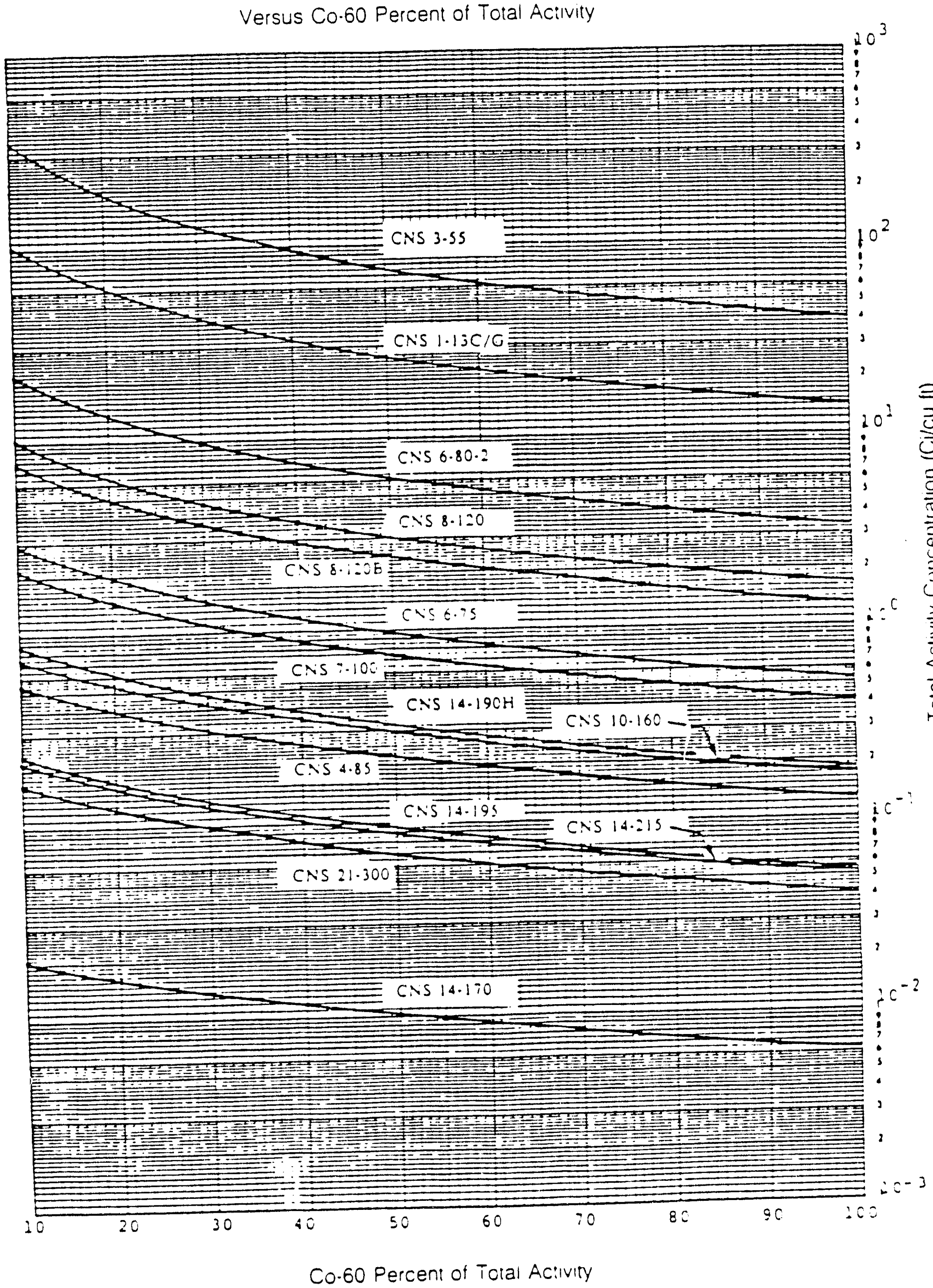
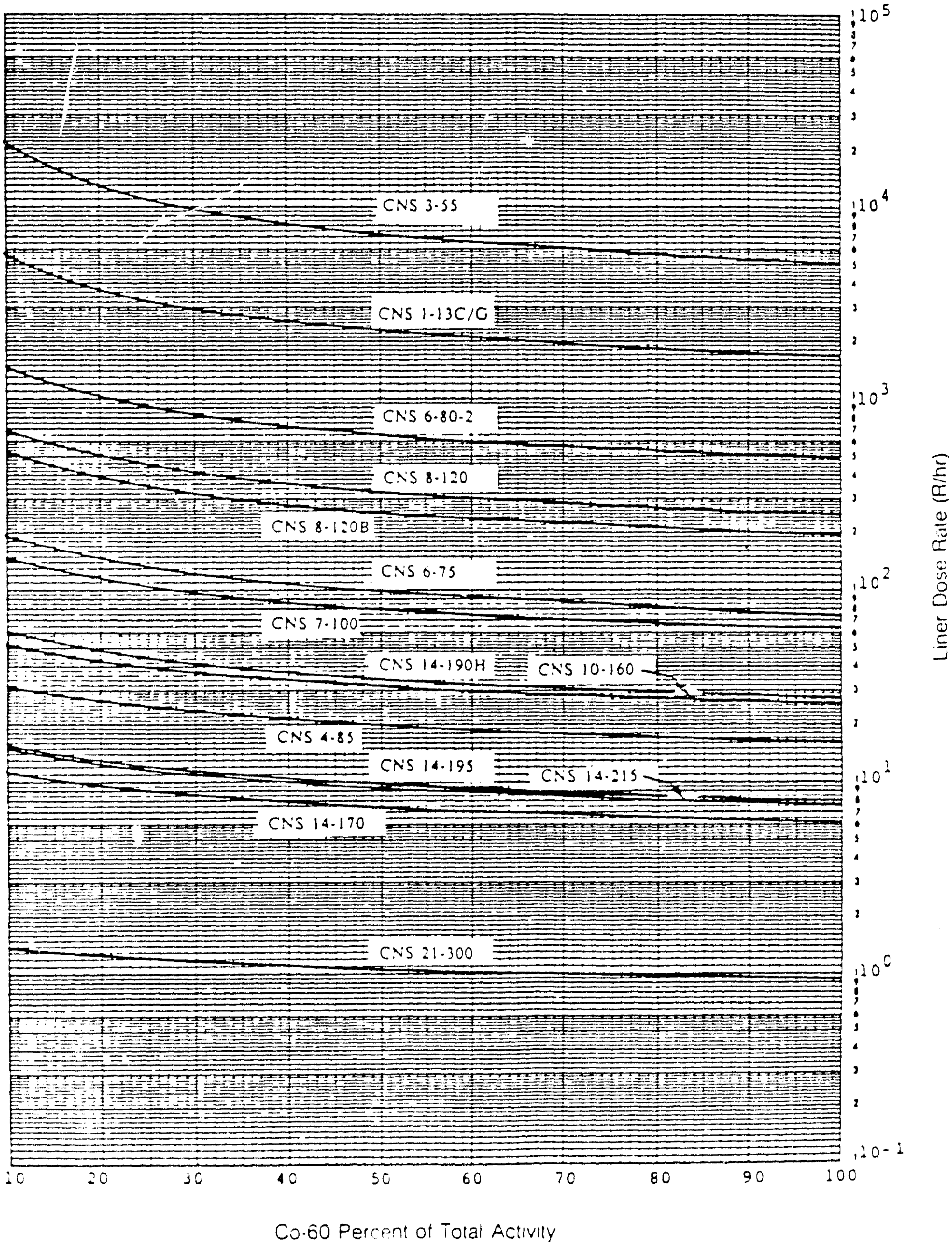


Figure 4
Resin Waste
Maximum Allowable Liner Dose Rate
Versus Co-60 Percent of Total Activity



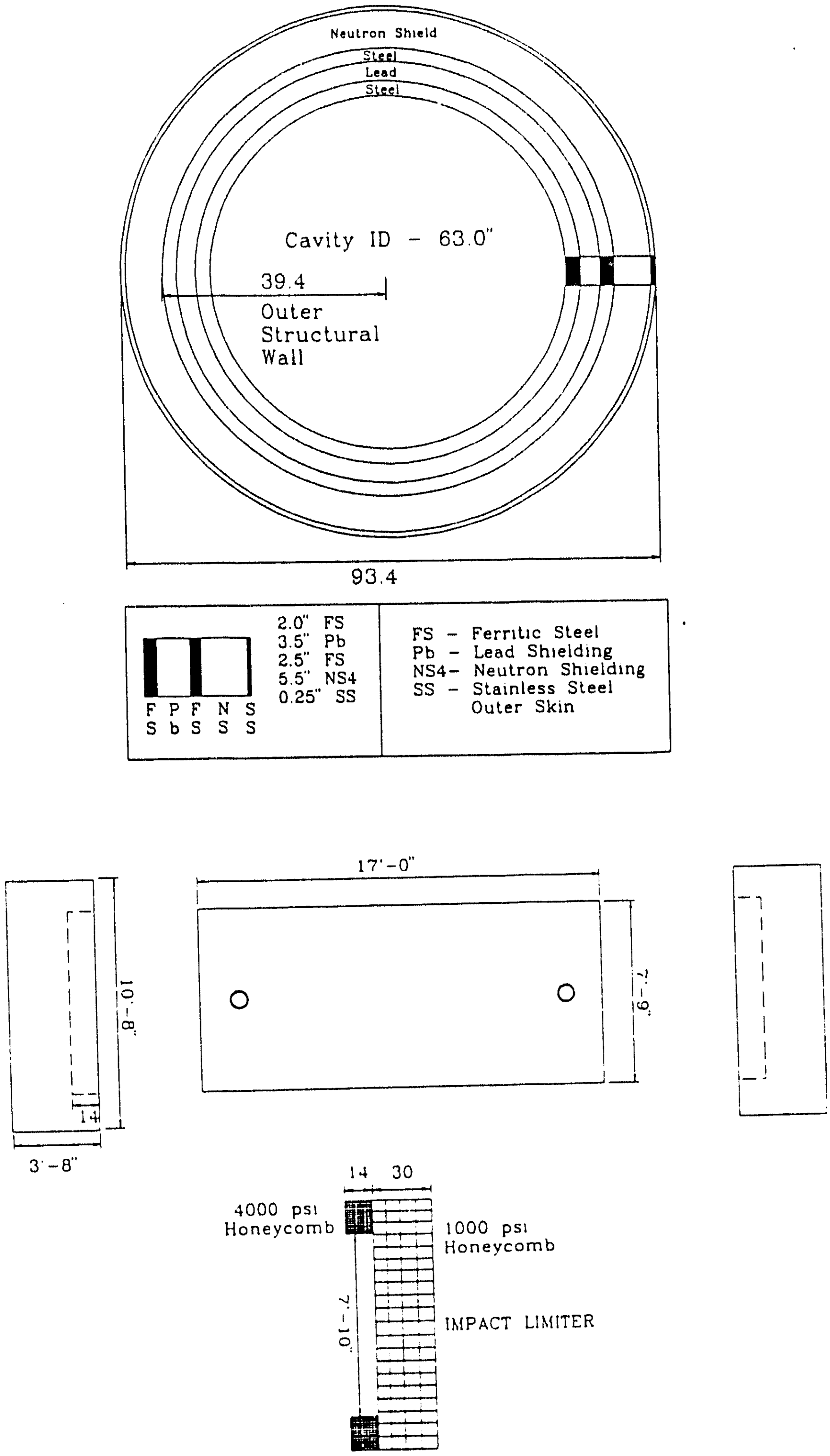
Appendix A.2

Transportation/Storage Casks

The MSB Transport Cask radial dimensions are illustrated in Figure. Radial dimensions are critical to the transport of a cask by rail because of the 128-inch width limitation. The length of a cask is generally not important because heavy weight railcars are quite long (up to 60 feet) to spread the load of the package and reduce the load per unit length on bridges. The outside diameter of the cask is 93.5 inches, and the cask cavity diameter is 63.0 inches. The 63.0-inch cask cavity allows adequate clearance to accept the 62.5 inch outside diameter MSB. The interfaces between the cask and impact limiter are shown in Figure. Figure also illustrates the construction of the Impact Limiters using 4000 psi crush strength aluminum honeycomb in a doughnut that encircles the end of the cask to accommodate side drops, with a 1000 psi honeycomb disk 30 inches thick for end and oblique angle drops.

Figure

MSB Transport Cask Dimensions

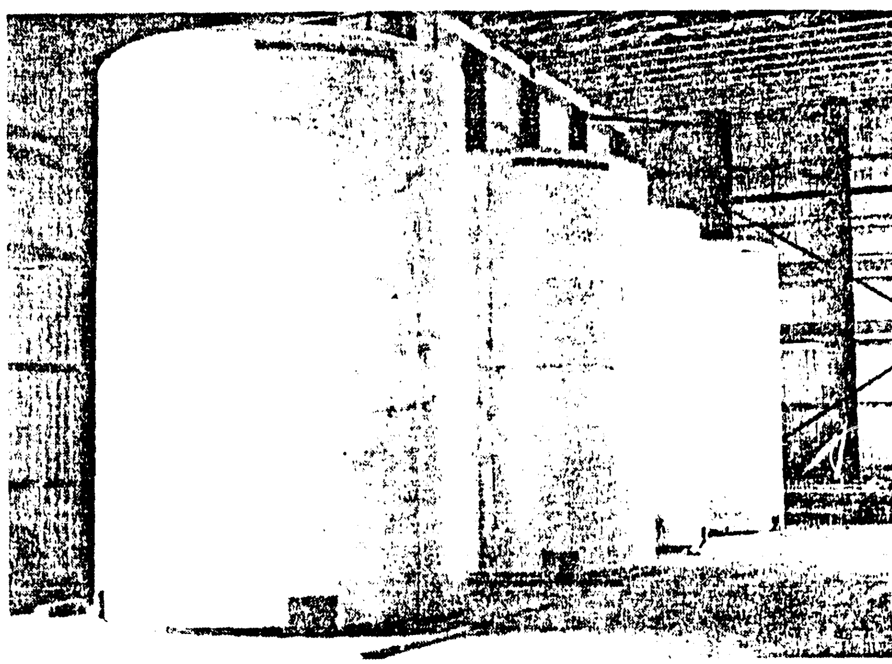


SIERRA NUCLEAR CORPORATION

5619 SCOTTS VALLEY DRIVE
SCOTTS VALLEY, CA 95066
(408) 438-6444
(408) 438-5206 (FAX)

570 COLONIAL PARK DRIVE
ROSWELL, GA 30075
(404) 518-7785
(404) 518-7883 (FAX)

VENTILATED STORAGE CASK



Four completed ventilated concrete casks.

The Ventilated Storage Cask (VSC) (Figure 1) is a second generation, NRC certified, dry irradiated fuel storage system that offers low up-front cost and modular addition in increments as small as a single cask. The VSC design takes full advantage of the experience gained by the Sierra Nuclear Corporation (SNC) design team on previous dry fuel storage projects and previous cask analyses and testing. The VSC represents the logical next step toward large scale implementation of low cost dry fuel storage. The VSC system has been loaded with consolidated fuel at the Idaho National Engineering Laboratory. The VSC has also been selected for use at Wisconsin Electric's Point Beach Nuclear Power Plant, Consumers Power's Power's Palisades Plant, and Entergy Operation's Arkansas Nuclear One Plant. Eight casks are currently on site at Palisades.

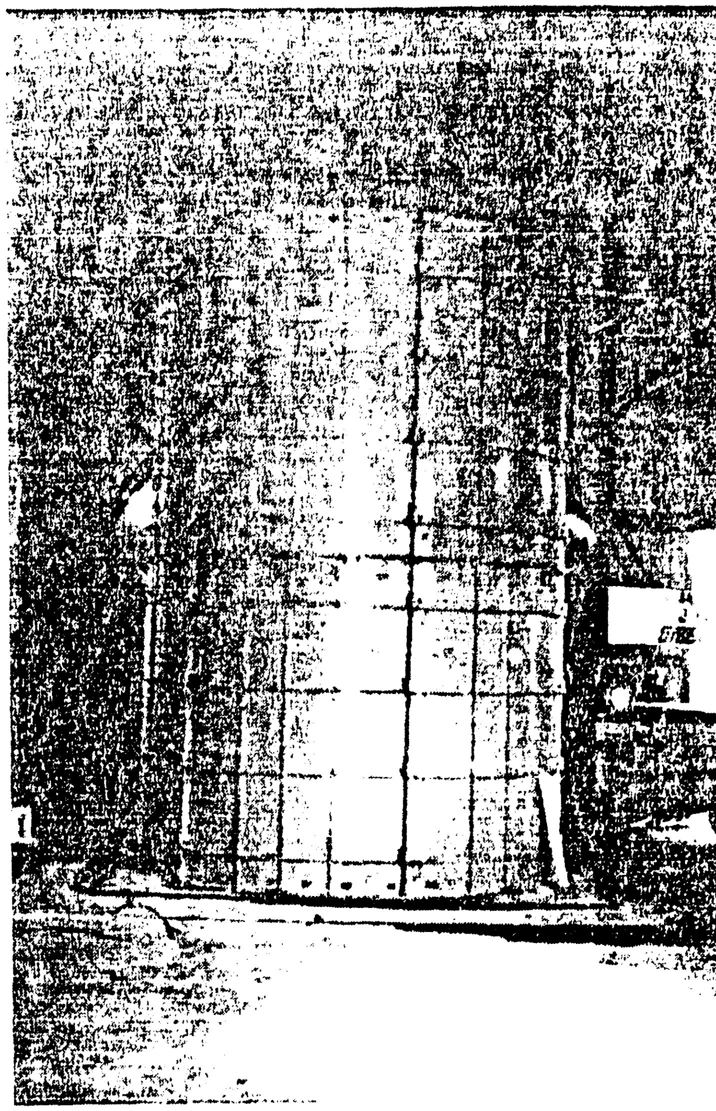
The VSC system is also fully compatible with future shipping options as its sealed steel basket can serve as a shipping cask basket.

THE VSC SYSTEM

The VSC storage system is made up of a ventilated concrete cask and a multiassembly sealed basket. The basket is a seal-welded, steel canister containing up to 24 pressurized water reactor assemblies or 52 boiling water reactor assemblies. The basket is designed to meet both storage and shipping requirements. The basket is stored in the central cavity of the concrete cask. The cask is ventilated by internal air flow paths that allow the decay heat to be removed by natural circulation.

The VSC system is provided with a unique handling system that allows for vertical loading of the basket into the concrete cask and greatly simplifies the handling of the thirty-ton basket compared to horizontally loaded concrete storage systems. Transferring the entire 24 PWR or 52 BWR assemblies at one time minimizes the number of operations and impact on plant personnel. A transfer cask and lifting yoke are used to move the basket into the fuel pool for loading. The transfer cask, containing the loaded basket is moved out of the pool to the decontamination area. The transfer cask with a loaded basket weighs under 100 tons. The transfer cask moves the sealed basket into the concrete cask within the controlled atmosphere of the plant auxiliary building. Thus, the cask that goes in the pool does not go out to the storage pad. This greatly reduces the possibility for the spread of radioactive contamination.

SNC also provides an alternative loading system that uses a single assembly transfer machine (weighing 35 tons) to move fuel from the pool to a basket contained in the concrete cask. Another feature of the VSC system is that the concrete cask is always in the vertical position and is moved on and off the transfer trailer with a specialized lifting skid or air pads. The cask can also be moved with a cask transporter like metal cask. Thus, the VSC system does not need specialty alignment skids and rams needed by other storage systems to place the fuel or cask into storage. Also, the VSC handling system allows the use of a close packed cask array with minimum handling areas, thus, using much less valuable plant space than horizontal systems, which require large transporter alignment and maneuvering room.

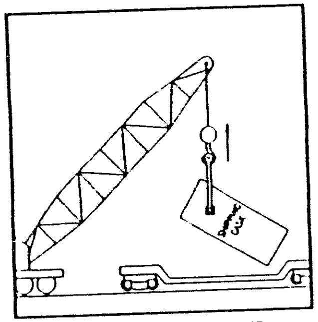


Removable exterior concrete form. Cask can be easily constructed at any site on an "as needed" basis. Totally flexible and modular.

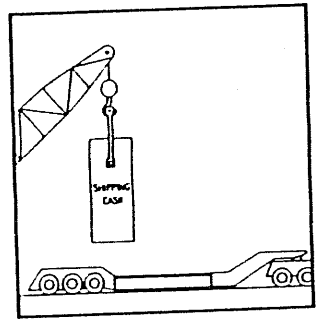
Another important feature of the VSC system is that the basket is shippable. At the end of on-site storage, the basket can be placed in a rail/barge cask and shipped off-site. If continued storage is needed at the receiving end, the empty concrete cask can also be shipped and the basket reinserted in the concrete cask for storage at their destination. Used in this manner, the VSC system could save the federal fuel management system hundreds of millions of dollars.

Another important feature of the VSC is its low up-front cost and low, modular addition cost. The up-front cost for the VSC system is limited to the cost of the ISFSI storage pad and fence, transfer cask, transfer trailer, skid, vacuum drying system and associated miscellaneous equipment. The total cost for this equipment is much less than the cost of large enclosed structures and complex remote handling equipment required in some storage systems. The VSC system cost is competitive, if not lower than consolidation cost and does not require continual activities in the fuel pool area. Indeed, in some instances, due to licensing constraints, the VSC system is competitive with pool reracking. This low initial incremental cost offers utilities the opportunity to implement the VSC dry fuel storage system in a prudent and cost effective manner and show adequate reasonableness of the expenditure of both capital and operating funds.

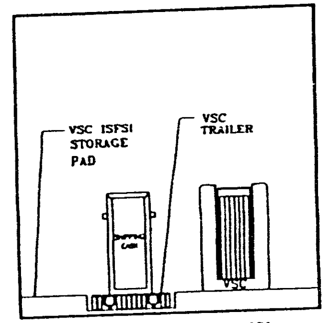
Unloading the VSC at the ISFSI



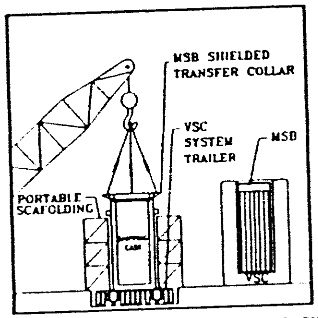
RECEIVE RAIL CASK AND UNLOAD WITH MOBILE CRANE IN YARD.



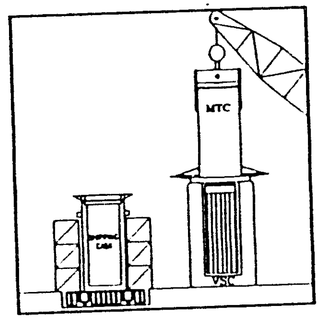
MOVE CASK TO VSC SYSTEM TRAILER.



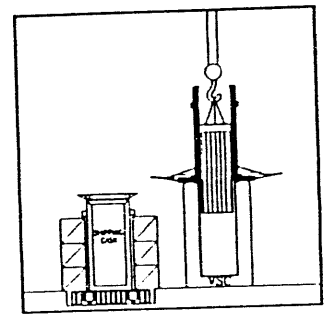
TOW CASK TO VSC ISFSI.



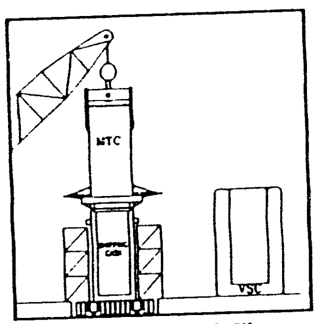
INSTALL SCAFOLDING, REMOVE CASK LID AND INSTALL TRANSFER COLLAR.



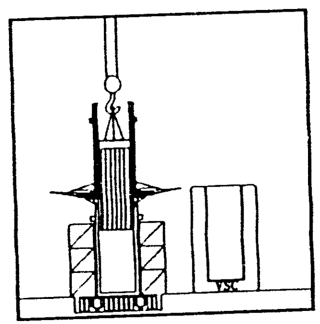
PLACE MTC ON VSC.



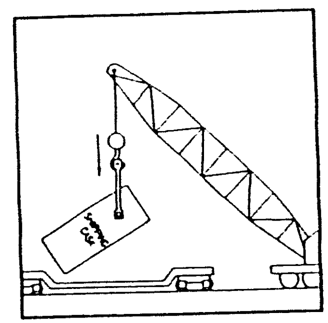
RAISE MSB INTO MTC.



MOVE TO TOP OF CASK.



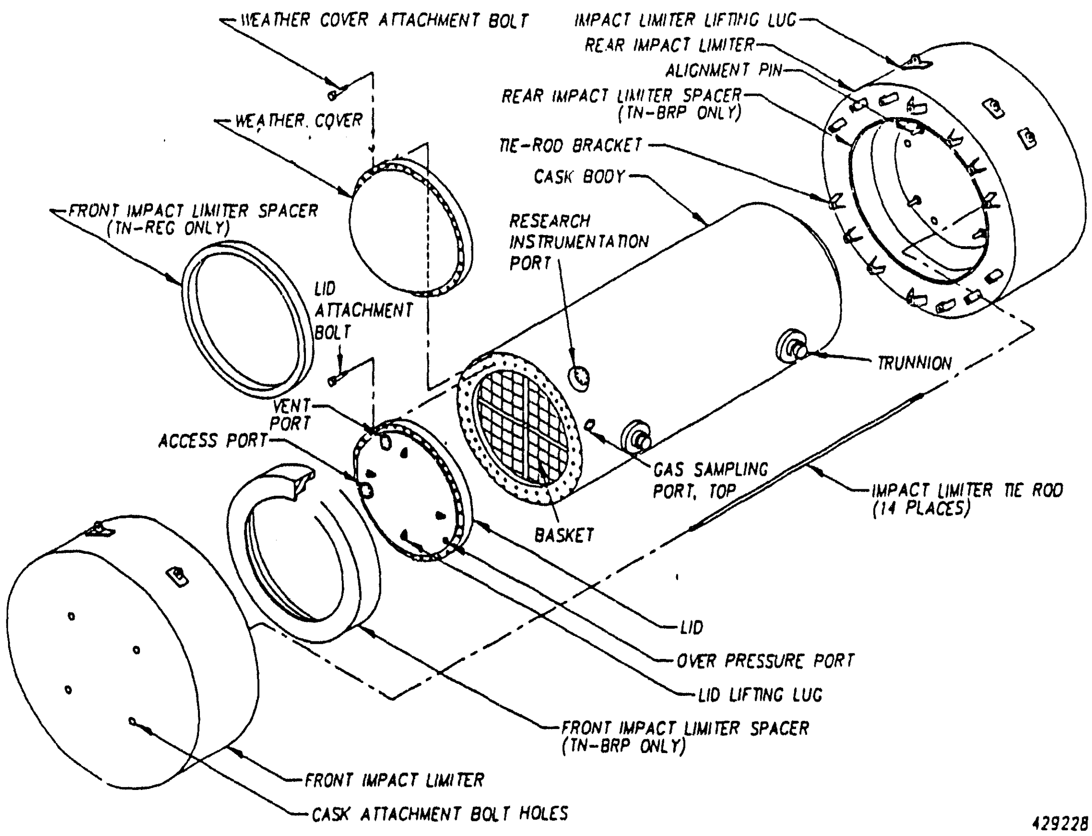
LOWER MSB INTO CASK



REPLACE CASK LID AND PUT CASK ON RAIL CAR AND SHIP OFF SITE.

TN-BRP AND TN-REG DUAL PURPOSE TRANSPORT AND STORAGE CASKS

Cask Characteristics	TN-BRP Cask	TN-REG Cask
Dimensions		
Packaging overall length (with impact limiters), in.	244.50	234.00
Packaging maximum diameter (with impact limiters), in.	131.00	131.00
Body outside diameter, in.	83.25	90.25
Body overall length (with lid), in.	190.50	180.00
Shell wall thickness, in.	9.62	9.25
Bottom thickness, in.	9.75	8.25
Lid thickness, in.	9.75	8.50
Cavity diameter, in.	64.00	71.75
Cavity length, in.	171.00	163.25
Number of lid bolts	48	48
Lid bolt nominal diameter, in.	1.63	1.63
Number of trunnions	4	4
Number of bolts per trunnion	14	14
Trunnion bolt diameter, in.	1.50	1.50
Weights		
Packaging (transport configuration with fuel assemblies), lb	215,000	225,000
Body and basket assembly (without fuel assemblies and impact limiters), lb	152,000	153,000
Fuel assemblies, lb	42,500	52,000
Impact limiters (front and rear combined total), lb	20,000	20,000
Transport frame	20,800	20,800
Tiedowns	8,500	8,500



TN-BRP and TN-REG dual purpose transport and storage casks

NAC S/T

(1) Type	Storage/Transport
(2) Manufacturer/Vendor	Nuclear Assurance Corporation
(3) Capacity (assys)	
(a) Intact SF	26 PWR (31 PWR w/burnup credit)
(b) Consolidated Fuel Rods	56 PWR; 122 BWR
(4) Weight (tons)	
(a) Loaded	100 (intact); 124 (consolidated)
(b) Empty	81
(5) Thermal	
(a) Design Heat Rejection (kW)	26 (16 for burnup credit version)
(b) Peak Clad Temperature (^{o}C)	360 max.
(6) Shape	Cylindrical
(7) Dimensions	
(a) Overall Length (in)	181.3
(b) Overall Diameter (in)	94
(c) Cavity Length (in)	164
(d) Cavity Diameter (in)	64.7
(e) Wall Thickness (in)	15
(f) Lid Thickness (in)	8.5
(g) Bottom Thickness (in)	8.8
(h) Basket Length (in)	155
(i) Basket Diameter (in)	64.5
(8) Neutron Snield	
(a) No. Rods	None
(b) Rod Diameter (in)	None
(c) Side Thickness (in)	7
(d) Lid Thickness (in)	None
(e) Bottom Thickness (in)	None
(9) Materials of Construction	
(a) Cask Body	Lead/SS
(b) Basket	Aluminum
(c) Neutron Shield	BISCO NS4FR
(10) No. Cooling Fins	None
(11) Cavity Atmosphere	He
(12) Cavity Pressure (psia)	30
(13) Outside Surface Dose (mR/hr)	100 max.

(14) Licensing Status TSAR docketed 12/84. License approval is expected in early 1988.

(15) Comments One cask has been fabricated by NAC for use at the Surry reactor site.

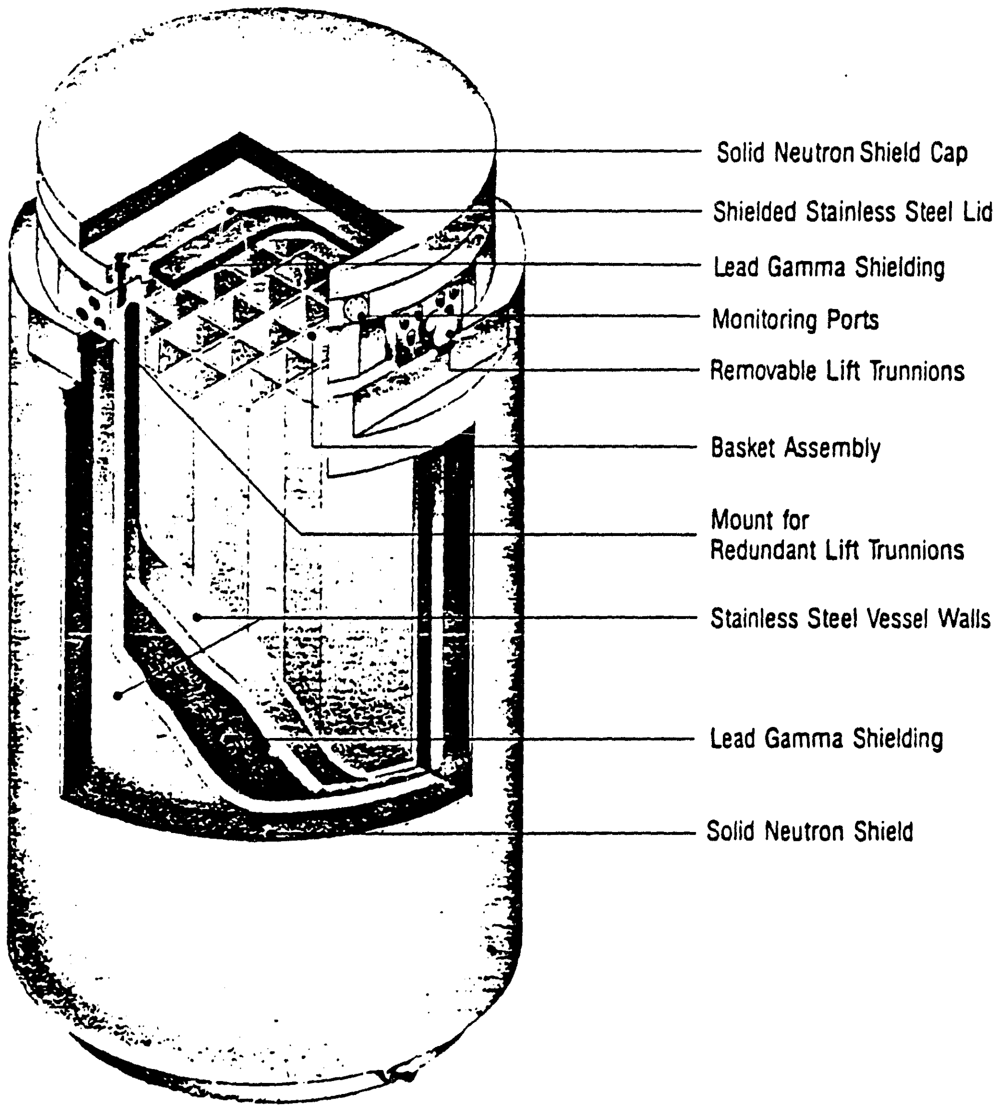
References

(1) Letter W. J. Lee (NAC) to W. Etz (JAI), July 29, 1987

(2) Personal communication with NAC, August 31, 1987

(3) J. V. Houston, Jr., The NAC S/T Status: An Update, INMM Spent Fuel Storage Seminar III, Washington, D.C., January 1986

(4) Letter W. J. Lee (NAC) to E. R. Johnson (JAI), February 8, 1988.



Solid Neutron Shield Cap
Shielded Stainless Steel Lid
Lead Gamma Shielding
Monitoring Ports
Removable Lift Trunnions
Basket Assembly
Mount for
Redundant Lift Trunnions
Stainless Steel Vessel Walls
Lead Gamma Shielding
Solid Neutron Shield

NAC S/T CASK

C-E DRY CAP

(1) Type	Storage/Transport
(2) Manufacturer/Vendor	Combustion Engineering/Sumitomo
(3) Capacity (assys)	
(a) Intact SF	24 PWR; 60 BWR
(b) Consolidated Fuel Rods	48 PWR; 100 BWR
(4) Weight (tons)	
(a) Loaded	111 (PWR-intact); 113 (BWR-intact) 125 (consolidated)
(b) Empty	93.3
(5) Thermal	
(a) Design Heat Rejection (kW)	24 (est.)
(b) Peak Clad Temperature (°C)	355 max.
(6) Shape	Cylindrical
(7) Dimensions	
(a) Overall Length (in)	196.9
(b) Overall Diameter (in)	90
(c) Cavity Length (in)	178.7
(d) Cavity Diameter (in)	64.6
(e) Wall Thickness (in)	12.7
(f) Lid Thickness (in)	9.5
(g) Bottom Thickness (in)	8.7
(h) Basket Length (in)	N/A
(i) Basket Diameter (in)	N/A
(j) Thickness of Basket Spacers (in)	N/A
(8) Neutron Shield	
(a) No. Rods	None
(b) Rod Diameter (in)	None
(c) Side Thickness (in)	3.2
(d) Lid Thickness (in)	None
(e) Bottom Thickness (in)	None
(9) Materials of Construction	
(a) Cask Body	Steel
(b) Basket	SS
(c) Neutron Shield	BISCO
(10) No. Cooling Fins	None
(11) Cavity Atmosphere	He
(12) Cavity Pressure (psia)	N/A
(13) Outside Surface Dose (mR/hr)	50 max. (PWR); 80 max. (BWR)
(14) Maximum Leak Rate (l/s)	N/A

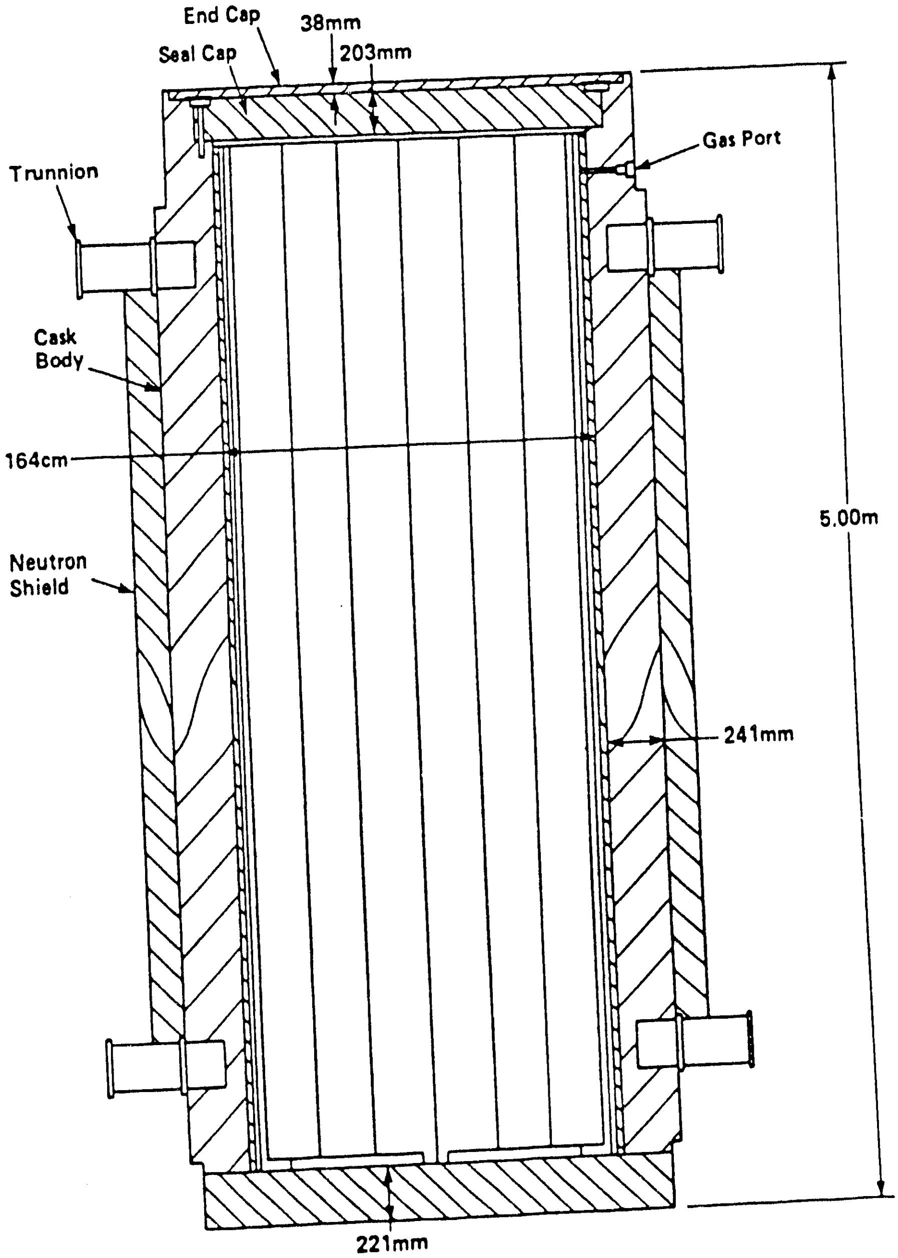
(15) Licensing Status TSAR submitted to NRC. NRC license expected in 1988.

(16) Comments None available at present, but can be ordered from Combustion Engineering.

References

(1) C. K. Anderson and W. J. Burns, The C-E Dry-Cap Spent Fuel Storage/Transport Cask, TIS-8195, Presented at PATRAM-86, Davos Switzerland, June 1986

N/A means not available.



C-E DRY-CAP SPENT FUEL STORAGE CASK

TN-24P

(1) Type	Storage/Transport
(2) Manufacturer/Vendor	Transnuclear Inc.
(3) Capacity (assys)	
(a) Intact SF	24
(b) Consolidated Fuel Rods	48
(4) Weight (tons)	
(a) Loaded	100
(b) Empty	82.3
(5) Thermal	
(a) Design Heat Rejection (kW)	20.6 (intact-vertical) 20.5 (intact-horizontal)
(b) Peak Clad Temperature (^{o}C)	221 (intact-vertical) 215 (intact-horizontal)
(6) Shape	Cylindrical
(7) Dimensions	
(a) Overall Length (in)	199.3
(b) Overall Diameter (in)	89.8
(c) Cavity Length (in)	163.4
(d) Cavity Diameter (in)	57.3
(e) Wall Thickness (in)	16.25
(f) Cooling Fin Length (in)	-
(g) Lid Thickness (in)	15.4 (24.9 w/protective cover)
(h) Bottom Thickness (in)	11.0
(i) Basket Length (in)	162.2
(j) Basket Diameter (in)	N/A
(k) Thickness of Basket Spacers	0.4
(8) Neutron Shield	
(a) No. Rods	N/A
(b) Rod Diameter (in)	N/A
(c) Side Thickness (in)	4.2
(d) Lid Thickness (in)	4.2
(e) Bottom Thickness (in)	None
(9) Materials of Construction	
(a) Cask Body	Forged Steel
(b) Basket	Al/B
(c) Neutron Shield	Resin (sides & bottom); granular polypropylene (lid)
(10) No. Cooling Fins	44
(11) Cavity Atmosphere	He
(12) Cavity Pressure (psia)	N/A
(13) Outside Surface Dose (mR/hr)	100
(14) Maximum Leak Rate (l/s)	N/A

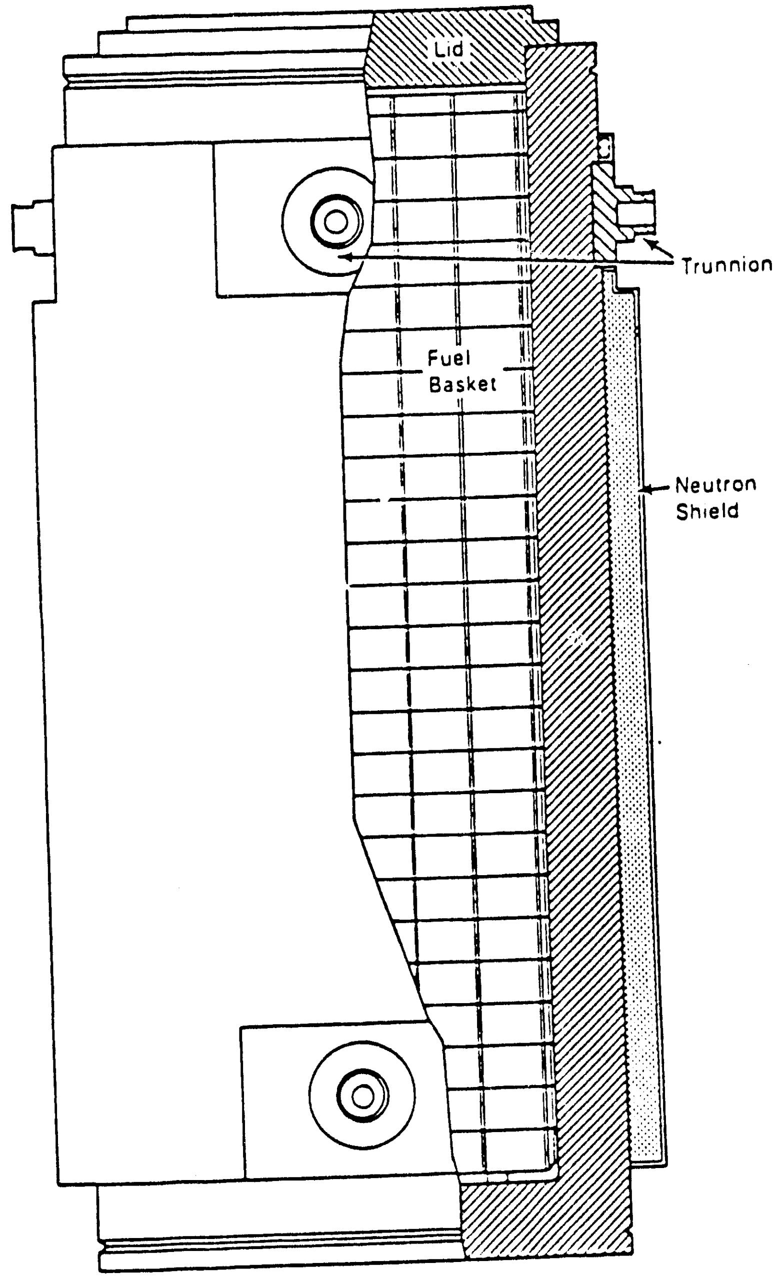
(15) Licensing Status TSAR submitted to NRC.

(16) Comments The cask is in existence at INEL and has been successfully tested there using Surry spent fuel.

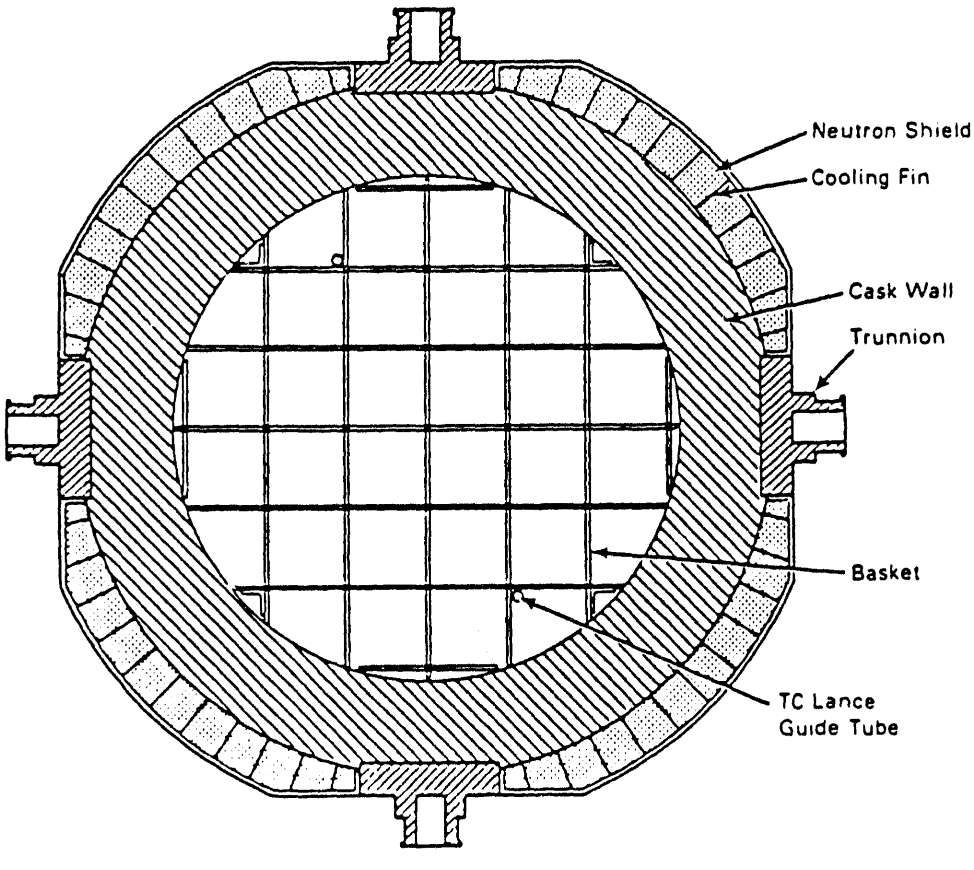
References

(1) Electric Power Research Institute, The TN-24P PWR Spent-Fuel Storage Cask: Testing and Analysis, EPRI NP-5128, April 1987

N/A means not available.



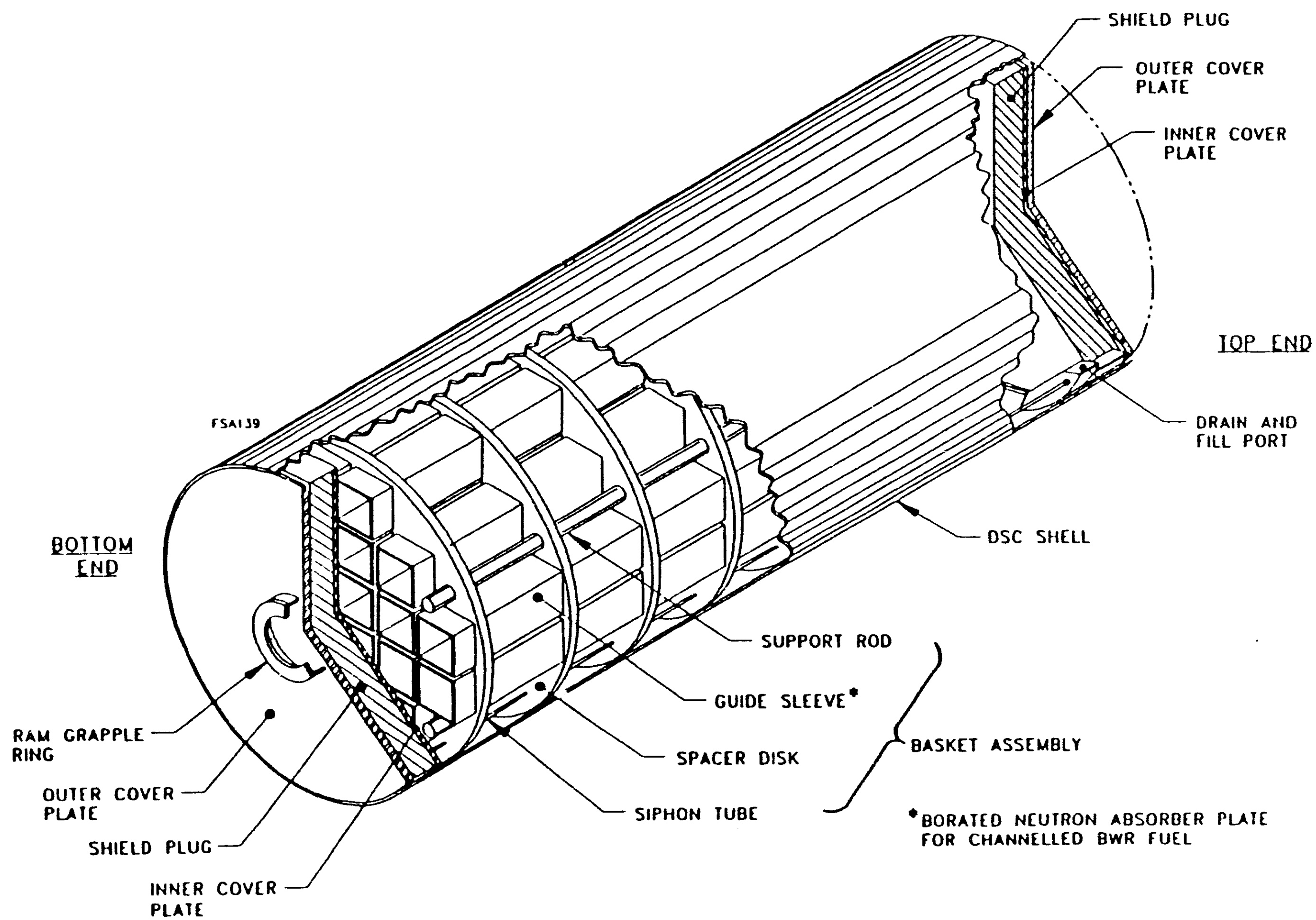
TN-24P PWR SPENT FUEL STORAGE CASK



TN-24P CASK CROSS SECTION

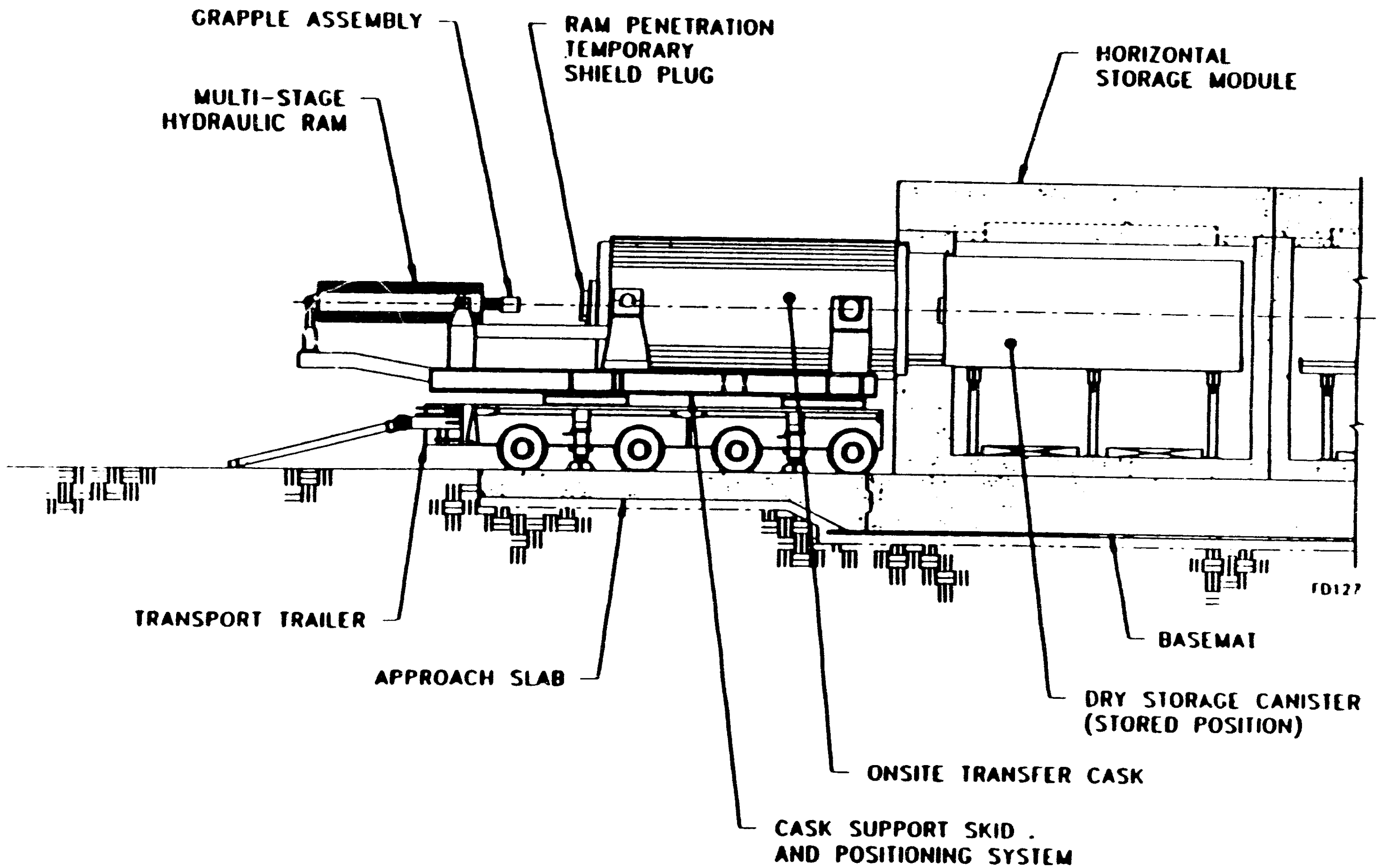
NUHOMS®-24P Canister and Cask Design Requirements for Transportation

NUHOMS®-24P CANISTER		NUHOMS®-24P TRANSPORTATION CASK (MP-187)	
(A) 10CFR72 STORAGE DESIGN BASIS	(B) 10CFR71 TRANSPORTATION DESIGN BASIS	(C) 10CFR71 DESIGN BASIS	
PHYSICAL PARAMETERS:			
• OUTSIDE DIAMETER	67.25 IN.	• CAVITY DIAMETER	68 IN.
• MAXIMUM LENGTH	186 IN.	• CAVITY LENGTH	187 IN.
• MAXIMUM LOADED WEIGHT	72,000 LBS	• MAXIMUM LOADED WEIGHT	125 TONS
CRITICALITY CONTROL:			
• BURNUP CREDIT OR BORON CREDIT	• BURNUP CREDIT OR MODERATOR EXCLUSION	• BURNUP CREDIT OR MODERATOR EXCLUSION	
• Keff < .95 (NOM)	• Keff < .95	• Keff < .95	
DECAY HEAT REMOVAL:			
• 16 Kw/DSC	16Kw/DSC	16Kw/DSC	
• MAXIMUM CLADDING TEMP			
≤ 340°C (LONG TERM)	N/A	N/A	
≤ 570°C (SHORT TERM)	< 380°C	< 380°C	
RADIOLOGICAL:			
• DOSE (NORMAL)			
≤ 200 MREM/HR (CONTACT)	≤ 200 MREM/HR (CONTACT)	≤ 200 MREM/HR (CONTACT) ≤ 10 MREM/HR @ 2M	
• DOSE (ACCIDENT)			
N/A	N/A	1R/HR @ 1M	
• SMEARABLE CONTAMINATION	≤ 22,000 $dpm/100cm^2$	≤ 22,000 $dpm/100cm^2$	
STRUCTURAL:			
• NORMAL/OFF-NORMAL LOADS			
N/A	1 FT FREE DROP	1 FT FREE DROP	
• ACCIDENT LOADS			
- SIDE DROP 75g's	30 FT DROP	30 FT DROP	
- END DROP 75g's	30 FT DROP	30 FT DROP	
- CORNER DROP 25g's	30 FT DROP	30 FT DROP	
- N/A	N/A	40 IN PUNCTURE	
• INTERNAL PRESSURE			
NORMAL < 10PSIG	< 10PSIG	< 10PSIG	
ACCIDENT < 50 PSIG	< 50PSIG	< 50PSIG	
OTHER:			
N/A	FIRE	FIRE	
FLOOD	N/A	SUBMERSION	

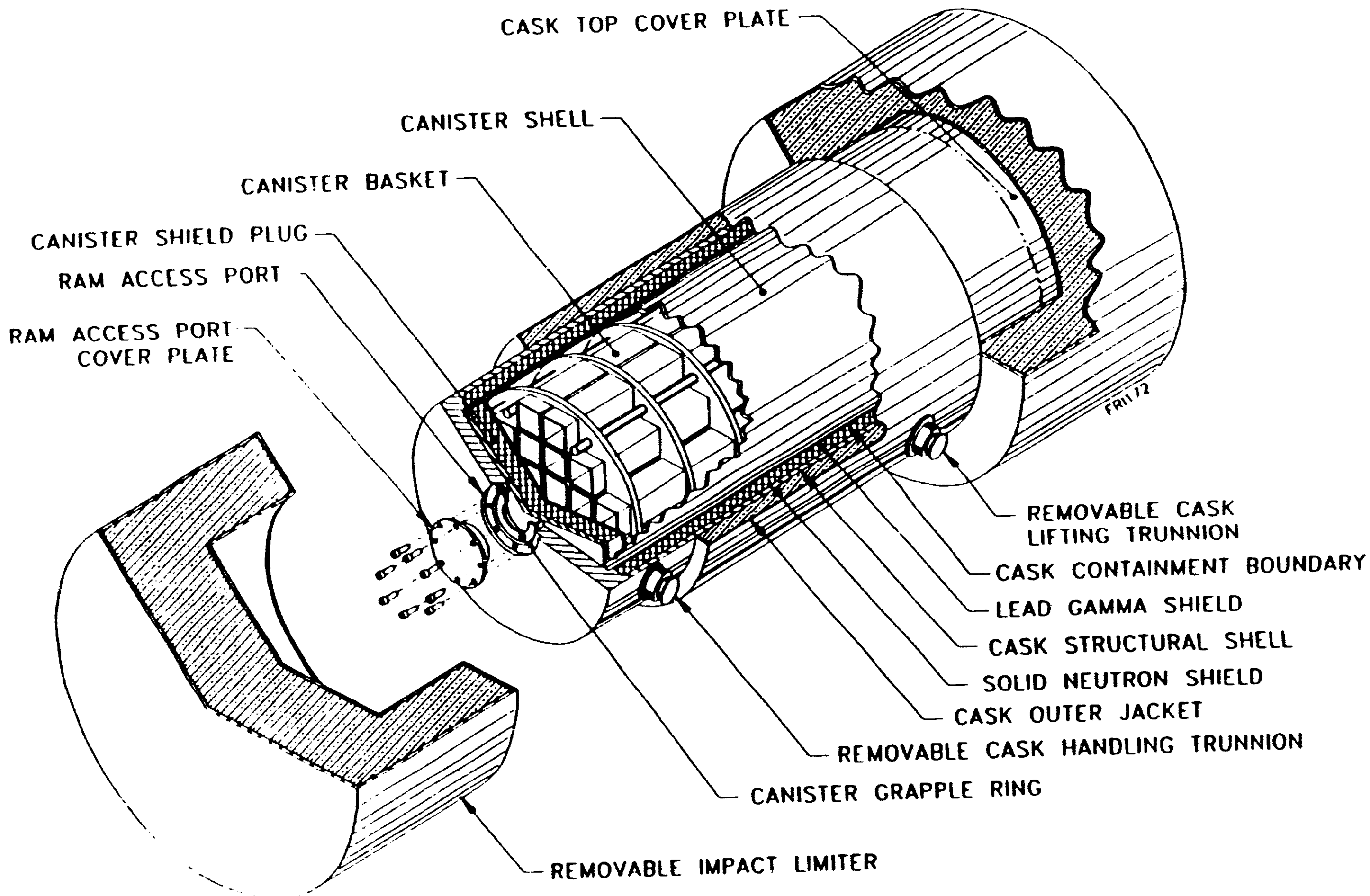


NUHOMS® Dry Shielded Canister Assembly Components

NUHOMS® System Components, Structures, and Transfer Equipment Elevation View



NUHOMS®
Multi-Purpose (MP-187) Cask - Exploded View



Pacific Nuclear

Appendix A.3

Transportation Packaging for Sealed Sources

SHIPPING CONTAINERS FOR SOURCES
[Radioactive Materials Packaging Database (RAMPAC) Query]

Package ID Number	Package	Package Description	Cavity	Cavity
USA/0018/S	S	Encapsulated Source	0.970	0.1285
USA/0030/S	S	Cylinder	N/A	N/A
USA/0036/S	S	Encapsulated Source	N/A	N/A
USA/0042/S	S	Encapsulated Source	N/A	N/A
USA/0043/S	S	Encapsulated Source	N/A	N/A
USA/0058/S	S	Encapsulated Source	N/A	N/A
USA/0061/B(U)	B	Container in Box	N/A	N/A
USA/0062/S	S	Encapsulated Source	N/A	N/A
USA/0065/S	S	Encapsulated Source	N/A	N/A
USA/0066/S	S	Encapsulated Source	0.30	N/A
USA/0069/S	S	Encapsulated Source	N/A	N/A
USA/0071/S	S	Encapsulated Source	N/A	N/A
USA/0072/S	S	Cylinder	N/A	N/A
USA/0073/S	S	Encapsulated Source	N/A	N/A
USA/0074/S	S	Encapsulated Source	N/A	0.125
USA/0077/S	S	Encapsulated Source	N/A	N/A
USA/0078/S	S	Encapsulated Source	N/A	N/A
USA/0081/S	S	Cylinder	0.59	N/A
USA/0083/S	S	Cylinder	N/A	N/A
USA/0084/S	S	Cylinder	N/A	1.18
USA/0086/S	S	Cylinder	0.160	0.008
USA/0087/S	S	Encapsulated Source	N/A	N/A
USA/0088/S	S	Encapsulated Source	N/A	N/A
USA/0089/B(U)	B	Source Changer	N/A	N/A
USA/0092/B(U)	B	Container in Box	N/A	N/A
USA/0095/S	S	Encapsulated Source	N/A	N/A
USA/0099/B(U)	B	Box	N/A	N/A
USA/0103/S	S	Encapsulated Source	N/A	N/A
USA/0110/B(U)	B	Cylinder	N/A	N/A
USA/0111/S	S	Encapsulated Source	N/A	N/A
USA/0112/S	S	Encapsulated Source	N/A	N/A
USA/0113/S	S	Encapsulated Source	N/A	N/A

Package ID Number	Package	Package Description	Cavity	Cavity
USA/0114/S	S	Encapsulated Source	N/A	N/A
USA/0115/S	S	Encapsulated Source	0.315	0.180
USA/0124/B(U)	B	Container in Drum	4.60	2.47
USA/0126/B(U)-85	B	Container in Drum	N/A	2.97
USA/0131/B(U)	B	Source Changer	N/A	N/A
USA/0132/B(U)	B	Container in Box	N/A	N/A
USA/0135/S	S	Encapsulated Source	N/A	N/A
USA/0137/S	S	Encapsulated Source	N/A	N/A
USA/0138/S	S	Encapsulated Source	N/A	1.050
USA/0139/S	S	Encapsulated Source	N/A	N/A
USA/0141/S	S	Encapsulated Source	0.895	0.154
USA/0149/S	S	Encapsulated Source	N/A	N/A
USA/0152/S	S	Encapsulated Source	N/A	N/A
USA/0154/S	S	Encapsulated Source	N/A	N/A
USA/0158/S	S	Encapsulated Source	N/A	N/A
USA/0159/S	S	Encapsulated Source	N/A	N/A
USA/0164/B(U)	B	Cylinder	N/A	N/A
USA/0165/S	S	Encapsulated Source	N/A	N/A
USA/0166/S	S	Encapsulated Source	N/A	N/A
USA/0168/B(U)	B	Container in Drum	N/A	N/A
USA/0169/B(U)	B	Container in Drum	N/A	N/A
USA/0170/B(U)	B	Container in Drum	N/A	N/A
USA/0171/B(U)	B	Encapsulated Source	N/A	N/A
USA/0172/B(U)	B	Container in Drum	N/A	N/A
USA/0173/B(U)	B	Cylinder	3.35	1.26
USA/0174/S	S	Encapsulated Source	N/A	N/A
USA/0179/S	S	Encapsulated Source	N/A	N/A
USA/0183/S	S	Encapsulated Source	N/A	N/A
USA/0185/S	S	Encapsulated Source	N/A	0.95
USA/0192/S	S	Encapsulated Source	N/A	N/A
USA/0193/B(U)	B	Cylinder	11.12	6.00
USA/0202/S	S	Encapsulated Source	N/A	N/A
USA/0205/S	S	Encapsulated Source	1.43	0.43
USA/0212/S	S	Encapsulated Source	N/A	N/A

Package ID Number	Package	Package Description	Cavity	Cavity
USA/0214/B(U)	B	Cylinder	18.87	6.37
USA/0221/S	S	Encapsulated Source	N/A	N/A
USA/0226/B(U)	B	Encapsulated Source	N/A	N/A
USA/0227/B(U)	B	Cylinder	N/A	N/A
USA/0228/B(U)	B	Cylinder	N/A	N/A
USA/0229/B(U)	B	Cylinder	N/A	N/A
USA/0230/B(U)	B	Cylinder	N/A	N/A
USA/0242/S	S	Encapsulated Source	N/A	N/A
USA/0243/B(U)	B	Container in Drum	N/A	N/A
USA/0245/S	S	Encapsulated Source	N/A	N/A
USA/0249/S	S	Encapsulated Source	N/A	N/A
USA/0250/B(U)	B	Container in Drum	N/A	N/A
USA/0251/B(U)	B	Drum	N/A	N/A
USA/0257/S	S	Encapsulated Source	N/A	N/A
USA/0263/S	S	Cylinder	N/A	N/A
USA/0267/B(U)	B	Container in Drum	N/A	N/A
USA/0272/B(U)	B	Cylinder	N/A	N/A
USA/0273/B(U)	B	Cylinder	N/A	N/A
USA/0276/S	S	Encapsulated Source	0.50	0.25
USA/0277/S	S	Encapsulated Source	N/A	N/A
USA/0279/S	S	Encapsulated Source	N/A	N/A
USA/0282/S	S	Encapsulated Source	N/A	N/A
USA/0283/S	S	Encapsulated Source	N/A	N/A
USA/0284/B(U)	B	Cylinder	N/A	N/A
USA/0290/S	S	Cylinder	10.75	1.07
USA/0292/S	S	Encapsulated Source	N/A	N/A
USA/0295/B(U)	B	Cylinder	N/A	N/A
USA/0296/B(U)	B	Box	N/A	N/A
USA/0297/S	S	Encapsulated Source	0.380	0.111
USA/0301/B(U)	B	Drum	N/A	N/A
USA/0302/B(U)	B	Drum	N/A	N/A
USA/0303/B(U)	B	Drum	N/A	N/A
USA/0304/B(U)	B	Drum	N/A	N/A
USA/0305/B(U)	B	Drum	N/A	N/A

Package ID Number	Package	Package Description	Cavity	Cavity
USA/0306/B(U)	B	Drum	N/A	N/A
USA/0307/B(U)	B	Drum	N/A	N/A
USA/0308/B(U)	B	Drum	N/A	N/A
USA/0309/B(U)	B	Drum	N/A	N/A
USA/0310/B(U)	B	Drum	N/A	N/A
USA/0311/B(U)	B	Drum	N/A	N/A
USA/0312/B(U)	B	Drum	N/A	N/A
USA/0313/B(U)	B	Encapsulated Source	N/A	N/A
USA/0314/B(U)	B	Drum	N/A	N/A
USA/0315/B(U)	B	Drum	N/A	N/A
USA/0316/B(U)	B	Drum	N/A	N/A
USA/0317/B(U)	B	Cylinder	N/A	N/A
USA/0320/B(U)	B	Cylinder	N/A	N/A
USA/0322/B(U)	B	Container in Drum	N/A	N/A
USA/0327/S	S	Cylinder	N/A	N/A
USA/0329/S	S	Encapsulated Source	N/A	N/A
USA/0331/S	S	Encapsulated Source	N/A	N/A
USA/0332/B(U)	B	Cylinder	N/A	N/A
USA/0332/B(U)	B	Cylinder	30.12	10.24
USA/0335/S	S	Encapsulated Source	N/A	N/A
USA/0336/S	S	Encapsulated Source	N/A	N/A
USA/0337/B(U)	B	Cylinder	N/A	N/A
USA/0342/B(U)	B	Cylinder	N/A	N/A
USA/0343/B(U)	B	Cylinder	N/A	N/A
USA/0344/B(U)	B	Cylinder	N/A	N/A
USA/0345/B(U)	B	Cylinder	N/A	N/A
USA/0346/B(U)	B	Cylinder	N/A	N/A
USA/0348/B(U)	B	Cylinder	N/A	11.50
USA/0350/S	S	Encapsulated Source	N/A	N/A
USA/0351/S	S	Encapsulated Source	N/A	N/A
USA/0352/S	S	Encapsulated Source	N/A	0.70
USA/0353/S	S	Encapsulated Source	N/A	N/A
USA/0354/S	S	Encapsulated Source	N/A	N/A
USA/0356/S	S	Encapsulated Source	N/A	N/A

Package ID Number	Package	Package Description	Cavity	Cavity
USA/0357/S	S	Encapsulated Source	N/A	0.187
USA/0363/S	S	Cylinder	N/A	N/A
USA/0365/B(U)	B	Drum	N/A	N/A
USA/0366/S	S	Encapsulated Source	N/A	N/A
USA/0367/S	S	Encapsulated Source	N/A	0.154
USA/0369/S	S	Encapsulated Source	1.49	1.31
USA/0370/B(U)	B	Container in Box	N/A	N/A
USA/0372/B(U)	B	Drum	N/A	N/A
USA/0373/B(U)	B	Cylinder	N/A	N/A
USA/0374/B(U)	B	Cylinder	N/A	N/A
USA/0375/B(U)	B	Drum	N/A	N/A
USA/0376/S	S	Encapsulated Source	N/A	N/A
USA/0377/S	S	Encapsulated Source	N/A	N/A
USA/0378/B(U)	B	Cylinder	N/A	N/A
USA/0382/B(U)	B	Drum	N/A	N/A
USA/0383/S	S	Encapulated Source	N/A	N/A
USA/0384/B(U)	B	Cylinder	N/A	6.40
USA/0385/B(U)	B	Box	N/A	N/A
USA/0390/S	S	Encapsulated Source	N/A	0.555
USA/0392/S	S	Encapsulated Source	N/A	N/A
USA/0393/S	S	Encapsulated Source	N/A	N/A
USA/0395/S	S	Encapsulated Source	N/A	N/A
USA/0396/S	S	Encapsulated Source	0.656	0.0787
USA/0398/S	S	Encapsulated Source	N/A	N/A
USA/0400/S	S	Encapsulated Source	N/A	N/A
USA/0402/B(U)	B	Cylinder	3.74	1.97
USA/0404/B(U)	B	Container	N/A	N/A
USA/0408/B(U)	B	Encapsulated Source	N/A	N/A
USA/0413/S	S	Encapsulated Source	N/A	N/A
USA/0415/S	S	Cylinder	16.95	0.319
USA/0417/S	S	Encapsulated Source	N/A	N/A
USA/0418/S	S	Encapsulated Source	N/A	N/A
USA/0419/S	S	Cylinder	N/A	N/A
USA/0420/S	S	Encapsulated Source	N/A	N/A

Package ID Number	Package	Package Description	Cavity	Cavity
USA/0421/S	S	Cylinder	N/A	N/A
USA/0422/S	S	Encapsulated Source	N/A	N/A
USA/0423/S	S	Encapsulated Source	N/A	N/A
USA/0424/S	S	Encapsulated Source	N/A	N/A
USA/0427/S	S	Cylinder	0.169	N/A
USA/0429/B(U)	B	Drum	N/A	N/A
USA/0430/B(U)F	B	Drum	N/A	N/A
USA/0431/S	S	Cylinder	N/A	N/A
USA/0440/B(U)	B	Cylinder	N/A	N/A
USA/0441/B(U)	B	Cylinder	N/A	N/A
USA/0444/B(U)	B	Cylinder	5.10	5.00
USA/0446/B(U)F	B	Cylinder	97.40	7.72
USA/0448/S	S	Cylinder	1.50	0.62
USA/0450/S	S	Cylinder	N/A	1.454
USA/0453/S	S	Cylinder	12.00	N/A
USA/0455/S	S	Cylinder	N/A	N/A
USA/0456/B(U)-85	B	Box	N/A	N/A
USA/0457/S	S	Cylinder	N/A	N/A
USA/0458/S	S	Encapsulated Source	N/A	N/A
USA/0459/B(U)-85	B	Container	N/A	N/A
USA/0462/S	S	Encapsulated Source	N/A	N/A
USA/0468/B(U)-85	B	Cylinder	N/A	6.37
USA/4888/B( )	B	Generator	N/A	N/A
USA/5362/B( )	B	Container in Box	46.63	9.48
USA/5757/B( )F	B	Cylinder	N/A	N/A
USA/5796/B(U)	B	Box	29.00	25.50
USA/5796/B(U)	B	Box	29.00	25.50
USA/5800/B	B	Container	N/A	N/A
USA/5830/B( )	B	Generator	N/A	N/A
USA/5830/B( )	B	Generator	N/A	N/A
USA/5862/B( )	B	Generator	N/A	N/A
USA/5939/B( )F	B	Cylinder	N/A	7.00
USA/5939/B( )F	B	Cylinder	N/A	7.00
USA/5939/X	X	Cylinder	N/A	7.00

Package ID Number	Package	Package Description	Cavity	Cavity
USA/5979/B( )	B	Cylinder	N/A	24.00
USA/5979/B( )	B	Cylinder	N/A	24.00
USA/5984/B( )	B	Cylinder	31.00	20.00
USA/6050/B(U)	B	Cylinder	N/A	3.75
USA/6125/B(U)	B	Box	N/A	N/A
USA/6162/B(U)	B	Cylinder	N/A	6.40
USA/6217/B(U)	B	Box	N/A	N/A
USA/6280/B( )	B	Cylinder	36.00	31.00
USA/6306/B(U)	B	Cylinder	18.87	6.37
USA/6350/B(U)	B	Box	N/A	N/A
USA/6351/B(U)	B	Cylinder	N/A	N/A
USA/6352/B(U)	B	Box	N/A	N/A
USA/6355/B(U)	B	Container in Box	N/A	N/A
USA/6358/B(U)	B	Cylinder	N/A	N/A
USA/6613/B(U)	B	Box	3.25	2.26
USA/6613/B(U)	B	Box	3.25	2.26
USA/6642/B( )	B	Cylinder	6.37	4.00
USA/6642/B( )	B	Cylinder	6.37	4.00
USA/6717/B(U)	B	Drum	N/A	N/A
USA/6717/B(U)	B	Drum	N/A	N/A
USA/6786/B( )	B	Generator	N/A	N/A
USA/9006/B(U)	B	Source Changer	N/A	N/A
USA/9006/B(U)	B	Source Changer	N/A	N/A
USA/9007/B(U)	B	Cylinder	N/A	N/A
USA/9007/B(U)	B	Cylinder	N/A	N/A
USA/9011/B( )	B	Box	32.00	38.00
USA/9011/B( )	B	Box	32.00	38.00
USA/9021/B(U)	B	Source Changer	N/A	N/A
USA/9021/B(U)	B	Source Changer	N/A	N/A
USA/9024/B( )	B	Cylinder	9.00	4.00
USA/9027/B(U)	B	Projector	N/A	N/A
USA/9027/B(U)	B	Projector	N/A	N/A
USA/9028/B(U)	B	Projector	N/A	N/A
USA/9028/B(U)	B	Projector	N/A	N/A

Package ID Number	Package	Package Description	Cavity	Cavity
USA/9029/B(U)	B	Projector	N/A	N/A
USA/9029/B(U)	B	Projector	N/A	N/A
USA/9030/B( )	B	Generator	N/A	N/A
USA/9032/B(U)	B	Source Changer	N/A	N/A
USA/9032/B(U)	B	Source Changer	N/A	N/A
USA/9033/B(U)	B	Projector	N/A	N/A
USA/9033/B(U)	B	Projector	N/A	N/A
USA/9035/B(U)	B	Projector	N/A	N/A
USA/9035/B(U)	B	Projector	N/A	N/A
USA/9036/B(U)	B	Source Changer	N/A	N/A
USA/9036/B(U)	B	Source Changer	N/A	N/A
USA/9039/B(U)	B	Drum	N/A	N/A
USA/9039/B(U)	B	Drum	N/A	N/A
USA/9053/B(U)	B	Cylinder	N/A	N/A
USA/9053/B(U)	B	Cylinder	N/A	N/A
USA/9056/B(U)	B	Projector	N/A.	N/A
USA/9056/B(U)	B	Projector	N/A	N/A
USA/9102/B( )	B	Container	N/A	8.25
USA/9107/B(U)	B	Source Changer	N/A	N/A
USA/9107/B(U)	B	Source Changer	N/A	N/A
USA/9126/B(U)	B	Container	N/A	N/A
USA/9126/B(U)	B	Container	N/A	N/A
USA/9127/B(U)	B	Encapsulated Source	N/A	N/A
USA/9127/B(U)	B	Encapsulated Source	N/A	N/A
USA/9128/B(U)	B	Source Changer	N/A	N/A
USA/9128/B(U)	B	Source Changer	N/A	N/A
USA/9137/B(U)	B	Source Changer	N/A	N/A
USA/9137/B(U)	B	Source Changer	N/A	N/A
USA/9141/B(U)	B	Box	N/A	N/A
USA/9141/B(U)	B	Box	N/A	N/A
USA/9143/B(U)	B	Box	N/A	N/A
USA/9143/B(U)	B	Box	N/A	N/A
USA/9147/B(U)	B	Source Changer	N/A	N/A
USA/9147/B(U)	B	Source Changer	N/A	N/A

Package ID Number	Package	Package Description	Cavity	Cavity
USA/9148/B(U)	B	Source Changer	N/A	N/A
USA/9148/B(U)	B	Source Changer	N/A	N/A
USA/9153/B( )	B	Generator	N/A	1.871
USA/9156/B(U)	B	Container in Drum	N/A	N/A
USA/9156/B(U)	B	Container in Drum	N/A	N/A
USA/9157/B(U)	B	Box	N/A	N/A
USA/9157/B(U)	B	Box	N/A	N/A
USA/9165/B(U)	B	Source Changer	N/A	N/A
USA/9165/B(U)	B	Source Changer	N/A	N/A
USA/9166/B(U)	B	Source Changer	N/A	N/A
USA/9166/B(U)	B	Source Changer	N/A	N/A
USA/9167/B(U)	B	Cylinder	N/A	N/A
USA/9167/B(U)T	B	Cylinder	N/A	N/A
USA/9167/X	B	Cylinder	N/A	N/A
USA/9180/B(U)	B	Container in Drum	N/A	N/A
USA/9180/B(U)	B	Container in Drum	N/A	N/A
USA/9182/B(U)	B	Cylinder	N/A	N/A
USA/9185/B(U)	B	Drum	N/A	N/A
USA/9185/B(U)	B	Drum	N/A	N/A
USA/9187/B(U)	B	Container	N/A	N/A
USA/9187/B(U)	B	Container	N/A	N/A
USA/9205/B(U)	B	Generator	N/A	26.10
USA/9215/B(U)	B	Cylinder	N/A	8.25
USA/9215/B(U)	B	Cylinder	N/A	8.25
USA/9245/B(U)	B	Drum	N/A	N/A
USA/9245/B(U)	B	Drum	N/A	N/A
USA/9511/B(U)	B	Cylinder	N/A	20.25
USA/9511/B(U) (DOE)	B	Cylinder	N/A	20.25
USA/9516/B(U)F (DOE)	B	Cylinder	N/A	N/A

Appendix A.4

DOT Specification 7A Packaging by DOE

(This appendix is extracted from WHC-EP-0558,
Test and Evaluation Document for DOT Specification 7A Packaging.)

Test and Evaluation Document for DOT Specification 7A Type A Packaging

Prepared for the U.S. Department of Energy
Assistant Secretary for Environment, Safety and Health

Westinghouse
Hanford Company Richland, Washington

Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

TEST AND EVALUATION DOCUMENT FOR THE U.S. DEPARTMENT OF TRANSPORTATION SPECIFICATION 7A TYPE A PACKAGINGS

1.0 INTRODUCTION

The U.S. Department of Energy (DOE) has been conducting, through several of its operating contractors, an evaluation and testing program to qualify Type A radioactive material packagings per U.S. Department of Transportation (DOT) Specification 7A (DOT-7A) of the Code of Federal Regulations (CFR), Title 49, Part 178 (49 CFR 178). The program is currently administered by the DOE, Division of Transportation and Packaging Safety, DOE/EH-33.3, at DOE-Headquarters (DOE-HQ) in Germantown, Maryland.

This document summarizes the evaluation and testing performed for all of the packagings successfully qualified in this program. This document supersedes *DOE Evaluation Document for DOT-7A Type A Packaging* (Edling 1987), originally issued in 1987 by Monsanto Research Corporation - Mound Laboratory (MLM), Miamisburg, Ohio, for the Department of Energy, Security Evaluation Program (DP-4). Mound Laboratory issued four revisions to the document between November 1988 and December 1989. In September 1989, the program was transferred to Westinghouse Hanford Company (Westinghouse Hanford) in Richland, Washington. One additional revision was issued in March 1990 by Westinghouse Hanford.

This document reflects the earlier material and incorporates a number of changes. Evaluation and testing activities on 12 DOT-7A Program Dockets resulted in the qualification of 29 new packaging configurations, which are incorporated herein and summarized below.

New Packaging Configurations.

Docket(s)	Configurations	Description
89-01	3	ORNL Y-12 series boxes
89-03	1	WIPP RH-TRU canister
89-04	2	ORNL low-level waste containers
89-08	2	ORNL modified 5A and 5B cylinders
89-09	6	WMCO banded, wooden boxes
89-12	1	OR Y-12 picture frame box
90-13/-18	5	RFP DOT-17C, 55-gallon drums
90-14	1	WHC liquid sample packaging
90-17/-20	2	ANL-E/FMPC DOT-17H, 30-gallon drums
90-19	4	OR Y-12 C-series wooden boxes
90-22	1	SRP process-water sample packaging
91-25	1	RF Model LWS-1 (liquids)

This document was prepared initially in July 1991 as a draft and submitted to DOE-HQ for review. The DOE-HQ forwarded a copy of the draft to the DOT for review. The DOT provided concurrence to the draft in April 1992 via a letter (included herein as Appendix E) which was forwarded to Westinghouse Hanford with DOE's direction to distribute this document. A number of miscellaneous changes have been made for completeness and to reflect the programmatic changes that have occurred since 1987.

1.1 PURPOSE AND SCOPE

The purpose of this document is to provide technical documentation of the evaluation and testing activities successfully completed to qualify a number of packagings to the requirements of DOT-7A (49 CFR 178.350). The packagings described herein are considered acceptable for transport of Type A quantities of radioactive material subject to the applicable restrictions and specifications.

The specific packaging data contained in this document will serve to meet the requirements of 49 CFR 173.415(a) for ". . . documentation of tests . . ." when the packagings are used as prescribed. In addition to the documentation of tests, the shipper must maintain on file other appropriate data applicable to the shipment, such as the following:

- Evaluation of the properties of the actual contents to be shipped for compatibility with the packaging
- The Quality Control Program and its implementation.

Therefore, it is apparent that this document does not "stand alone" for all the documentation needed when offering a package for transportation. The shipper is responsible in many areas for ensuring that the loaded package is acceptable.

Changes in technology and in the mission of the various DOE facilities and contractors will generate the need for new packaging designs on a continuing basis. If a new design is needed (i.e., not currently covered in this document), contact one of the DOT-7A Program administrative or technical contacts listed in Sections 1.1.1 and 1.1.2, respectively, for assistance on qualifying a new packaging.

1.1.1 Administrative Contacts

The DOT-7A Program is currently administered by the DOE, Division of Quality Verification and Transportation Safety, DOE/EH-33.3, at DOE-HQ in Germantown, Maryland. The responsible persons are as follows:

M. E. Wangler, Director
Division of Transportation and Packaging Safety
U.S. Department of Energy, EH-33.3
19901 Germantown Road
Germantown, MD 20874
COMM/FTS 301-903-5078

F. G. Punch
Division of Transportation and Packaging Safety
U.S. Department of Energy, EH-33.3
19901 Germantown Road
Germantown, MD 20874
COMM/FTS 301-903-6020

Any organization wishing to have a packaging qualified in this program should contact one of the persons listed above.

1.1.2 Technical Contacts

Westinghouse Hanford, Transportation and Packaging, is currently conducting the evaluation and testing activities. The persons responsible for these activities are as follows:

J. H. Hummer, Manager
Packaging Programs and Testing, MSIN G2-02
Westinghouse Hanford Company
P.O. Box 1970
2355 Stevens Drive
Richland, WA 99352
COMM/FTS 509-376-9361

J. H. O'Brien, Project Engineer
Packaging Programs and Testing, MSIN G2-02
Westinghouse Hanford Company
P.O. Box 1970
2355 Stevens Drive
Richland, WA 99352
COMM/FTS 509-376-2808

Please contact one of the persons listed above with any technical questions or any questions regarding dockets that have been established in the program.

The program has a great deal of experience with designs and materials that adequately perform to the requirements.

The normal approach to qualification of a new packaging design is to develop the design and operational documentation, review this documentation, and expose several test units to the Type A packaging tests (49 CFR 173.465 and 173.466). If the packaging performs adequately, it will be approved for use and included in this document at the next revision.

1.2 RESPONSIBILITIES

There are a number of specific functions that must be performed to ensure that a DOT-7A package is properly prepared for safe transport and in full compliance with the applicable regulations. The affiliation or the specific arrangements between the designer, manufacturer, and user should be adequately described and understood.

The following paragraphs discuss specific responsibilities.

1.2.1 The U.S. Department of Energy

The Packaging Certification Staff of DOE/EH-33.3 is responsible for the administration of the DOT-7A Program. This includes approval authority for all of the various program documents, requests for evaluation and testing of new packagings, and approval of their qualification. General programmatic direction is also under the control of DOE/EH-33.3.

1.2.2 Shipper

Shippers of Type A quantities of radioactive material are generally responsible for all aspects of the shipment. It is DOE policy to fully comply with the regulations for such shipments as established in 49 CFR 173. Normally the shipper will be able to locate an acceptable packaging, which places primary emphasis on ensuring compatibility with contents and correctness in operations.

1.2.3 Manufacturer

The manufacturer of a DOT-7A Type A packaging, which is covered in this document or otherwise authorized for use within the DOE system, is responsible for using materials, fabrication methods, manufacturing, and quality controls to ensure that the packaging is equivalent to the specified design. No design changes, substitutions, or changes in fabrication methods or controls are authorized without the approval of DOE/EH-33.3.

1.2.4 Testing Laboratory

The testing laboratory is responsible for evaluation and testing of new DOT-7A packaging designs based on the direction of DOE/EH-33.3. This process involves review of the applicants design data, inspection of the test unit packages, performance of the Type A packaging tests, and documentation of the results. Westinghouse Hanford is currently performing this function for DOE/EH-33.3; Westinghouse Hanford is also maintaining and distributing the various DOT-7A Program documents.

1.3 APPLICABLE U.S. DEPARTMENT OF TRANSPORTATION REGULATIONS

The DOT regulations for shipping hazardous materials are located in 49 CFR, Parts 100-500. Copies of these regulations can be obtained from the Government Printing Office or other sources. The packagings described herein have been qualified to meet DOT-7A (49 CFR 178.350) for Type A packagings. Specification 7A is a general specification and invokes the applicable requirements of 49 CFR 173, Subparts A, B, and I.

Some of the important regulations affecting shipments of Type A quantities of radioactive material are summarized in the following paragraphs. The primary sections of the regulations applicable to Type A packaging requirements are as follows:

178.350	Specification 7A; general packaging, Type A
173.21	Forbidden materials and packages
173.22	Shipper's responsibility
173.24	Standard requirements for all packages
173.411	General design requirements
173.412	Additional design requirements for Type A packages
173.415(a)	Authorized Type A packages
173.461	Demonstration of compliance with tests
173.462	Preparations of specimens for testing
173.463	Packaging and shielding--testing for integrity
173.465	Type A packaging tests
173.466	Additional tests for Type A packagings designed for liquids and gases
173.474	Quality control for construction of packaging
173.475	Quality control requirements prior to each shipment of radioactive material.

1.3.1 Contents Characterization

Specification 7A packagings are qualified for transporting Type A quantities of radioactive material. Characterization of contents for compatibility with the selected packaging is an important aspect of any shipment and is primarily the responsibility of the shipper. The regulations address this area with a number of items, which are summarized in the following paragraphs.

1.3.1.1 Radiological. The following items in 49 CFR 173, Subpart I address the radiological characteristics of the material to be shipped:

173.431	Activity limits for Type A and Type B packages
173.433	Requirements for determination of A_1 and A_2 values for radionuclides

173.441 Radiation level limitations

173.455 Classification of fissile materials packages.

The shipper must characterize the payload as needed to determine compliance with these requirements.

1.3.1.2 Physical Form. The physical form of the material has an indirect affect on the applicability of a number of requirements. For example, the density of the material will affect the gross weight, which affects the requirements invoked for package handling features. In the DOT-7A Program, solid materials are classed into one of three Material Forms (Forms) as follows:

- Form No. 1: Solids--any particle size
  - A packaging qualified for these contents is expected to contain radioactive contents of any representative particulate form.
- Form No. 2: Solids--large particle size only (cement grade sand or larger)
  - Contents of a corresponding particulate size such as soil or construction debris. (Glass or plastic labware having fine particulate available for dispersion would not fit this category and would require a packaging qualified for fine particulate, Form No. 1.)
- Form No. 3: Solid material with no removable or dispersible contamination (for definition, see 49 CFR 173.443, "Contamination control").
  - Metals with activation products
  - Forms of metals/alloys/compounds of uranium, thorium
  - Solid materials with the radioactive material firmly fixed in place, possibly by the application of a fixing media (paint etc.)
  - Solidified material

NOTE: These are examples only and each form must be analyzed for compliance with the "no removable or dispersible contamination" criterion found in 49 CFR 173.443.

Packagings intended to transport liquids and gases must be designed to withstand more severe test conditions than those designed for solids.

1.3.1.3 Thermal. Thermal limitations and requirements applicable to packagings are addressed in the following sections:

173.412(d)	Containment and shielding--temperature range
173.442	Thermal limitations
173.448(b)	Heat output.

The thermal heat generation of the contents for whatever reason must not degrade the packaging. Normally, Type A quantities of radionuclides do not generate enough decay heat to be of concern. If there is any doubt, the decay heat should be calculated and the package design analyzed to ensure no problems.

1.3.1.4 Chemical. The chemical characteristics of the contents are addressed by the following requirements:

173.21	Forbidden materials and packages
173.24(a)(3)	Mixture, reaction
173.24(c)(5)	Reaction
173.24(c)(6)	Closures, gaskets
173.24(d)	Plastic compatibility/permeability
173.412(g)	Compatibility, behavior under irradiation
173.412(h)	Gas generation, radiolysis.

Generally, the contents must not react with the packaging so as to degrade it and must not develop chemical conditions which could lead to an explosion. The basic chemical makeup of the nonradioactive constituents of the contents to be shipped must be understood in order to adequately design a packaging.

1.3.2 Packaging Design

The regulatory requirements primarily applicable to the design of a Type A packaging are listed as follows:

173.24(a)	Design and construction
173.24(c)	Design and construction criteria
173.24(d)	Polyethylene packagings and receptacles
173.411(a)-(f)	General design requirements
173.412	Additional design requirements for Type A packages

173.462(c) Containment system . . . specified

173.462(d) External features . . . clearly identified.

The packagings identified in this document have been designed and qualified to meet these requirements for transporting contents as shown in the subsequent sections. The following paragraphs are intended to summarize the design-related requirements.

1.3.2.1 General Arrangement. The packaging design will generally fall into one of three basic configurations: (1) single packaging, (2) composite packaging, or (3) combination packaging (see definitions 49 CFR 171.8 as revised by HM-181 dated December 21, 1990). Single packagings are generally recommended for solids meeting the definition of Form 2 or Form 3, or gases. For packaging of solids classed as Form 1 and liquids, composite or combination packagings are recommended.

1.3.2.2 Containment. The requirements that pertain directly to containment of contents are as follows:

173.24(a) Design and construction

173.24(c)(5) Reaction

173.24(c)(6) Closures and gaskets

173.24(d) Polyethylene packagings and receptacles

173.462(c) Containment system . . . specified.

Basically, there can be, "no significant release of the hazardous materials to the environment," and the packaging must remain effective when subjected to normal conditions of transport, with account being taken for any reactions between the contents and the packaging materials. In practice, "no significant release," implies no measurable leakage based on visual evaluation.

Containment is formed by those materials or components that are or may be in direct contact with the contents during shipment. The design process will involve choices of basic material, use of filters or other pressure relief devices, gaskets or other seal materials, closure mechanisms, and other features. Typical containment materials are high-density polyethylene (HDPE), polypropylene, glass, and steel.

1.3.2.3 Shielding. The following requirements directly address shielding design of Type A packagings:

173.412(d) Temperature (-40°F to +158°F), brittle fracture

173.412(k) Shielding/containment interface

173.441 Radiation level limitations.

Shielding may be required for Type A quantities of radionuclides. Lead or steel are commonly used materials for shielding. The regulations require that the shielding and containment system remain intact and effective when subjected to normal conditions of transport.

1.3.2.4 Lifting and Handling. The following requirements directly address the design of lifting and handling features of Type A packagings:

173.411(a) Handling, securing

173.411(b) Manual handling (gross weight 22 to 110 lb)

173.411(c) Mechanical handling (gross weight above 110 lb)

173.411(d) Lifting attachments.

The exterior design of the packaging must address these items.

1.3.2.5 Tiedown. The following requirements directly address the design of tiedown features of Type A packagings:

173.411(a) Handling, securing

173.412(l) Tiedown, failure.

Package tiedown features and equipment must be designed to comply with these requirements.

1.3.3 Package Qualification and Testing

Type A packagings must be designed to withstand the tests delineated in 49 CFR 173, Sections 173.465 and/or 173.466 as applicable. Section 173.461 addresses the methods by which compliance with these requirements may be addressed. The DOT-7A Program typically demonstrates acceptable performance by exposing several prototype test units to the test conditions. The tests that are performed are described briefly below.

1.3.3.1 Reduced Pressure Test [49 CFR 173.412(i)]. The reduced pressure test is intended to simulate the reduction of ambient (external) pressure to the package to 3.5 psia. This may be achieved by pressurizing the internal cavity of the packaging to 11.2 psig or by placing a closed packaging into a chamber that can be evacuated to 3.5 psia. In both cases, leak detection by visual, soap bubble, pressure change or other method is used.

1.3.3.2 Water Spray Test [49 CFR 173.465(b)]. The water spray test simulates exposure to rainfall of approximately 2 in./hour for at least one hour. This test must precede each of the other tests or test sequences described in 49 CFR 173.465. The time interval between the end of the water spray test and the beginning of the next test shall be such that the water has soaked in to the maximum extent without appreciable drying of the exterior of the package. The time interval is two hours if the spray is applied from four different directions simultaneously. Other tests will follow immediately if the spray is applied from each of the four directions consecutively.

1.3.3.3 Compression Test [49 CFR 173.465(d)]. The compression test lasts for a period of at least twenty-four hours. The compressive load is equivalent to either five times the weight of the actual package or 1,300 kg/m^2 (265 lb/ft^2) multiplied by the vertically projected area of the package, whichever is greater. The load is applied uniformly to two opposite sides of the package, one of which must be the base on which the package would normally stand.

1.3.3.4 Penetration Test [49 CFR 173.465(e) and 173.466(a)(2)]. The package is placed on a rigid, flat, horizontal surface. A bar (penetration bar) 3.2 cm (1.25 in.) in diameter with a hemispherical end, weighing 6 kg (13.2 lb), with its longitudinal axis vertical, is dropped onto the center of the weakest part of the package, so that, if it penetrates far enough, it will hit the containment system. The bar must not be deformed by the test.

The distance of the fall of the bar is measured from its lower end to the upper surface of the package. The determination of this distance depends on the basic physical form of the contents for which the packaging is designed. The penetration drop height for packagings designed to contain only solids is 1 m (3.3 ft). This distance is 1.7 m (5.5 ft) for packagings designed to contain liquids and/or gases.

1.3.3.5 Free Drop Test [49 CFR 173.465(c) and 173.466(a)(1)]. The free drop test consists of a fall onto a flat, horizontal, rigid surface. The orientation of the test package is such that the fall will cause maximum damage to the package and its safety features. The distance of the fall will be measured from the lowest part of the packaging to the upper surface of the target.

1.3.3.6 Demonstration of Compliance With Tests. Following the test sequences, which expose the prototypes to the applicable tests, the performance of the packaging is evaluated. If determined acceptable, the packaging is approved for use by DOE/EH-33.3 and included in this document.

1.3.4 The HM-181 Regulation Changes

The HM-181 implemented regulations that will effect requirements for packaging and transportation of hazardous materials in the United States, similar to the United Nations (UN) recommendations for packaging of dangerous goods.

The final ruling of HM-181 was issued on December 21, 1990. Under the HM-181 regulation changes, most nonbulk hazardous material packagings must be tested against performance criteria that simulate stresses encountered during shipment. The results of these tests must be documented and the packagings marked or certified with a UN certification. Packagings not marked with the certification will be refused entry into international destinations and may be refused by domestic air carriers. The transition period in which all domestic shipments must attain compliance is five years or sooner, depending on the material to be shipped.

The packaging test requirements vary depending on the density, vapor pressure and packing group for a particular material. Packing Group I packagings are subjected to the most stringent performance tests. Packing Groups II and III invoke progressively less stringent performance requirements.

The HM-181 regulation changes have no direct affect on this document or the use of Specification 7A. However, there is an indirect affect since HM-181 resulted in the deletion of many of the specification packagings covered in 49 CFR 178. For example, the DOT Specification 17-C drum (49 CFR 178.115) was deleted from the regulations. This document refers in many places to this and similar specifications. Accordingly, when referring to these specifications in procedures, specifications, and purchasing documents, reference the specification followed by the words, "in effect in December 1990 (i.e., prior to DOT rulemaking HM-181)." Another indirect affect may be encountered when shipping liquids via an air carrier. The HM-181 requirements regarding qualification of the packaging to the reduced external pressure conditions may be invoked, requiring review and/or additional testing of the packagings described herein.

1.4 USE OF TYPE B PACKAGINGS

The U.S. Nuclear Regulatory Commission (NRC)-approved Type B packagings may be used to transport Type A quantities of radioactive materials provided applicable requirements are met. The NRC provided some clarification regarding such use of NRC-approved Type B packagings in Information Notice 90-82 dated December 31, 1990 (NRC 1990). This information is summarized in the following paragraphs.

The NRC and DOT share primary responsibility for approving package designs for transportation of radioactive materials within the United States. The NRC regulations for the transportation of radioactive materials are codified in 10 CFR Part 71, "Packaging and Transportation of Radioactive Material." The DOT's hazardous materials regulations, which include radioactive material, are codified in 49 CFR Parts 100-199. Requirements for shippers of radioactive materials are given in 49 CFR 173.400 through 173.478. In addition, a provision in the NRC regulations, 10 CFR 71.5, requires that NRC licensees comply with DOT's hazardous materials regulations.

In general, pursuant to 10 CFR Part 71, NRC approves package designs for shipment of fissile and greater-than-Type A quantities of radioactive material. The design for packages up to Type A quantities is subject to the requirements of DOT in 49 CFR Part 173.

In authorizing the use of NRC-approved packages for transportation of Type A quantities of radioactive material, DOT regulations specify, in 49 CFR 173.415, that certain conditions be met. One condition (49 CFR 173.471) is that the shipment of the package be made in compliance with the terms of the NRC certificate of compliance (certificate). For example, a radiographic source changer authorized for a Type B quantity of a specific radionuclide in special form is also authorized for a Type A quantity of the same specific radionuclide in special form, provided that all the terms and conditions of the certificate are met. Note that NRC approvals include the type and form of material, the maximum quantity of material per package, and the operating instructions and maintenance procedures for the package.

Alternately, an NRC-approved package may be shipped under the provisions of 49 CFR 173.415(a) as a DOT-7A package. In this instance, the shipper (if requested) must provide DOT with a complete documentation of tests and an engineering evaluation or comparative data showing that the construction methods, packaging design, and materials of construction comply with DOT-7A. The shipper is required to maintain this documentation on file for at least one year after the latest shipment. Thus, a radiographic source changer approved by NRC for shipment of a specific radionuclide in special form could be used to ship a Type A quantity of a different nuclide, provided that the package is re-evaluated under the provisions of 49 CFR 173.415(a).

When an NRC-approved package is used as a DOT-7A package, the NRC package identification marking should be covered and new markings ("USA DOT-7A TYPE A" and "radioactive material") affixed to the package, pursuant to 49 CFR 173.415(a).

Users of the NRC-approved packages should be aware of the requirements for using NRC-approved packages for low-level radioactive materials exempted under 10 CFR 71.10. In particular, users of NRC-approved packages should:

- Determine what provision of 49 CFR 173.415 applies
- Comply with all requirements in 49 CFR 173.415(a) and 49 CFR 178.350 when the shipment is made pursuant to 49 CFR 173.415(a). Note that the use of an NRC-approved package pursuant to 49 CFR 173.415(a) requires that the package be re-evaluated as a DOT-7A Type A package, and that the shipper maintain the evaluation on file for one year after the last shipment
- Comply with all terms and conditions in the NRC certificate when the shipment is made pursuant to 49 CFR 173.415(c).

1.5 PROCUREMENT

Normally DOE shippers will procure complete packagings or components of packagings from commercial suppliers to satisfy shipment needs. The DOE/EH-33.3 recommends that any packaging procurement be conducted in two basic steps:

1. Obtain from the packaging supplier the documentation that will demonstrate compliance with the requirements (i.e., drawings, specifications, etc.) and perform a technical review.
2. Upon acceptance of the documentation (i.e., all comments satisfactorily resolved), release the supplier to manufacture the packagings or components.

Procurement of the packagings identified herein or their components will involve preparation of a technical specification followed by execution of the normal process used for procuring equipment or components. The following paragraphs summarize this process.

1.5.1 Specification Development

The shipper should prepare a technical specification for the packaging or component to be supplied that includes, as a minimum, any technical requirements specified in this document. The specification should also identify any other deliverables desired and the requirements applicable to each. When the specification is complete, the shipper normally will prepare a purchase requisition, which will accompany the specification, to initiate the formal procurement process.

1.5.2 Request for Proposals

The first formal step in the procurement process is preparation of a purchase requisition and the subsequent issuance of a request for proposal (RFP). The procurement package will include the completed specification, schedule requirements, and other pertinent technical information such as technical evaluation criteria, technical proposal instructions to bidders, etc. Upon completion and management approval of the purchase requisition and the specification, the shipper should contact the purchasing organization at the site or facility to coordinate the RFP process. The buyer who is the cognizant purchasing representative will become the focal point in the process of negotiating with potential suppliers.

1.5.3 Order Placement

Normally several or more suppliers will respond to the RFP. This will initiate a selection process for determining the candidate who will supply acceptable deliverables for the lowest cost. The selection process will normally involve the shipper's technical review of each of the proposals and procurement department review including cost and price analysis. Upon completion of the reviews, a supplier (the seller) will be selected and the order placed.

1.5.4 Documentation Review and Approval

The next major action for the shipper will be to review any seller-provided documentation such as drawings, specifications, analyses, manufacturing processing instructions, and quality control processes. Upon acceptance of this data, the supplier will be released to manufacture the components or packagings per the purchase order.

1.5.5 Packaging Manufacturing and Delivery

The seller will manufacture the fleet packagings as specified in the purchase order when released by the buyer. When complete, the packagings will be delivered to the shipper's facility for receiving inspection and use.

1.6 PACKAGING OPERATIONS

Packaging operations involve assembling the packaging, loading the contents, closing the package, and preparing for shipment. The operating instructions for a packaging are the primary vehicle for the shipper to maintain control on the assembly, loading, and closure processes for a packaging and its preparation for shipment and other items. Accordingly, shippers are requested to ensure that the operating instructions for the packaging system to be used implement the operational requirements discussed in the following paragraphs.

The operating instructions should consist of the following primary elements:

- Packaging description
- Authorized contents
- Preloading inspections
- Loading procedure
- Preparation for shipment
- Preshipment inspections
- Shipment requirements
- Unloading procedure
- Reuse/reconditioning (if applicable).

The packaging description and authorized contents sections should be similar to the material for a packaging included herein.

The shipper should determine, per the following requirements, the preloading inspections to be performed and the acceptance criteria considered necessary to ensure that the packaging complies and that adequate quality control is implemented.

173.474 Quality control for construction of packaging

173.475 Quality control requirements prior to each shipment of radioactive materials.

The loading procedure should address all operations necessary to correctly assemble the packaging components, load the contents, and close the packaging.

The section addressing preparation for shipment should address labeling and placarding requirements (49 CFR 173.444 and 173.446) and any other applicable requirements. If the package must be secured to the conveyance in a particular fashion, this should also be specified in a subsection to be entitled, "Tiedown."

The section(s) addressing preshipment inspections should address verifications for compliance with the following requirements:

173.441 Radiation level limitations

173.442 Thermal limitations

173.443 Contamination control.

The section addressing shipment requirements should address requirements and procedures applicable when the package is en route to its destination. For example, the requirements of 49 CFR 173.447, "Storage incident to transportation," should be addressed in this section.

The unloading procedure should detail all steps necessary to safely unload the package from the conveyance and for unloading the contents from the packaging.

If the packaging may be reused, the operating instructions should include procedures for reconditioning the packaging to a state that will meet the design requirements established in the drawing and specification.

1.7 QUALITY ASSURANCE

The quality assurance program implemented by the shipper's organization must implement actions to provide adequate confidence that the shipments will comply with the regulations. The DOE Order 5700.6C includes general quality elements to be considered in development of the shippers quality program. Shippers are cautioned to invoke only the quality requirements applicable to Type A packaging and transportation.

The following regulatory requirements address quality control applicable to Type A packagings:

173.474 Quality control for construction of packaging

173.475 Quality control requirements prior to each shipment of radioactive materials.

The shipper is responsible for ensuring that the packaging materials, components, and arrangement are in accordance with the qualified design as documented herein. The shipper is also responsible for ensuring that the packaging is assembled, loaded (with compatible contents), closed, and prepared for shipment properly.

The DOE/EH-33.3 recommends that quality control be implemented as needed for the shipper to ensure compliance with the regulations. This is considered best achieved at three possible points in the packaging operation process:

1. Receiving inspections for procured packagings or components. The inspections should be of adequate scope and detail to ensure that the supplied hardware complies with the qualified design.

2. Preloading inspections to be performed prior to assembly and loading of the packaging. These inspections should verify that no packaging components have been damaged or altered and the arrangement is in accordance with the qualified design.

3. Preshipment inspections to be performed prior to shipment. This final inspection should verify that the assembled package, its marking and labeling, and its tiedown arrangement (if applicable) are correct. Further, preshipment inspections should address verifications for compliance with the following requirements:

173.441 Radiation level limitations

173.442 Thermal limitations

173.443 Contamination control.

The data presented for specific packagings in this document includes applicable quality control elements. This data should be used for guidance in implementing the inspections mentioned above.

Appendix A.4.1

Steel Drums

2.0 STEEL DRUMS

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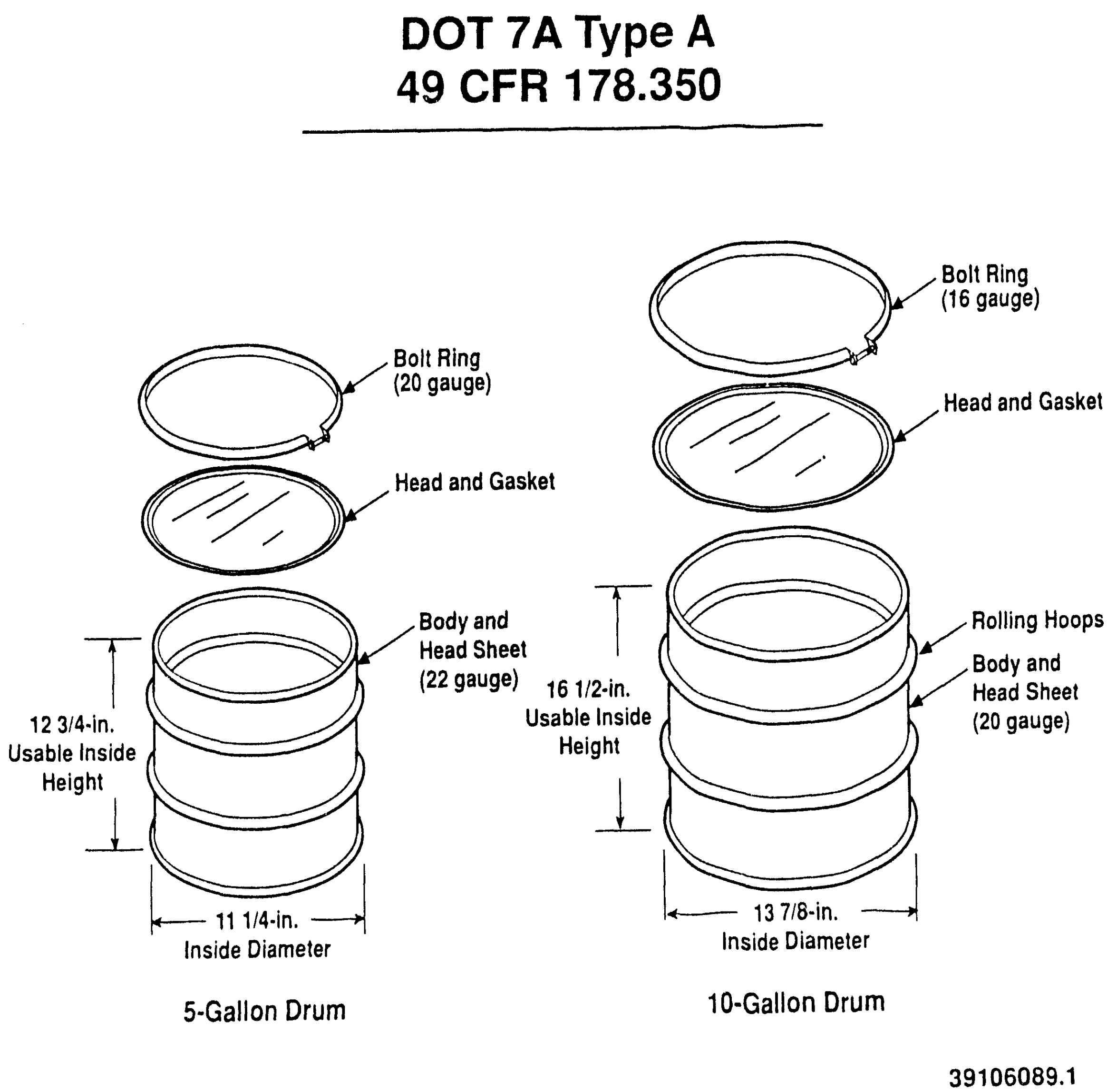
Figure 2-1. DOT-6C 5- and 10-Gallon Steel Drums, 49 CFR 178.99.



2.1 DOT-6C 5- AND 10-GALLON STEEL DRUMS (DOCKETS: MLM)

2.1.1 Package Description

Dimensions

Drum	Height (in.)	Diameter (in.)
5-gallon interior	12.50	11.25
5-gallon exterior	13.50	12.25
10-gallon interior	15.75	14.00
10-gallon exterior	17.25	15.00

Materials/Method of Construction

5 gallon		10 gallon	
Body and head sheet	22 gauge	Body and head sheet	20 gauge
Ring	20 gauge	Ring	16 gauge
Bolt	0.218 in.	Bolt	0.312 in.
Gasket required		Gasket required	

2.1.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

2.1.2.1 Physical Form

2.1.2.1.1 Solids only. Three forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements (e.g., room temperature vulcanizing [RTV], etc.).

- Material Form No. 1: Solids--any particle size.
- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.)
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.443, Contamination controls.)

2.1.2.1.2 Maximum Gross Weight. Form No. 1, No. 2, and No. 3:

- 5-gal = 80 lb
- 10-gal = 160 lb.

2.1.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

2.1.2.3 Radiological. Dents approximately 1.1 in. and 1.5 in. appeared in the 5-gal and 10-gal drums, respectively, following the 4-ft drop test on the bottom edge. The shipper must ensure that the radiation level at the surface of the package would not increase by more than 20% if such deformations occurred.

2.1.3 Restrictions/Specifications

For Form No. 1 Contents--RTV sealant (or equivalent) must be applied to the surface of the gasket in contact with the drum body.

For Form No. 2 and No. 3 Contents--No packaging component requirements other than specified in Section 2.1.1.

Bolt closure tightened, with tapping, until the lugs begin to bend inward or come together--typically less than 40 ft-lb. A jam nut shall also be used to prevent unintentional loosening during transport.

The gasket material must have an operating range of -40 °F to +158 °F.

For heavy bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

2.1.4 49 CFR 178.350 REGULATORY REQUIREMENTS

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-1.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-1.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-1.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. This test was conducted on nine different types of steel drums and a total of 26 packages. In all cases, there was no detectable effect on the ability of the packaging to meet the subsequent Type A tests. Also, in all cases, there was no inleakage of water as a result of this test. See Appendix D, Table D-1.
Free drop	Pass. 4-ft drop test conducted on: Top - approximately 45° on bolt Bottom - approximately 45° Side - flat on bolt. See Appendix D, Table D-10.
Corner drop	Not required.
Compression	Pass. This test was conducted at greater than five times the gross weight for 24 hr. No detectable effect on the packaging was observed. See Appendix D, Table D-23.
Penetration	Pass. This test was conducted on the center of the lid, on the center of side body, and on the lid close to the closure ring. See Appendix D, Table D-30.

2.1.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface sealing surface	Vendor qualifications and experience	Functional: • Ease of lid/closure ring application • Bolt closure ring--bolt size • Gasket, adhesive, as specified • Geometry, as specified Acceptable Conditions: • Lack of dents, no deformation of sealing surfaces
Gasket		• Dimensions, as specified
Weld areas		• Continuous welds, no sharp edges
Body and chime	Metal thickness	Lot tests by shipper, as appropriate.
Air leak tests	Bolt size	Vendor Data and/or Certification: • Marking • Test data • Type A document provided as appropriate • Air leak tests
	Protective coating application	Visual: • Surface/coating as specified • Lack of imperfections in application • Lack of rust, dents, nicks

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

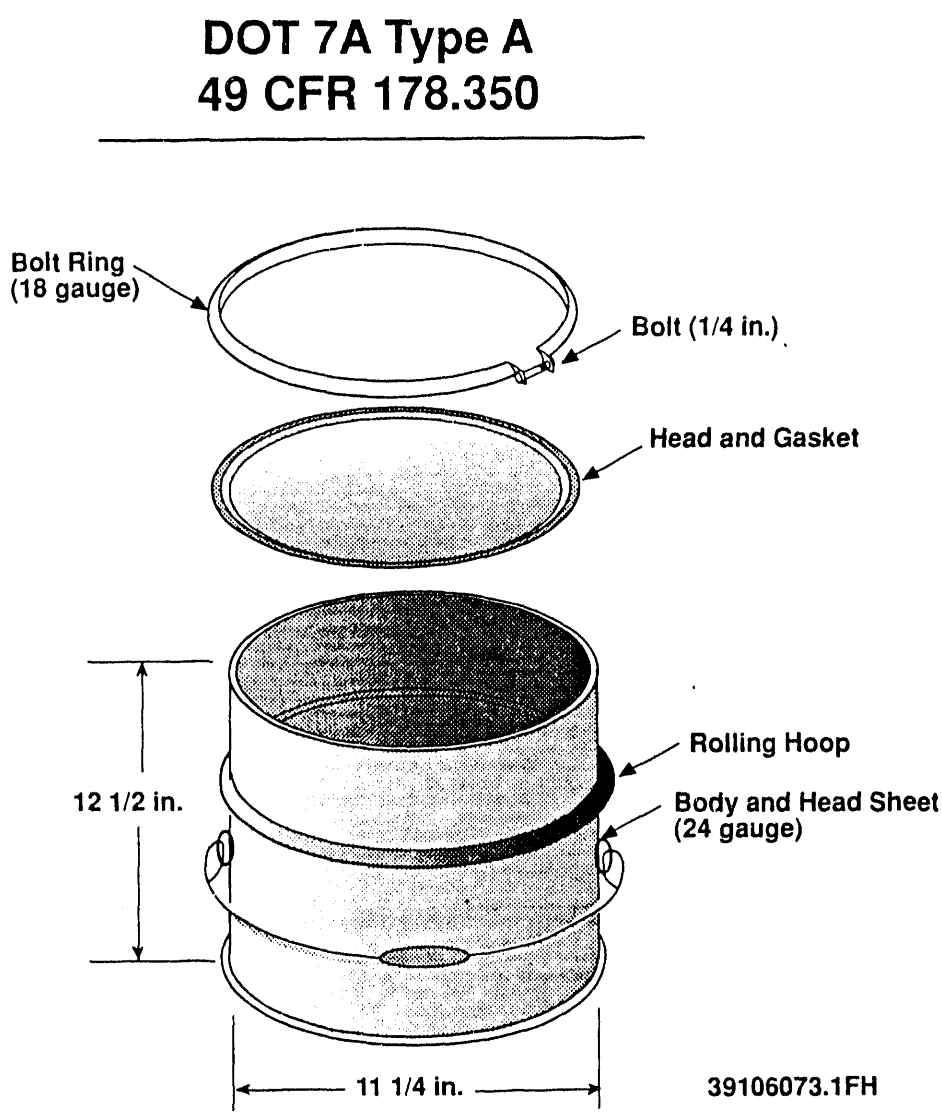
2.1.6 Additional Information

Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

2.1.6.1 Primary Users

Site/Contact/Phone	Address
Rocky Flats Plant D. M. Krieg COMM/FTS 303-966-2377	Rocky Flats Plant P. O. Box 464 Golden, CO 80402-0464

Figure 2-2. DOT-17C 5-Gallon Steel Drum, 49 CFR 178.115.



2.2 DOT-17C 5-GALLON STEEL DRUM (DOCKETS: MLM)

2.2.1 Package Description

Dimensions

5-gallon drum	Height (in.)	Diameter (in.)
Interior	12.5	11.25
Exterior (with ring)	13.0	12.00

Materials/Method of Construction

5 gallon	
Body and head sheet	24 gauge
Ring	16 gauge
Bolt	0.25 in.
Gasket required	

2.2.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

2.2.2.1 Physical Form

2.2.2.1.1 Solids Only. Three forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements (e.g., RTV, etc.).

- Material Form No. 1: Solids--any particle size.
- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.)
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.443, Contamination control.)

2.2.2.1.2 Maximum Gross Weight. Form No. 1, No. 2 and No. 3:

- 100 lb.

2.2.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

2.2.2.3 Radiological. The 4-ft drop test caused deformation of the package resulting in a decrease in the distance from the exterior to the center of the package at the bottom edge of 0.5 in. (approximate). The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such a deformation would occur.

2.2.3 Restrictions/Specifications

For Form No. 1 Contents--RTV sealant (or equivalent) must be applied to the surface of the gasket in contact with the drum body.

For Form No. 2 and No. 3 Contents--No packaging component requirements other than as specified in Section 2.2.1.

Bolt closure tightened, with tapping, until the lugs begin to bend inward or come together--typically less than 40 ft-lb. A jam nut shall also be used to prevent unintentional loosening during transport.

The gasket material must have an operating range of -40 °F to +158 °F.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

2.2.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-1.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-1.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-1.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. Tests were conducted on all three styles of drums and demonstrated no inleakage of water. Further, the water spray test preceded each of the remaining Type A tests. In no case was there any effect on the ability of the packagings to meet the required tests. See Appendix D, Table D-1.
Free drop	Pass. Sixty-nine separate drop tests were conducted (22 on Styles 1A and B, 26 on Style 2, and 21 on Style 3). Drops were conducted on edges, top corners, bottom corners, and the ends. In all cases, there was no loss of contents or major distortion of the packagings. See Appendix D, Table D-10.
Corner drop	Not required.
Compression	Pass. The test was conducted on all three styles at greater than five times the gross weight for greater than 24 hr. There was no visible distortion of the packagings or loss of contents. See Appendix D, Table D-23.
Penetration	Pass. The test was conducted at several points on all three styles of the packagings with no significant effect. The tests on the bungs left no discernable mark. The impact on the centers of the covers resulted in a maximum dent of 0.25 in. The tests on the closure rings left no visible effect. See Appendix D, Table D-30.

2.2.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface sealing surface	Vendor qualifications and experience	Functional: • Ease of lid/closure ring application • Bolt closure ring--bolt size • Gasket, adhesive, as specified • Geometry, as specified Acceptable Conditions: • Lack of dents, no deformation of sealing surfaces
Gasket		• Dimensions, as specified
Weld areas		• Continuous welds, no sharp edges
Body and chime	Metal thickness	Lot tests by shipper, as appropriate.
Air leak tests	Bolt size	Vendor Data and/or Certification: • Marking • Test data • Type A document provided as appropriate • Air leak tests
	Protective coating application	Visual: • Surface/coating as specified • Lack of imperfections in application • Lack of rust, dents, nicks

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

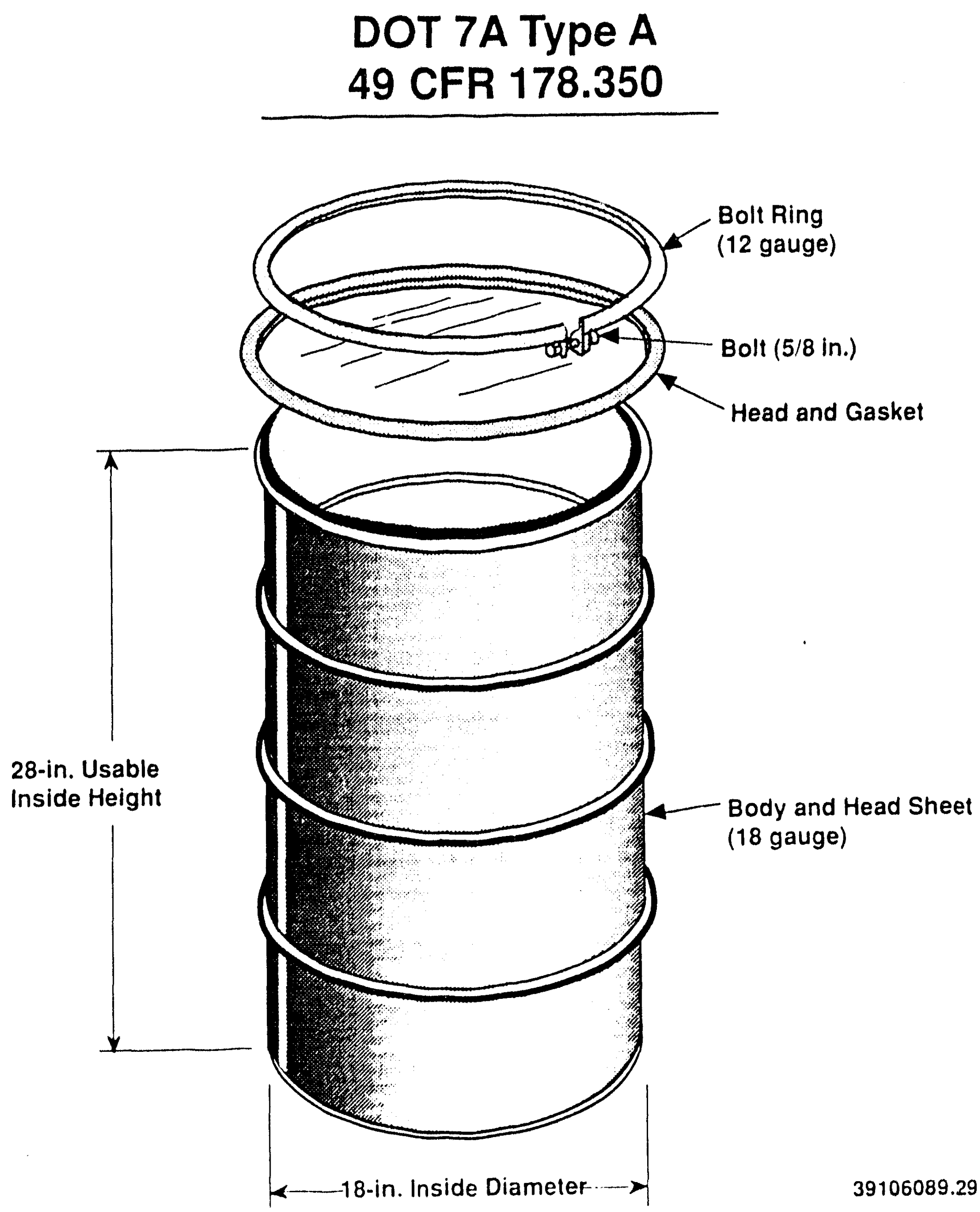
2.2.6 ADDITIONAL INFORMATION

Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

2.2.6.1 Primary Users

Site/Contact/Phone	Address
Los Alamos National Laboratory N. King COMM/FTS 505-667-4125	Los Alamos National Laboratory P.O. Box 1663 Los Alamos, NM 87545
Battelle Columbus Laboratories T. R. Emsweiler 614-879-5165	Battelle Columbus Laboratories 505 King Avenue Columbus, OH 43201

Figure 2-3. DOT-17C 30-Gallon Steel Drum, 49 CFR 178.115.



2.3 DOT-17C 30-GALLON STEEL DRUM (DOCKETS: MLM)

2.3.1 Package Description

Dimensions

30-gallon drum	Height (in.)	Diameter (in.)
Interior	28.0	18.0
Exterior	29.5	20.0

Materials/Method of Construction

30 gallon	
Body and head sheet	18 gauge
Ring	12 gauge
Bolt	0.625 in.
Gasket required	

2.3.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

2.3.2.1 Physical Form

2.3.2.1.1 Solids Only. Three forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements (e.g., RTV, etc.).

- Material Form No. 1: Solids--any particle size.
- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.)
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.443, Contamination control.)

2.3.2.1.2 Maximum Gross Weight

- Form No. 1 = 400 lb
- Form No. 2 = 500 lb
- Form No. 3 = 500 lb.

2.3.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

2.3.2.3 Radiological. The 4-ft drop test caused deformation of the package resulting in a decrease in the distance from the exterior to the center of the package at the bottom edge of 2.75 in. (approximate). The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such a deformation would occur.

2.3.3 Restrictions/Specifications

For Form No. 1 Contents--RTV sealant (or equivalent) must be applied to the surface of the gasket in contact with the drum body.

For Form No. 2 and No. 3 Contents--No packaging component requirements other than specified in Section 2.3.1.

The lid closure ring bolt shall be tightened to 40 ± 4 ft-lb with tapping of ring during tightening. A jam nut shall also be used to prevent unintentional loosening during transport.

The gasket material must have an operating range of -40 °F to +158 °F.

For heavy bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/ containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

2.3.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-1.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-1.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-1.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	<u>Pass.</u> This test was conducted on nine different types of steel drums and a total of 26 packages. In all cases, there was no detectable effect on the ability of the packaging to meet the subsequent Type A tests. Also, in all cases, there was no inleakage of water as a result of this test. See Addendum 1, Table D-1.
Free drop	<u>Pass</u>. 4-ft drop test conducted on: Top - approximately 45° on bolt Bottom - approximately 45° Side - flat on bolt. See Appendix D, Table D-10.
Corner drop	Not required.
Compression	<u>Pass</u>. This test was conducted at greater than five times the gross weight for 24 hr. No detectable effect on the packaging was observed. See Appendix D, Table D-23.
Penetration	<u>Pass</u>. This test was conducted on the center of the lid, on the center of the side body, and on the lid close to the closure ring. See Appendix D, Table D-30.

2.3.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface sealing surface	Vendor qualifications and experience	Functional: • Ease of lid/closure ring application • Bolt closure ring--bolt size • Gasket, adhesive, as specified • Geometry, as specified Acceptable Conditions: • Lack of dents, no deformation of sealing surfaces
Gasket		• Dimensions, as specified
Weld areas		• Continuous welds, no sharp edges
Body and chime	Metal thickness	Lot tests by shipper, as appropriate.
Air leak tests	Bolt size	Vendor Data and/or Certification: • Marking • Test data • Type A document provided as appropriate • Air leak tests
	Protective coating application	Visual: • Surface/coating as specified • Lack of imperfections in application • Lack of rust, dents, nicks

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

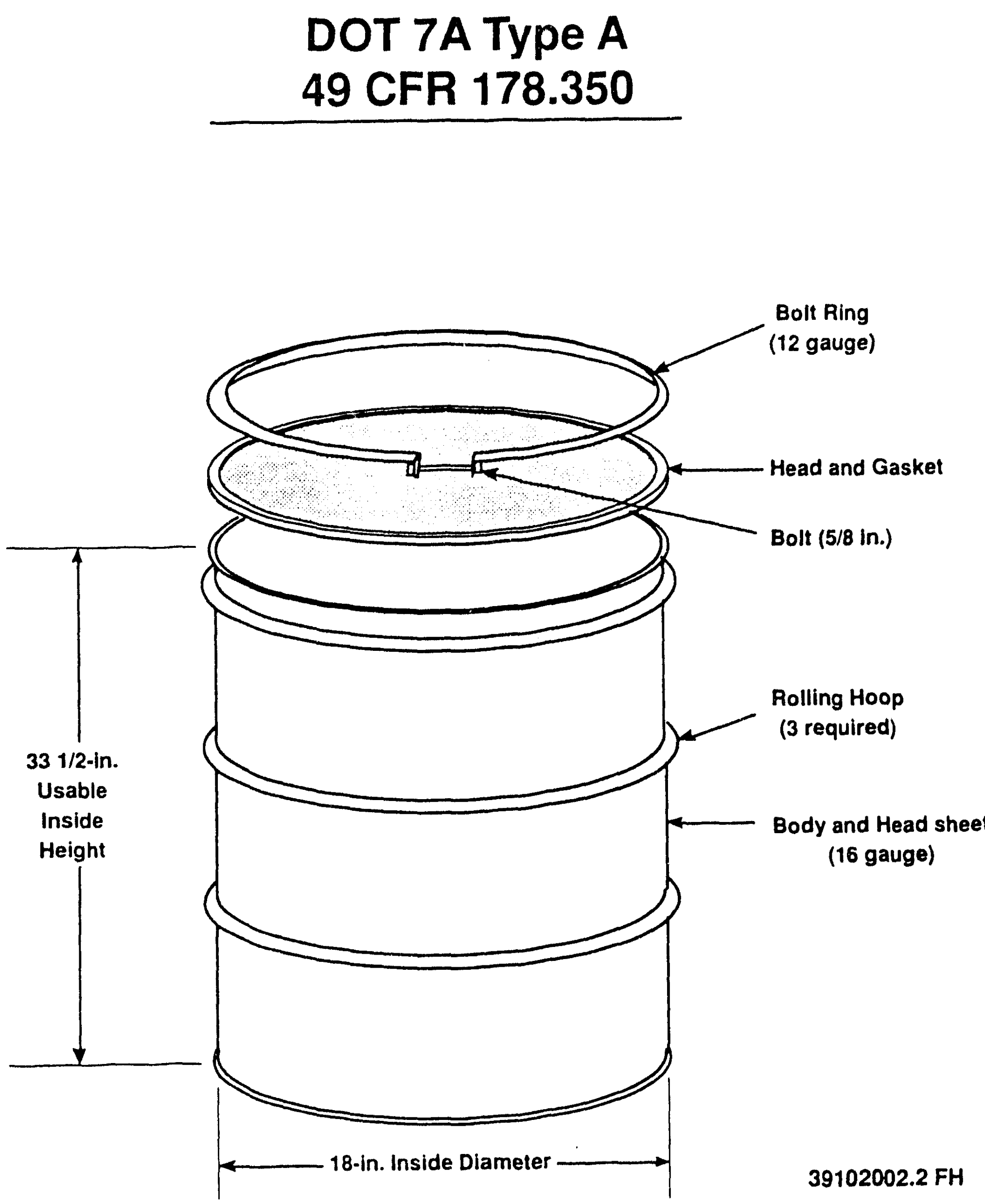
2.3.6 Additional Information

Evaluation and testing of the subject packaging took place at MLM. A complete test report is available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

2.3.6.1 Primary Users

Site/Contact/Phone	Address
Battelle Columbus Laboratories T. R. Emsweiler 614-879-5165	Battelle Columbus Laboratories 505 King Avenue Columbus, OH 43201

Figure 2-4. DOT-17C 35-Gallon Steel Drum, 49 CFR 178.115.



2.4 DOT-17C 35-GALLON STEEL DRUM (DOCKETS: MLM)

2.4.1 Package Description

Dimensions

35-gallon drum	Height (in.)	Diameter (in.)
Interior	33.50	18.00
Exterior	34.75	20.50

Materials/Method of Construction

35 gallon	
Body and head sheet	16 gauge
Ring	12 gauge
Bolt	0.625 in.
Gasket required	

2.4.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

2.4.2.1 Physical Form

2.4.2.1.1 Solids Only. Three forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements (e.g., RTV, etc.).

- Material Form No. 1: Solids--any particle size.
- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.).
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see CFR 173.443, Contamination control.)

2.4.2.1.2 Maximum Gross Weight. Form No. 1, No. 2 and No. 3:

- 400 lb.

2.4.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

2.4.2.3 Radiological. The 4-ft drop test caused deformation of the package resulting in a decrease in the distance from the exterior to the center of the package at the top edge of 1.125 in. (approximate). The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such a deformation would occur.

2.4.3 Restrictions/Specifications

For Form No. 1 and No. 2 Contents--RTV sealant (or equivalent) must be applied to the surface of the gasket in contact with the drum body.

For Form No. 3 Contents--No packaging component requirements other than as specified in Section 2.4.1.

The locking ring bolt shall be tightened to 40 ± 4 ft-lb with tapping of the ring during tightening per the following procedure:

1. Tighten the bolt to 40 ft-lb torque.
2. Hit the closure ring vigorously with a metal hammer, eight to nine times, equally spaced around the ring.
3. Repeat this cycle three additional times.
4. Torque bolt one last time to 40 ft-lb.

A jam nut shall also be used to prevent unintentional loosening during transport.

The cover seal gasket material must have operating range of -40 °F to +158 °F.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

2.4.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-1.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-1.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-1.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. This test was conducted on a total of six packagings. In all cases, there was no detectable effect on the ability of the packaging to meet the subsequent Type A test. Also, there was no inleakage of water as a result of this test. See Appendix D, Table D-1.
Free drop	Pass. 4-ft drop test conducted on: Top - approximately 45° on bolt Bottom - approximately 45° Side - flat on bolt. See Appendix D, Table D-10.
Corner drop	Not required.
Compression	Pass. This test was conducted at greater than five times the gross weight for 24 hr. No detectable effect on the packaging was observed. See Appendix D, Table D-23.
Penetration	Pass. This test was conducted on the center of the lid, on the center of side body, and on the lid close to the closure ring. Only minor dents occurred. See Appendix D, Table D-30.

2.4.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface sealing surface	Vendor qualifications and experience	Functional: • Ease of lid/closure ring application • Bolt closure ring--bolt size • Gasket, adhesive, as specified • Geometry, as specified Acceptable Conditions: • Lack of dents, no deformation of sealing surfaces
Gasket		• Dimensions, as specified
Weld areas		• Continuous welds, no sharp edges
Body and chime	Metal thickness	Lot tests by shipper, as appropriate.
Air leak tests	Bolt size	Vendor Data and/or Certification: • Marking • Test data • Type A document provided as appropriate • Air leak tests
	Protective coating application	Visual: • Surface/coating as specified • Lack of imperfections in application • Lack of rust, dents, nicks

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

2.4.6 Additional Information

Evaluation and testing of the subject packaging took place at MLM in 1989. A complete test report is available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

2.4.6.1 Primary User(s):

Site/Contact/Phone	Address
Rocky Flats Plant Doyle Mitchell COMM/FTS 303-966-4421	Rocky Flats Plant P.O. Box 464 Golden, CO 80402-0464

Figure 2-5. DOT-17C 55-Gallon Steel Drum.

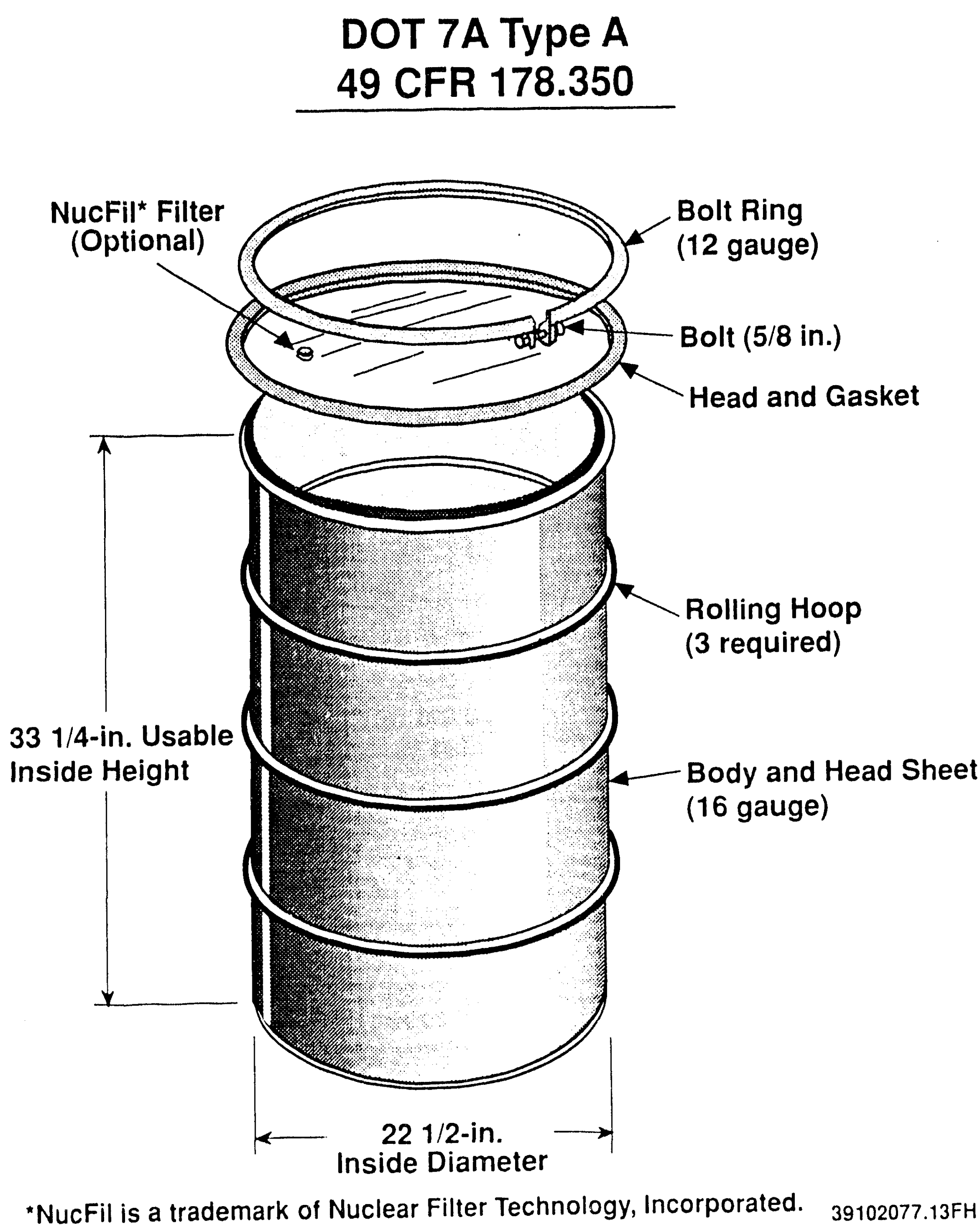
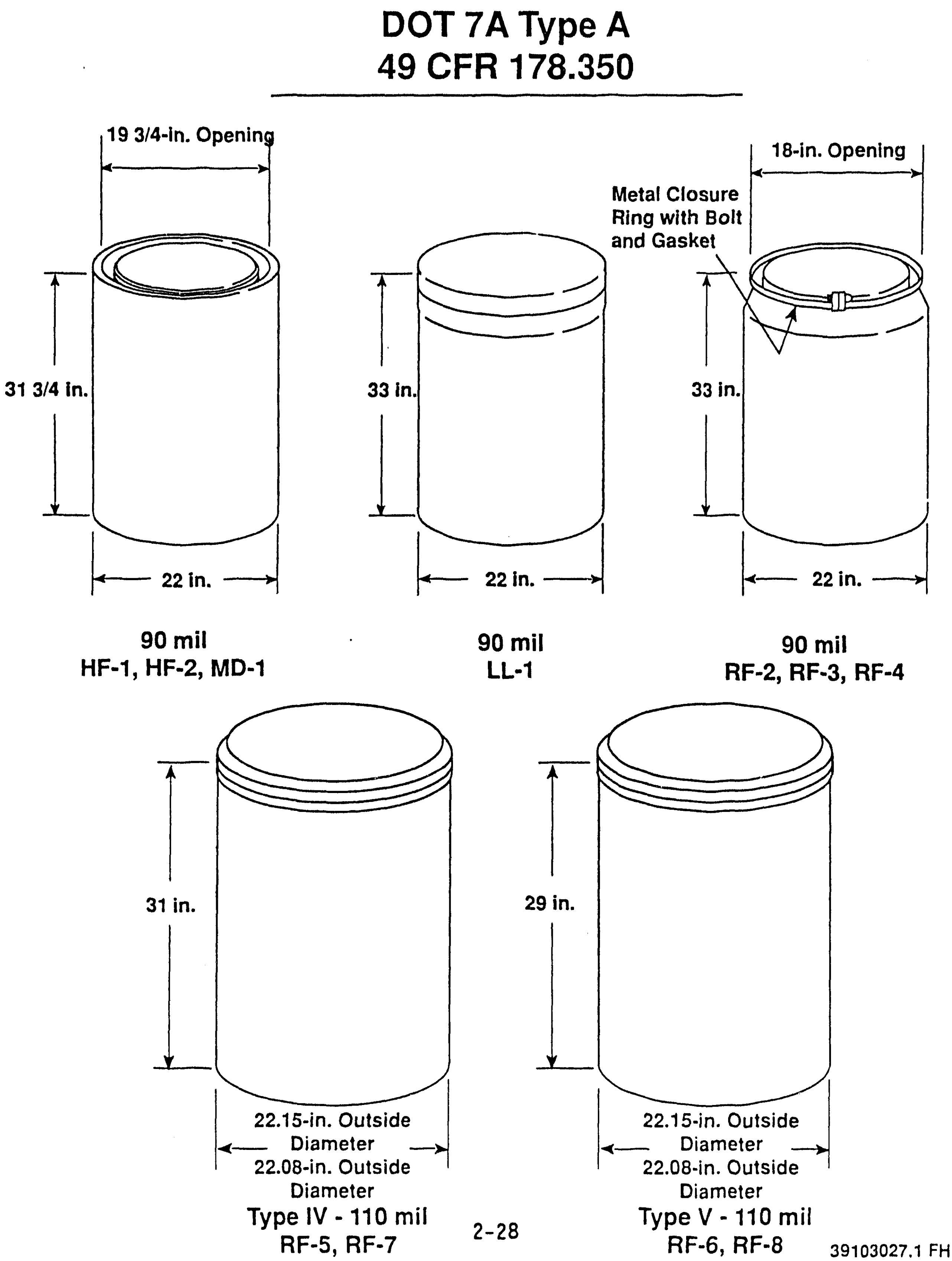


Figure 2-6. High-Density Polyethylene Liners for Use with DOT-17C 55-Gallon Steel Drums.



2.5 DOT-17C 55-GALLON STEEL DRUM, OPTIONAL PRESSURE RELIEF DEVICE AND/OR HIGH-DENSITY POLYETHYLENE LINER (DOCKETS: MLM; 89-13-7A, 01/90; 90-18-7A, 01/91)

2.5.1 Package Description

Authorized Configurations (sheet 1 of 2)

HF-1	Drum with vent clip, liner, bag and catalyst: a DOT-17C drum with a vent clip, with a 90-mil HDPE liner (vented or nonvented), which encloses a 4-mil polyethylene bag, which encloses the contents.
HF-2	Drum with liner: a DOT-17C (filtered or nonfiltered) drum with an HDPE liner (90-mil body, 110-mil head, vented or nonvented), which encloses the contents.
LL-1	Drum with liner: a DOT-17C (filtered or nonfiltered) drum with an HDPE liner (90-mil body, 110-mil head, vented or nonvented), which encloses the contents.
MD-1	Drum with liner: a DOT-17C (filtered or nonfiltered) drum with an HDPE liner (90-mil body, 110-mil head, vented or nonvented), which encloses the contents.
RF-1	Drum with polyethylene bag: a DOT-17C nonfiltered drum with an optional 4-mil polyethylene bag, which encloses the contents. For Form No. 1 materials, either the bag or sealing the lid gasket to the body seal interface with RTV adhesive is required.
RF-2	Filtered drum, liner with bag: a DOT-17C filtered (NucFil-014*) drum with a 90-mil HDPE liner, which encloses a 4-mil polyethylene bag, which encloses the contents.
RF-3	Drum with liner: a DOT-17C nonfiltered drum with an HDPE liner (90-mil body, 110-mil head, vented or nonvented), which encloses the contents.
RF-4	Filtered drum with vented liner and bag: a DOT-17C filtered (NucFil-014) drum with a vented HDPE 90-mil liner, which encloses a 10-mil plastic bag, which encloses the contents.
RF-5	Filtered drum, closed Type IV liner: a DOT-17C filtered (NucFil-014) drum with a Type IV HDPE 110-mil liner, which encloses a 10-mil plastic bag, which encloses the contents.
RF-6	Filtered drum, PVC bag with Type V liner: a DOT-17C filtered (NucFil-014) drum with a 10-mil plastic drum liner (polyethylene bag), which encloses a PVC glovebox bag, which encloses a Type V HDPE 110-mil liner, which encloses the contents.

Authorized Configurations (sheet 2 of 2)

RF-7	Filtered drum, vented liner with bag: a DOT-17C filtered (NucFil-014) drum with a vented Type IV HDPE 110-mil liner, which encloses a 10-mil plastic bag, which encloses the contents.
RF-8	Filtered drum, PVC bag with Type V liner: a DOT-17C filtered (NucFil-014) drum with a 10-mil plastic drum liner (polyethelene bag), which encloses a PVC glovebox bag, which encloses a vented Type V HDPE 110-mil liner, which encloses the contents.
G-1	Filtered drum: a DOT-17C drum with catalyst packet and NucFil filter or vent clip--single packaging. Authorized only for use with Form No. 2 and 3 contents, see Section 2.5.2.1.
G-2	Drum (nonfiltered): a DOT-17C drum (nonfiltered)--single packaging. Authorized only for use with Form No. 2 and 3 contents, see Section 2.5.2.1.

*NucFil is a trademark of Nuclear Filter Technology, Incorportated.
HDPE = high-density polyethylene.
PVC = polyvinyl chloride.
RTV = room temperature vulcanizing.

Dimensions

55-gallon drum	Height (in.)	Diameter (in.)
Interior	33.25	22.25
Exterior	35.00	24.00

Materials/Method of Construction (sheet 1 of 2)

Drums	Standard 17C (steel or galvanized steel)
Drum lid	Steel with .750-in. Rieke Bung fitting welded on (required on filtered configurations only)
Drum gasket	Closed cell Neoprene[a] meeting ASTM D1056 grade SCE-45, 30-40 durometer, shore-A Tubular styrene-butadiene Butadiene foam
Pressure relief devices	
Vent Clip	Stainless steel, 304, per Rockwell Hanford drawing H-2-28798
Filter	Nuclear Filter Technology, Incorporated Model NucFil-014[b]

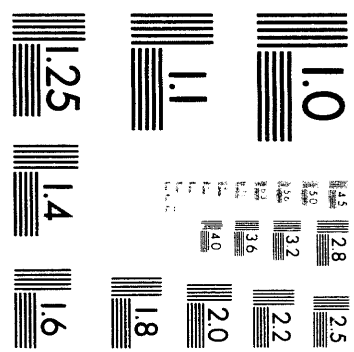
Materials/Method of Construction (sheet 2 of 2)

Liners	
HF-1, HF-2, MD-1	Per RHO-MA-222, Rev. 4 (RHO 1987) Open-head molded polyethylene liner with carbon black Snap-lock closure; use of adhesive bonding optional, but not required Vent hole (if used) is at the center of the head with approximately .750-in. diameter
LL-1	Open-head molded polyethylene liner without carbon black Vent hole (if used) is at the center of the head with approximately .750-in. diameter
RF-2, RF-3, RF-4	Open-head molded polyethylene liner with carbon black Bolted closure ring with gasket Vent hole (if used) is at the center of the head with approximately .750-in. diameter
F-5, RF-6, RF-7, RF-8	Open-head, molded, polyethylene (density is 0.946 to 0.953 per ASTM-D-792 [ASTM 1986]) liner with 2.5% black (Type IV) or brown color (Type V) added, minimum 110-mil thick Lid bolted closure ring, 16 gauge mild steel, .500-in. square back, with .375-in. bolt Head is gasketed and the vent hole (if used) is at the center with approximately 1-in. diameter

[a]Neoprene is a trademark of E. I. duPont de Nemours & Company.
[b]NucFil is a trademark of Nuclear Filter Technology, Incorporated.
ASTM = American Society for Testing and Materials.

2.5.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing/analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0

3 of 5

2.5.2.1 Physical Form

2.5.2.1.1 Solids Only. Three forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements.

- Material Form No. 1: Solids--any particle size.
- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.).
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.443, Contamination control.)

2.5.2.1.2 Maximum Gross Weight

- Form No. 1 = 900 lb
- Form No. 2 = 1,000 lb
- Form No. 3 = 1,000 lb.

2.5.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

2.5.2.3 Radiological. The 4-ft drop test caused deformation of the package resulting in a decrease in the distance from the exterior to the center of the package at the bottom chime of 2.5 in. (approximate). The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such a deformation would occur.

2.5.3 Restrictions/Specifications

The lid-locking ring bolt shall be tightened to 40 ± 4 ft-lb torque with tapping of ring during tightening. A jam nut shall also be used to prevent unintentional loosening during transport.

The NucFil filter (if used) shall be installed using Loctite* No. 262 (Red) and torqued to 5 ft-lb or tack-welded to prevent unintentional loosening.

The drum gasket material must have an operating range of -40 °F to +158 °F.

If a vented liner is used, a 10-mil (minimum thickness) polyethylene bag must be placed inside the liner to enclose the contents.

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*Loctite is a trademark of Loctite Corporation.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/ containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

2.5.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-1.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-1.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-1.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. This test was conducted and there was no inleakage of water. See Appendix D, Table D-1.
Free drop	Pass. Multiple 4-ft drop tests have been conducted on a number of test units with successful results. The impact orientations included: Top - CG over corner on bolt Top - flat on top Bottom - CG over corner Bottom - flat on bottom Side - flat on bolt. See Appendix D, Table D-10.
Corner drop	Not required.
Compression	Pass. This test was conducted on a number of test units with successful results. See Appendix D, Table D-23.
Penetration	Pass. Penetration bar was dropped on a number of test units impacting all potentially vulnerable features with no adverse affects on the packaging. The features impacted included the lid, the filter, the side, and the bottom center. See Appendix D, Table D-30.

2.5.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface sealing surface	Vendor qualifications and experience	Functional: • Ease of lid/closure ring application • Bolt closure ring--bolt size • Gasket, adhesive, as specified • Geometry, as specified Acceptable Conditions: • Lack of dents, no deformation of sealing surfaces
Gasket		• Dimensions, as specified
Weld areas		• Continuous welds, no sharp edges
Body and chime	Metal thickness	Lot tests by shipper, as appropriate.
Air leak tests	Bolt size	Vendor Data and/or Certification: • Marking • Test data • Type A document provided as appropriate • Air leak tests
	Protective coating application	Visual: • Surface/coating as specified • Lack of imperfections in application • Lack of rust, dents, nicks

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

2.5.6 Additional Information

Evaluation and testing of configurations HF-1, HF-2, LL-1, MD-1, RF-1, RF-2, and RF-3 took place at MLM and were documented in Edling 1987. Westinghouse Hanford performed testing and evaluation to qualify the vented liner versions of HF-2, LL-1, MD-1 and RF-3 and configuration RF-4 in January 1990 as part of Docket 89-13-7A. Configurations RF-5, RF-6, RF-7 and RF-8 were qualified based on evaluation and extension of test results in January 1991 as part of Docket 90-18-7A. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

2.5.6.1 Primary Users

Site/Contact/Phone	Address
Rocky Flats Plant D. M. Krieg COMM/FTS 303-966-2377	Rocky Flats Plant P.O. Box 464 Golden, CO 80402-0464
Hanford T. Romano COMM/FTS 509-376-0610	Westinghouse Hanford Company P.O. Box 1970 Richland, WA 99352
Lawrence-Livermore National Laboratory I. Meisel COMM/FTS 510-422-7406	Lawrence-Livermore National Laboratory P.O. Box 808 Livermore, CA 94550
MLM Don Wikstrom COMM/FTS 513-865-3919	EG&G/Mound Mound Road Miamisburg, OH 45342

2.5.6.2 Suppliers

Liners: HF, MD - Orbitron Products
901 S. Main St.
Delphos, OH 45833
419-692-9060

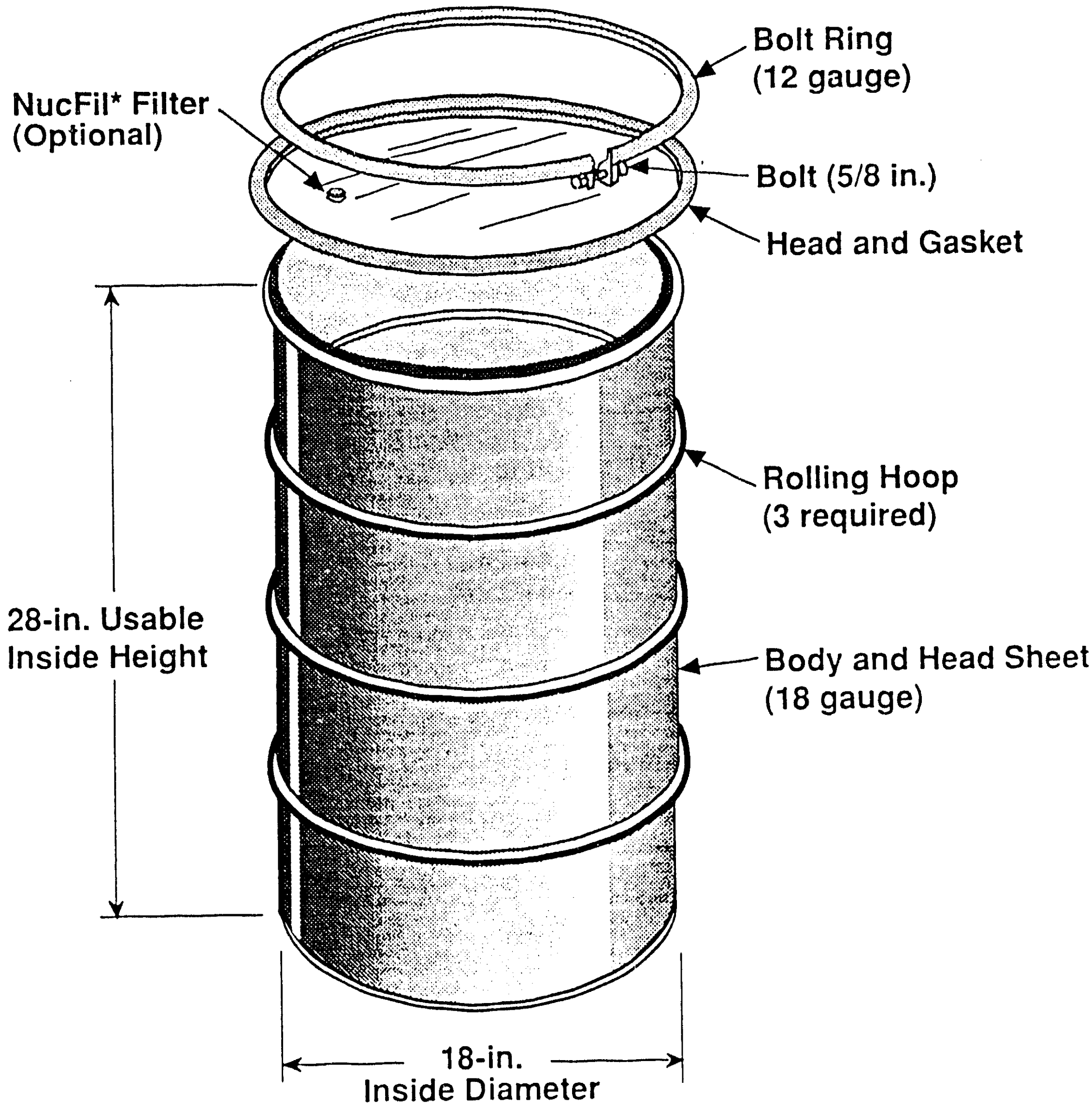
RF - K&M Plastic
1601 Pratt Blvd.
Elkgrove, IL 60007
312-439-3311

Plasti-Drum
1225 Davies
Lockport, IL 60441
815-838-7210

Russell Stanley Co.
8 Ritter Ave.
Woodbridge, NJ 07095
201-634-6000

Figure 2-7. DOT-17H 30-Gallon Steel Drum.

DOT 7A Type A
49 CFR 178.350



*NucFil is a trademark of Nuclear Filter Technology, Incorporated.

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2.6 DOT-17H 30-GALLON STEEL DRUM, OPTIONAL PRESSURE RELIEF DEVICE (DOCKETS: MLM 90-17-7A, 07/90--90-20-7A, 07/90)

2.6.1 Package Description

Authorized Configurations

AW-1	Filtered drum with bag: a DOT-17H filtered (NucFil-031*) drum with a 20-mil polyethylene filtered (NucFil-030) bag, which encloses an HDPE 100-mil vented liner, which encloses the contents.
FM-1	Filtered drum with bag: a DOT-17H filtered (NucFil-031) drum with a 20-mil polyethylene filtered (NucFil-030) bag, which encloses the contents.
OR-1	Drum (nonfiltered): a DOT-17H drum (nonfiltered)--single packaging. An RTV sealant must be applied to the seal for Material Form No. 1 contents, see Section 2.6.2.

*NucFil is a trademark of Nuclear Filter Technology, Inc. (NFTI).
HDPE = high-density polyethylene.

Dimensions

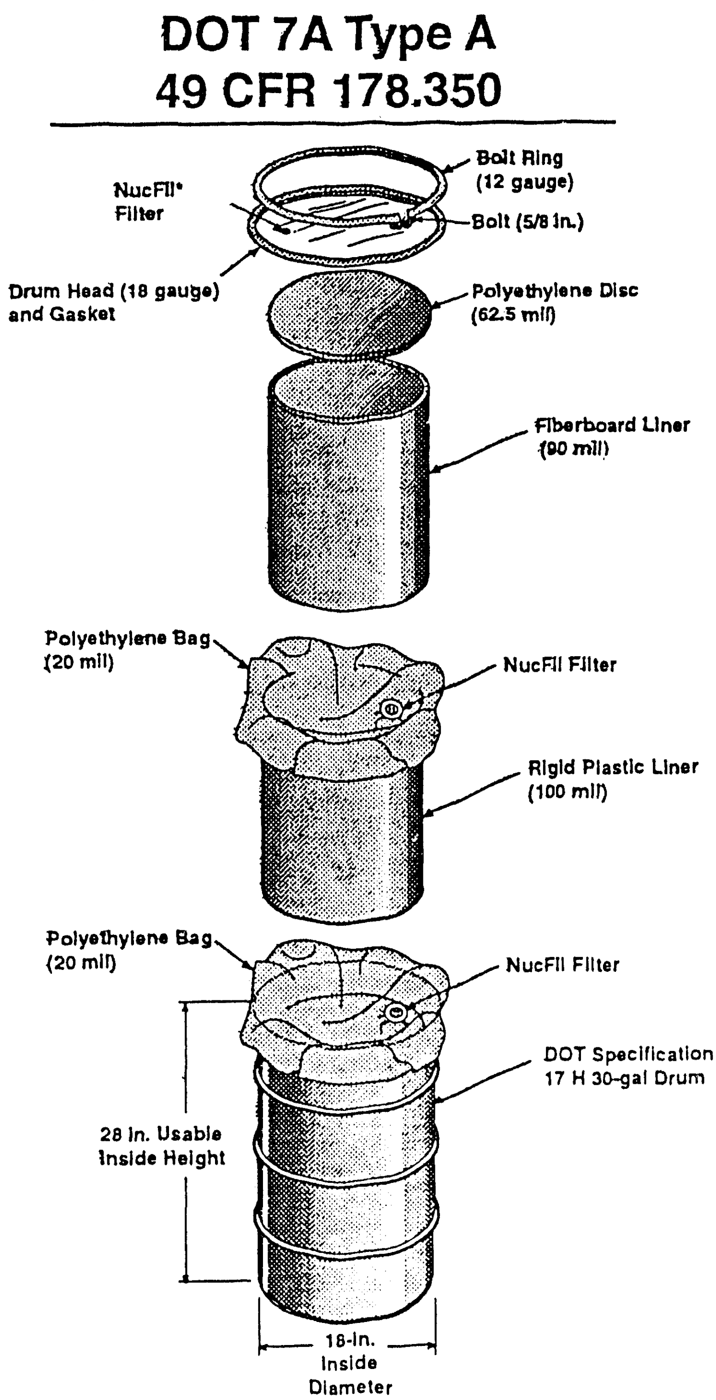
17H 30-gallon drum	Height (in.)	Diameter (in.)
Interior	28.0	18.0
Exterior	29.5	20.0

Materials/Method of Construction

Drum	Steel, DOT-17H, 49 CFR 178.118
Body and lid	18 gauge
Ring	12 gauge
Ring bolt	.625 in.
Gasket	Tubular, styrene--butadiene
Plastic bag	Polyethylene, 20-mil
Filter - drum	NFTI Model NucFil-031*
- bag	NFTI Model NucFil-030
Rigid liner	Polyethylene (high density), 100-mil
Liner lid	Polyethylene (high density), .062 in.
Fiberboard liner	90-mil, single wall, 26 gal

*NucFil is a trademark of Nuclear Filter Technology, Inc.

Figure 2-8. High-Density Polyethylene Liners for Use with DOT-17H 30-Gallon Steel Drums.



*NucFil is a trademark of Nuclear Filter Technology, Incorporated.

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2.6.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

2.6.2.1 Physical Form

2.6.2.1.1 Solids Only. Three forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements (e.g., RTV, etc.).

- Material Form No. 1: Solids--any particle size.
- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.).
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.443, Contamination control.)

2.6.2.1.2 Maximum Gross Weight. Material Forms No. 1, No. 2, and No. 3:

- 400 lb.

2.6.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

2.6.2.3 Radiological. The 4-ft drop test caused deformation of the package resulting in a decrease in the distance from the exterior to the center of the package at the bottom chime of 2.75 in. (approximate). The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such a deformation would occur.

2.6.3 Restrictions/Specifications

Material Form No. 1 contents--RTV must be applied to the seal gasket to body interface when the packaging is used to ship Form No. 1 contents.

The lid locking ring bolt shall be tightened to 40 ± 4 ft-lb torque with tapping of the ring during tightening. A jam nut shall also be used to prevent unintentional loosening during transport.

The NucFil filter (if used) shall be installed using Loctite No. 262 (Red) and torqued to 5 ft-lb or tack-welded to prevent unintentional loosening.

The drum gasket material must have an operating range of -40 °F to +158 °F.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

2.6.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-1.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-1.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-1.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. This test was conducted on a number of test units with no inleakage of water. See Appendix D, Table D-1.
Free drop	Pass. Multiple drop tests at varying impact angles on a number of test units with successful results. The orientations included: Top - CG over corner on bolt Top - flat on top Bottom - CG over corner Bottom - flat on bottom. See Appendix D, Table D-10.
Corner drop	Not required.
Compression	Pass. This test was conducted on several test units at more than five times the maximum gross weight with successful results. See Appendix D, Table D-23.
Penetration	Pass. All potentially vulnerable package features were subjected to the penetration impact with no adverse affects. See Appendix D, Table D-30.

2.6.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface sealing surface	Vendor qualifications and experience	Functional: • Ease of lid/closure ring application • Bolt closure ring--bolt size • Gasket, adhesive, as specified • Geometry, as specified Acceptable Conditions: • Lack of dents, no deformation of sealing surfaces
Gasket		• Dimensions, as specified
Weld areas		• Continuous welds, no sharp edges
Body and chime	Metal thickness	Lot tests by shipper, as appropriate.
Air leak tests	Bolt size	Vendor Data and/or Certification: • Marking • Test data • Type A document provided as appropriate • Air leak tests
	Protective coating application	Visual: • Surface/coating as specified • Lack of imperfections in application • Lack of rust, dents, nicks

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

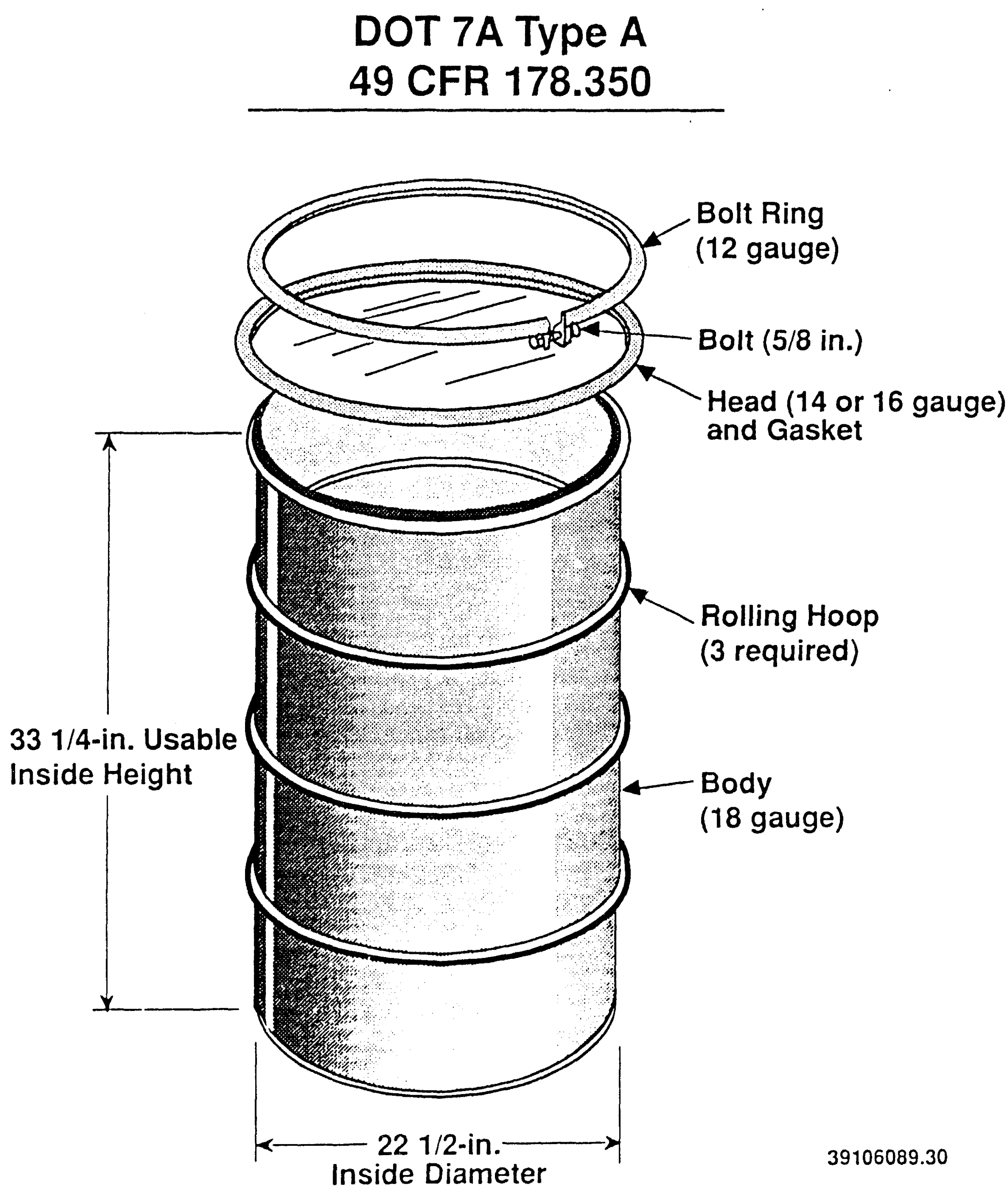
2.6.6 Additional Information

Evaluation and testing of configuration OR-1 took place at MLM and was documented in Edling 1987. Westinghouse Hanford qualified configurations AW-1 and FM-1 which utilize filtered drums and inner filtered bags. The testing and evaluation for these packagings was performed in July 1990 as part of Dockets 90-17-7A and 90-20-7A. Complete reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

2.6.6.1 Primary Users

Site/Contact/Phone	Address
Fernald C. E. Block COMM/FTS 513-738-6469	Westinghouse Materials Company of Ohio P.O. Box 398704 Cincinnati, OH 45239
Argonne National Laboratory-East (ANL-E) R. Ditch COMM/FTS 708-972-5865	Argonne National Laboratories 9700 South Cass Ave. Argonne, IL 60439
Oak Ridge National Laboratory H. E. Crowder COMM/FTS 615-576-5454	Martin Marietta Energy Systems Y-12 Plant Oak Ridge, TN 37830

Figure 2-9. DOT-17H 55-Gallon Steel Drum.



2.7 DOT 17H 55-GALLON STEEL DRUM (DOCKETS: MLM)

2.7.1 Package Description

Dimensions

55-gallon drum	Height (in.)	Diameter (in.)
Interior	33.25	22.25
Exterior	35.00	24.00

Materials/Method of Construction

55 gallon	
Body	18 gauge
Head	14 or 16 gauge
Ring	12 gauge
Bolt	0.625 in.
Gasket required	

2.7.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

2.7.2.1 Physical Form

2.7.2.1.1 Solids Only. Three forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements (e.g., RTV, etc.).

- Material Form No. 1: Solids--any particle size.
- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.).
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.443, Contamination control.)

2.7.2.1.2 Maximum Gross Weight.

- Form No. 1 = 900 lb
- Form No. 2 = 1,000 lb
- Form No. 3 = 1,000 lb.

2.7.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

2.7.2.3 Radiological. The 4-ft drop test caused deformation of the package resulting in a decrease in the distance from the exterior to the center of the package at the top edge of 3.75 in. (approximate). The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such a deformation would occur.

2.7.3 Restrictions/Specifications

For Form No. 1 Contents--RTV sealant (or equivalent) must be applied to the surface of the gasket in contact with the drum body.

For Form No. 2 and No. 3 Contents--No packaging component requirements other than specified in Section 2.7.1.

The lid closure ring bolt shall be tightened to 40 ± 4 ft-lb with tapping of ring during tightening. A jam nut shall also be used to prevent unintentional loosening during transport.

The gasket material must have an operating range of -40 °F to +158 °F.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

2.7.4 CFR 173.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-1.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-1.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-1.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. Tests were conducted on a total of 26 test units of 9 different types of steel drums. In all cases, there was no detectable effect on the ability of the packaging to meet the subsequent Type A tests. In all cases, there was no inleakage of water. See Appendix D, Table D-1.
Free drop	Pass. 4-ft drop test conducted on: Top - approximately 45° on bolt Bottom - approximately 45° Side - flat on bolt. See Appendix D, Table D-10.
Corner drop	Not required.
Compression	Pass. The test was conducted at five times the gross weight for 24 hr. No detectable effect on the packaging was observed. See Appendix D, Table D-23.
Penetration	Pass. The test was not conducted. Conclusion based on successful testing of comparable DOT-17H drum. See Appendix D, Table D-30.

2.7.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface sealing surface	Vendor qualifications and experience	Functional: • Ease of lid/closure ring application • Bolt closure ring--bolt size • Gasket, adhesive, as specified • Geometry, as specified Acceptable Conditions: • Lack of dents, no deformation of sealing surfaces
Gasket		• Dimensions, as specified
Weld areas		• Continuous welds, no sharp edges
Body and chime	Metal thickness	Lot tests by shipper, as appropriate.
Air leak tests	Bolt size	Vendor Data and/or Certification: • Marking • Test data • Type A document provided as appropriate • Air leak tests
	Protective coating application	Visual: • Surface/coating as specified • Lack of imperfections in application • Lack of rust, dents, nicks

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

2.7.6 Additional Information

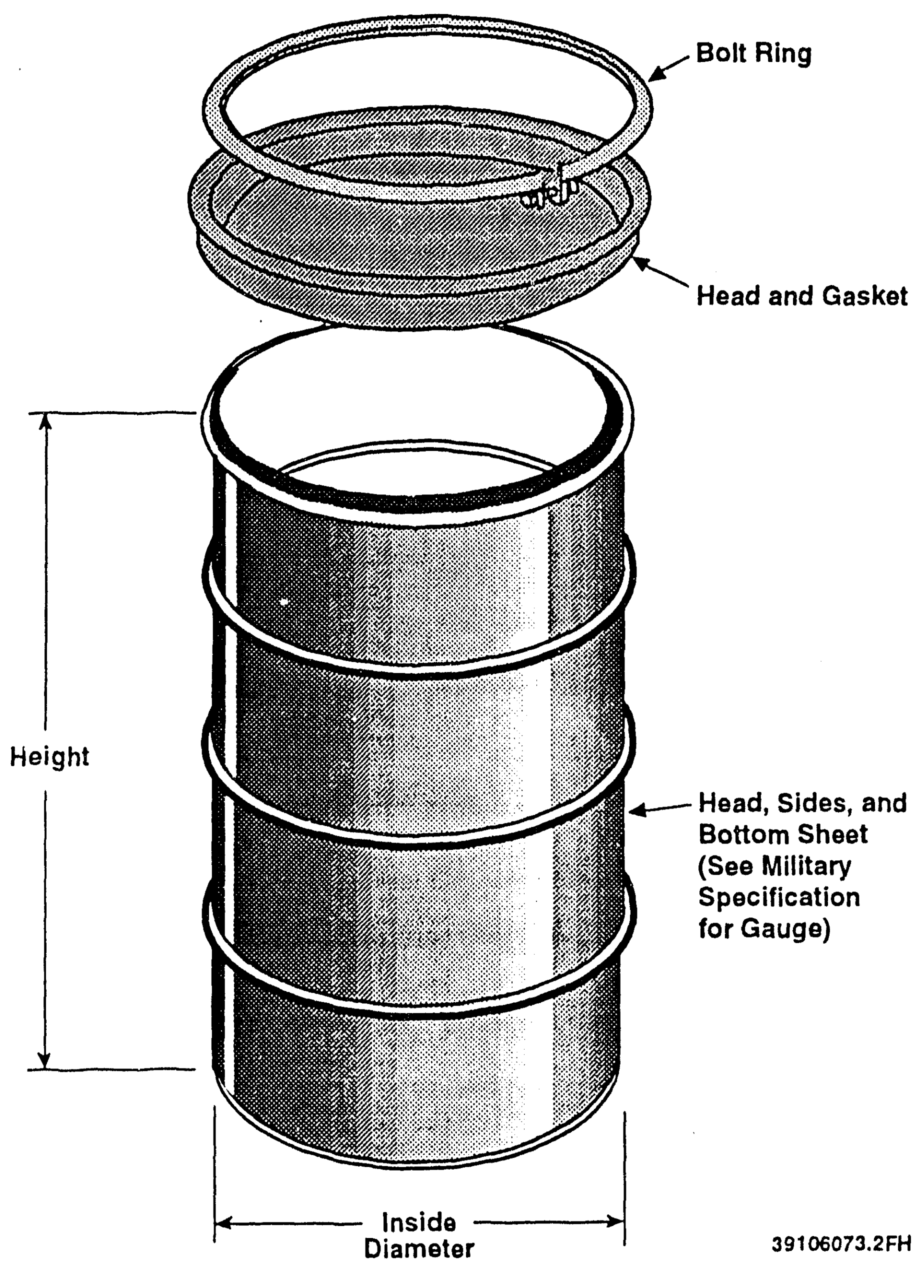
Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

2.7.6.1 Primary Users

Site/Contact/Phone	Address
MLM Don Wikstrom COMM/FTS 513-865-3919	Mound Laboratories Mound Road Miamisburg, OH 45342
Battelle T. R. Emsweiler 614-879-5165	Battelle Columbus Laboratories 505 King Avenue Columbus, OH 43201
ORNL H. E. Crowder COMM/FTS 615-574-2689	Martin-Marietta Energy Systems, Inc. P.O. Box Y Oak Ridge Y-12 Plant Oak Ridge, TN 37830

Figure 2-10. Steel Drums, Military Specification Containers of Varying Sizes.

DOT 7A Type A
49 CFR 178.350



2.8 MILITARY SPECIFICATION (MS) DRUMS--VARIOUS SIZES (DOCKETS: MLM)

2.8.1 Package Description

Dimensions and Weights

Drum number	Volume (gal)	Inside height (in.)	Inside diameter (in.)	Gross weight (lb)
MS-24347-21[a]	0.25	4.25	5.00	10
MS-24347-27	1.25	7.25	8.50	35
MS-27684-11	3.00	8.08	10.50	60
MS-27684-12	4.00	12.86	10.50	110
MS-27684-13	6.00	16.74	10.50	80
MS-27684-16	8.00	21.48	10.50	80
MS-27684-18	12.00	19.68	13.81	200
MS-27683-36	30.00	26.99	18.25	400
MS-27683-42	45.00	26.11	22.50	500
MS-27683-50	85.00	36.00[b]	26.00	800

[a]This number refers to the body number of the drum on the drawing.
[b]Normal height for this drum is 34.43 in. Be sure to specify the additional height when ordering.

2.8.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

2.8.2.1 Physical Form

2.8.2.1.1 Solids Only. Three forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements (e.g., RTV, etc.).

- Material Form No. 1: Solids--any particle size.
- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.).
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.443, Contamination control.)

2.8.2.1.2 Maximum Gross Weight. See table in Section 2.8.1.

2.8.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

2.8.2.3 Radiological. The 4-ft drop test caused deformations of the package resulting in decreases in the distance from the exterior to the center of the package (see table below). The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such deformations would occur.

2.8.3 Restrictions/Specifications

Drum number	Volume (gal)	RTV required		Liner required[b]		Maximum distance reduction to package center (in.)
		Form No. 1	Form No. 2	Form No. 1	Form No. 2	
MS-24347-21[a]	0.25	No	No	Yes	No	1.625 side
MS-24347-27	1.25	No	No	Yes	No	1.250 side
MS-27684-11	3.00	No	No	Yes	No	1.0 side
MS-27684-12	4.00	No	No	Yes	No	1.0 lid
MS-27684-13	6.00	No	No	Yes	No	1.0 lid
MS-27684-16	8.00	No	No	Yes	No	1.0 lid
MS-27684-18	12.00	No	No	Yes	No	1.0 lid
MS-27683-36	30.00	No	No	Yes	No	1.0 lid
MS-27683-42	45.00	No	No	Yes	No	0.375 side
MS-27683-50	85.00	Yes	No	No	No	0.375 side

[a]This number refers to the body number of the drum on the drawing.
[b]The liner shall be high density polyethylene, 4-mil thickness minimum.

The lid locking ring bolt shall be tightened to 40 ± 4 ft-lb torque with tapping of ring during tightening. A jam nut shall also be used to prevent unintentional loosening during transport.

The drum gasket material must have an operating range of -40 °F to +158 °F.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

2.8.4 CFR 173.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-1.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-1.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-1.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. Tests were conducted on a total of 26 test units of nine different types of steel drums. In all cases, there was no detectable effect on the ability of the packaging to meet the subsequent Type A tests. In all cases, there was no inleakage of water. See Appendix D, Table D-1.
Free drop	Pass. 4-ft drop test conducted on: Top - approximately 45° on bolt Bottom - approximately 45° Side - flat on bolt. See Appendix D, Table D-10.
Corner drop	Not required
Compression	Pass. The test was conducted at five times the gross weight for 24 hr. No detectable effect on the packaging was observed. See Appendix D, Table D-23.
Penetration	Pass. Significant dents occurred in the smaller packages. The reduction in distance to the package center is shown in the table in Section 2.8.3. Each shipper must ensure that the radiation level at the surface of the package will not increase more than 20% as a result of such a deformation. See Appendix D, Table D-30.

2.8.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface sealing surface	Vendor qualifications and experience	Functional: • Ease of lid/closure ring application • Bolt closure ring--bolt size • Gasket, adhesive, as specified • Geometry, as specified Acceptable Conditions: • Lack of dents, no deformation of sealing surfaces
Gasket		• Dimensions, as specified
Weld areas		• Continuous welds, no sharp edges
Body and chime	Metal thickness	Lot tests by shipper, as appropriate.
Air leak tests	Bolt size	Vendor Data and/or Certification: • Marking • Test data • Type A document provided as appropriate • Air leak tests
	Protective coating application	Visual: • Surface/coating as specified • Lack of imperfections in application • Lack of rust, dents, nicks

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

2.8.6 Additional Information

Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

2.8.6.1 Primary Users

Site/Contact/Phone	Address
MLM Don Wikstrom COMM/FTS 513-865-3919	EG&G/Mound Mound Road Miamisburg, OH 45342

Figure 2-11. 71-Gallon Square Steel Drum, 6½-Inch Crimped Cover.

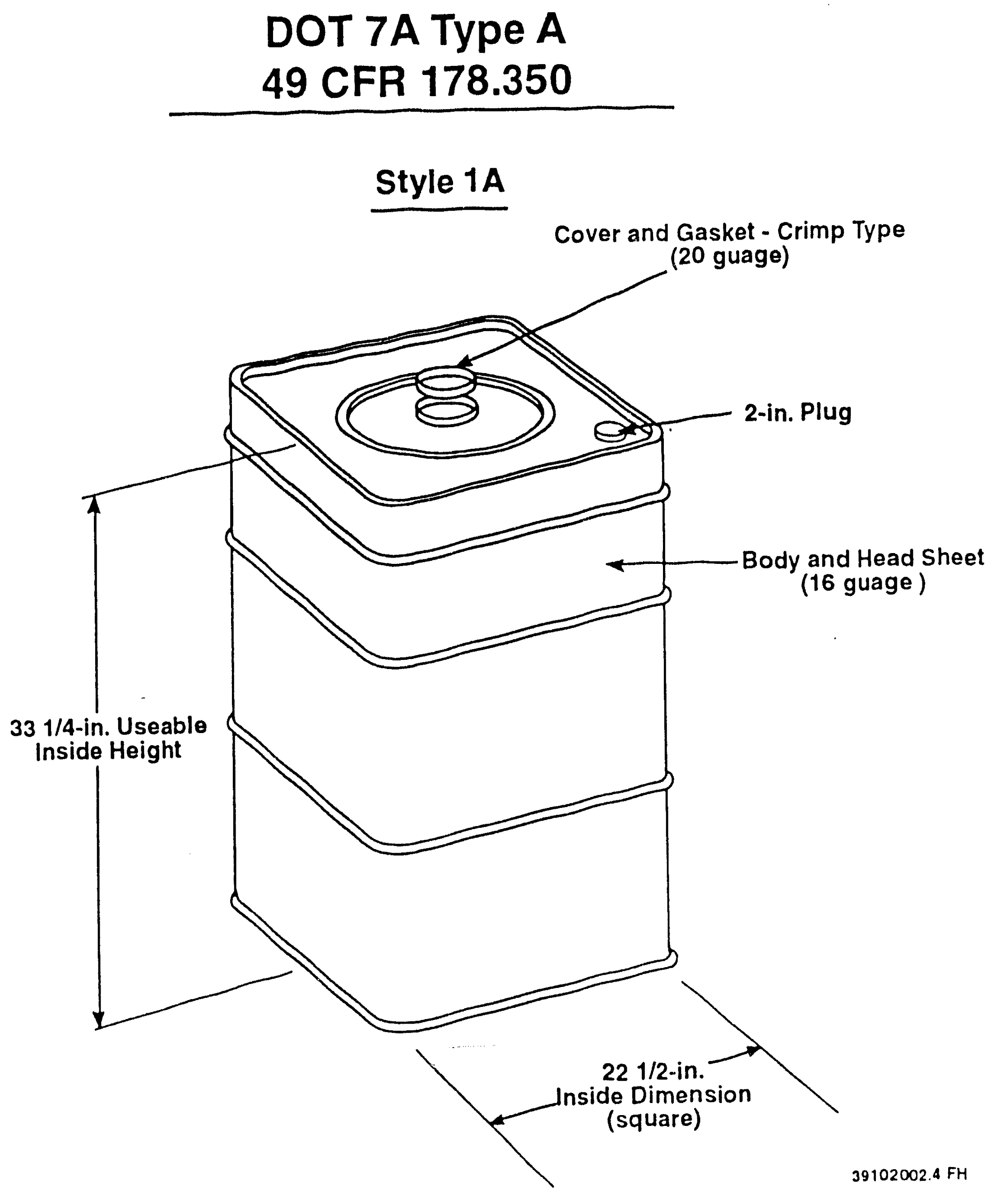


Figure 2-12. 71-Gallon Square Steel Drum, 6½-Inch Crimped Cover.

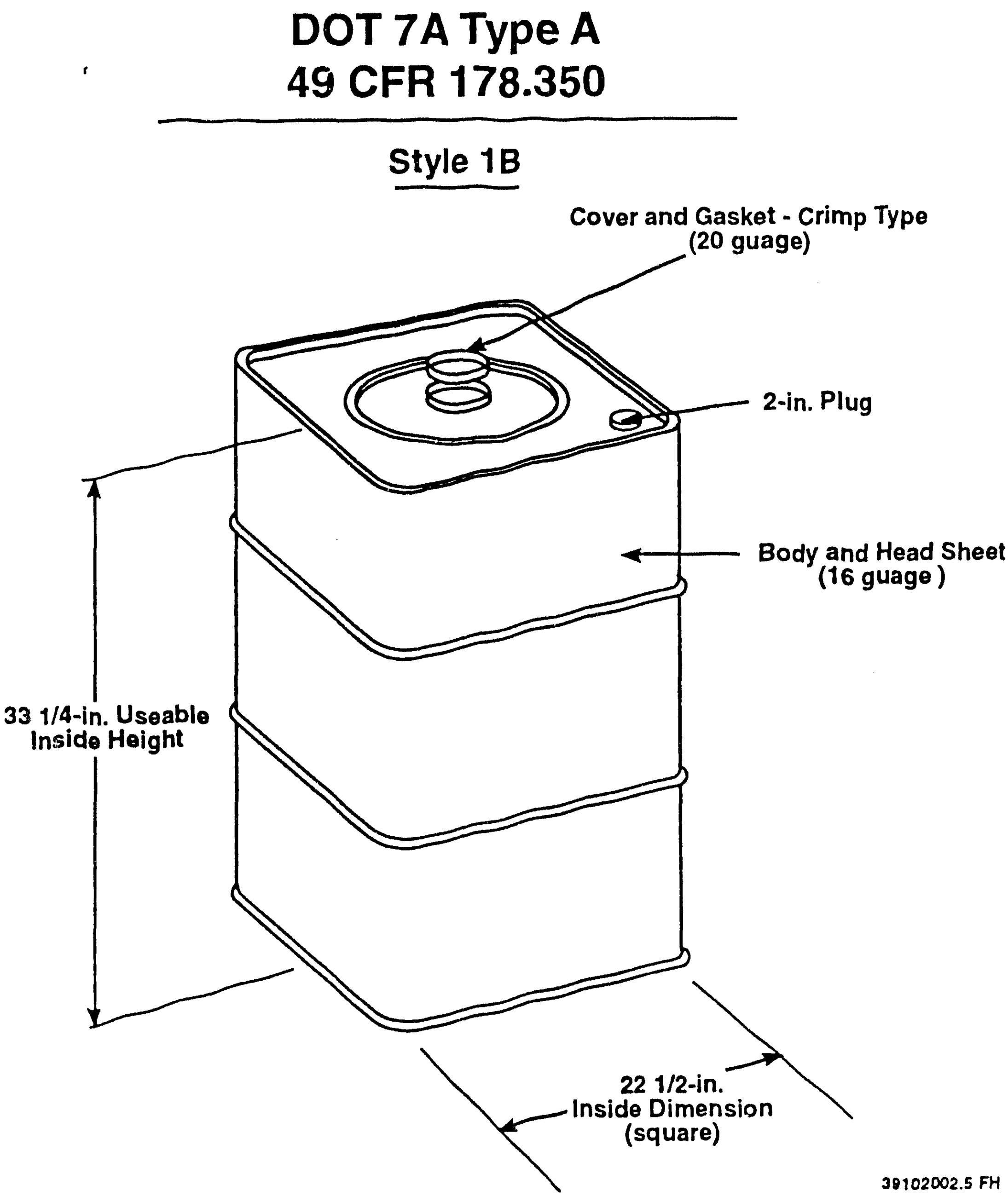


Figure 2-13. 71-Gallon Square Steel Drum, 18¼-Inch Removable Head.

DOT 7A Type A
49 CFR 178.350

Style 2

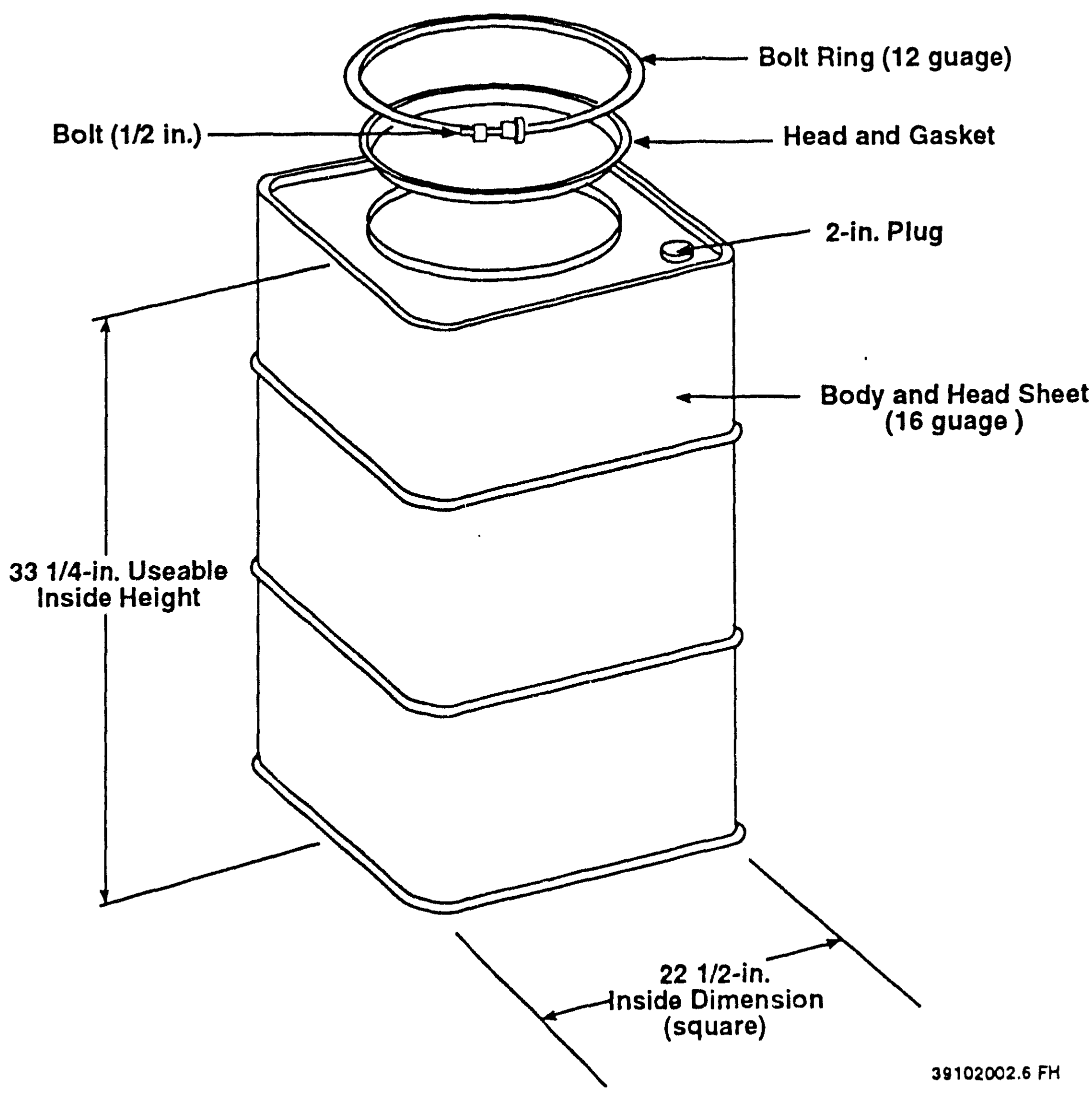
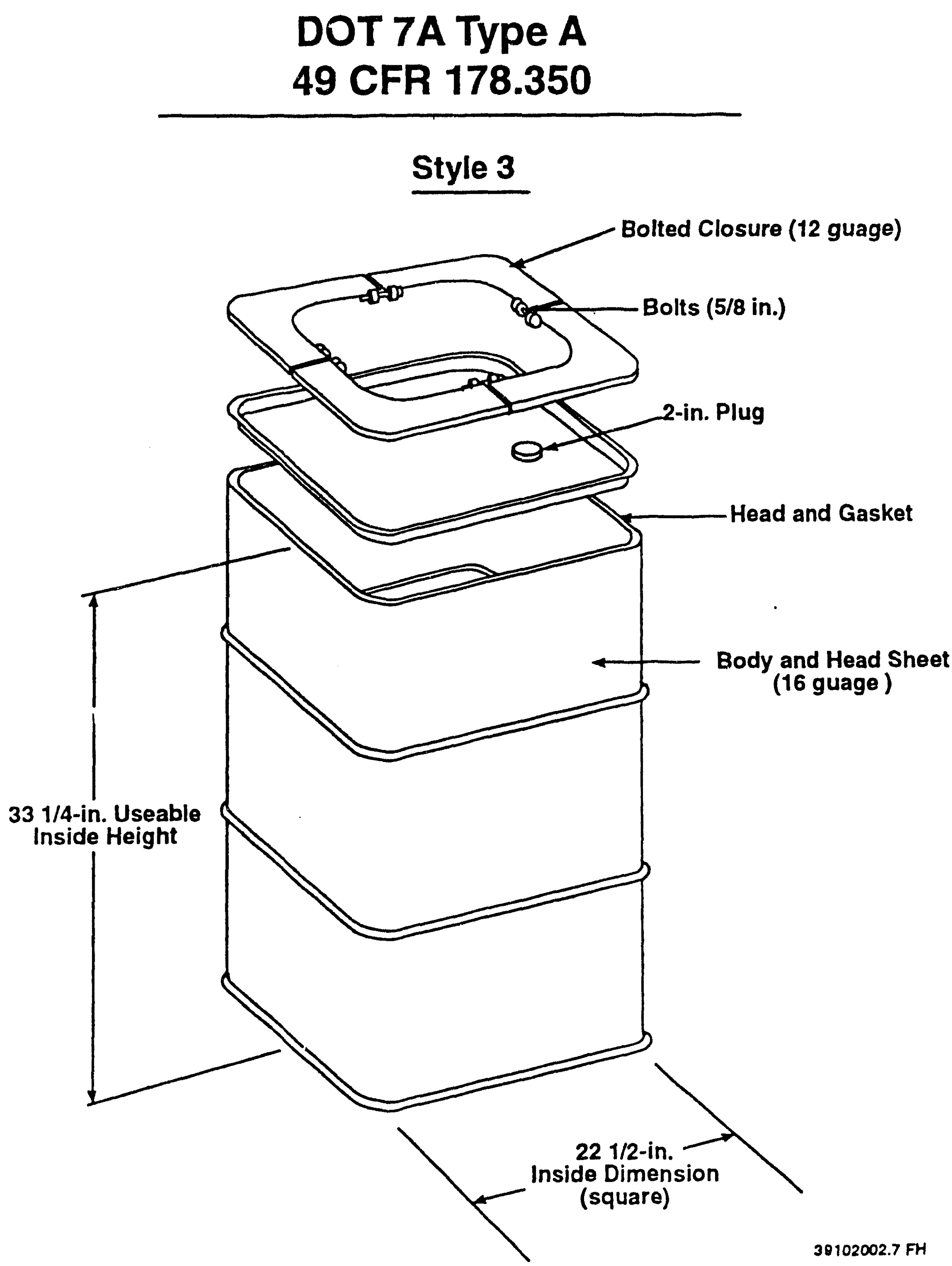


Figure 2-14. 71-Gallon Square Steel Drum, Fully Removable Head.



2.9 SQUARE 71-GALLON STEEL DRUM, PACKAGING SPECIALTIES (DOCKETS: MLM)

Style 1A, 6½-in. Crimped Cover; Style 1B, 6½-in. Crimped Cover; Style 2, 18¼-in. Removable Head; Style 3, Fully Removable Head.

2.9.1 Package Description

Dimensions

71-gallon drum	Height (in.)			Width (in.)[a]		
	Style 1A & 1B	Style 2	Style 3	Style 1A & 1B	Style 2	Style 3
External	34.75	34.75	34.88	23.50	23.50	23.50
Internal	33.25	33.25	33.25	22.25	22.25	22.25

[a]Each equal side, including rolling hoop.

Materials/Methods of Construction (sheet 1 of 2)

Style 1A & 1B[a]	
Body, head sheet	16 gauge steel
Cover (6½ in.)	20 gauge steel
Gasket	Neoprene[b] foam, ASTM-D-1056-85
Threaded plug	2-in. MTP[c] Tri-sure,[d] 2-in. pressed steel plug Neoprene gasket
Style 2	
Body, head sheet, and cover (18.250-in. diameter)	16 gauge steel
Bolted closure ring	12 gauge steel with 0.500-in. matched steel lugs and 0.500-in. bolt
Cover gasket	Neoprene, half-round tubular Mil-R-6855, Class 2, Grade 60 MS-27683-81
Threaded plug	Same as Style 1

Materials/Methods of Construction (sheet 2 of 2)

Style 3	
Body and head (removable)	16 gauge steel
Cover gasket	Neoprene, half-round tubular
Bolted closure	12 gauge steel with 0.625-in. bolts (4)
Threaded plug	Same as Styles 1 and 2

NOTE: Drawings; Packaging Specialties: Style 1A--PN.225035WV71GC, Style 1B-PN.225035WVTST1, Style 2-PN.225035EGTST1 and Style 3-PN.2250350HTST1.

[a]Style 1A has a welded collar and Style 1B has a rolled (one piece) collar against which the cover is crimped.
[b]Neoprene is a trademark of E. I. duPont de Nemours.
[c]MTP is a trademark of Moll Plasticrafters Limited Partnership.
[d]Tri-Sure is a trademark of American Flange & Manufacturing Company, Inc.

2.9.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

2.9.2.1 Physical Form

2.9.2.1.1 Solids Only. Three forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements.

- Material Form No. 1: Solids--any particle size.
- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.).
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.443, Contamination Control.)

2.9.2.1.2 Maximum Gross Weight. Form No. 1, No. 2, and No. 3:

- 1,350 lb.

2.9.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

2.9.2.3 Radiological. Maximum dent of 4 in. (Style 1), 3.75 in. (Style 2), or 4.5 in. (Style 3) resulted from the 4-ft drop test on the bottom edge of the packaging. Each shipper must ensure that the radiation level at the surface of the packaging will not increase by more than 20% if such deformations would occur.

2.9.3 Restrictions/Specifications

The bung closure shall be tightened to 15 ft-lb on all styles.

The bolt closure shall be tightened to 30 ft-lb for Style 2 and 15 ft-lb for Style 3.

Tighten the bolt per the following procedure:

1. Tighten the bolt to the designated ft-lb torque.
2. Hit the closure ring vigorously with a metal hammer, 8 to 9 times,equally spaced around the closure ring.
3. Repeat this cycle three additional times.
4. Torque bolt one last time to the designated ft-lb.

A jam nut shall also be used to prevent unintentional loosening during transport.

The seal gasket material must have an operating range of -40 °F to +158 °F.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps), equipment or materials with sharp corners or protrusions, or material/ equipment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

2.9.4 CFR 173.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-1.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-1.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-1.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. Tests were conducted on all 3 styles of drums and demonstrated no inleakage of water. Further, the water spray test preceded each of the remaining Type A tests. In no case was there any effect on the ability of the packagings to meet the required tests. See Appendix D, Table D-1.
Free drop	Pass. Sixty-nine separate drop tests were conducted (22 on Styles 1A and 1B, 26 on Style 2, and 21 on Style 3). Drops were conducted on edges, top corners, bottom corners, and the ends. In all cases there was no loss of contents or major distortion of the packagings. See Appendix D, Table D-10.
Corner drop	Not Required.
Compression	Pass. The test was conducted on all three styles with greater than five times the gross weight for greater than 24 hr. There was no visible distortion of the packagings or loss of contents. See Appendix D, Table D-23.
Penetration	Pass. The test was conducted at several points on all three styles of the packagings with no significant effect. The tests on the bungs left no discernable mark. The impact on the centers of the covers resulted in a maximum dent of 0.25 in. The tests on the closure rings left no visible effect. See Appendix D, Table D-30.

2.9.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface sealing surface	Vendor qualifications and experience	Functional: • Ease of lid/closure ring application • Bolt closure ring--bolt size
Gasket		• Geometry, as specified • Size, material, geometry as specified Acceptable Conditions: • Lack of dents, no deformation of sealing surfaces • Dimensions, as specified • Gasket size, materials, geometry
Welds		• Continuous, no sharp edges
Body and chime	Metal thickness	Lot tests by shipper, as appropriate. • Metal type, thickness, and quality as specified • Bolt number, locations, and materials as specified with appropriate vendor/shipper data/certification: - Marking - Test data - Type A document provided as appropriate • Air leak as appropriate
	Protective coating application	Visual: • Surface/coating as specified • Lack of imperfections • Lack of rust, dents, nicks

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

2.9.6 Additional Information

Evaluation and testing of the subject packaging took place at MLM in 1989. A complete test report is available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

2.9.6.1 Primary Users

Site/Contact/Phone	Address
West Valley Nuclear Services (WVNS) Steve Ketola COMM/FTS 716-942-4314	Department of Energy West Valley Project West Valley, New York

Appendix A.4.2

Steel Boxes

3.0 STEEL BOXES

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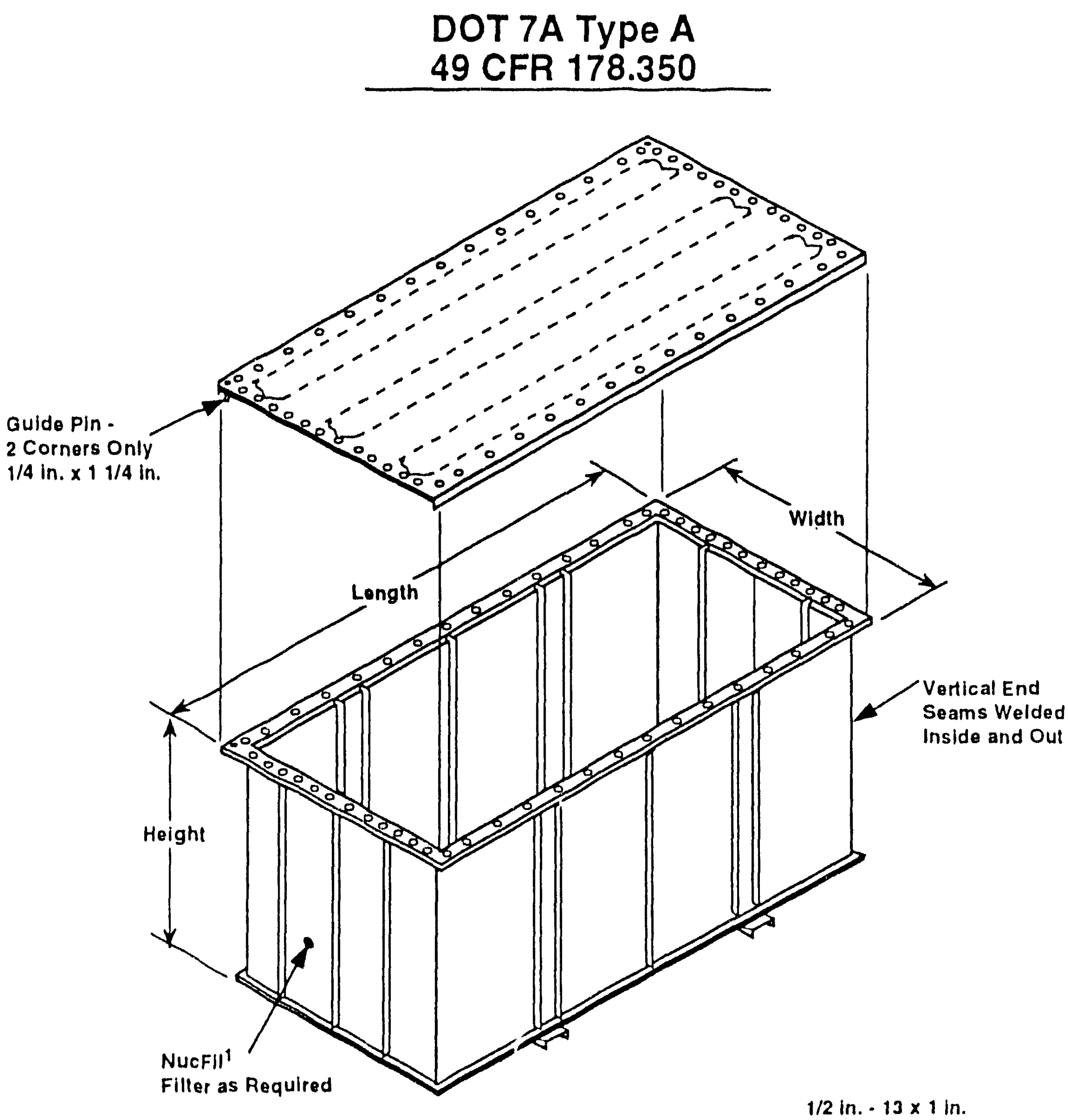
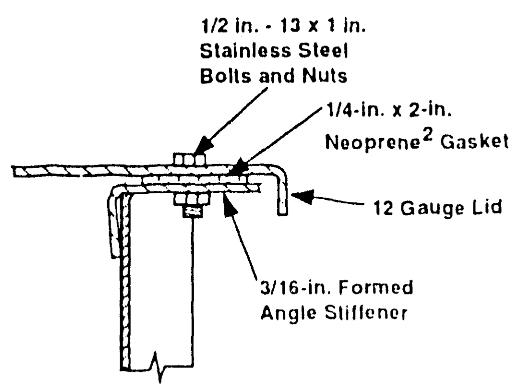
Figure 3-1. Capital Industries, Incorporated, Family of Filtered and Nonfiltered Steel Boxes.





[1]NucFil is a trademark of Nuclear Filter Technology, Incorporated.

[2]Neoprene is a trademark of E.I. duPont de Nemours and Company.

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3.1 CAPITAL INDUSTRIES--FAMILY OF STEEL BOXES (DOCKETS: MLM)

3.1.1 Package Description

Dimensions and Weights

Model		Height (in.)	Width (in.)	Length (in.)	Authorized gross weight (lb)	Engineering drawing number
S-0510-0823	Interior	51.00	48.375	82.375	7,000	S-0483-0510-0823-0104, sheets 1 and 2
	Exterior	54.00	54.000	88.000		
V-0510-0823	Interior	51.00	42.375	82.375	7,000	S-0483-0510-0823-0104, sheets 1 and 2
	Exterior	54.00	54.000	88.000		
S-0450-0846	Interior	45.00	39.625	84.625	5,240	S-0396-0450-0846-0104, sheets 1 and 6
	Exterior	48.00	45.000	90.000		
S-0730-0846	Interior	73.00	48.625	84.625	8,700	S-0486-0730-0846-0134, sheets 1 and 6
	Exterior	76.00	54.000	90.000		
S-0240-0906	Interior	24.00	48.375	90.625	3,672	S-0486-0240-0906-0104, sheets 1 and 6
	Exterior	27.00	54.000	96.000		
S-0480-0906	Interior	48.00	48.000	90.625	6,120	S-0486-0480-0906-0104, sheets 1 and 6
	Exterior	51.00	54.000	96.000		
S-0730-1006	Interior	73.00	48.625	100.625	10,400	S-0486-0730-1006-0134, sheets 1 and 6
	Exterior	76.00	54.000	106.000		
S-0480-1376	Interior	48.00	48.625	137.625	9,295	S-0486-0480-1376-0134, sheets 1 and 6
	Exterior	51.00	54.000	143.000		
S-0840-1440	Interior	84.00	72.000	144.000	22,700	S-0720-0840-1440-0187, sheets 1 and 6
	Exterior	86.75	77.375	149.375		

Materials/Method of Construction

Model	Part	Description
V-0510-0823	Sides, top, ends, and bottom	12 gauge steel
S-0510-0823	Sides, top, and ends	12 gauge steel
S-0480-0906	Bottom	10 gauge steel
S-0240-0906		
S-0450-0844		
S-0730-1006	Sides, top, ends, and bottom	10 gauge steel
S-0730-0846		
S-0480-1376		
S-0840-1440	Sides, top, ends, and bottom	0.187-in. steel plate
		0.187-in. structural members
	Continuous welds	
	Bolt closure depends on box size	0.5 - 13 x 1.5 in.
		0.5 - 13 x 1.25 in.
		0.5 - 13 x 1 in.
	Gasket	2 in. x 0.25 in. Neoprene[a]
		30 durometer or high-density closed cell
	Filter	NucFil[b]
	Skids	

[a]Neoprene is a trademark of E. I. duPont de Nemours and Company.
[b]NucFil is a trademark of Nuclear Filter Technology, Inc.

3.1.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

3.1.2.1 Physical Form

3.1.2.1.1 Solids Only. Three forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements.

- Material Form No. 1: Solids--any particle size
- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.)
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.443, Contamination control.)

3.1.2.1.2 Maximum Gross Weight. See Dimensions and Weights table in Section 3.1.1.

3.1.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

3.1.2.3 Radiological. The 4-ft drop test caused deformations of the package resulting in small decreases in the distance from the exterior to the center of the package. The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such deformations would occur.

3.1.3 Restrictions/Specifications

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

3.1.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-2.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-2.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-3.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. Test not conducted; however, this test would not adversely affect the ability of this packaging to meet the Type A test requirements and there would not be an inleakage of water. See Appendix D, Table D-2.
Free drop	Pass. This test was conducted on a top, lid corner (S-0518-0823, V-0510-0823, S-0840-1440 and S-0730-1006). There was no loss of contents or significant distortion of package geometry. The remaining packagings were evaluated by analysis based on the tested packages. See Appendix D, Table D-11.
Corner drop	Not required.
Compression	Pass. Tests were conducted with greater than five times the gross weight for 24 hr. There was no loss of contents or significant package distortion. These data were then used for analysis of similar packages. See Appendix D, Table D-24.
Penetration	Pass. Steel box--This test was successfully conducted on the top (middle) with only a minor dent. Filter--Tests were conducted with impacts directly on the filter top. Only a minor dent resulted, and there was no loss of contents or containment in either the filter or the filter housing. See Appendix D, Table D-31.

3.1.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface Sealing surface	Vendor qualifications and experience	Functional: • Ease of lid application • Flange--flat surface; no foreign matter • Geometry, as specified Acceptable Conditions: • Lack of dents, no deformation of sealing surfaces • Dimensions, as specified
Gasket		• Gasket size, materials, geometry
Weld areas		• Continuous welds, no sharp edges
Body	Metal thickness Bolt size and spacing	Lot tests by shipper, as appropriate, and/or vendor certification.
Air leak tests	Protective coating	Visual: • Surface/coating as specified • Lack of imperfections in application • Lack of rust, dents, nicks
Filter Type Efficiency, flow characteristics	Filter location and installation	Acceptable Conditions: • Filter free-flowing • Filter securely installed

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

3.1.6 Additional Information

Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

3.1.6.1 Primary User(s)

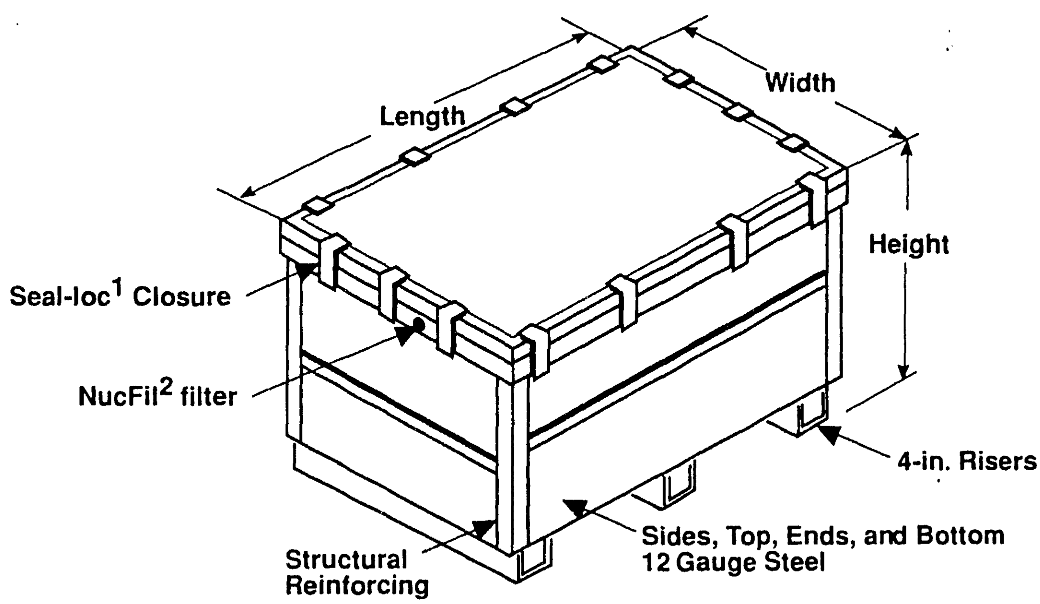
Site/Contact/Phone	Address
MLM Don Wikstrom COMM/FTS 513-865-3919	EG&G/Mound Mound Road Miamisburg, OH 45342

3.1.6.2 Suppliers

Capital Industries, Inc.
5801 3rd Avenue, S.
P. O. Box 80983
Seattle, WA 98108
206-762-8585

Figure 3-2. Container Products Corporation, Family of Filtered and Nonfiltered Steel Boxes.

DOT 7A Type A
49 CFR 178.350



Note: This configuration shows a filtered steel box. Container No. 3 (B-96-5-RA-B) is an unfiltered box with reinforcing structure to allow compliance with the reduced pressure test.

[1]Seal-loc is a trademark of Container Products Corporation.

[2]NucFil is a trademark of Nuclear Filter Technology, Incorporated.

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3.2 CONTAINER PRODUCTS CORPORATION--FAMILY OF STEEL BOXES (DOCKETS: MLM)

3.2.1 Package Description

Dimensions and Weights

Model		Height (in.)	Width (in.)	Length (in.)	Authorized gross weight (lb)	Engineering drawing number
B-96-5-S/L-FD	Exterior	52.000	48.625	93.375	6,050	01-2101-1-00, Revision 0
	Interior	44.000	43.000	88.000		
B-96-5-S/L-RA	Exterior	52.000	48.625	93.625	6,800	01-1901-1-00, Revision 0
	Interior	44.000	43.000	88.000		
B-96-5-RA-B	Exterior	51.254	47.250	92.250	6,500	01-2201-1-01, Revision 0
	Interior	44.000	43.000	88.000		
B-96-5-FD-B	Exterior	51.250	47.250	92.250	6,500	01-2301-1-01, Revision 0
	Interior	44.000	43.000	88.000		
467-C-S/L FD TRU waste container	Exterior	38.500	54.000	68.000	4,000	01-3700-1-00, Revision C
	Interior	33.500	52.000	66.000		
B-12-44-4-S/L FD	Exterior	28.250	51.625	77.625	4,625	01-3100-1-00, Revision B
	Interior	23.000	46.000	72.000		
B-25-4-S/L FD	Exterior	52.187	48.625	75.625	4,820	01-2800-1-00, Revision C
	Interior	47.000	43.000	70.000		
B-52-4-S/L FD	Exterior	43.187	54.625	54.625	4,775	04-1000-1-00, Revision F
	Interior	38.000	49.000	49.000		
B-82-6-S/L FD	Exterior	52.187	47.187	74.187	6,775	01-2300-1-00, Revision 0
	Interior	47.000	43.000	70.000		
B-87-6-S/L FD	Exterior	43.187	57.625	81.625	6,970	04-1300-1-00, Revision B
	Interior	38.000	52.000	76.000		
B-96-6-S/L FD	Exterior	48.1876	48.567	93.567	7,000	04-1200-1-00, Revision 0
	Interior	44.000	43.000	88.000		
B-96-8-S/L FD	Exterior	48.187	48.567	93.567	9,100	04-1200-2-0, Revision 0
	Interior	44.000	43.000	88.000		

Materials/Method of Construction

Sides, top, ends, and bottom	12 gauge steel, ASTM A569 low-carbon hot rolled steel
Closure	Seal-loc[a] or bolt depending on box style
Gasket	Closed cell Neoprene[b] (Mil R-6130-B)
Sealant	Scotch No. 776 (Mil D-17951-B)
Filter	NucFil[c]

[a]Seal-loc is a trademark of Container Products Corporation.
[b]Neoprene is a trademark of E. I. duPont de Nemours and Company.
[c]NucFil is a trademark of Nuclear Filter Technology, Inc.
ASTM = American Society for Testing and Materials.

3.2.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

3.2.2.1 Physical Form

3.2.2.1.1 Solids Only. Three forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements.

- Material Form No. 1: Solids--any particle size
- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.)
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.443, Contamination control.)

3.2.2.1.2 Maximum Gross Weight. See Dimensions and Weights table in Section 3.2.1.

3.2.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

3.2.2.3 Radiological. The 4-ft drop test caused deformations of the package resulting in small decreases in the distance from the exterior to the center of the package. The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such deformations would occur.

3.2.3 Restrictions/Specifications

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

3.2.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-2.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-2.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-3.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. Test not conducted; however, this test would not adversely affect the ability of this packaging to meet the Type A test requirements and there would be no inleakage of water. See Appendix D, Table D-2.
Free drop	Pass. This test was conducted on a top, lid corner (four individual boxes). There was no loss of contents or significant distortion of package geometry. The remaining packages were evaluated by analysis based on the tested packages. See Appendix D, Table D-11.
Corner drop	Not required.
Compression	Pass. Tests were conducted with greater than five times the gross weight for 24 hr. There was no significant effect. There was no loss of contents or significant package distortion. These data were then used for analysis of similar packages. See Appendix D, Table D-24.
Penetration	Pass. Steel box--Tests were successfully conducted on the box itself with only minor dents resulting. Filter--Tests were conducted with impacts on the filter top. Only a minor dent resulted, and there was no loss of contents or containment in either the filter or the filter housing. See Appendix D, Table D-31.

3.2.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface Sealing surface	Vendor qualifications and experience	Functional: • Ease of lid application • Flange--flat surface; no foreign matter • Geometry, as specified Acceptable Conditions: • Lack of dents, no deformation of sealing surfaces • Dimensions, as specified
Gasket		• Gasket size, materials, geometry
Weld areas		• Continuous welds, no sharp edges
Body	Metal thickness Bolt size and spacing	Lot tests by shipper, as appropriate, and/or vendor data/verification: • Marking • Test data • Type A Certification Document as appropriate
Air leak tests	Protective coating	Visual: • Surface/coating as specified • Lack of imperfections in application • Lack of rust, dents, nicks
Filter Type Efficiency, flow characteristics	Filter location and installation	Acceptable Conditions: • Filter free-flowing • Filter securely installed

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

3.2.6 Additional Information

Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

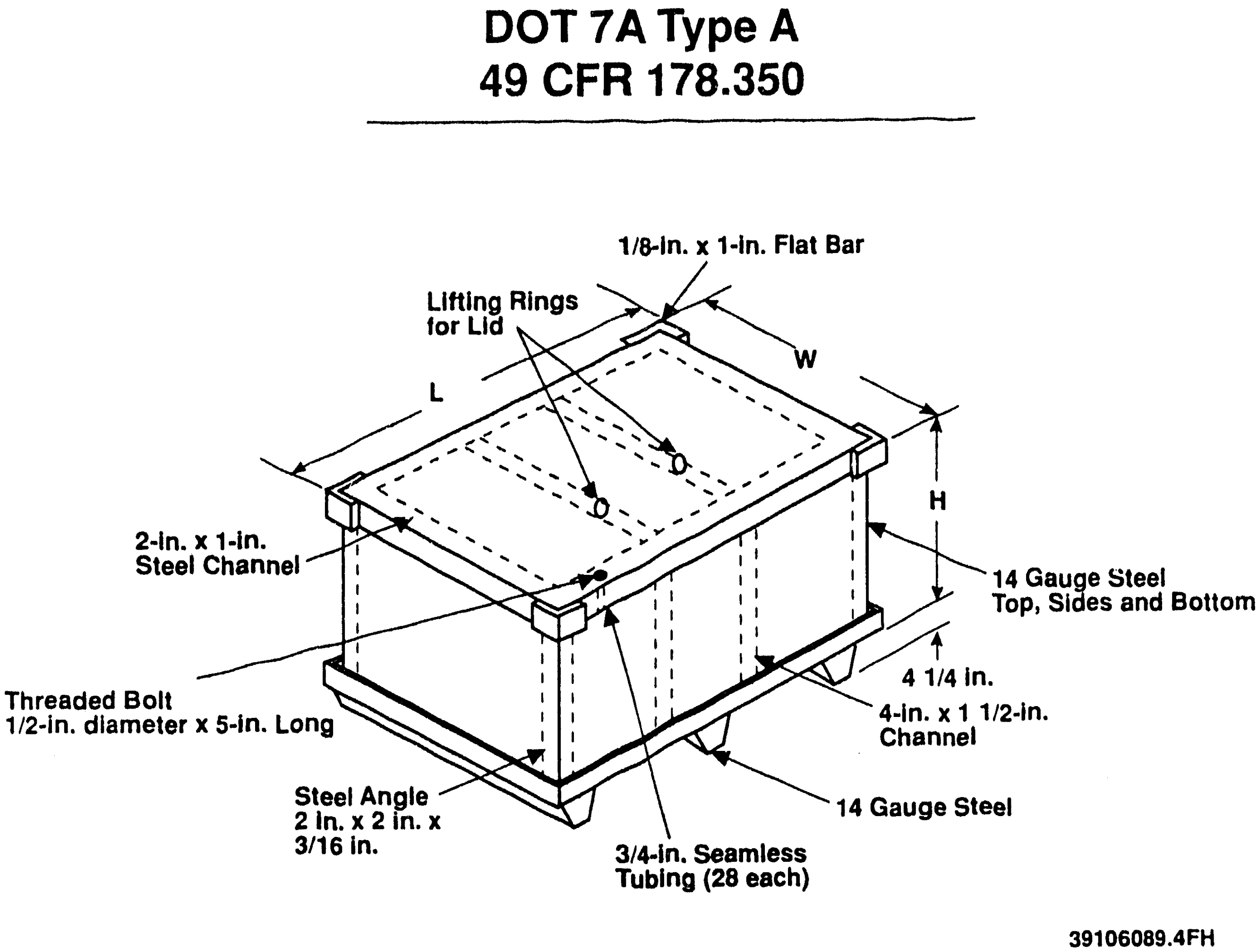
3.2.6.1 Primary User(s)

Site/Contact/Phone	Address
DOE T. G. Adams 716-942-3235	U.S. Department of Energy Idaho Operations Office West Valley Project Office P. O. Box 191 West Valley, NY 14171

3.2.6.2 Suppliers

Container Products Corp.
P. O. Box 3767
Wilmington, NC 28406
COMM 919-392-6100

Figure 3-3. RoGar Chemical and Nuclear Services, Family of Steel Boxes.



3.3 ROGAR FAMILY OF STEEL BOXES (DOCKETS: MLM)

3.3.1 Package Description

Dimensions and Weights

Model		Height (in.)	Width (in.)	Length (in.)	Authorized gross weight (lb)	Engineering drawing number
R-1	Interior	38.5	38.5	68.0	7,750	RENS - 031, Revision 0
	Exterior	42.5	41.5	71.0		
R-2	Interior	38.5	54.0	68.0	7,820	RENS - 032, Revision 0
	Exterior	52.5	57.0	71.0		
R-3	Interior	54.0	54.0	88.0	7,920	RENS - 034, Revision 2
	Exterior	58.0	57.0	91.0		
R-4	Interior	48.0	48.0	84.0	7,920	RENS - 036, Revision 0
	Exterior	52.0	51.0	87.0		

Materials/Method of Construction

Sides, top, ends, and bottom	14 gauge steel
Skids	14 gauge steel
Bolt closure	0.5-in. diameter x 5 in. long - 28 required
Gasket	0.25 in. x 1.75 in. Neoprene[a]
All seams welded except closure	
Filter	NucFil[b]

[a]Neoprene is a trademark of E. I. duPont de Nemours and Company.
[b]NucFil is a trademark of Nuclear Filter Technology, Inc.

3.3.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

3.3.2.1 Physical Form

3.3.2.1.1 Solids Only. Three forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements.

- Material Form No. 1: Solids--any particle size
- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.)
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.443, Contamination control.)

3.3.2.1.2 Maximum Gross Weight. See Dimensions and Weights table in Section 3.3.1.

3.3.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

3.3.2.3 Radiological. The 4-ft drop test caused deformations of the package resulting in small decreases in the distance from the exterior to the center of the package. The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such deformations would occur.

3.3.3 Restrictions/Specifications

Lifting rings are for placement of the lid only. Procedures and training must ensure that these are rendered inoperable prior to shipment (i.e., welded in place, cut off, etc.).

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

3.3.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-2.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-2.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-3.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. Test not conducted; however, this test would not adversely affect the ability of this packaging to meet the Type A test requirements, and there would be no inleakage of water. See Appendix D, Table D-2.
Free drop	Pass. This test was conducted on a top, lid corner. There was no loss of contents or significant deformation of package geometry. See Appendix D, Table D-11.
Corner drop	Not required.
Compression	Pass. Tests were conducted with greater than five times the gross weight for 24 hr with no distortion of the package geometry. See Appendix D, Table D-24.
Penetration	Pass. Steel box--This test was successfully conducted on the top (middle) with only a minor dent. Filter--Tests were conducted with impacts on the filter top. Only a minor dent resulted, and there was no loss of contents or containment in either the filter or the filter housing. See Appendix D, Table D-31.

3.3.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface Sealing surface	Vendor qualifications and experience	Functional: • Ease of lid application • Flange--flat surface; no foreign matter • Geometry, as specified Acceptable Conditions: • Lack of dents, no deformation of sealing surfaces
Gasket		• Dimensions, as specified • Gasket size, materials, geometry
Weld areas		• Continuous welds, no sharp edges
Body	Metal thickness Bolt size and spacing	Lot tests by shipper, as appropriate, and/or vendor data/verification: • Marking • Test data • Type A Certification Document provided as appropriate
Air leak tests	Protective coating application	Visual: • Surface/coating as specified • Lack of imperfections in application • Lack of rust, dents, nicks
Filter Type Efficiency, flow characteristics	Filter location and installation	Acceptable Conditions: • Filter free-flowing • Filter securely installed

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

3.3.6 Additional Information

Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

3.3.6.1 Primary User(s)

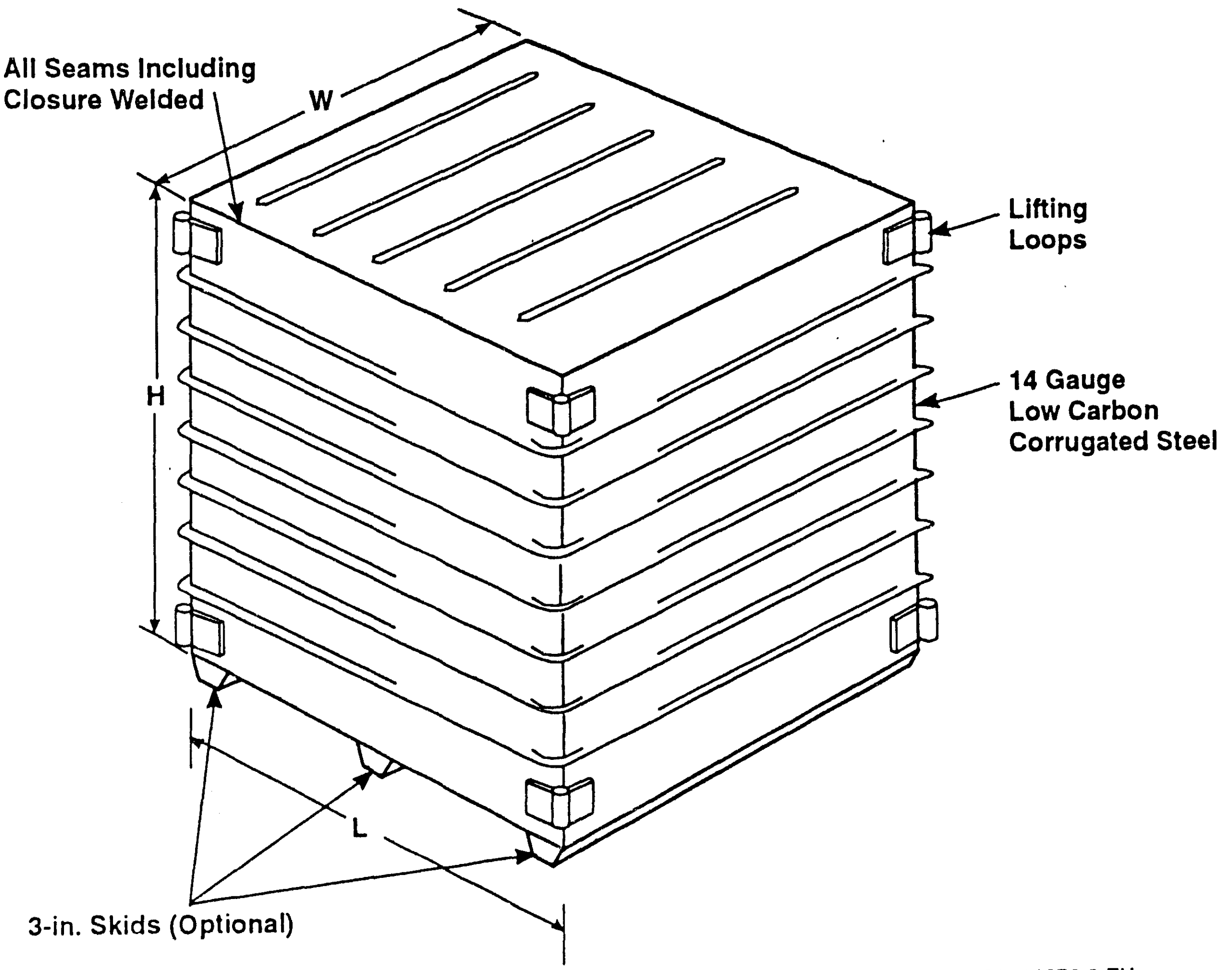
Site/Contact/Phone	Address
MLM Don Wikstrom COMM/FTS 513-865-3919	EG&G/Mound Mound Road Miamisburg, OH 45342

3.3.6.2 Suppliers

RoGar Chemical & Nuclear Services, Inc.
582 Mayten Drive
Livermore, CA 94550
415-443-6101

Figure 3-4. Rocky Flats SAND Box Steel Box.

DOT 7A Type A
49 CFR 178.350



3.4 ROCKY FLATS SAND BOX--STEEL BOX (DOCKETS: MLM)

3.4.1 Package Description

Dimensions and Weights

Model	Height (in.)	Width (in.)	Length (in.)	Authorized gross weight (lb)
Style 1	54.00	54.00	88.00	7,000
Style 2	48.00	48.00	84.00	6,000
Style 3	38.50	50.50	74.50	6,000
Style 4	38.50	54.00	68.00	6,000

Materials/Method of Construction

Sides, top, ends, and bottom	14 gauge mild steel
Lifting loops	0.25-in. low-carbon steel
Pipe coupling and plugs	Carbon steel
All seams continuous welds	--
Closure is welded	--
Filter (if used, not required)	NucFil*

*NucFil is a trademark of Nuclear Filter Technology, Inc.

3.4.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

3.4.2.1 Physical Form

3.4.2.1.1 Solids Only. Three forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements.

- Material Form No. 1: Solids--any particle size
- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.)

- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.443, Contamination control.)

3.4.2.1.2 Maximum Gross Weight. See Dimensions and Weights table in Section 3.4.1.

3.4.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

3.4.2.3 Radiological. The 4-ft drop test caused deformations of the package resulting in small decreases in the distance from the exterior to the center of the package. The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such deformations would occur.

3.4.3 Restrictions/Specifications

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

3.4.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-2.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-2.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-3.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. Test not conducted; however, this test would not adversely affect the ability of this packaging to meet the Type A test requirements, and there would be no inleakage of water. See Appendix D, Table D-2.
Free drop	Pass. Tests on each box size were performed with varying drop angles and impact points. There was no loss of contents or significant deformation of package geometry. See Appendix D, Table D-11.
Corner drop	Not required.
Compression	Pass. Both static and dynamic compression tests were conducted at up to 36,700 lb for 24 hr. See Appendix D, Table D-24.
Penetration	Pass. The test was performed on the center of the top of each container with a resulting dent of 0.125 in., which had no effect on container integrity. NOTE: For Nuclear Filter Technology filters, if used, the penetration test has routinely been done. See Appendix D, Table D-31.

3.4.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface Sealing surface	Vendor qualifications and experience	Functional: • Ease of lid application • Flange--flat surface; no foreign matter • Geometry, as specified Acceptable Conditions: • Lack of dents, no deformation of sealing surfaces
Gasket		• Dimensions, as specified • Gasket size, materials, geometry
Weld areas		• Continuous welds, no sharp edges
Body	Metal thickness Bolt size and spacing	Lot tests by shipper, as appropriate, and/or vendor data/verification: • Marking • Test data • Type A certification document provided as appropriate
Air leak tests	Protective coating	Visual: • Surface/coating as specified • Lack of imperfections in application • Lack of rust, dents, nicks
Filter Type Efficiency, flow characteristics	Filter location and installation	Acceptable Conditions: • Filter free-flowing • Filter securely installed

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

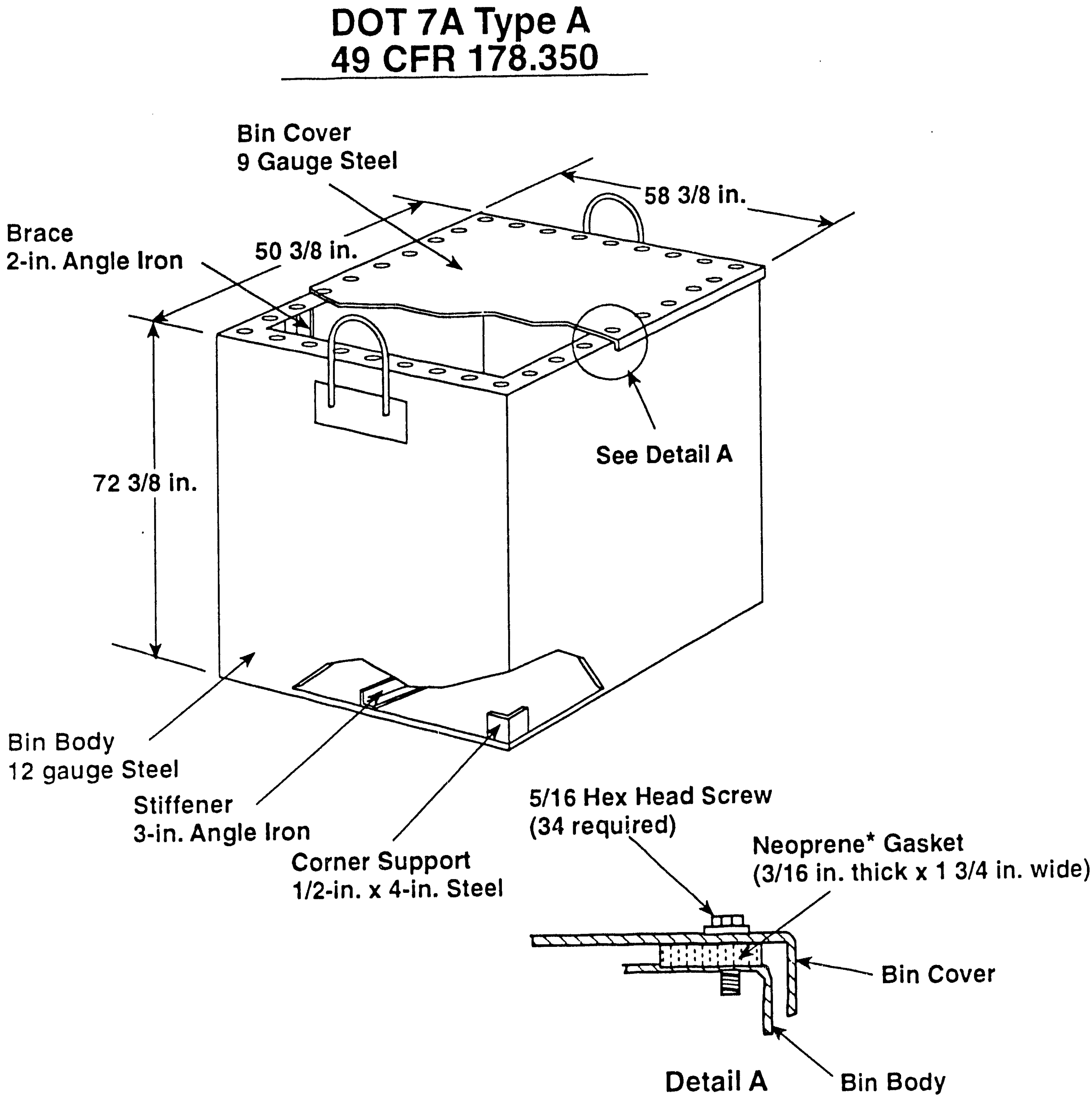
3.4.6 Additional Information

Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

3.4.6.1 Primary User(s)

Site/Contact/Phone	Address
Rocky Flats R. R. Riddle COMM/FTS 303-966-2377	Rocky Flats Plant P. O. Box 464 Golden, Colorado 80402-0464

Figure 3-5. ANL M-4 Bin Steel Box.



*Neoprene is a trademark of E.I. duPont de Nemours and Company.

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3.5 ANL M-4 STEEL BIN (DOCKETS: MLM)

3.5.1 Package Description

Dimensions

Model	Height (in.)	Width (in.)	Length (in.)
ANL M-4	72.375	58.375	50.375

Materials/Method of Construction

Body	18 gauge
Cover	9 gauge
Bolts	0.312-in. hex head screws (34 required)
Neoprene* gasket	0.187 in. x 1.75 in.
Welded seams (except cover)	--

*Neoprene is a trademark of E. I. duPont de Nemours and Company.

3.5.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

3.5.2.1 Physical Form

3.5.2.1.1 Solids Only. Three forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements.

- Material Form No. 1: Solids--any particle size
- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.)
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.443, Contamination control.)

3.5.2.1.2 Maximum Gross Weight. 3,000 lb. (Based on limitation of overpack used. It is expected that the bin would pass with a much higher gross weight.)

3.5.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

3.5.2.3 Radiological. The 4-ft drop test caused deformations of the package resulting in small decreases in the distance from the exterior to the center of the package. The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such deformations would occur.

3.5.3 Restrictions/Specifications

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

3.5.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-2.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-2.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-3. NOTE: This packaging failed the reduced pressure test without the RTV or equivalent.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. This test was not conducted; however, this test would not adversely affect the ability of this packaging to meet the Type A test requirements and there would be no inleakage of water. See Appendix D, Table D-2.
Free drop	Pass. Tests conducted. There was no loss of contents or significant deformation of package geometry. See Appendix D, Table D-11.
Corner drop	Not required.
Compression	Pass. By reference to tests conducted on M-3 steel bin. See Appendix D, Table D-24.
Penetration	Pass. Test conducted with only minor dents resulting. See Appendix D, Table D-31.

RTV = room temperature vulcanizing.

3.5.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface Sealing surface	Vendor qualifications and experience	Functional: • Ease of lid application • Flange--flat surface; no foreign matter • Geometry, as specified Acceptable Conditions: • Lack of dents, no deformation of sealing surfaces • Dimensions, as specified
Gasket		• Gasket size, materials, geometry
Weld areas		• Continuous welds, no sharp edges
Body	Metal thickness Bolt size and spacing	Lot tests by shipper, as appropriate, and/or vendor certification: • Marking • Test data • Type A Certification Document provided as appropriate • Air leak test
Air leak tests	Protective coating application	Visual: • Surface/coating as specified • Lack of imperfections in application • Lack of rust, dents, nicks

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

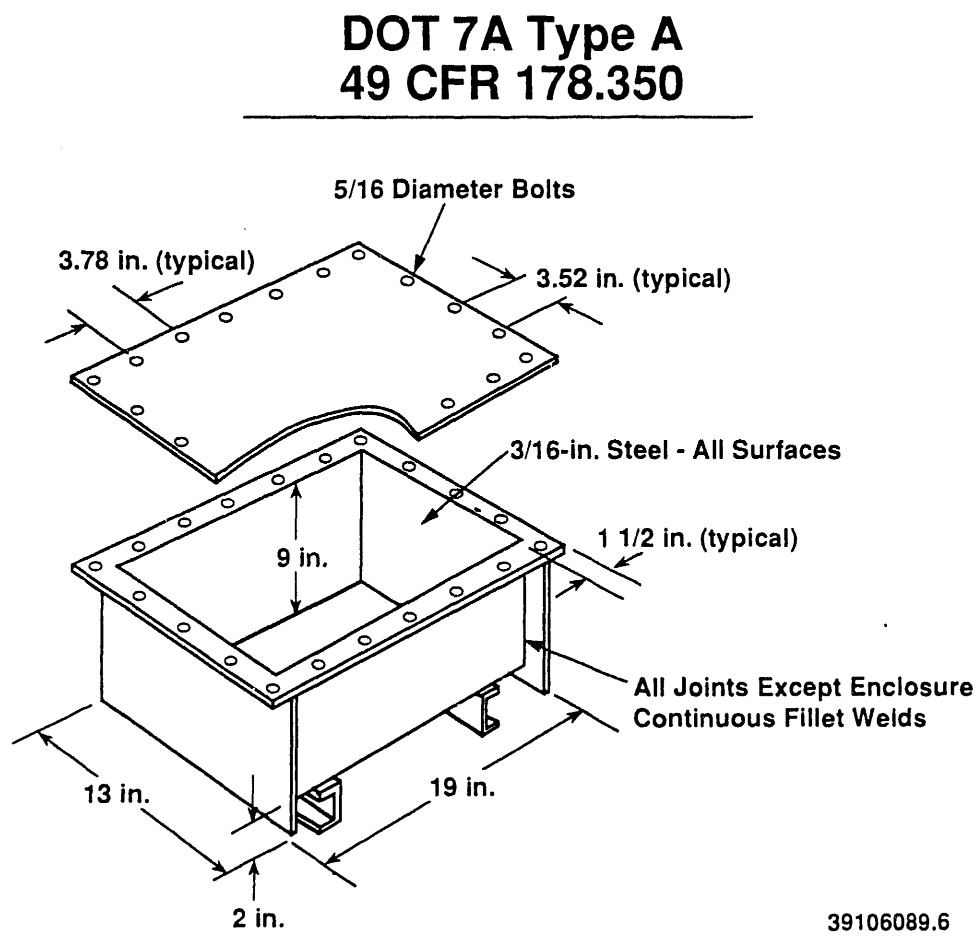
3.5.6 Additional Information

Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

3.5.6.1 Primary User(s)

Site/Contact/Phone	Address
ANL C. L. Cheever COMM/FTS 708-252-3311	Argonne National Laboratory 9700 South Cass Avenue Argonne, IL 60439

Figure 3-6. ANL-West 7A-860 Steel Box.



3.6 ANL-WEST STEEL BOX (DOCKETS: MLM)

3.6.1 Package Description

Dimensions

Model		Height (in.)	Width (in.)	Length (in.)
ANL-W steel box	Interior	9.000	13	19
	Exterior	11.375	16	22

Materials/Method of Construction

Body and lid	0.187-in. steel
All joints (except closure)	Continuous fillet welds
Bolts	0.312-in. diameter on approximately 3.5-in. spacings
Gaskets	Not required

NOTE: Drawing No. A 1000-0037-DD-00.

3.6.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

3.6.2.1 Physical Form

3.6.2.1.1 Solids Only. Only one form is authorized:

- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.443, Contamination control.)

3.6.2.1.2 Maximum Gross Weight. 960 lb. (Empty packaging weight--885 lb, net contents--75 lb.)

3.6.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

3.6.2.3 Radiological. The 4-ft drop test caused deformations of the package resulting in small decreases in the distance from the exterior to the center of the package. The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such deformations would occur.

3.6.3 Restrictions/Specifications

The following two possible approaches are acceptable with respect to addressing inleakage and ensuring that there is no transport of radioactive materials out of the packaging.

- Securely enclose the radioactive contents within the box (i.e., wrapped and sealed in plastic, etc.) so that any inleaking water cannot come in contact with the radioactive material.

- Ensure that there is no loose or removable contamination that could be entrained in any liquid and that the radioactive material is not soluble in the liquid. Thus, even if the liquids come in contact with the radioactive material, there could be no transport from the package.

NOTE: There are obviously other possible approaches; however, if an alternative approach is chosen, the basis for the choice must be supported and documented. Using one of these alternatives or an equivalent method allows these boxes to meet this requirement.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

3.6.4 49 CFR 173.850 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-2.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-2.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-3.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. This test was not conducted; however, this test would not adversely affect the ability of this packaging to meet the Type A test requirements. See Section 3.6.3, Restrictions/Specifications, and Appendix D, Table D-2.
Free drop	Pass. This test was conducted and there was no loss of contents and no detectable change in package geometry. The contents were pieces of lead. See Appendix D, Table D-11.
Corner drop	Not required.
Compression	Pass. This test was conducted with 4,800 lb for 24 hr with no detectable effect on the packaging. See Appendix D, Table D-24.
Penetration	Pass. This test was conducted and had no significant effect. See Appendix D, Table D-31.

3.6.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface Sealing surface	Vendor qualifications and experience	Functional: • Ease of lid application • Flange--flat surface; no foreign matter • Geometry, as specified Acceptable Conditions: • Lack of dents, no deformation of sealing surfaces • Dimensions, as specified
Weld areas		• Continuous welds, no sharp edges
Body	Metal thickness Bolt size and spacing	Lot tests by shipper, as appropriate, and/or vendor certification: • Marking • Test data • Type A Certification Document provided as appropriate • Air leak test
	Protective coating	Visual: • Surface/coating as specified • Lack of imperfections in application • Lack of rust, dents, nicks

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

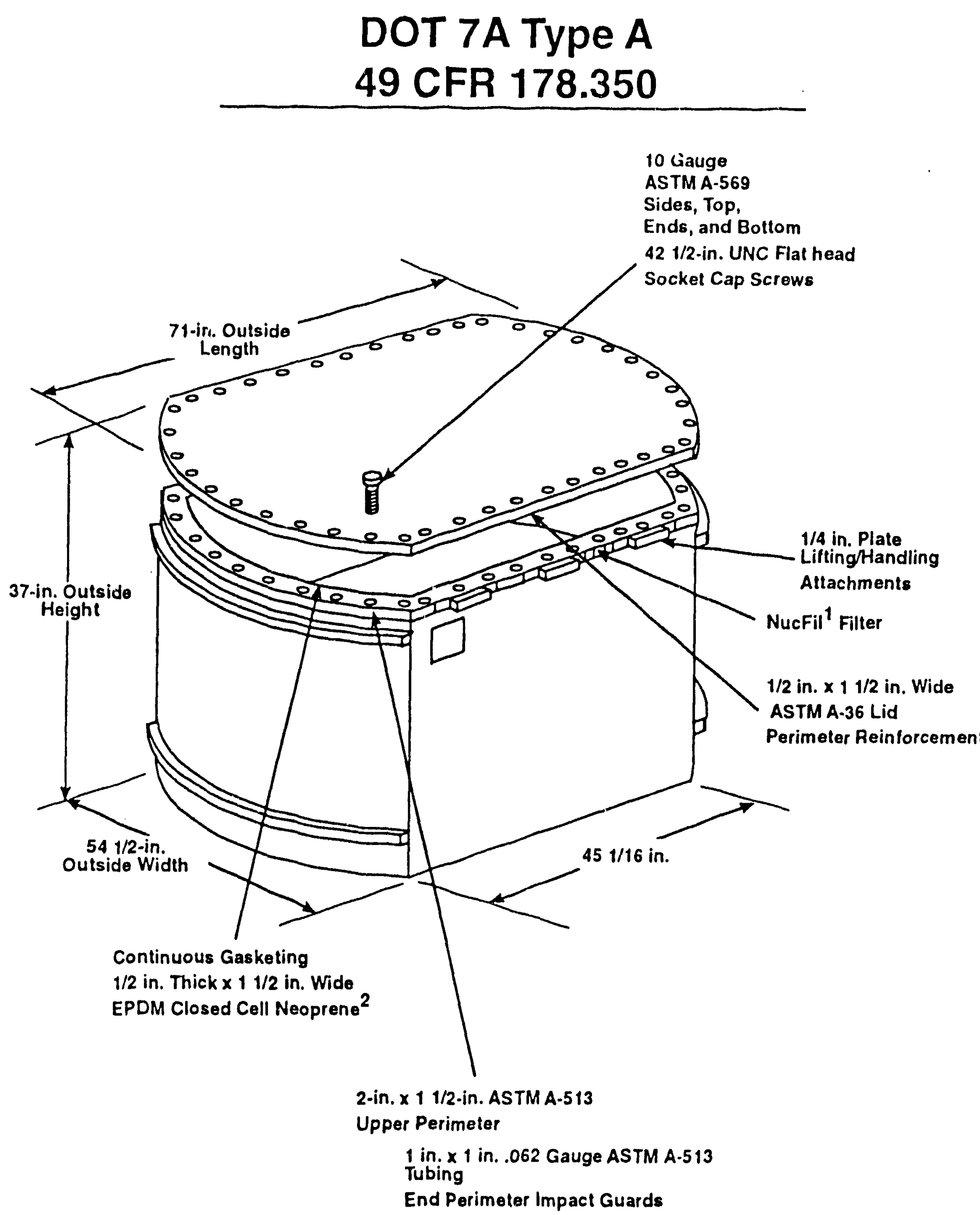
3.6.6 Additional Information

Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

3.6.6.1 Primary User(s)

Site/Contact/Phone	Address
ANL Max Geisler COMM/FTS 208-526-7727	Argonne National Laboratory--West P. O. Box 2528 Idaho Falls, ID 83403-2528

Figure 3-7. TRUPACT-II Standard Waste Box, Style 1, Bolted Closure.



ASTM = American Society for Testing and Materials
EPDM = Ethylenepropylenediene-monomer

[1]NucFil is a trademark of Nuclear Filter Technology, Incorporated.

[2]Neoprene is a trademark of E.I. duPont de Nemours and Company.

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3.7 TRUPACT-II STANDARD WASTE BOX (DOCKETS: MLM; 89-07-7A, 09/89)

3.7.1 Package Description

Dimensions and Weights

Model		Height (in.)	Width (in.)	Length (in.)	Empty package weight (lb)
TRUPACT-II standard waste box	External	37.0	54.5	71.0	640
	Internal	36.7	52.0	68.7	640

Materials/Method of Construction

Sides, top, ends and bottom	10-gauge, ASTM A569 low carbon hot rolled steel
Steel flat bar	ASTM A-36 commercial quality structural grade
Rectangular tubing	ASTM A-500 or ASTM A-513 commercial quality structural grade carbon steel
Closure	Bolted, 1/2-in. flat head cap screws MS 24667
Gasket	EPDM material, 1/2 in. thick, 1 1/2 in. wide, ASTM-D-1056-67
Filter	NFTI Model NucFil*-013

NOTE: Westinghouse Electric Drawing No. 165-F-001-W, latest revision.
*NucFil is a trademark of Nuclear Filter Technology, Inc. (NFTI)
ASTM = American Society for Testing and Materials.
EPDM = ethylenepropylenediene-monomer.

3.7.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

3.7.2.1 Physical Form

3.7.2.1.1 Solids Only. Five forms are authorized. Each shipper must determine the most appropriate form for his particular contents.

- Material Form No. 1: Solids--any particle size
- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.)
- Material Form No. 3: Solids--objects with no significant or removable contamination. (For definition see 49 CFR 173.443, Contamination control.)
- Material Form No. 4: Solids as described in Form No. 3 above, including large, bulky, dense objects with sharp and obtrusive members or components, but having Form No. 1 and/or No. 2 as dispersible contaminates associated with the material. (e.g., steel plates, motors, valves, steel pipes, concrete blocks, etc.)
- Material Form No. 5: Four 55-gal drums (in any arrangement not exceeding 1,000 lb per drum) and overpacked within the standard waste box (SWB).

3.7.2.1.2 Maximum Gross Weight.

- 4,000 lb.

3.7.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

3.7.2.3 Radiological. A dent (approximately 4 in.) resulted from the 4-ft drop test on the bottom edge. The shipper must ensure that the radiation level at the surface of the package will not increase by more than 20% if such a deformation would occur.

3.7.3 Restrictions/Specifications

The SWB shall be operated in accordance with the Westinghouse/Waste Isolation Division instruction entitled, *Acceptance/Use Instruction Sheet for the TRUPACT-II Standard Waste Box - Bolted Lid Style* (WID 1989).

The lid closure bolts must be torqued to a minimum of 50 ft-lb.

The NucFil filter (if used) shall be installed using Loctite No. 262 (Red) and torqued to 5 ft-lb or tack-welded to prevent unintentional loosening.

The cover seal gasket material must have an operating range of -40 °F to 158 °F.

For heavy, bulky materials (e.g., concrete chunks, motors, and pumps), equipment or materials with sharp corners or protrusions, or material/equipment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

3.7.4 49 CFR 173.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-2.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-2.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-3.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. Tests were conducted which demonstrated no inleakage of water. The water spray test preceded each of the remaining tests. In no case was there any effect on the ability of the packaging to meet the remaining tests. See Appendix D, Table D-2.
Free drop	Pass. Four separate drop tests were conducted on top and bottom corners and on the ends. In all cases there was no loss of contents or significant distortion of the packagings. See Appendix D, Table D-11.
Corner drop	Not required.
Compression	Pass. The test was conducted with greater than five times the gross weight for more than 24 hr. There was no significant distortion of the packaging or loss of contents. See Appendix D, Table D-24.
Penetration	Pass. The test was conducted on the top center of the packaging with no significant effect. The test was also done with the bar hitting the filter housing. Again there was no significant effect. The test on the top of the cover left no discernable mark and the impact on the filter housing left only a scuff mark. An ultraviolet inspection indicated no leakage of contents. See Appendix D, Table D-31.

3.7.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface Sealing surface	Vendor qualification and experience	Functional
		• Ease of lid application
		• Flange--flat surface; no foreign matter
Gasket		• Geometry as specified
		• Size, material, geometry as specified
		Acceptable conditions
		• Lack of dents, no deformation of sealing surfaces
		• Dimensions as specified
Welds		• Continuous, no sharp edges
Body		• Metal type, thickness, and quality as specified
		• Bolt number, locations, and materials as specified
		Lot test by shipper as appropriate and/or vendor data/certification:
		• Marking
		• Test data
		• Type A certification document provided as appropriate
	Protective coating	Visual
		• Surface coating as specified
		• Lack of imperfections
		• Lack of rust, dents, nicks
Filter		Acceptable
		• Type, location, and installation as specified

*These criteria apply to first-time and to reuse as a DOT-7A Type A packaging.

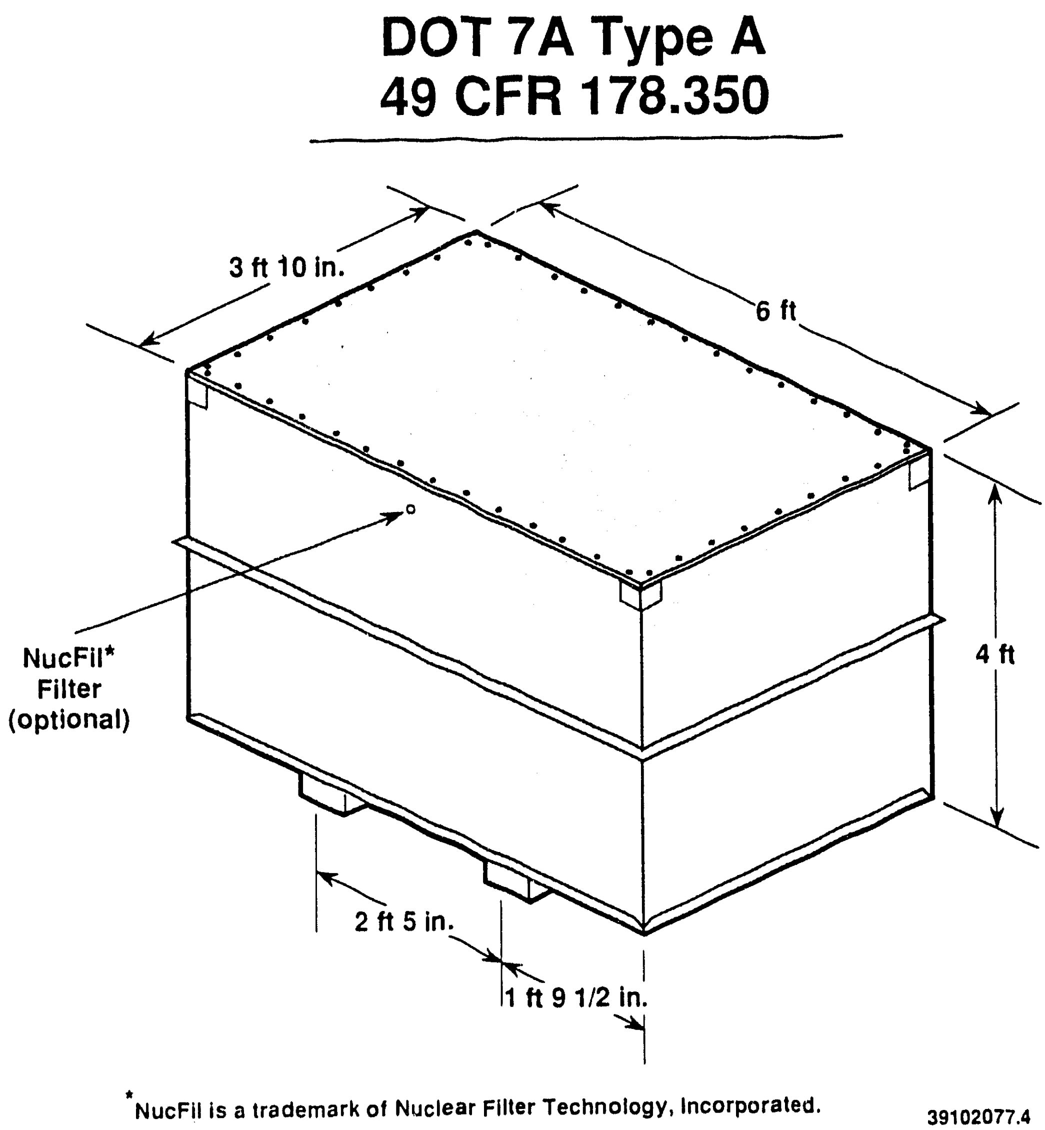
3.7.6 Additional Information

Evaluation and testing of the subject packaging took place at MLM in 1989. A complete test report is available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

3.7.6.1 Primary User(s)

Site/Contact/Phone	Address
Waste Isolation Pilot Plant M. L. Caviness 505-885-8883	Westinghouse/Waste Isolation Division P.O. Box 2078 Carlsbad, NM 88221

Figure 3-8. ORNL Low-Level Waste Container.



3.8 ORNL LOW-LEVEL WASTE CONTAINER (DOCKETS: 89-04-7A, 10/90)

3.8.1 Package Description

Dimensions and Weights

Model	Height (in.)	Width (in.)	Length (in.)	Packaging empty weight (lb)	
External	50.25	46.00	72.00	Vented	1,150
Internal	47.00	45.75	71.75	Nonvented	1,230

Materials/Method of Construction

Major components	Material	Thickness
Sides, ends, bottom	ASTM A569 Steel	11 gauge
Top	ASTM A36 Steel	0.250 in.
Bracing	ASTM A36 Steel	Varies
Square tubing	ASTM A501 or A500B	0.500 in. x 0.500 in. x 0.250 in.
Gasket	Nitrile BUNA-N MIL R-3065	0.500 in. x 0.500 in. x 19.333 ft.
Lid bolts	Grade 5 Steel A449	0.375-16 UNC x 1 in. 0.500-13 UNC x 1 in.

NOTES: Container is continuously welded construction with a bolted lid. Filter: NFTI NucFil-013 carbon composite filter (vented container only). Drawings: Martin Marietta Energy Systems, Inc., DPME-13053-B755, Rev. A, Vented Container and DPME-13053-B756, Rev. A, Nonvented Container.
ASTM = American Society for Testing and Materials.

3.8.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

3.8.2.1 Physical Form

3.8.2.1.1 Solids Only. Three forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements.

- Material Form No. 1: Solids--any particle size
- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.)

- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.443, Contamination control.)

3.8.2.1.2 **Weights**

	Vented	Nonvented
Payload weight	7,000 lb	9,000 lb
Maximum gross weight	8,150 lb	10,230 lb

3.8.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

3.8.2.3 Radiological. The shipper shall ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level prior to the test) as a result of the decrease in distance to the center of the package resulting from the 4-ft drop test. The decrease in distance to the center of the package as a result of testing was 4 3/4 in. for the vented container and 1 1/2 in. for the nonvented container.

3.8.3 Restrictions/Specifications

Operation of the subject packagings shall be in accordance with one of the following procedures (as applicable):

Operations, Maintenance and Inspection Procedure for DOT-7A Type A K1401-7V Low Level Waste Container (Vented) (Holbrook 1991a)

Operations, Maintenance and Inspection Procedure for DOT-7A Type A K1401-9NV Low Level Waste Container," (Non-vented) (Holbrook 1991b)

The lid closure gasket material shall have an operating range of -40 °F to 158 °F.

Torquing requirements shall be 30 ± 3 ft-lb for the 3/8-in. bolts and 40 ± 4 ft-lb for the 1/2-in. bolts.

The NucFil filter (if used) shall be installed using Loctite No. 262 (Red) and torqued to 5 ft-lb or tack-welded to prevent unintentional loosening.

For heavy, bulky materials (e.g., concrete chunks, motors, and pumps), equipment or materials with sharp corners or protrusions, or material/ equipment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

3.8.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-2.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-2.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-3.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	<u>Pass</u>. Drop test was conducted and there was no inleakage of water and no features on the package that would retain free-standing water. See Appendix D, Table D-2.
Free drop	<u>Pass</u>. Drop tests from a height of 4 ft were conducted as follows: • Flat on top lid • Flat on end containing filter • Center of gravity over struck corner with top end facing down • Center of gravity over struck corner with bottom end facing down. See Appendix D, Table D-11.
Corner drop	Not required.
Compression	<u>Pass</u>. A compressive load of 42,475 lb was applied to the package for 24 hr. See Appendix D, Table D-24.
Penetration	<u>Pass</u>. The 1.25-in.-diameter, 13.2-lb penetration bar was dropped from a height of 40 in. on the top of the container. See Appendix D, Table D-31.

3.8.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface Sealing surface	Vendor qualification and experience	Functional • Ease of lid application • Flange--flat surface; no foreign matter
Gasket		• Geometry as specified • Size, material, geometry as specified Acceptable conditions • Lack of dents, no deformation of sealing surfaces • Dimensions as specified
Welds		• Continuous, no sharp edges
Body		• Metal type, thickness, and quality as specified • Bolt number, locations, and materials as specified • Lot test by shipper as appropriate and/or vendor data/certification: - Marking - Test data - Type A certification document provided as appropriate
	Protective coating	Visual • Surface coating as specified • Lack of imperfections • Lack of rust, dents, nicks.
Filter		Acceptable • Type, location, and installation as specified.

*These criteria apply to first-time and to reuse as a DOT-7A Type A packaging.

3.8.6 Additional Information

The packagings were evaluated and tested by Westinghouse Hanford as part of Docket 89-04-7A. Testing was completed on Model K1401-7V (vented) in June 1990 and in October 1990 for Model K1401-9NV (nonvented). A complete test report is available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

3.8.6.1 Primary User(s)

Site/Contact/Phone	Address
ORNL R. H. Holbrook COMM/FTS 615-576-9182	Oak Ridge National Laboratory Martin Marietta Energy Systems, Inc. P.O. Box 2003 Oak Ridge, Tennessee 37831-7365

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Appendix A.4.3

Wooden Boxes

4.0 WOODEN BOXES

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Figure 4-1. ANL-West 7A-217 Wooden Box (contents restricted, see Section 4.1.3).

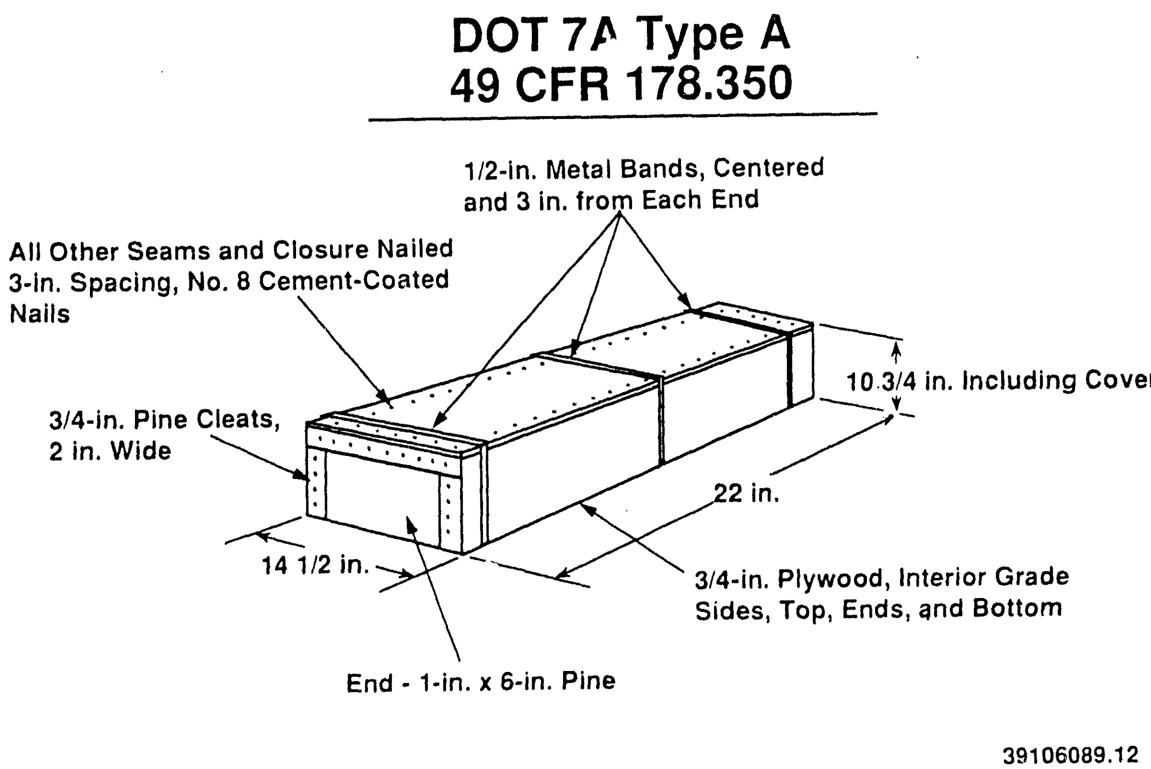


Figure 4-2. ANL-West 7A-375 Wooden Box (contents restricted, see Section 4.1.3).

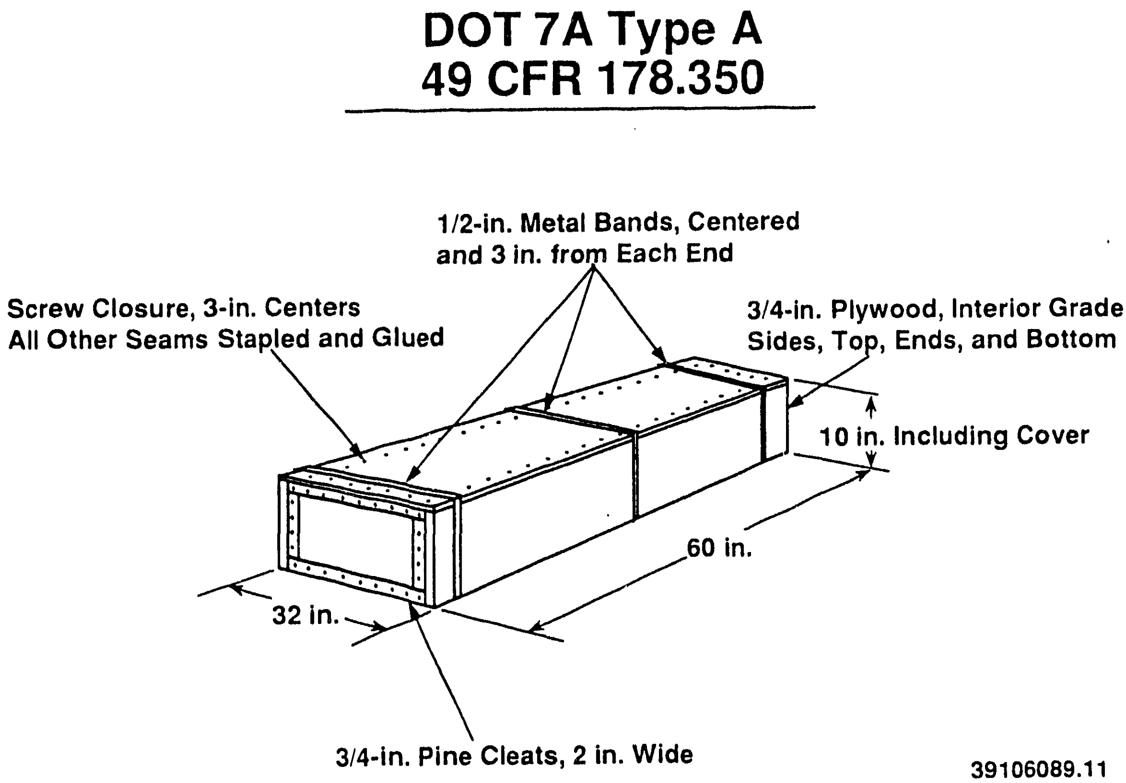


Figure 4-3. ANL-West 7A-670 Wooden Box (contents restricted, see Section 4.1.3).

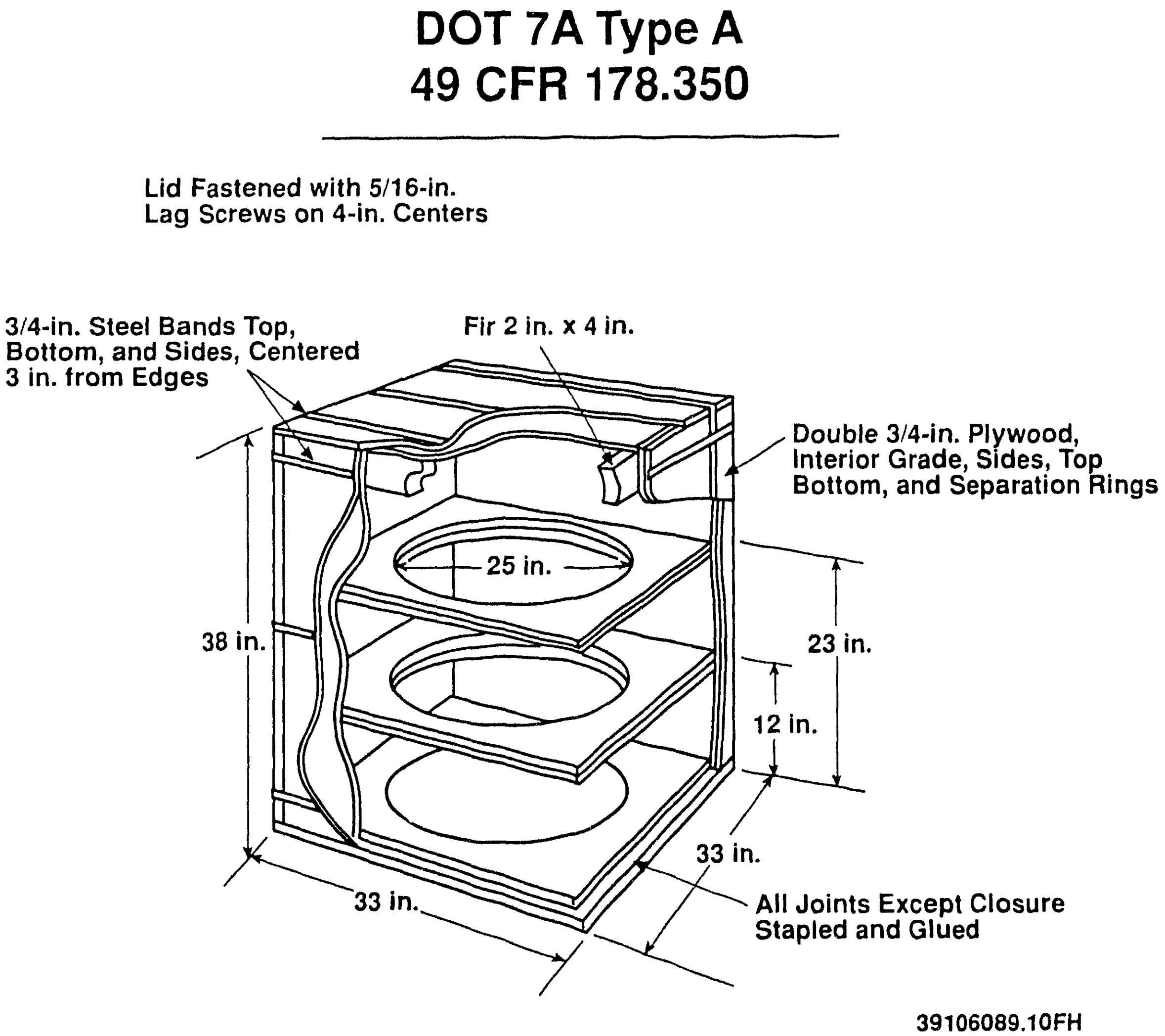


Figure 4-4. ANL-West 7A-880 Wooden Box (contents restricted, see Section 4.1.3).

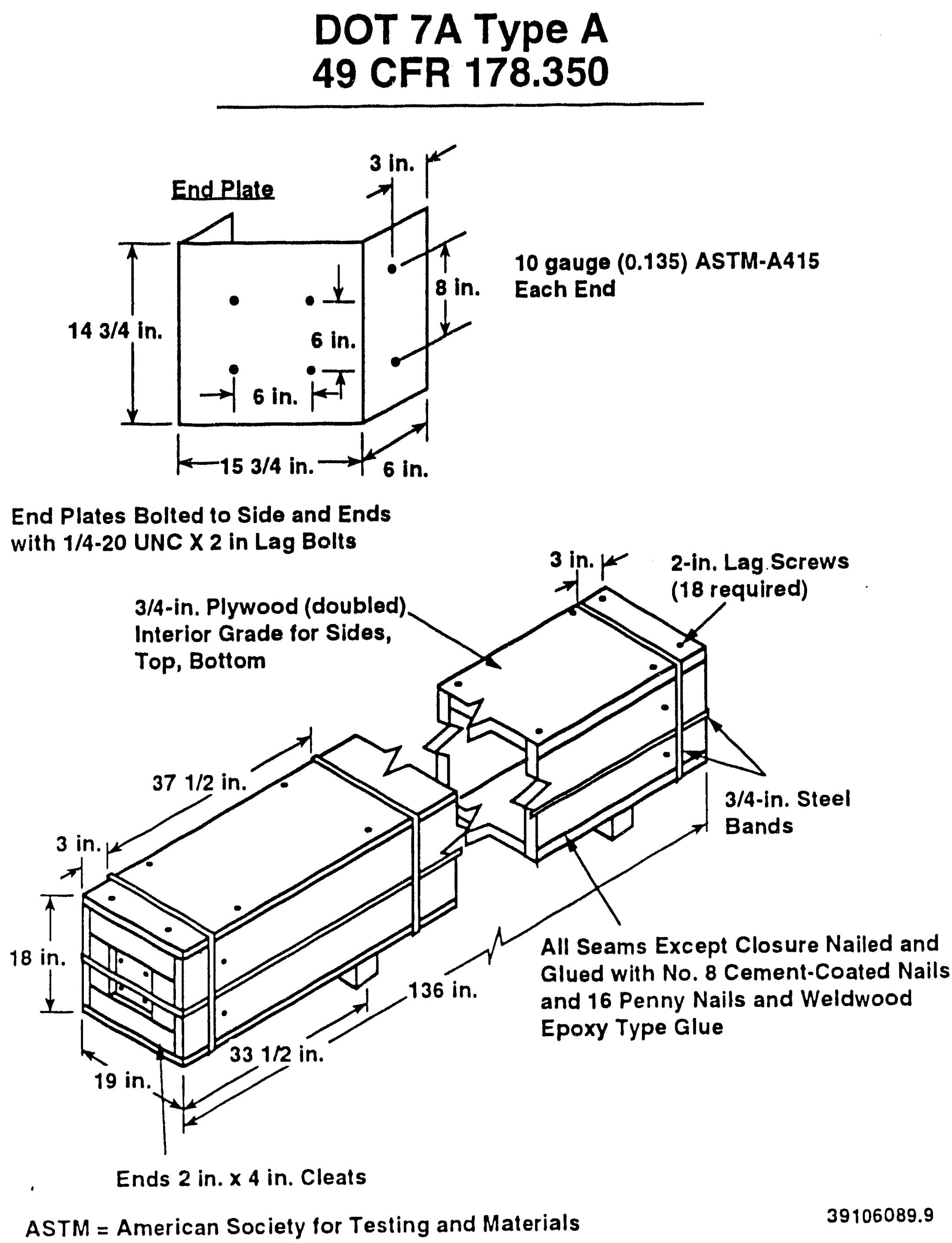


Figure 4-5. ANL-West 7A-995 Wooden Box.

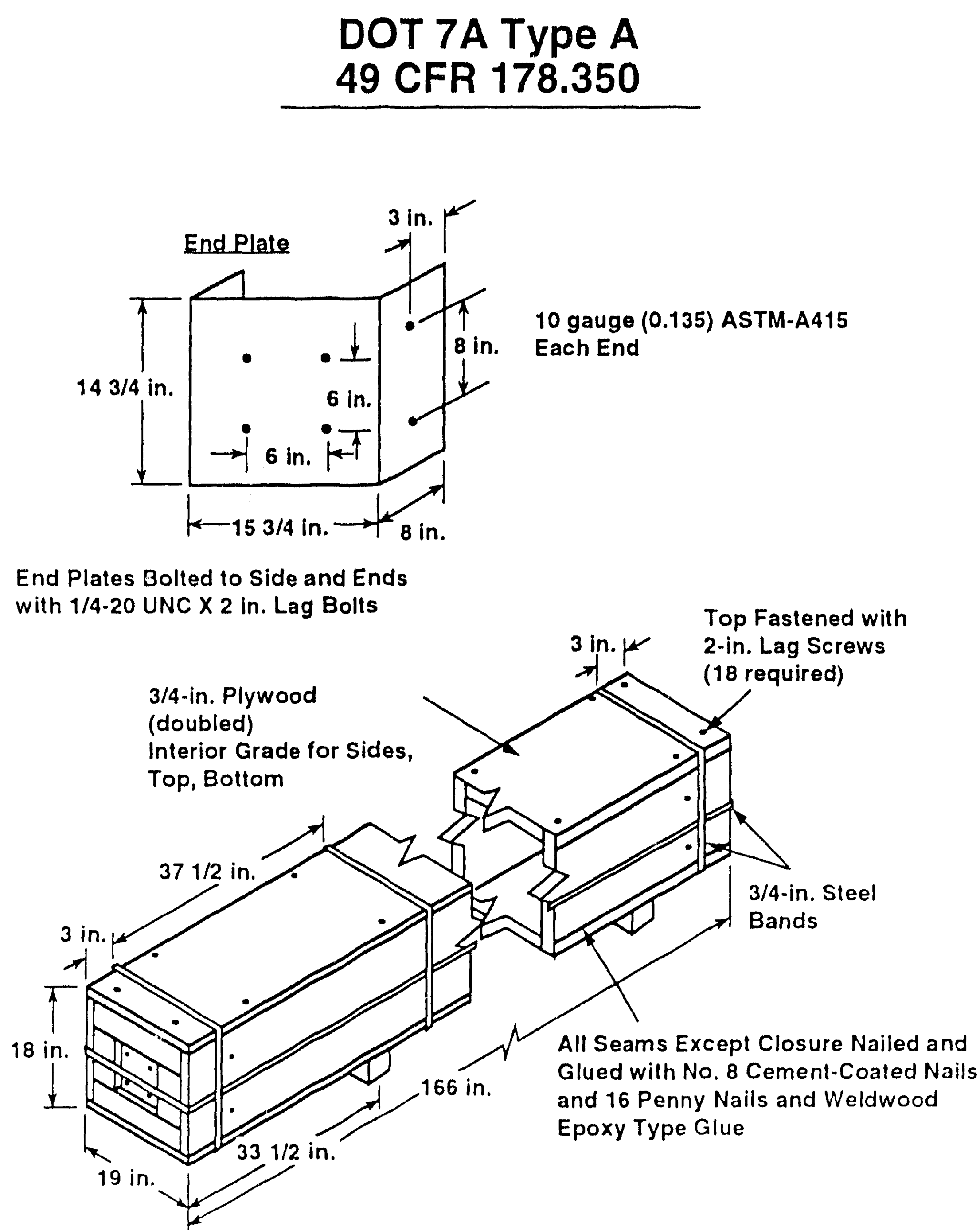
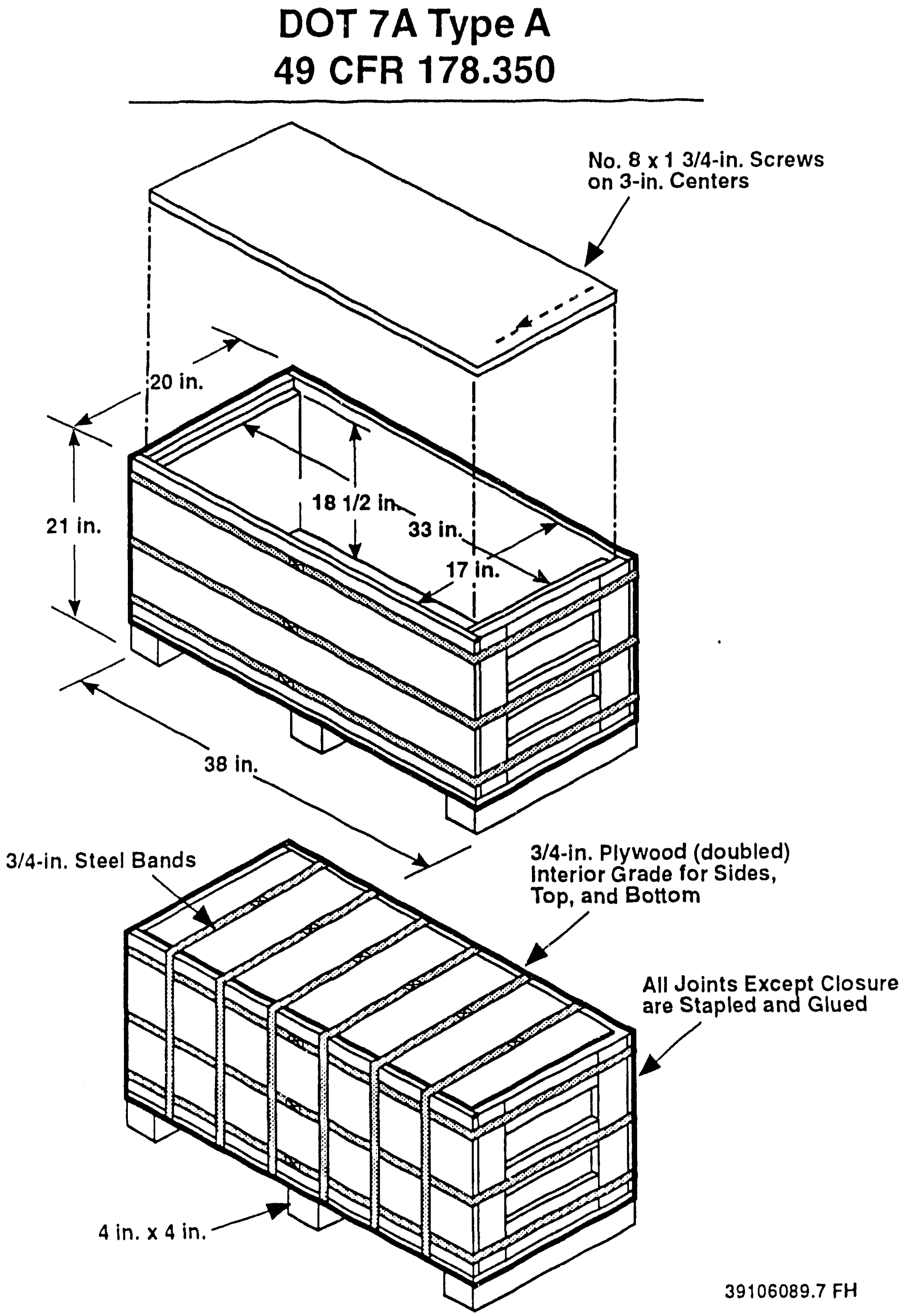
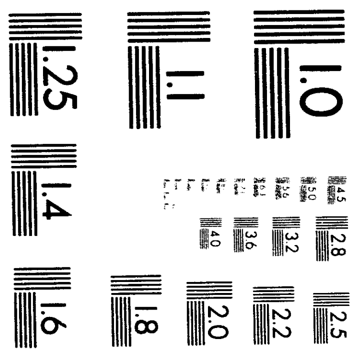


Figure 4-6. ANL-West 7A-1315 Wooden Box
(contents restricted, see Section 4.1.3)




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0

4 of 5

4.1 ANL-WEST FAMILY OF WOODEN BOXES (DOCKETS: MLM)

4.1.1 Package Description

Dimensions and Weights

Model	Height (in.)	Width (in.)	Length (in.)	Authorized gross weight (lb)
ANL-7A-217[a]	10.75	14.5	22	217
ANL-7A-375[b]	10.00	32.0	60	375
ANL-7A-670[c]	38.00	33.0	33	670
ANL-7A-880[d]	18.00[g]	19.0	136	880
ANL-7A-995[e]	18.00[g]	19.0	166	995
ANL-7A-1315[f]	21.00[h]	20.0	38	1,315

[a]See ANL-W container design SPM-AP-1.
[b]See ANL-W container design SPM-PS-5.
[c]See ANL-W container design SPM-PS-8.
[d]See ANL-W container design SPM-HFEF-1.
[e]See ANL-W W0093-0812-EE-01.
[f]See ANL-W container design SPM-PS-9.
[g]Height does not include skids.
[h]Height includes skids.

4.1.1.1 Materials/Method of Construction. All appropriate information is given in Figures 4-1 through 4-6.

4.1.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

4.1.2.1 Physical Form

4.1.2.1.1 Solids Only. One material form is authorized:

- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.433, Contamination control.)

4.1.2.1.2 Maximum Gross Weight. See the Dimensions and Weights table in Section 4.1.1.

4.1.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

4.1.2.3 Radiological. The 4-ft drop test caused deformations of the package resulting in small decreases in the distance from the exterior to the center of the package. The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such deformations would occur.

4.1.3 Restrictions/Specifications

The following three possible approaches are acceptable with respect to addressing inleakage and ensuring that there is no transport of radioactive materials out of the packaging.

- Securely enclose the radioactive contents within the box (e.g., wrap and seal in plastic, etc.) so that any inleaking water cannot come in contact with the radioactive material.
- Seal the box using GEOCEL* or its equivalent. If the box is reused, it must be re-coated with at least one coat to cover the seal areas before each shipment.
- The third approach is to ensure that there is no loose or removable contamination that could be entrained in any liquid and that the radioactive material is not soluble in the liquid. Thus, even if the liquids come in contact with the radioactive material, there could be no transport from the package.

NOTE: There are obviously other possible approaches; however, if an alternative approach is chosen, the basis for the choice must be supported and documented. Using one of these alternatives or an equivalent method allows these wooden boxes to meet this requirement.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

*GEOCEL is a trademark of GEOCEL Corporation.

4.1.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-3.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-3.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-5.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. Tests conducted on representative packagings demonstrated that this test did not affect the ability of the packaging to meet other Type A test requirements. With the actions required in Section 4.1.3, Restrictions/Specifications, these packagings also satisfy this test requirement with respect to potential inleakage of water. See Appendix D, Table D-3.
Free drop	Pass. This drop was made on the top corner with the boxes inverted. There was no loss of contents and no significant change in packaging geometry. See Appendix D, Table D-12.
Corner drop	Not required.
Compression	Pass. The tests were conducted with greater than five times the gross weight shown in the Dimensions and Weights table in Section 4.1.1 for 24 hr. There was no detectable effect. See Appendix D, Table D-25.
Penetration	Pass. This test was conducted on each package with no significant effect. See Appendix D, Table D-32.

4.1.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/inspection criteria*
Lid/body interface Sealing surface	Vendor qualifications and experience	Functional: • Ease of lid application • Mating surfaces flat and smooth, no foreign matter • Geometry, as specified
		Acceptable conditions:
	Joints/seams	• Dimensions, as specified • Glued
	Closure	• As specified, nail or screw • Caulking on lid • Steel banding of proper size and location
	Vendor qualification and experience	Vendor data as appropriate. Lot tests/inspections as appropriate by shipper.

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

4.1.6 Additional Information

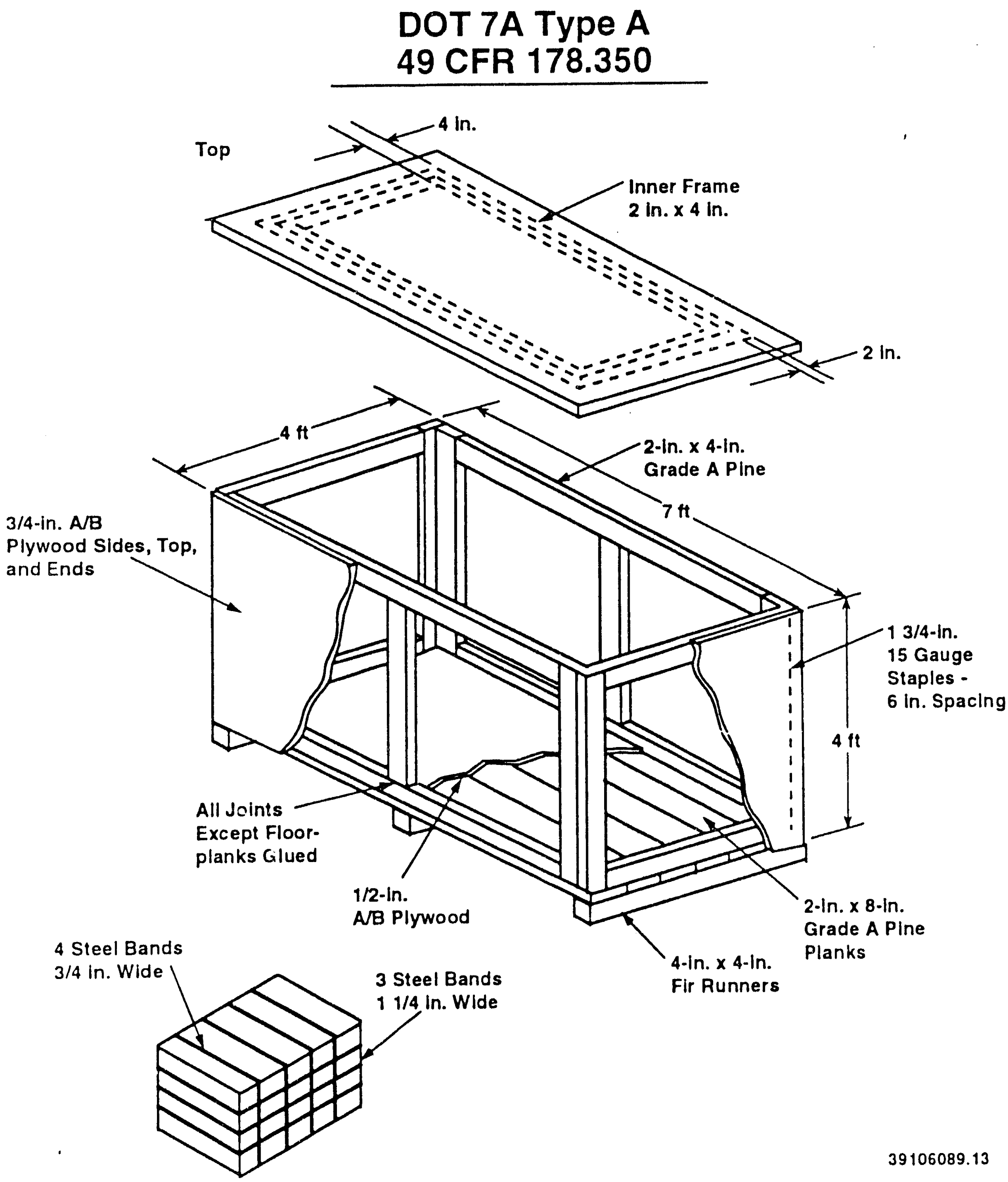
Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

4.1.6.1 Primary Users

Site/Contact/Phone	Address
Argonne National Laboratory-West (ANL-W) M. C. Geisler COMM/FTS 208-526-0111 COMM/FTS 208-533-7666	Argonne National Laboratory-West P.O. Box 2528 Idaho Falls, ID 83401

4.1.6.2 Supplier. Manufactured by Argonne National Laboratory-West.

Figure 4-7. LLNL Flush Panel Wooden Box (contents restricted, see Section 4.2.3).



4.2 LLNL FLUSH PANEL WOODEN BOX (DOCKETS: MLM)

4.2.1 Package Description

Dimensions

Height (in.)	Width (in.)	Length (in.)
48*	48	84

*Does not include lid or skids.

Materials/Method of Construction

Interior frame	2-in. x 4-in. pine
Sub-flooring	2-in. x 8-in. pine planks (Grade A)
Sides, top, lid	0.75-in. A/B plywood
Inner flooring	0.5-in. A/B plywood
Staples	1.75-in. 15-gauge with 6-in. spacing
Joints/seams	All except floor planks glued
Steel band	3 steel bands (1.25 in. wide) around sides and ends
	4 steel bands (0.75 in. wide) around top, sides, and bottom

4.2.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

4.2.2.1 Physical Form

4.2.2.1.1 Solids Only. Two material forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements.

- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.)
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.433, Contamination control.)

4.2.2.1.2 Maximum Gross Weight

- 2,500 lb.

4.2.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

4.2.2.3 Radiological. The 4-ft drop test caused deformations of the package resulting in small decreases in the distance from the exterior to the center of the package. The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such deformations would occur.

4.2.3 Restrictions/Specifications

The following three possible approaches are acceptable with respect to addressing inleakage and ensuring that there is no transport of radioactive materials out of the packaging.

- Securely enclose the radioactive contents within the box (e.g., wrap and seal in plastic, etc.) so that any inleaking water cannot come in contact with the radioactive material.
- Seal the box using GEOCEL or its equivalent. If the box is reused, it must be re-coated with at least one coat to cover the seal areas before each shipment.
- Ensure that there is no loose or removable contamination that could be entrained in any liquid and that the radioactive material is not soluble in the liquid. Thus, even if the liquids come in contact with the radioactive material, there could be no transport from the package.

NOTE: There are obviously other possible approaches; however, if an alternative approach is chosen, the basis for the choice must be supported and documented. Using one of these alternatives or an equivalent method allows these wooden boxes to meet this requirement.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

4.2.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory Requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-3.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-3.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-5.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. Tests conducted on representative packagings demonstrated that this test did not affect the ability of the packaging to meet other Type A test requirements. With the actions required in Section 4.2.3, Restrictions/Specifications, these packagings also satisfy this test requirement with respect to potential inleakage of water. See Appendix D, Table D-3.
Free drop	Pass. This drop was made on the top corner with the box inverted and held at a 45° angle. There was no loss of contents and no significant change in packaging geometry. See Appendix D, Table D-12.
Corner drop	Not required.
Compression	Pass. This test was conducted with greater than five times the gross weight shown in Section 4.2.2.1.2 for 24 hr. There was no detectable effect. See Appendix D, Table D-25.
Penetration	Pass. This test was conducted on each package with no significant effect. See Appendix D, Table D-32.

4.2.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/inspection criteria*
Lid/body interface Sealing surface	Vendor qualifications and experience	Functional: • Ease of lid application • Mating surfaces flat and smooth, no foreign matter • Geometry, as specified Acceptable Conditions:
	Joints/seams	• Dimensions, as specified • Glued
	Closure	• As specified, nail or screw • Caulking on lid • Steel banding of proper size and location • Nail-type and spacing
	Vendor qualifications and experience	Vendor data as appropriate. Lot tests/inspections as appropriate by shipper.

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

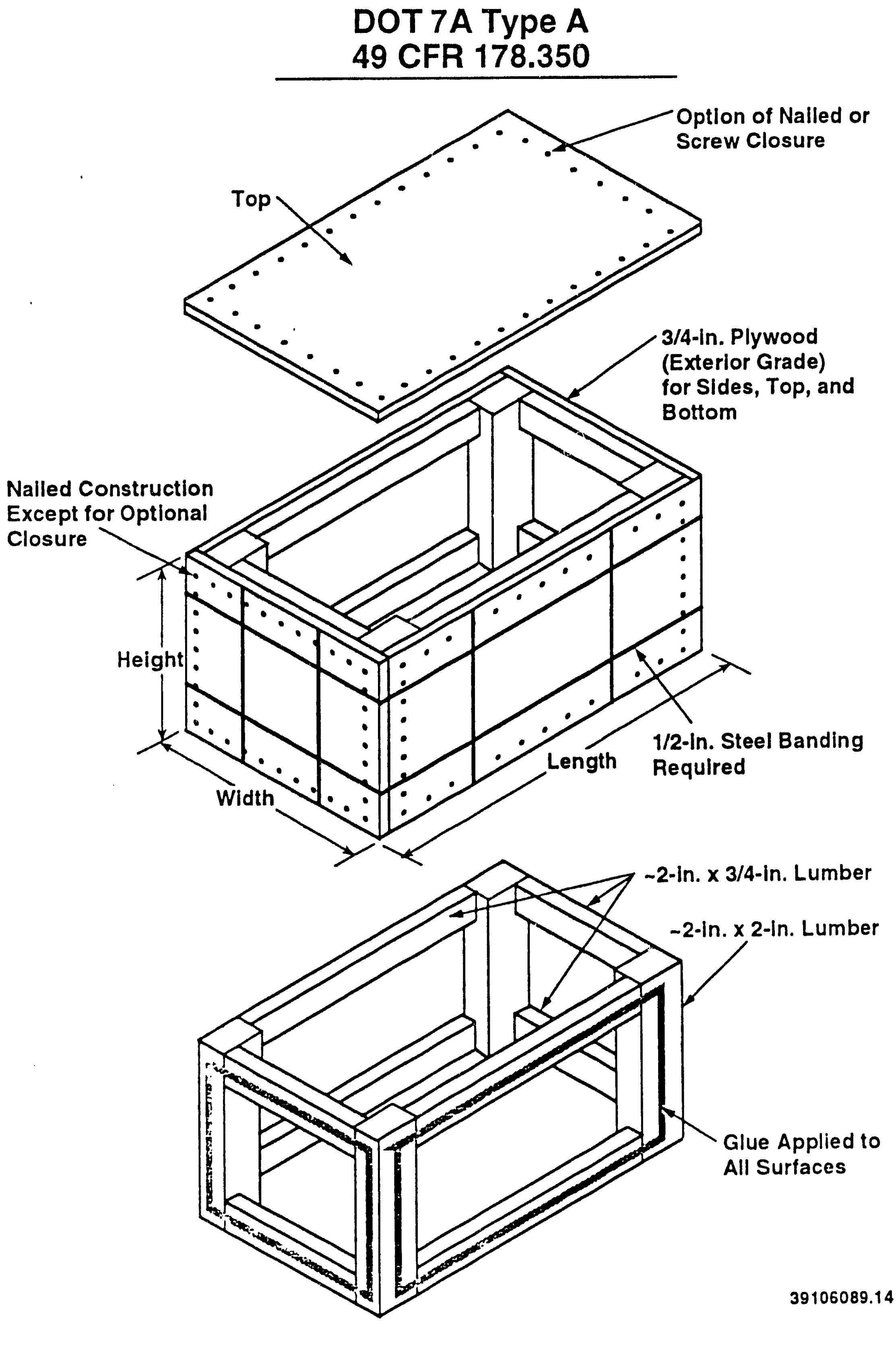
4.2.6 Additional Information

Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

4.2.6.1 Primary Users

Site/Contact/Phone	Address
LLNL Irene Meisel COMM/FTS 510-422-5448	University of California Lawrence Livermore National Laboratory P.O. Box 808 Livermore, CA 94550

Figure 4-8. Configuration A Light Duty Wooden Box (contents restricted, see Section 4.3.3).



4.3 MOUND WOODEN BOX - CONFIGURATION A (DOCKETS: MLM)

4.3.1 Package Description

Dimensions and Weights

Model	Height (in.)	Width (in.)	Length (in.)	Authorized gross weight (lb)
MA-1	8	8	8	40
MA-2	8	8	36	100
MA-3	12	12	12	100
MA-4	12	12	36	100

Materials/Method of Construction

Sides, ends, top, and bottom	0.75-in. exterior grade plywood
Interior frame	Corner posts, 2-in. x 2-in. pine
	Braces, 2-in. x 0.75-in. pine
Nailed construction	Nails, 1.5, 2, and 3 in., depending on thickness of material
	Nail spacing approximately 2 in.
All seams/joints glued	
Steel banding (0.5 in.)	2 bands around sides and ends
	2 bands around top, ends, and bottom
	x band, as appropriate, to provide bands (top to bottom) at least every 18 in. around package
Closure (optional)	May be nail or screw closure
	Nails (see above)
	Screws, 2-in. and 3-in. No. 10 screws depending on thickness of material

4.3.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

4.3.2.1 Physical Form

4.3.2.1.1 Solids Only. Two material forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements.

- Material Form No. 2: Solids--large particle size (e.g., sand, concrete, debris, soil, etc.)
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.433, Contamination control.)

4.3.2.1.2 Maximum Gross Weight. See the Dimensions and Weights table in Section 4.3.1.

4.3.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

4.3.2.3 Radiological. The 4-ft drop test caused deformations of the package resulting in small decreases in the distance from the exterior to the center of the package. The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such deformations would occur.

4.3.3 Restrictions/Specifications

The following three possible approaches are acceptable with respect to addressing inleakage and ensuring that there is no transport of radioactive materials out of the packaging.

- Securely enclose the radioactive contents within the box (e.g., wrap and seal in plastic, etc.) so that any inleaking water cannot come in contact with the radioactive material.
- Seal the box using GEOCEL or its equivalent. If the box is reused, it must be re-coated with at least one coat to cover the seal areas before each shipment.
- Ensure that there is no loose or removable contamination that could be entrained in any liquid and that the radioactive material is not soluble in the liquid. Thus, even if the liquids come in contact with the radioactive material, there could be no transport from the package.

NOTE: There are obviously other possible approaches; however, if an alternative approach is chosen, the basis for the choice must be supported and documented. Using one of these alternatives or an equivalent method allows these wooden boxes to meet this requirement.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

4.3.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-3.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-3.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-5.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. Tests conducted on representative packagings demonstrated that this test did not affect the ability of the packaging to meet other Type A test requirements. With the actions required in Section 4.4.3, Restrictions/Specifications, these packagings also satisfy this test requirement with respect to potential inleakage of water. See Appendix D, Table D-4.
Free drop	Pass. This drop was made on the top corner with the boxes inverted and held at a 45° angle. There was no loss of contents and no significant change in packaging geometry. See Appendix D, Table D-13.
Corner drop	The corner drop was conducted on all four packagings. This allows their potential use at less than 110 lb. See Appendix D, Table D-20.
Compression	Pass. The tests were conducted with greater than five times the gross weight shown in the Dimensions and Weights table in Section 4.3.1 for 24 hr. There was no detectable effect. See Appendix D, Table D-25.
Penetration	Pass. This test was conducted on each package with no significant effect. See Appendix D, Table D-32.

4.3.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/inspection criteria*
Lid/body interface Sealing surface	Vendor qualifications and experience	Functional: • Ease of lid application • Mating surfaces flat and smooth, no foreign matter • Geometry, as specified
		Acceptable conditions:
	Joints/seams	• Dimensions, as specified • Glued
	Closure	• As specified, nail or screw • Caulking on lid • Steel banding of proper size and location • Nail-type and spacing
	Vendor qualifications and experience	Vendor data as appropriate. Lot tests/inspections as appropriate by shipper.

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

4.3.6 Additional Information

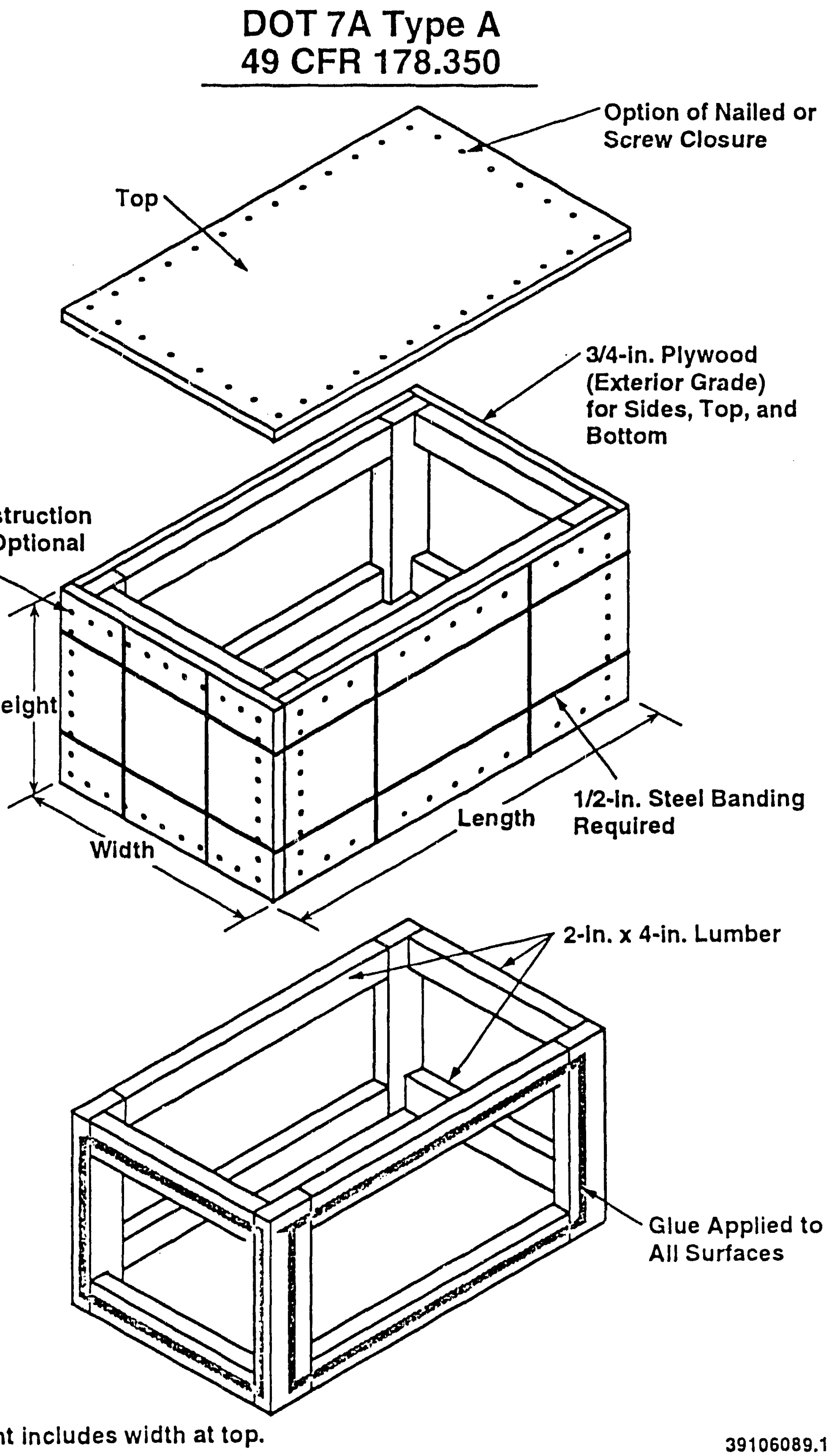
Evaluation and testing of this packaging performed at MLM were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

4.3.6.1 Primary Users

Site/Contact/Phone	Address
MLM Don Wikstrom COMM/FTS 513-865-3919	Mound-MRC P.O. Box 32 Mound Road Miamisburg, OH 45342

4.3.6.2 Supplier. Manufactured onsite.

Figure 4-9. Configuration B Medium Duty Wooden Box (contents restricted, see Section 4.4.3).



Note: Height includes width at top.

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4.4 MOUND WOODEN BOX - CONFIGURATION B (DOCKETS: MLM)

4.4.1 Package Description

Dimensions and Weights

Model	Height (in.)	Width (in.)	Length (in.)	Authorized gross weight (lb)
MA-1	12	12	12	150
MA-2	16	16	16	150
MA-3	24	24	24	200
MA-4	12	12	36	150
MA-5	16	16	36	150
MA-6	24	24	36	200

Materials/Method of Construction

Sides, ends, top, and bottom	0.75-in. exterior grade plywood
Interior frame	2-in. x 4-in. pine
Nailed construction	Nails, 1.5, 2, and 3 in., depending on thickness of material
	Nail spacing approximately 2 in.
All seams/joints glued	
Steel banding (0.5 in.)	2 bands around sides and ends
	2 bands around top, ends, and bottom
	x band, as appropriate, to provide bands (top to bottom) at least every 18 in. around package
Closure (optional)	May be nail or screw closure
	Nails (see above)
	Screws, 2-in and 3-in. No. 10 screws, depending on thickness of material

4.4.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

4.4.2.1 Physical Form

4.4.2.1.1 Solids Only. Two material forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements.

- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.)
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.433, Contamination control.)

4.4.2.1.2 Maximum Gross Weight. See the Dimensions and Weights table in Section 4.4.1.

4.4.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

4.4.2.3 Radiological. The 4-ft drop test caused deformations of the package resulting in small decreases in the distance from the exterior to the center of the package. The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such deformations would occur.

4.4.3 Restrictions/Specifications

The following three possible approaches are acceptable with respect to addressing inleakage and ensuring that there is no transport of radioactive materials out of the packaging.

- Securely enclose the radioactive contents within the box (e.g., wrap and seal in plastic, etc.) so that any inleaking water cannot come in contact with the radioactive material.
- Seal the box using GEOCEL or its equivalent. If the box is reused, it must be re-coated with at least one coat to cover the seal areas before each shipment.
- Ensure that there is no loose or removable contamination that could be entrained in any liquid and that the radioactive material is not soluble in the liquid. Thus, even if the liquids come in contact with the radioactive material, there could be no transport from the package.

NOTE: There are obviously other possible approaches; however, if an alternative approach is chosen, the basis for the choice must be supported and documented. Using one of these alternatives or an equivalent method allows these wooden boxes to meet this requirement.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

4.4.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-3.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-3.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-5.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. Tests conducted on representative packagings demonstrated that this test did not affect the ability of the packaging to meet other Type A test requirements. With the actions required in Section 4.4.3, Restrictions/Specifications, these packagings also satisfy this test requirement with respect to potential inleakage of water. See Appendix D, Table D-4.
Free drop	Pass. This drop was made on the top corner with the box inverted and held at a 45° angle. There was no loss of contents and no significant change in packaging geometry. See Appendix D, Table D-13.
Corner drop	Corner drop was conducted on all six packagings. This allows their potential use at less than 110 lb. See Appendix D, Table D-20.
Compression	Pass. The tests were conducted with greater than five times the gross weight shown in the Dimensions and Weights table in Section 4.4.1 for 24 hr. There was no detectable effect. See Appendix D, Table D-25.
Penetration	Pass. This test was conducted on each package with no significant effect. See Appendix D, Table D-32.

4.4.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/inspection criteria*
Lid/body interface Sealing surface	Vendor qualifications and experience	Functional: • Ease of lid application • Mating surfaces flat and smooth, no foreign matter • Geometry, as specified
		Acceptable conditions:
	Joints/seams	• Dimensions, as specified • Glued
	Closure	• As specified, nail or screw • Caulking on lid • Steel banding of proper size and location • Nail-type and spacing
	Vendor qualifications and experience	Vendor data as appropriate. Lot tests/inspections as appropriate by shipper.

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

4.4.6 Additional Information

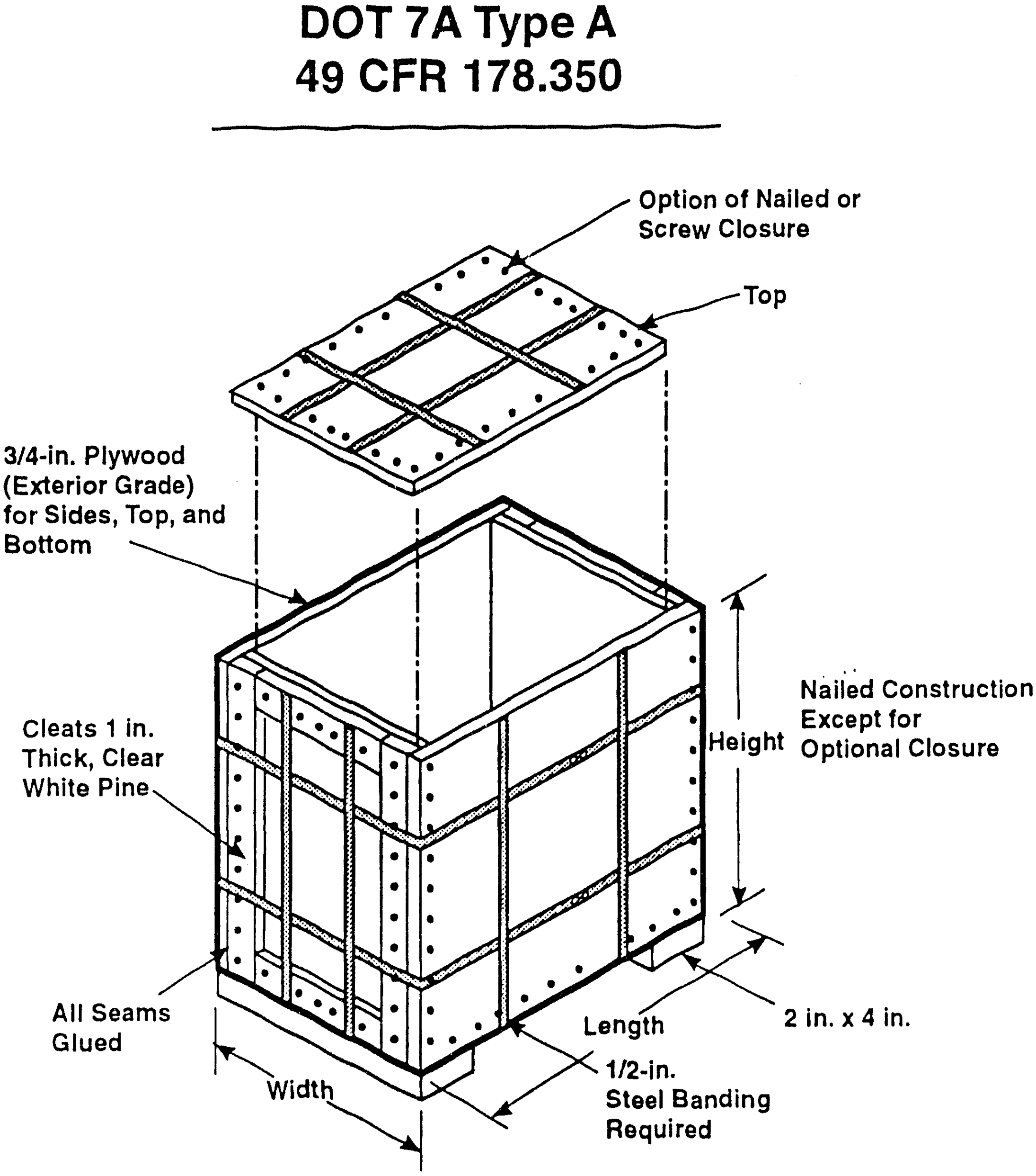
Evaluation and testing of this packaging were performed at MLM and were documented in Edling in 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

4.4.6.1 Primary Users

Site/Contact/Phone	Address
MLM Don Wikstrom COMM/FTS 513-865-3919	Mound-MRC P.O. Box 32 Mound Road Miamisburg, OH 45342

4.4.6.2 Supplier. Manufactured onsite.

Figure 4-10. Configuration C Medium Duty Wooden Box (contents restricted, see Section 4.5.3).



Note: 2-in. x 4-in. interior frame not shown.

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4.5 MOUND WOODEN BOX - CONFIGURATION C (DOCKETS: MLM)

4.5.1 Package Description

Dimensions and Weights

Model	Height (in.)	Width (in.)	Length (in.)	Authorized gross weight (lb)
MC-1	12	12	12	150
MC-2	24	24	24	300
MC-3	14	14	22	250
MC-4	6	6	24	100
MC-5	12	12	36	150

Materials/Method of Construction

Sides, ends, top, and bottom	0.75-in. exterior grade plywood
Interior frame	2-in. x 4-in. pine
Nailed construction	Nails, 1.5, 2, and 3 in., depending on thickness of material Nail spacing approximately 2 in.
All seams/joints glued	
Steel banding (0.5 in.)	2 bands around sides and ends 2 bands around top, ends, and bottom x band, as appropriate, to provide bands (top to bottom) at least every 18 in. around package
Closure (optional)	May be nail or screw closure Nails (see above) Screws, 2-in and 3-in. No. 10 screws, depending on thickness of material

4.5.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

4.5.2.1 Physical Form

4.5.2.1.1 Solids Only. Two material forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements.

- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.)
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.433, Contamination control.)

4.5.2.1.2 Maximum Gross Weight. See the Dimensions and Weights table in Section 4.5.1.

4.5.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

4.5.2.3 Radiological. The 4-ft drop test caused deformations of the package resulting in small decreases in the distance from the exterior to the center of the package. The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such deformations would occur.

4.5.3 Restrictions/Specifications

The following three possible approaches are acceptable with respect to addressing inleakage and ensuring that there is no transport of radioactive materials out of the packaging.

- Securely enclose the radioactive contents within the box (e.g., wrap and seal in plastic, etc.) so that any inleaking water cannot come in contact with the radioactive material.
- Seal the box using GEOCEL or its equivalent. If the box is reused, it must be re-coated with at least one coat to cover the seal areas before each shipment.
- Ensure that there is no loose or removable contamination that could be entrained in any liquid and that the radioactive material is not soluble in the liquid. Thus, even if the liquids come in contact with the radioactive material, there could be no transport from the package.

NOTE: There are obviously other possible approaches; however, if an alternative approach is chosen, the basis for the choice must be supported and documented. Using one of these alternatives or an equivalent method allows these wooden boxes to meet this requirement.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

4.5.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-3.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-3.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-5.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. Tests conducted on representative packagings demonstrated that this test did not affect the ability of the packaging to meet other Type A test requirements. With the actions required in Section 4.5.3, Restrictions/Specifications, these packagings also satisfy this test requirement with respect to potential inleakage of water. See Appendix D, Table D-4.
Free drop	Pass. This drop was made on the top corner with the boxes inverted and held at a 45° angle. There was no loss of contents and no significant change in packaging geometry. See Appendix D, Table D-13.
Corner drop	The corner drop was conducted on all five packagings. This allows their potential use at less than 110 lb. See Appendix D, Table D-20.
Compression	Pass. The tests were conducted with greater than five times the gross weight shown in the Dimensions and Weights table in Section 4.5.1 for 24 hr. There was no detectable effect. See Appendix D, Table D-25.
Penetration	Pass. This test was conducted on each package with no significant effect. See Appendix D, Table D-32.

4.5.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/inspection criteria*
Lid/body interface Sealing surface	Vendor qualifications and experience	Functional: • Ease of lid application • Mating surfaces flat and smooth, no foreign matter • Geometry, as specified
		Acceptable conditions:
	Joints/seams	• Dimensions, as specified • Glued
	Closure	• As specified, nail or screw • Caulking on lid • Steel banding of proper size and location • Nail-type and spacing
	Vendor qualification and experience	Vendor data as appropriate. Lot tests/inspections as appropriate by shipper.

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

4.5.6 Additional Information

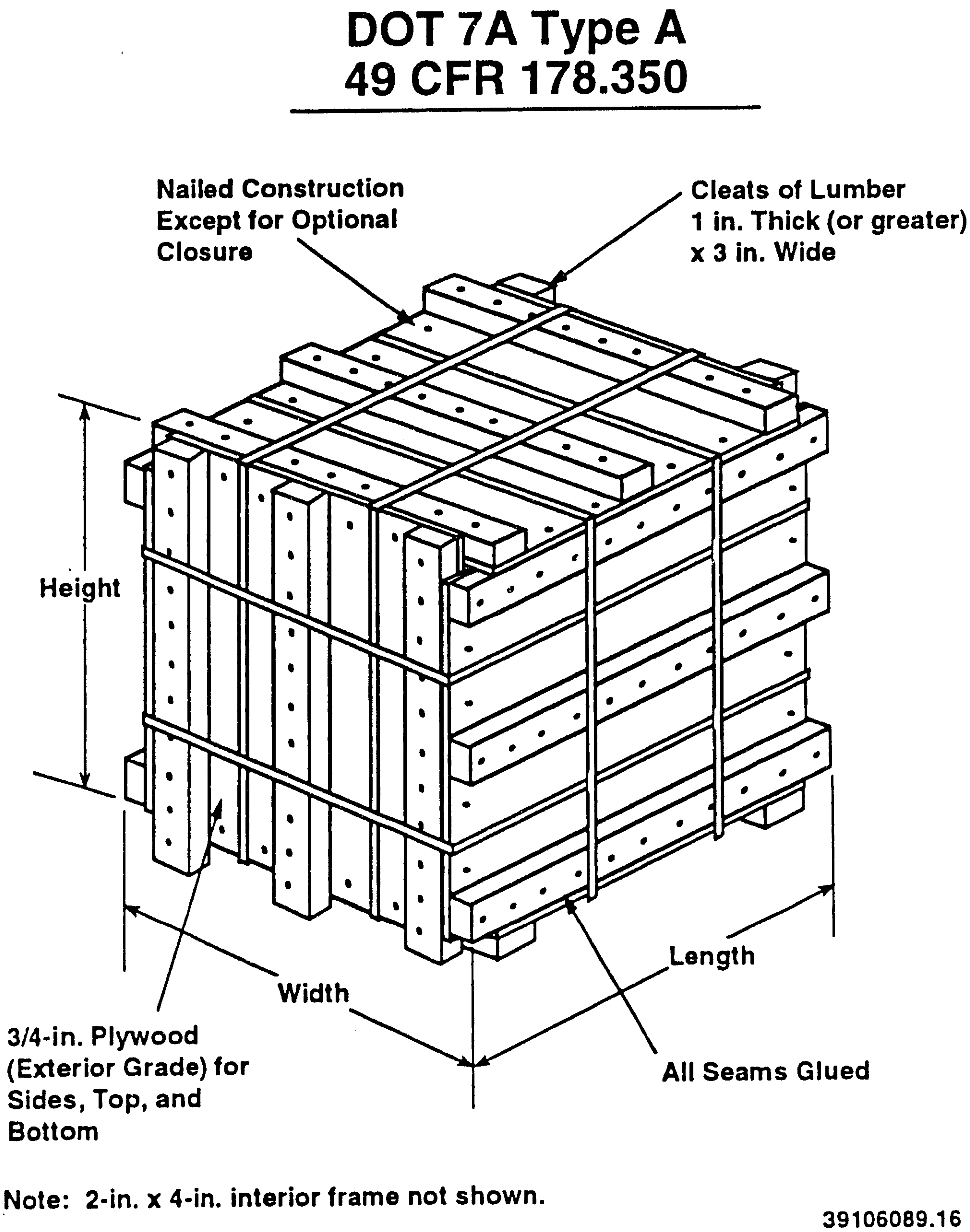
Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

4.5.6.1 Primary Users

Site/Contact/Phone	Address
MLM Don Wikstrom COMM/FTS 513-865-3919	Mound-MRC P.O. Box 32 Mound Road Miamisburg, OH 45342

4.5.6.2 Supplier. Manufactured onsite.

Figure 4-11. Configuration D Heavy Duty Wooden Box
(contents restricted, see Section 4.6.3).



4.6 MOUND WOODEN BOX - CONFIGURATION D (DOCKETS: MLM)

4.6.1 Package Description

Dimensions and Weights

Model	Height (in.)	Width (in.)	Length (in.)	Authorized gross weight (lb)
MD-1	14	17.5	14	200
MD-2	24	27.5	24	300
MD-3	12	15.5	48	250
MD-4	12	15.5	60	250
MD-5	8	11.5	32	200
MD-6	12	15.5	28	200

Materials/Method of Construction

Sides, ends, top, and bottom	0.75-in. exterior grade plywood
Interior frame	2-in. x 4-in. pine
Nailed construction	Nails, 1.5, 2, and 3 in., depending on thickness of material
	Nail spacing approximately 2 in.
All seams/joints glued	
Steel banding (0.5 in.)	2 bands around sides and ends
	2 bands around top, ends, and bottom
	x band, as appropriate, to provide bands (top to bottom) at least every 18 in. around package
Closure (optional)	May be nail or screw closure
	Nails (see above)
	Screws, 2-in. and 3-in. No. 10 screws, depending on thickness of material

4.6.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

4.6.2.1 Physical Form

4.6.2.1.1 Solids Only. Two material forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements.

- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.)
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.433, Contamination control.)

4.6.2.1.2 Maximum Gross Weight. See the Dimensions and Weights table in Section 4.6.1.

4.6.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

4.6.2.3 Radiological. The 4-ft drop test caused deformations of the package resulting in small decreases in the distance from the exterior to the center of the package. The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such deformations would occur.

4.6.3 Restrictions/Specifications

The following three possible approaches are acceptable with respect to addressing inleakage and ensuring that there is no transport of radioactive materials out of the packaging.

- Securely enclose the radioactive contents within the box (e.g., wrap and seal in plastic, etc.) so that any inleaking water cannot come in contact with the radioactive material.
- Seal the box using GEOCEL or its equivalent. If the box is reused, it must be re-coated with at least one coat to cover the seal areas before each shipment.
- Ensure that there is no loose or removable contamination that could be entrained in any liquid and that the radioactive material is not soluble in the liquid. Thus, even if the liquids come in contact with the radioactive material, there could be no transport from the package.

NOTE: There are obviously other possible approaches; however, if an alternative approach is chosen, the basis for the choice must be supported and documented. Using one of these alternatives or an equivalent method allows these wooden boxes to meet this requirement.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

4.6.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-3.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-3.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-5.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. Tests conducted on representative packagings demonstrated that this test did not affect the ability of the packaging to meet other Type A test requirements. With the actions required in Section 4.6.3, Restrictions/Specifications, these packagings also satisfy this test requirement with respect to potential inleakage of water. See Appendix D, Table D-4.
Free drop	Pass. This drop was made on the top corner with the boxes inverted and held at a 45° angle. There was no loss of contents and no significant change in packaging geometry. See Appendix D, Table D-13.
Corner drop	The corner drop was conducted on all six packagings. This allows their potential use at less than 110 lb. See Appendix D, Table D-20.
Compression	Pass. The tests were conducted with greater than five times the gross weight shown in the Dimensions and Weights table in Section 4.6.1 for 24 hr. There was no detectable effect. See Appendix D, Table D-25.
Penetration	Pass. This test was conducted on each package with no significant effect. See Appendix D, Table D-32.

4.6.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/inspection criteria*
Lid/body interface Sealing surface	Vendor qualifications and experience	Functional: • Ease of lid application • Mating surfaces flat and smooth, no foreign matter • Geometry, as specified Acceptable conditions:
	Joints/seams	• Dimensions, as specified • Glued
	Closure	• As specified, nail or screw • Caulking on lid • Steel banding of proper size and location • Nail-type and spacing
	Vendor qualification and experience	Vendor data as appropriate. Lot tests/inspections as appropriate by shipper.

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

4.6.6 Additional Information

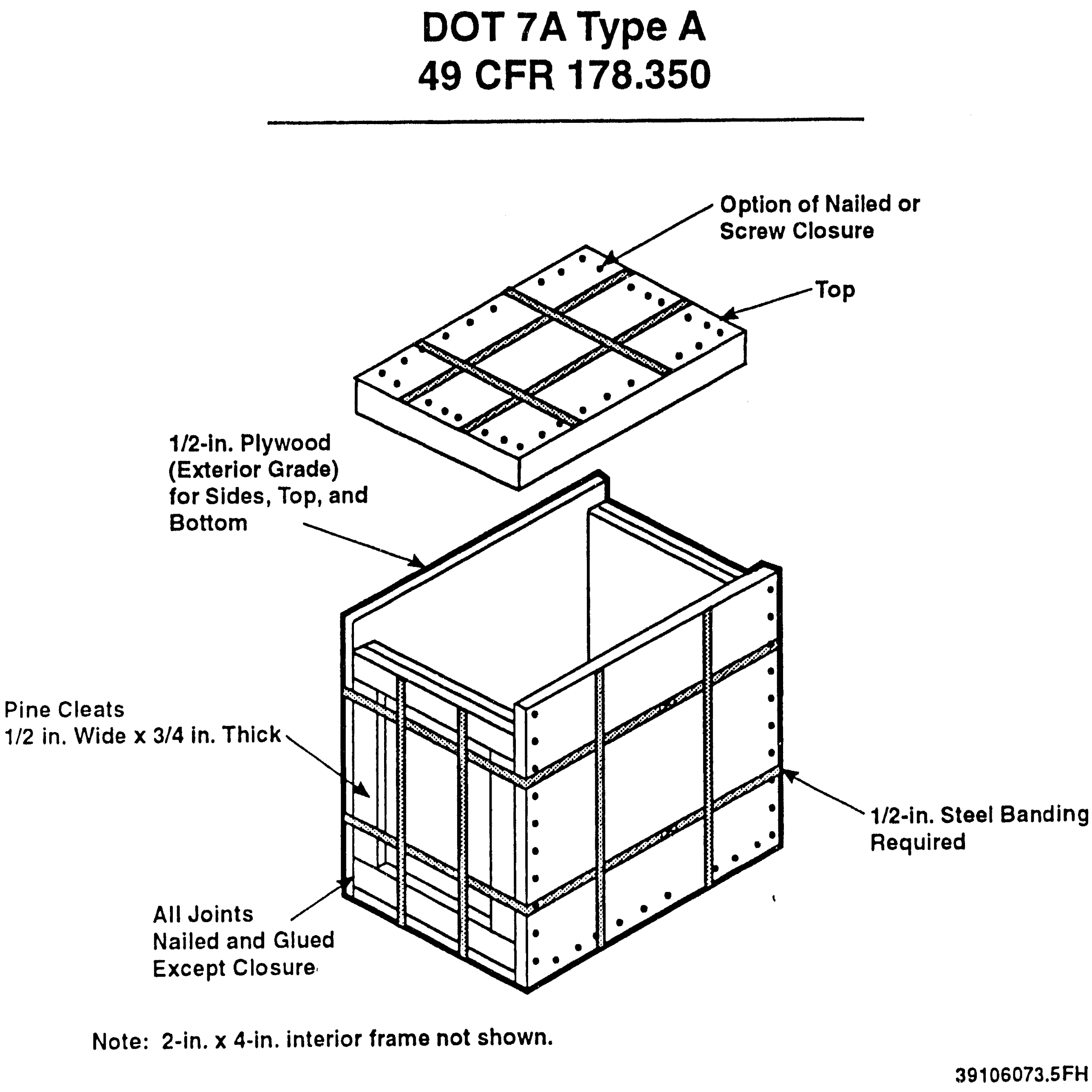
Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

4.6.6.1 Primary Users

Site/Contact/Phone	Address
MLM Don Wikstrom COMM/FTS 513-865-3919	Mound-MRC P.O. Box 32 Mound Road Miamisburg, OH 45342

4.6.6.2 Supplier. Manufactured onsite.

Figure 4-12. Configuration E-150 Wooden Box (contents restricted, see Section 4.7.3).



4.7 MOUND WOODEN BOX - CONFIGURATION E (DOCKETS: MLM)

4.7.1 Package Description

Dimensions

Model	Height (in.)	Width (in.)	Length (in.)
ME-1	17	15	18.5
ME-2	13	17	20.5
ME-3	21	21	22.5

Materials/Method of Construction

Sides, ends, top, and bottom	0.75-in. exterior grade plywood
Cleats	0.75-in. x 0.5-in. pine
Interior frame	2-in. x 4-in. pine
Nailed construction	Nails, 1.5, 2, and 3 in. depending on thickness of material
	Nail spacing approximately 2 in.
All seams/joints glued	
Steel banding (0.5 in.)	2 bands around sides and ends
	2 bands around top, ends, and bottom
	x band, as appropriate, to provide bands (top to bottom) at least every 18 in. around package
Closure (optional)	May be nail or screw closure
	Nails (see above)
	Screws, 2-in. and 3-in. No. 10 screws depending on thickness of material

4.7.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

4.7.2.1 Physical Form

4.7.2.1.1 Solids Only. Two material forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements.

- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.)
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.433, Contamination control.)

4.7.2.1.2 Maximum Gross Weight

- 150 lb.

4.7.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

4.7.2.3 Radiological. The 4-ft drop test caused deformations of the package resulting in small decreases in the distance from the exterior to the center of the package. The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such deformations would occur.

4.7.3 Restrictions/Specifications

The following three possible approaches are acceptable with respect to addressing inleakage and ensuring that there is no transport of radioactive materials out of the packaging.

- Securely enclose the radioactive contents within the box (e.g., wrap and seal in plastic, etc.) so that any inleaking water cannot come in contact with the radioactive material.
- Seal the box using GEOCEL or its equivalent. If the box is reused, it must be re-coated with at least one coat to cover the seal areas before each shipment.
- Ensure that there is no loose or removable contamination that could be entrained in any liquid and that the radioactive material is not soluble in the liquid. Thus, even if the liquids come in contact with the radioactive material, there could be no transport from the package.

NOTE: There are obviously other possible approaches; however, if an alternative approach is chosen, the basis for the choice must be supported and documented. Using one of these alternatives or an equivalent method allows these wooden boxes to meet this requirement.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

4.7.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-3.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-3.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-5.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. Tests conducted on representative packagings demonstrated that this test did not affect the ability of the packaging to meet other Type A test requirements. With the actions required in Section 4.7.3, Restrictions/Specifications, these packagings also satisfy this test requirement with respect to potential inleakage of water. See Appendix D, Table D-4.
Free drop	Pass. This drop was made on the top corner with the boxes inverted and held at a 45° angle. There was no loss of contents and no significant change in packaging geometry. See Appendix D, Table D-13.
Corner drop	The corner drop was conducted on two of the packagings. This allows their potential use at less than 110 lb. See Appendix D, Table D-20.
Compression	Pass. The tests were conducted with greater than five times the gross weight given in Section 4.7.2.1.2 for 24 hr. There was no detectable effect. See Appendix D, Table D-25.
Penetration	Pass. This test was conducted on each package with no significant effect. See Appendix D, Table D-32.

4.7.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/inspection criteria*
Lid/body interface Sealing surface	Vendor qualifications and experience	Functional: • Ease of lid application • Mating surfaces flat and smooth, no foreign matter • Geometry, as specified Acceptable conditions:
	Joints/seams	• Dimensions, as specified • Glued
	Closure	• As specified, nail or screw • Caulking on lid • Steel banding of proper size and location • Nail-type and spacing
	Vendor qualification and experience	Vendor data as appropriate. Lot tests/inspections as appropriate by shipper.

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

4.7.6 Additional Information

Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

4.7.6.1 Primary Users

Site/Contact/Phone	Address
MLM Don Wikstrom COMM/FTS 513-865-3919	Mound-MRC P.O. Box 32 Mound Road Miamisburg, OH 45342

4.7.6.2 Suppliers. Manufactured onsite.

Figure 4-13. NLO Family of Banded, Wooden Boxes (contents restricted, see Section 4.8.3).

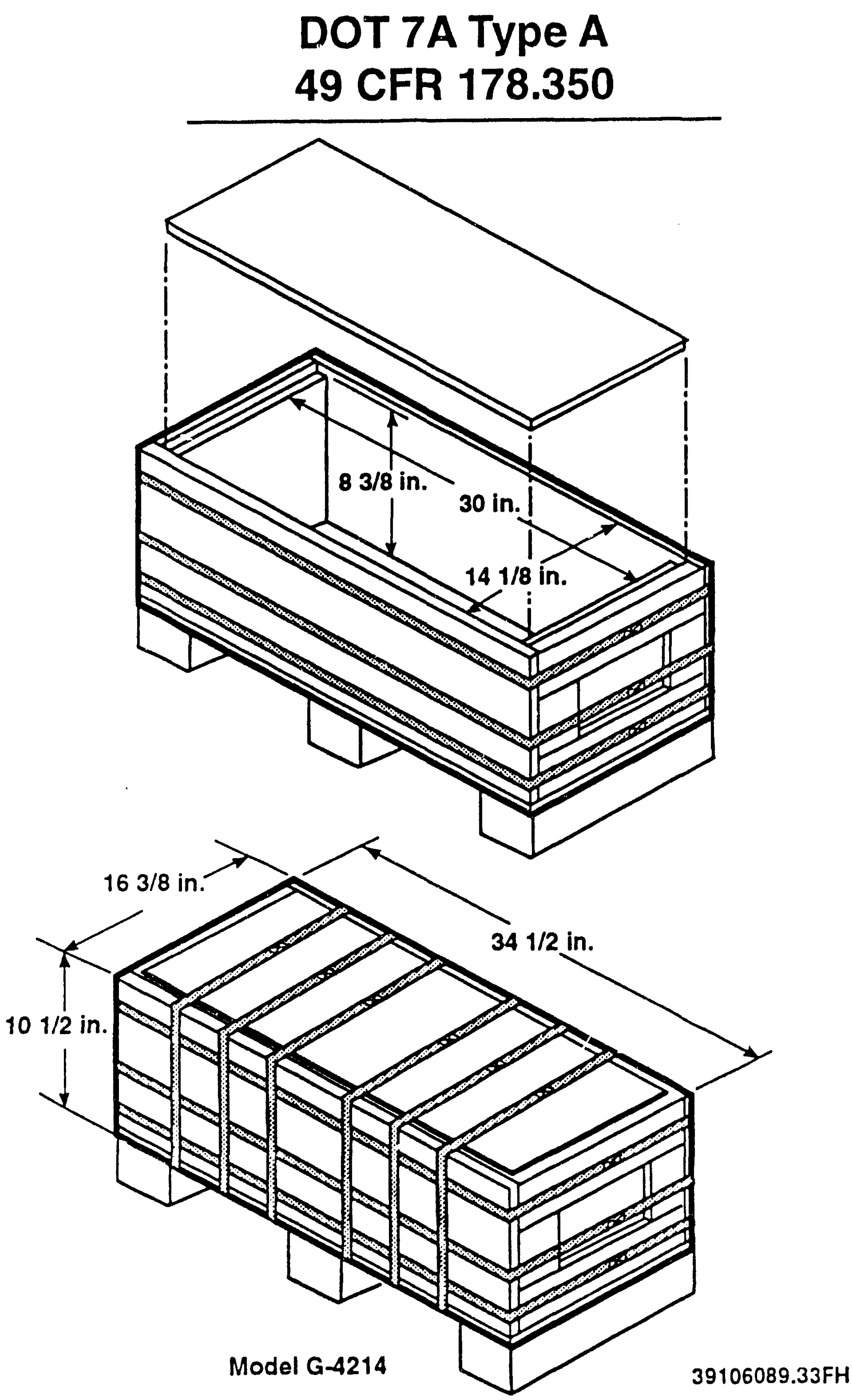


Figure 4-14. NLO Family of Banded, Wooden Boxes (contents restricted, see Section 4.8.3).

DOT 7A Type A
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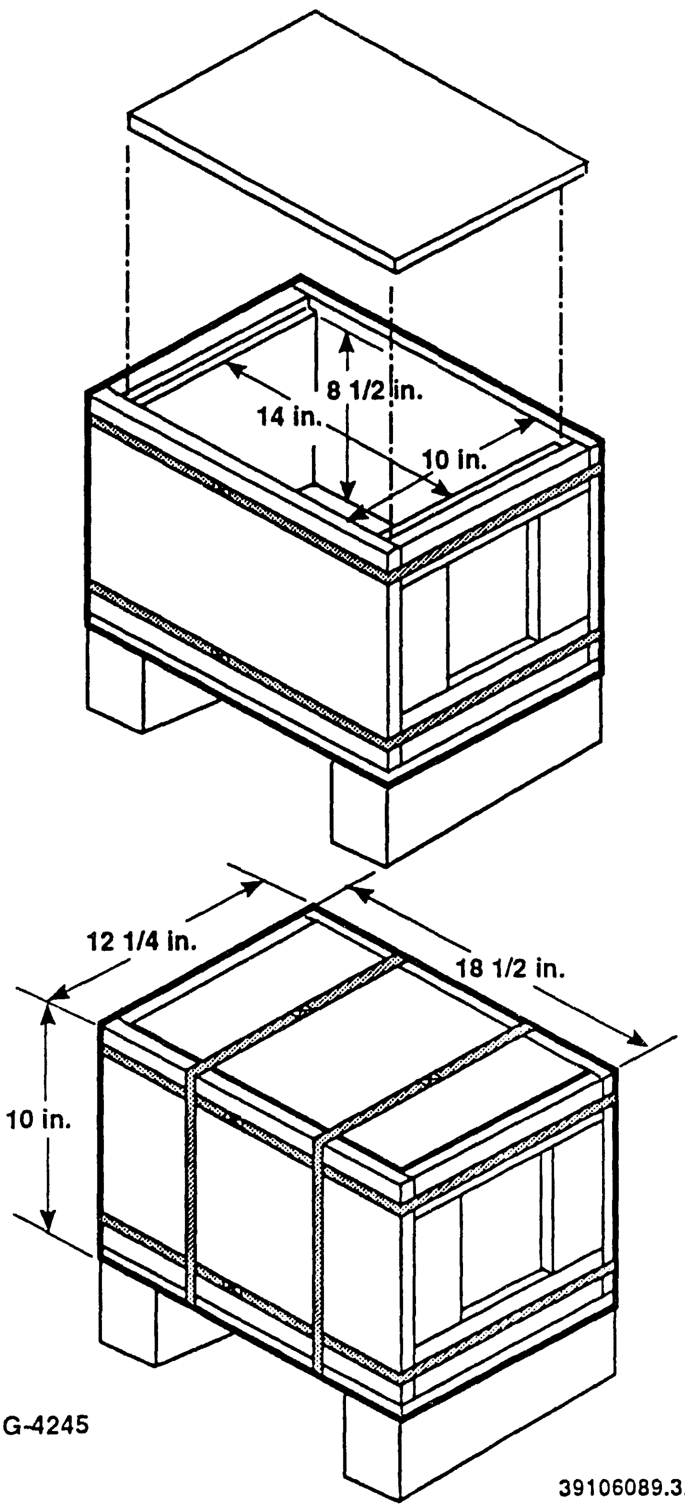


Model G-4245

39106089.32FH

Figure 4-15. NLO Family of Banded, Wooden Boxes (contents restricted, see Section 4.8.3).

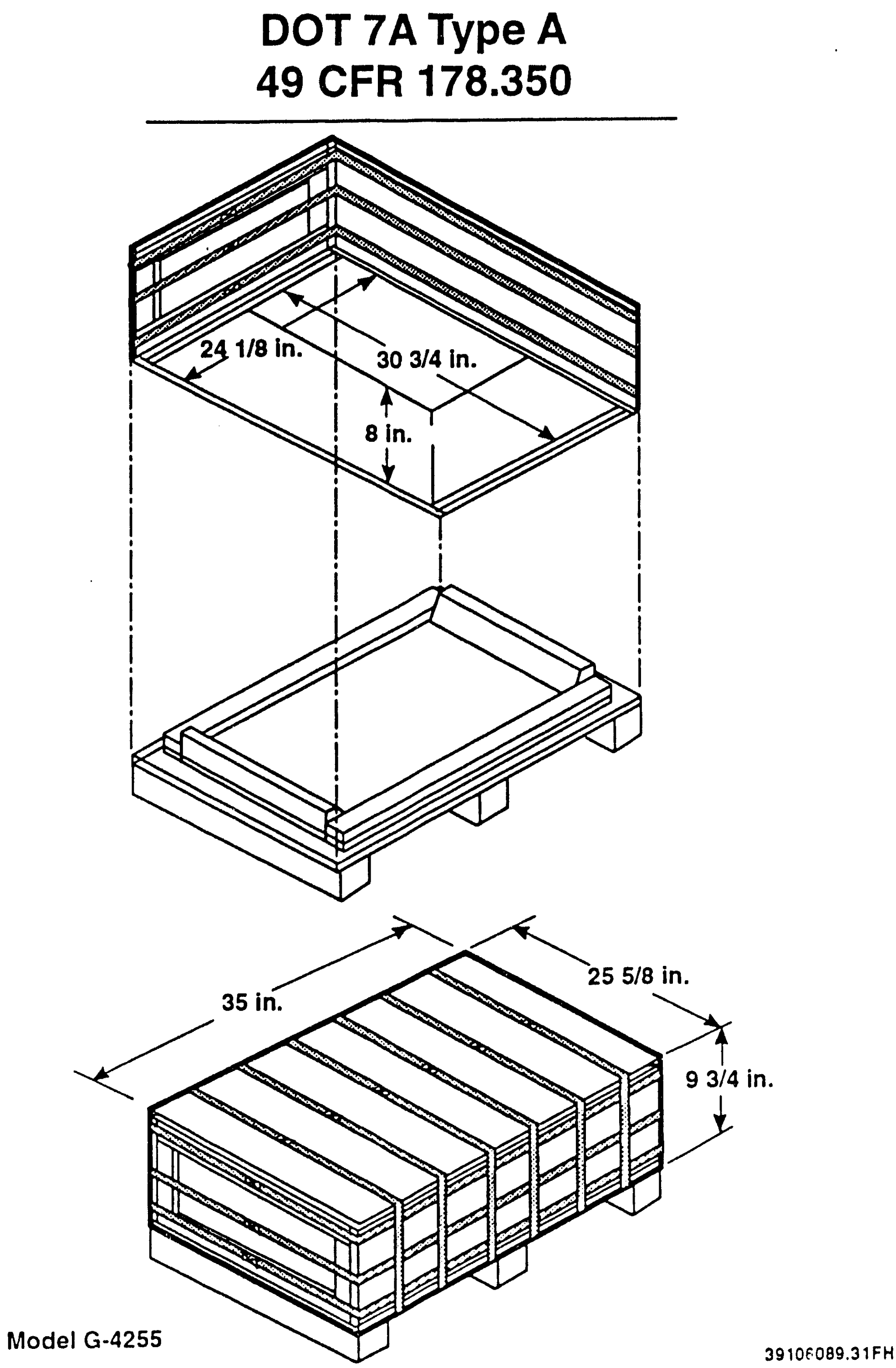
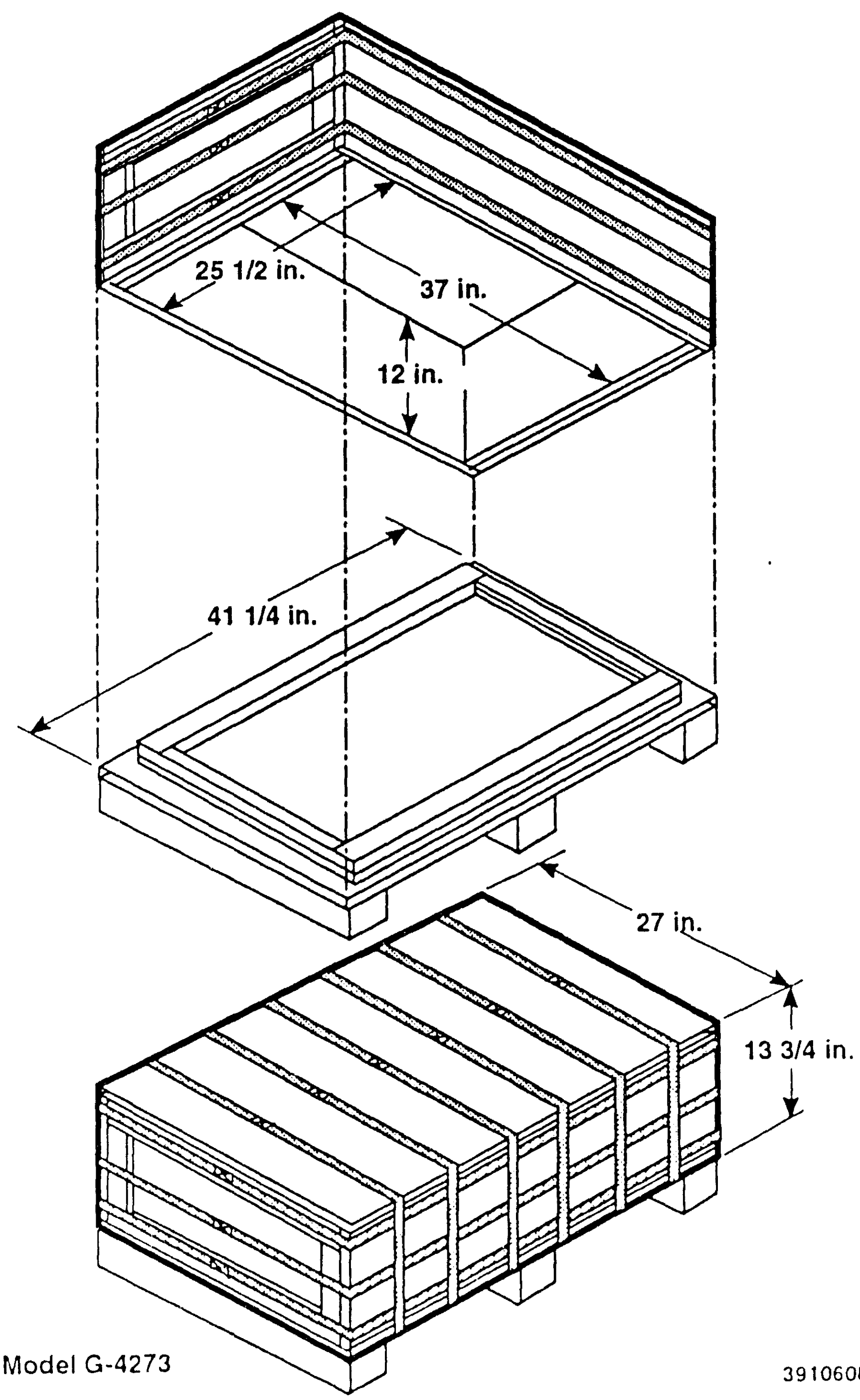


Figure 4-16. NLO Family of Banded, Wooden Boxes
(contents restricted, see Section 4.8.3).

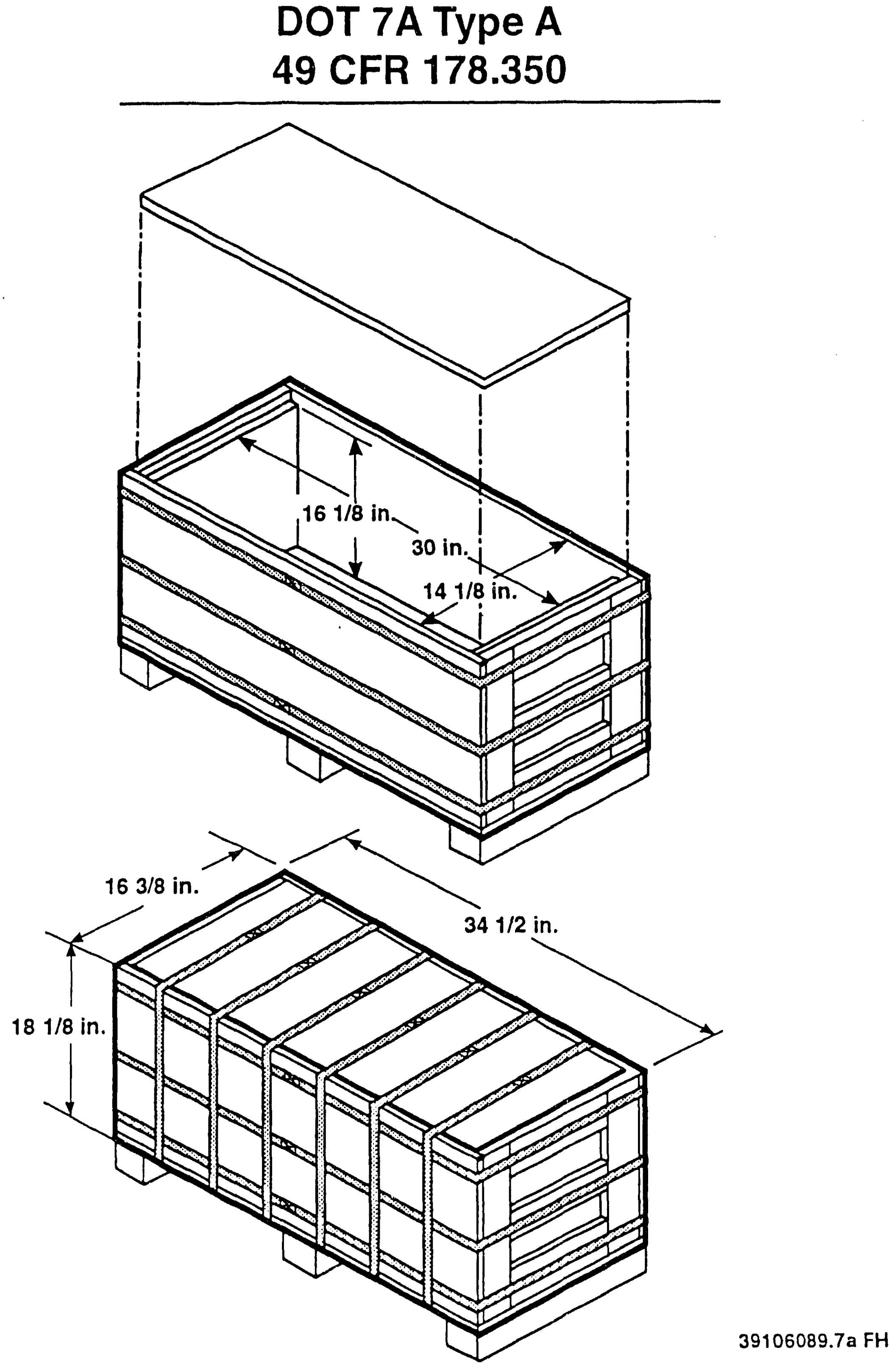
DOT 7A Type A
49 CFR 178.350



Model G-4273

39106089.36FH

Figure 4-17. NLO Family of Banded, Wooden Boxes (contents restricted, see Section 4.8.3).



4.8 NLO FAMILY OF BANDED, WOODEN BOXES (DOCKETS: MLM)

4.8.1 Package Description

Dimensions and Weights

Model	External dimension				Internal dimension			Empty weight (lb)	Authorized gross weight (lb)
	Width (in.)	Length (in.)	Height (in.)	Skid (in.)	Width (in.)	Length (in.)	Height (in.)		
G-4214	16.375	34.50	10.500	4.000	14.125	30.00	8.372	55	1,805
G-4245	12.250	18.50	10.000	3.250	10.000	14.00	8.500	25	250
G-4255	25.625	35.00	9.750	3.250	24.125	30.75	8.000	120	1,500
G-4273	27.000	41.25	13.750	3.250	25.500	37.00	12.000	140	3,250
G-4292	16.375	34.50	18.125	3.625	14.125	30.00	16.125	80	852

Materials/Method of Construction

Drawing No. NLO-G-4214 and G-4292	
Sides and ends	1.125-in. thick white pine
Bottom	1-in. hardwood
Lids	2, 0.5-in. plywood
Banding	See drawing, 1.25-in. steel
Skids	3 wooden, 3.625 in. or 4 in.
Drawing No. NLO-G-4245	
Lid	1, 0.5-in. plywood
Banding	2 vertical and 2 horizontal
Skids	3.25 in.
Drawing No. NLO-G-4255 and G-4273	
All construction	0.75-in. exterior grade plywood
Skids	3 wooden, 3.625 in. or 4 in.

4.8.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

4.8.2.1 Physical Form

4.8.2.1.1 Solids Only. One material form is authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements.

- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.433, Contamination control.)

4.8.2.1.2 Maximum Gross Weight. See Dimensions and Weights table, Section 4.8.1.

4.8.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

4.8.2.3 Radiological. The 4-ft drop test caused deformations of the package resulting in small decreases in the distance from the exterior to the center of the package. The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such deformations would occur.

4.8.3 Restrictions/Specifications

The following three possible approaches are acceptable with respect to addressing inleakage and ensuring that there is no transport of radioactive materials out of the packaging.

- Securely enclose the radioactive contents within the box (e.g., wrap and seal in plastic, etc.) so that any inleaking water cannot come in contact with the radioactive material.

- Seal the box using GEOCEL or its equivalent. If the box is reused, it must be re-coated with at least one coat to cover the seal areas before each shipment.

- Ensure that there is no loose or removable contamination that could be entrained in any liquid and that the radioactive material is not soluble in the liquid. Thus, even if the liquids come in contact with the radioactive material, there could be no transport from the package.

NOTE: There are obviously other possible approaches; however, if an alternative approach is chosen, the basis for the choice must be supported and documented. Using one of these alternatives or an equivalent method allows these wooden boxes to meet this requirement.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

4.8.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Requirements

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-3.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-3.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-5.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. Tests conducted on representative packagings demonstrated that this test did not affect the ability of the packaging to meet other Type A test requirements. With the actions required in Section 4.8.3, Restrictions/Specifications, these packagings also satisfy this test requirement with respect to potential inleakage of water. See Appendix D, Table D-5.
Free drop	Pass. By analysis and comparison to tests conducted on G-4214 loaded with 1,750 lb and dropped 30 ft. No significant distortion of package geometry or loss of contents would result. See Appendix D, Table D-14.
Corner drop	Not required.
Compression	Pass. By analysis and comparison to test conducted at 9,050 lb. No distortion or loss of contents would result. See Appendix D, Table D-25.
Penetration	Pass. This test was conducted on each package with no significant effect. See Appendix D, Table D-32.

4.8.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/inspection criteria*
Lid/body interface Sealing surface	Vendor qualifications and experience	Functional: • Ease of lid application • Mating surfaces flat and smooth, no foreign matter • Geometry, as specified Acceptable conditions:
	Joints/seams	• Dimensions, as specified • Glued
	Closure	• As specified, nail or screw • Caulking on lid • Steel banding of proper size and location • Nail-type and spacing
	Vendor qualifications and experience	Vendor data as appropriate. Lot tests/inspections as appropriate by shipper.

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

4.8.6 Additional Information

Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

4.8.6.1 Primary Users

Site/Contact/Phone	Address
Fernald L. C. Dolan COMM/FTS 513-738-6208	Westinghouse Materials Company of Ohio P.O. Box 398704 Cincinnati, OH 45239
C. E. Block COMM/FTS 513-763-1151	

Figure 4-18. Y-12 Series B Wooden Boxes (contents restricted, see Section 4.9.3).

DOT 7A Type A
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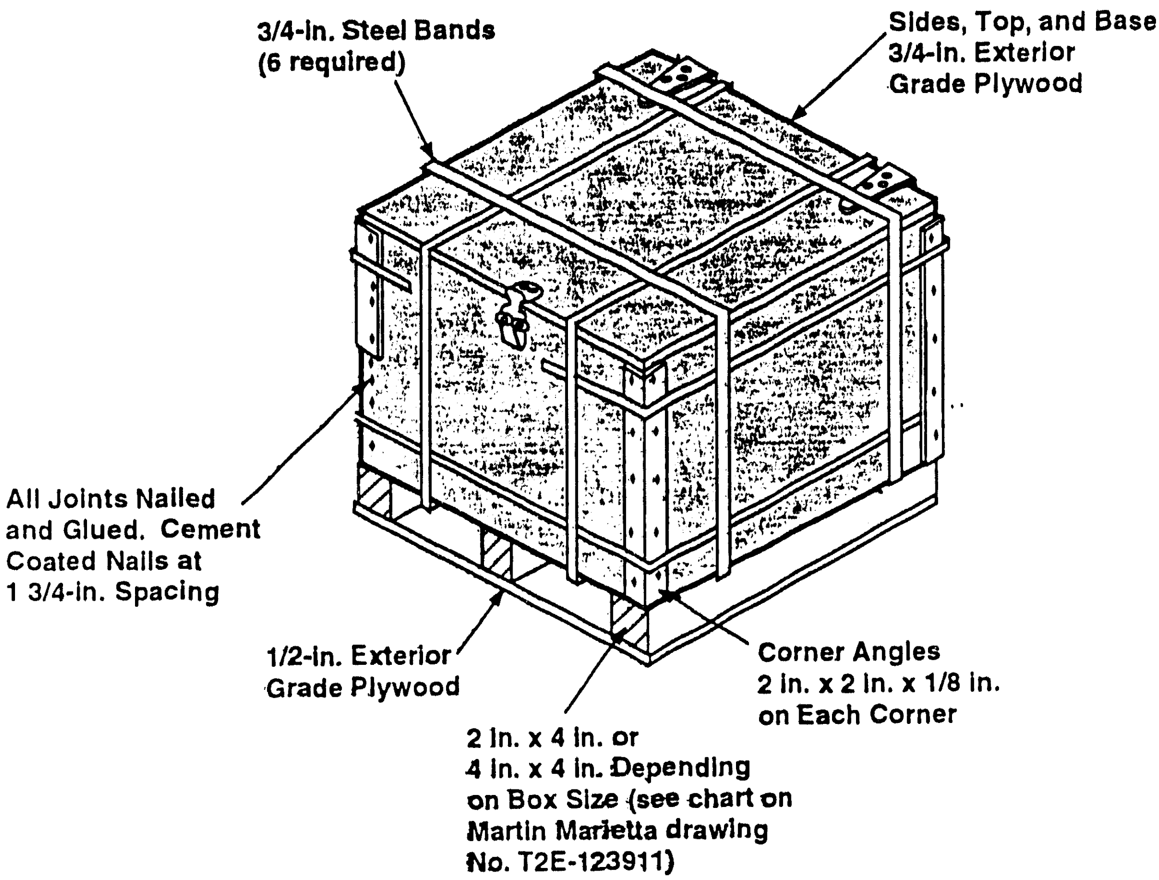

Note: Inside lined with 1/4-in.-thick Ethafoam* (not shown on drawing)

*Ethafoam is a trademark of Dow Chemical Company.

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4.9 Y-12 SERIES B WOODEN BOXES (DOCKETS: MLM)

4.9.1 Package Description

Dimensions

Model		Height (in.)	Width (in.)	Length (in.)
B-1	Interior	26.000	18.0	18.0
	Exterior	27.875	19.5	19.5
B-2	Interior	26.000	20.0	20.0
	Exterior	27.875	21.5	21.5
B-3	Interior	18.000	24.0	24.0
	Exterior	19.875	25.5	25.5
B-4	Interior	30.000	26.0	26.0
	Exterior	31.750	27.5	27.5
B-5	Interior	36.000	30.0	30.0
	Exterior	37.750	31.5	31.5
B-6	Interior	12.000	20.0	20.0
	Exterior	13.750	21.5	21.5
B-7	Interior	36.000	24.0	24.0
	Exterior	37.875	25.5	25.5
B-8	Interior	26.000	24.0	24.0
	Exterior	27.750	25.5	25.5

Materials/Methods of Construction

Sides, ends, top, and bottom	0.75-in. exterior grade plywood
All joints nailed and glued	
Nails	Cement coated
Steel banding	0.75 in., 6 required
Corner angles	2 in. x 2 in. x 0.125 in.
Ethafoam*	0.25 in.
Corner braces (inside and triangular)	1 in each corner, 4 in. x 4 in.

NOTE: See Martin Marietta Energy Systems (MMES) Drawing No. T2E-123911.

*Ethafoam is a trademark of the Dow Chemical Company.

4.9.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

4.9.2.1 Physical Form

4.9.2.1.1 Solids Only. One material form is authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements.

- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.433, Contamination control.)

4.9.2.1.2 Maximum Gross Weight

- 400 lb.

4.9.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

4.9.2.3 Radiological. The 4-ft drop test caused deformations of the package resulting in small decreases in the distance from the exterior to the center of the package. The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such deformations would occur.

4.9.3 Restrictions/Specifications

The following three possible approaches are acceptable with respect to addressing inleakage and ensuring that there is no transport of radioactive materials out of the packaging.

- Securely enclose the radioactive contents within the box (e.g., wrap and seal in plastic, etc.) so that any inleaking water cannot come in contact with the radioactive material.
- Seal the box using GEOCEL or its equivalent. If the box is reused, it must be re-coated with at least one coat to cover the seal areas before each shipment.
- Ensure that there is no loose or removable contamination that could be entrained in any liquid and that the radioactive material is not soluble in the liquid. Thus, even if the liquids come in contact with the radioactive material, there could be no transport from the package.

NOTE: There are obviously other possible approaches; however, if an alternative approach is chosen, the basis for the choice must be supported and documented. Using one of these alternatives or an equivalent method allows these wooden boxes to meet this requirement.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

4.9.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-3.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-3.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-5.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. This test was conducted on eight boxes prior to the 4-ft drop test and the penetration test. As expected, it did not affect the packages or the test results. With the actions required in Section 4.9.3, Restrictions/ Specifications, these packagings also satisfy this test requirement with respect to potential inleakage of water. See Appendix D, Table D-5.
Free drop	Pass. These packages were dropped on a lid corner with the box inverted at approximately at 45° angle. There was no loss of contents or significant change in packaging geometry. See Appendix D, Table D-13.
Corner drop	The corner drop was conducted on packagings B-1, B-2, and B-6. This allows their potential use at less than 110 lb. See Appendix D, Table D-20.
Compression	Pass. This test was conducted at five times the gross weight for 24 hr with no loss of contents or significant change in package geometry. See Appendix D, Table D-25.
Penetration	Pass. This test was conducted on the top (middle), with only minor dents resulting. See Appendix D, Table D-32.

4.9.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/inspection criteria*
Lid/body interface Sealing surface	Vendor qualifications and experience	Functional: • Ease of lid application • Mating surfaces flat and smooth, no foreign matter • Geometry, as specified
		Acceptable conditions:
	Joints/seams	• Dimensions, as specified • Glued
	Closure	• Nail-type and spacing • As specified, nail or screw • Caulking on lid • Steel banding of proper size and location
	Vendor qualifications and experience	Vendor data as appropriate. Lot tests/inspections as appropriate by shipper.

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

4.9.6 Additional Information

Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

4.9.6.1 Primary Users

Site/Contact/Phone	Address
ORNL H. E. Crowder COMM/FTS 615-574-2689	Martin Marietta Energy Systems, Inc. P.O. Box Y Oak Ridge Y-12 Plant Oak Ridge, TN 37830

Figure 4-19. Y-12 Picture Frame Wooden Box (contents restricted, see Section 4.10.3).

DOT 7A Type A
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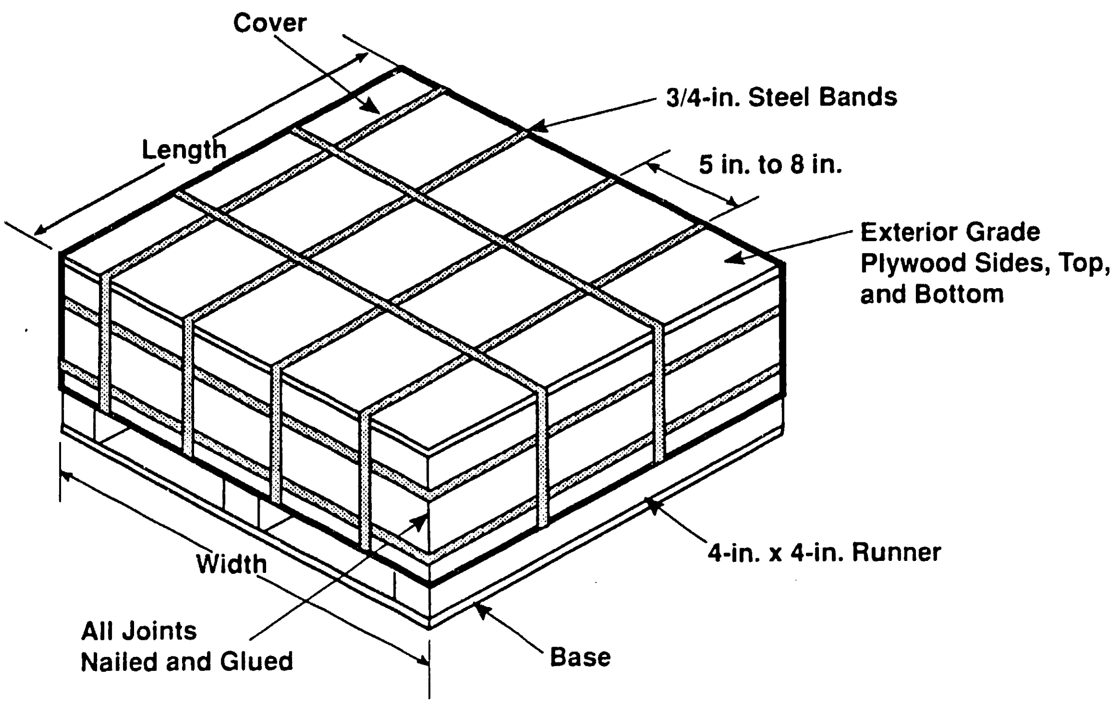


4.10 Y-12 PICTURE FRAME WOODEN BOXES (DOCKETS: MLM, 89-12-7A, 06/91)

4.10.1 Package Description

Dimensions and Weights

Model	Height (in.)	Width (in.)	Length (in.)	Authorized gross weight (lb)
PF-1	6.0	25.00	25.00	500
PF-2	6.0	31.50	31.50	750
PF-3	6.0	37.50	37.50	1,000
PF-4	10.0	13.50	25.00	500
PF-5	10.0	13.50	31.50	750
PF-6	12.0	15.00	37.50	1,000
PF-7	5.0	22.50	59.50	750
PF-8	12.0	20.00	70.25	1,000
PF-10	14.5	48.00	48.00	2,500

Materials/Method of Construction

Sides and top	0.75-in. exterior grade plywood
Base sheet	1-in. exterior grade plywood
Bottom sheet	0.5-in. exterior grade plywood
Steel bands	0.75-in. per spacing in reference document
Joints/seams	Nailed and glued
Nails	See drawings

4.10.1.1 Drawings. MMES Drawing No. T2E-125268 (PF-1 through PF-8) and No. T2E-800530A014 (PF-10).

4.10.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

4.10.2.1 Physical Form

4.10.2.1.1 Solids Only. One material form is authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements.

- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.433, Contamination control.)

4.10.2.1.2 Maximum Gross Weight. See the Dimensions and Weights table in Section 4.10.1.

4.10.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

4.10.2.3 Radiological. The 4-ft drop test caused deformations of the package resulting in small decreases in the distance from the exterior to the center of the package. The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such deformations would occur.

4.10.3 Restrictions/Specifications

The following two possible approaches are acceptable with respect to addressing inleakage and ensuring that there is no transport of radioactive materials out of the packaging.

- Securely enclose the radioactive contents within the box (e.g., wrap and seal in plastic, etc.) so that any inleaking water cannot come in contact with the radioactive material.
- Seal the box using GEOCEL or its equivalent. If the box is reused, it must be re-coated with at least one coat to cover the seal areas before each shipment.

NOTE: There are obviously other possible approaches; however, if an alternative approach is chosen, the basis for the choice must be supported and documented. Using one of these alternatives or an equivalent method allows these wooden boxes to meet this requirement.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

4.10.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-3.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-3.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-5.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. Tests conducted on representative packagings demonstrated that this test did not affect the ability of the packaging to meet other Type A test requirements. With the actions required in Section 4.10.3, Restrictions/Specifications, these packagings also satisfy this test requirement with respect to potential inleakage of water. See Appendix D, Table D-5.
Free drop	Pass. These tests were conducted on the corner edge. There was no loss of contents and no significant change in packaging geometry. See Appendix D, Table D-13.
Corner drop	Not required.
Compression	Pass. The tests were conducted with greater than five times the gross weight shown in the Dimensions and Weights table in Section 4.10.1 for 24 hr. There was no detectable effect. See Appendix D, Table D-25.
Penetration	Pass. This test was conducted on each package with no significant effect. See Appendix D, Table D-32.

4.10.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/inspection criteria*
None	Lid/body interface	Functional: • Ease of lid application • Mating surfaces flat and smooth, no foreign matter • Geometry, as specified Acceptable conditions:
	Joints/seams	• Dimensions, as specified • Glued
	Closure	• As specified, nail or screw • Caulking on lid • Steel banding of proper size and location • Nail-type and spacing
	Vendor qualification and experience	Vendor data as appropriate. Lot tests/inspections as appropriate by shipper.

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

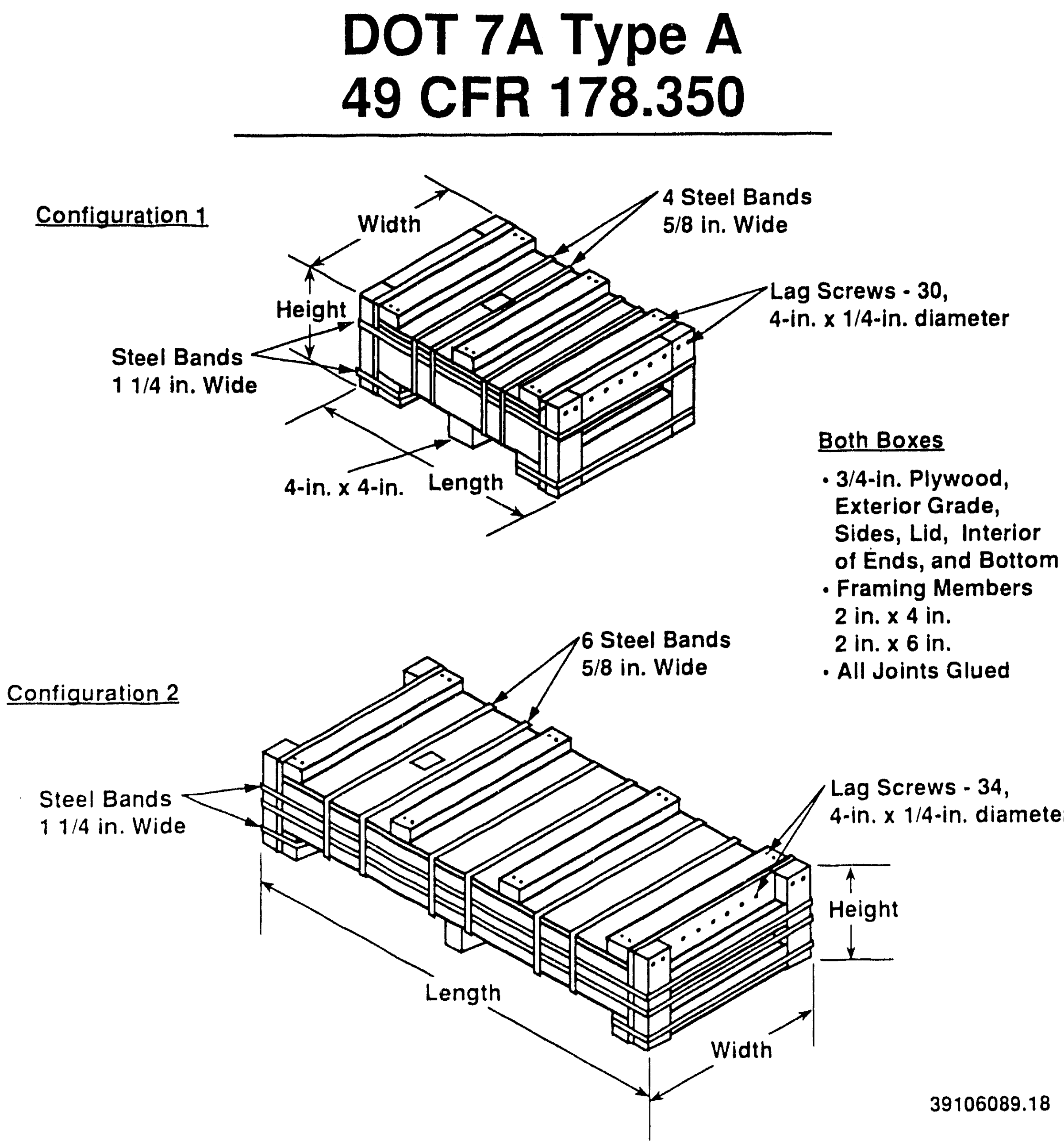
4.10.6 Additional Information

Evaluation and testing of packaging Model Nos. PF-1 through PF-8 were performed at MLM and were documented in Edling 1987. Evaluation and testing of Model PF-10 took place at Westinghouse Hanford as part of Docket 89-12-7A with testing completed in June 1991. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

4.10.6.1 Primary Users

Site/Contact/Phone	Address
ORNL J. C. Copeland COMM/FTS 615-574-2689	Martin Marietta Energy Systems, Inc. P.O. Box Y Oak Ridge Y-12 Plant Oak Ridge, TN 37830
H. E. Turner COMM/FTS 615-574-2688	

Figure 4-20. Rocky Flats RA Series Wooden Boxes (contents restricted, see Section 4.11.3).



4.11 ROCKY FLATS RA SERIES OF WOODEN BOXES (DOCKETS: MLM)

4.11.1 Package Description

Dimensions

Model		Height (in.)	Width (in.)	Length (in.)
Configuration 1	Interior	6.0	16.625	21.125
	Exterior	14.0	21.125	25.625
Configuration 2	Interior	2.5	26.750	59.125
	Exterior	10.5	31.250	63.625

Materials/Method of Construction

Sides, lid, interior of ends, and bottom	0.75-in. exterior grade plywood
Framing members All joints nailed and glued	2-in. x 4-in. lumber
Closure	Lag screws, 4 in. x 0.25-in. diameter
Steel banding	0.625-in. steel bands around top, sides, and bottom 1.25-in. steel band around sides and ends See diagrams for proper spacing

NOTE: For details of construction, see Rockwell RF-PE Drawings D14062-P14974, sheets 1 through 3, and D14061-P14926, sheets 1 through 3.

4.11.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

4.11.2.1 Physical Form

4.11.2.1.1 Solids Only. One material form is authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements.

- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.433, Contamination control.)

4.11.2.1.2 Maximum Gross Weight

- Configuration 1--900 lb
- Configuration 2--1,250 lb.

4.11.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

4.11.2.3 Radiological. The 4-ft drop test caused deformations of the package resulting in small decreases in the distance from the exterior to the center of the package. The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such deformations would occur.

4.11.3 Restrictions/Specifications

The following three possible approaches are acceptable with respect to addressing inleakage and ensuring that there is no transport of radioactive materials out of the packaging.

- Securely enclose the radioactive contents within the box (e.g., wrap and seal in plastic, etc.) so that any inleaking water cannot come in contact with the radioactive material.
- Seal the box using GEOCEL or its equivalent. If the box is reused, it must be re-coated with at least one coat to cover the seal areas before each shipment.
- Ensure that there is no loose or removable contamination that could be entrained in any liquid and that the radioactive material is not soluble in the liquid. Thus, even if the liquids come in contact with the radioactive material, there could be no transport from the package.

NOTE: There are obviously other possible approaches; however, if an alternative approach is chosen, the basis for the choice must be supported and documented. Using one of these alternatives or an equivalent method allows these wooden boxes to meet this requirement.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

4.11.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-3.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-3.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-5.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. This test was conducted prior to the compression test with no loss of contents or significant distortion of packaging geometry. This same package was dropped 4 ft approximately 28 hr later. Tests conducted on similar packagings demonstrate that this test did not affect the ability of the packaging to meet other Type A test requirements. With the actions required in Section 4.11.3, Restrictions/Specifications, these packagings also satisfy this test requirement with respect to potential inleakage of water. See Appendix D, Table D-5.
Free drop	Pass. This drop was made on the top corner with the boxes inverted at approximately a 45° angle. There was no loss of contents and no significant change in packaging geometry. See Appendix D, Table D-13.
Corner drop	Not required.
Compression	Pass. This test was conducted at five times the gross weight for 24 hr with no loss of contents or significant change in package geometry. see Appendix D, Table D-25.
Penetration	Pass. By analysis and comparison to previous tests on 0.75-in. plywood, which resulted in only minor dents. See Appendix D, Table D-32.

4.11.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/inspection criteria*
Lid/body interface Sealing surface	Vendor qualifications and experience	Functional: • Ease of lid application • Mating surfaces flat and smooth, no foreign matter • Geometry, as specified Acceptable conditions:
	Joints/seams	• Dimensions, as specified • Glued
	Closure	• As specified, nail or screw • Caulking on lid • Steel banding of proper size and location • Nail-type and spacing
	Vendor qualifications and experience	Vendor data as appropriate. Lot tests/inspections as appropriate by shipper.

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

4.11.6 Additional Information

Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

4.11.6.1 Primary Users

<u>Site/Contact/Phone</u>	<u>Address</u>
Rocky Flats R. R. Riddle COMM/FTS 303-966-4596	Rocky Flats Plant P.O. Box 464 Golden, CO 80402-0464

Figure 4-21. WMCO Family of Banded, Wooden Boxes (contents restricted, see Section 4.12.3).

DOT 7A Type A
49 CFR 178.350

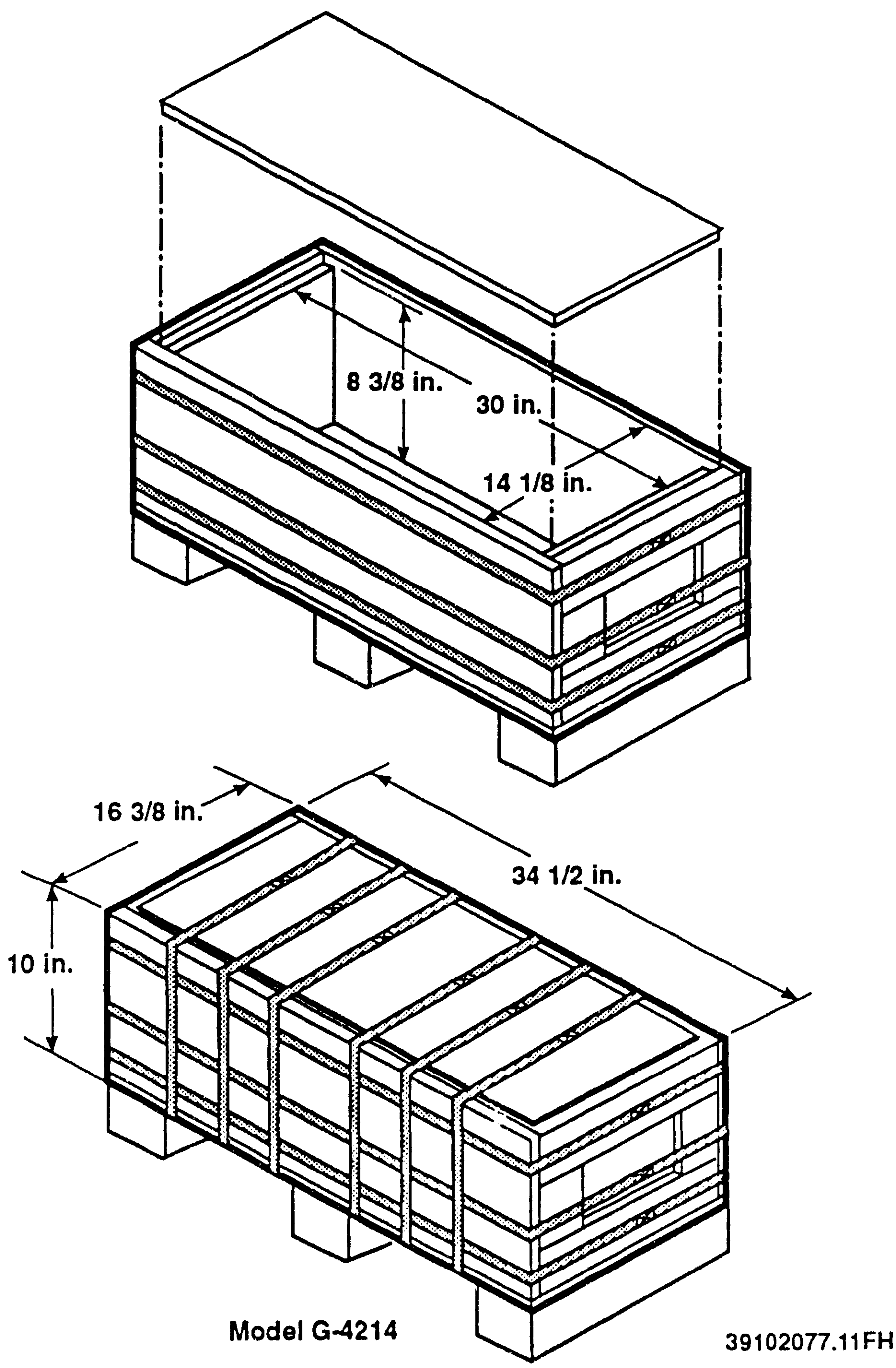


Figure 4-22. WMCO Family of Banded, Wooden Boxes (contents restricted, see Section 4.12.3).

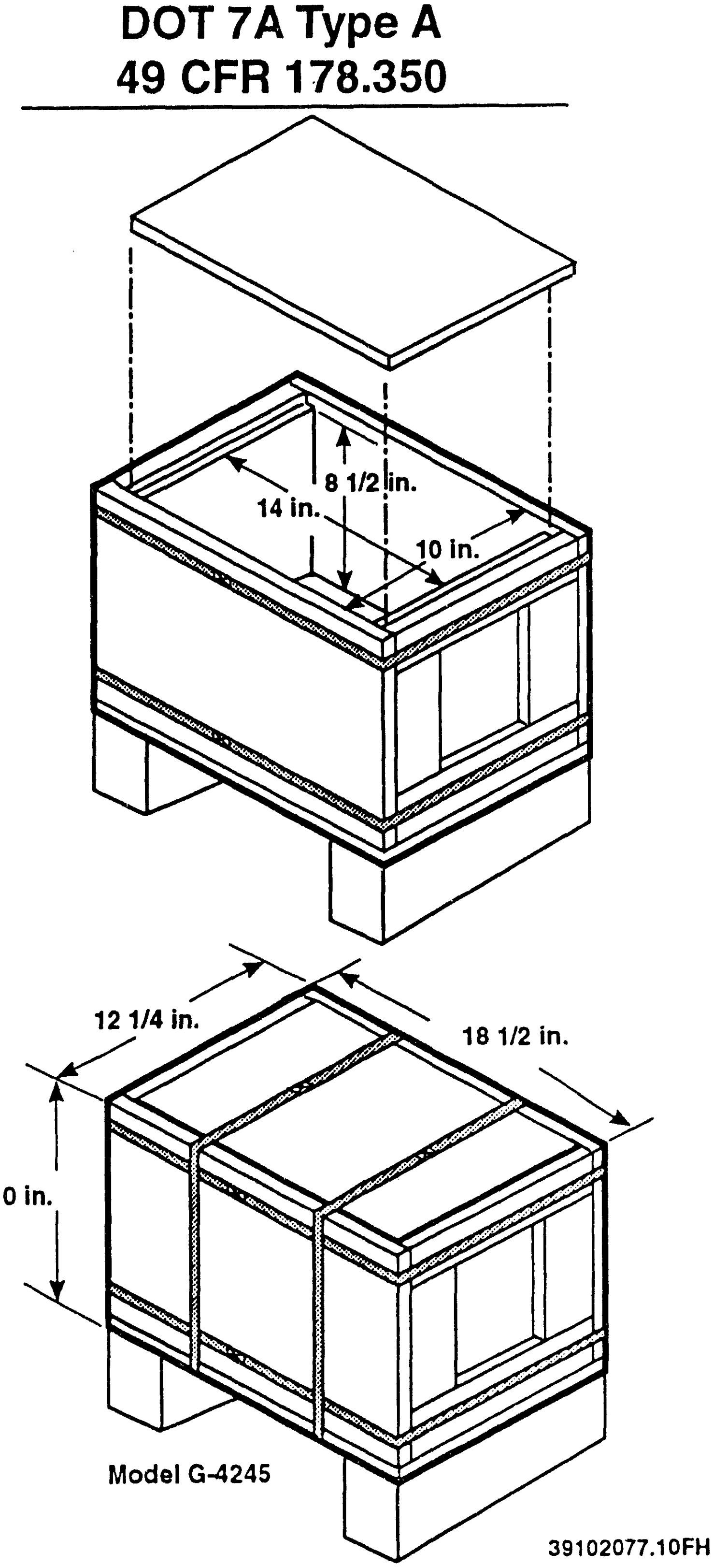
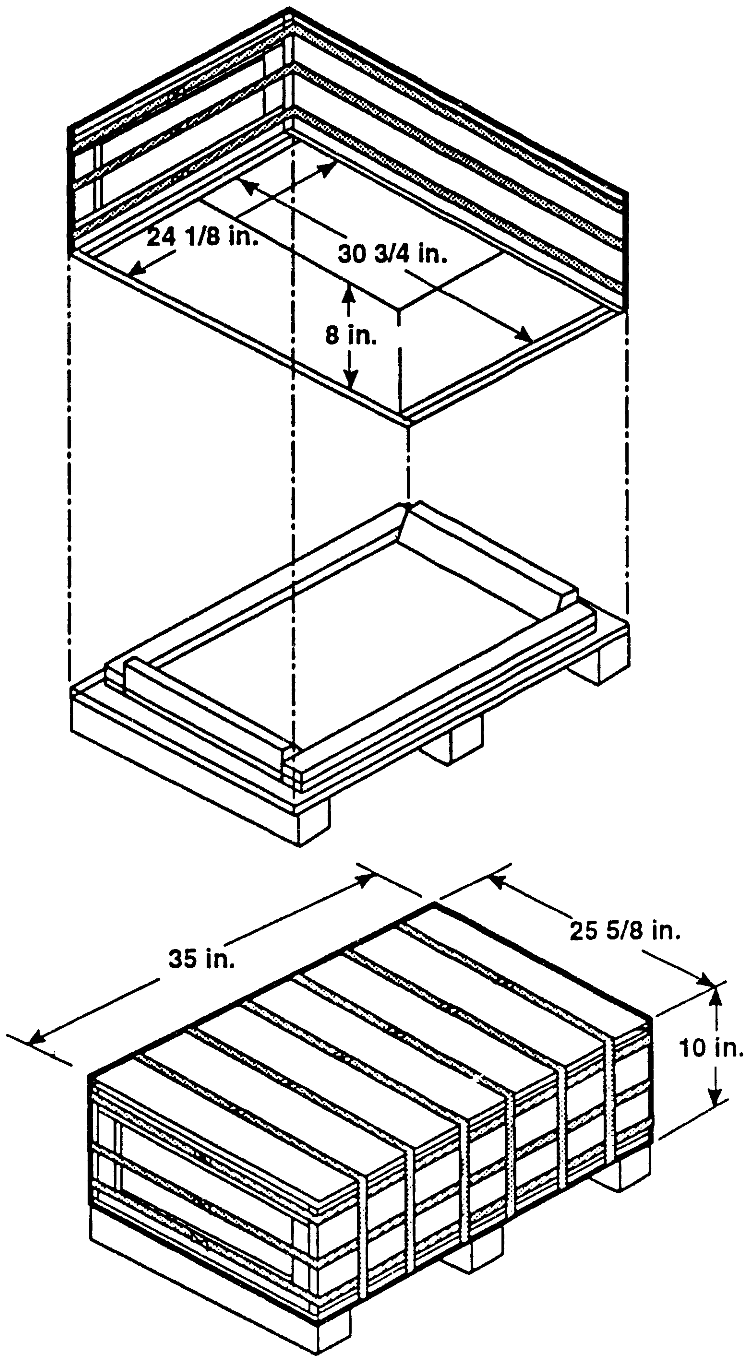


Figure 4-23. WMCO Family of Banded, Wooden Boxes (contents restricted, see Section 4.12.3).

DOT 7A Type A
49 CFR 178.350



Model G-4255

39102077.9FH

Figure 4-24. WMCO Family of Banded, Wooden Boxes (contents restricted, see Section 4.12.3).

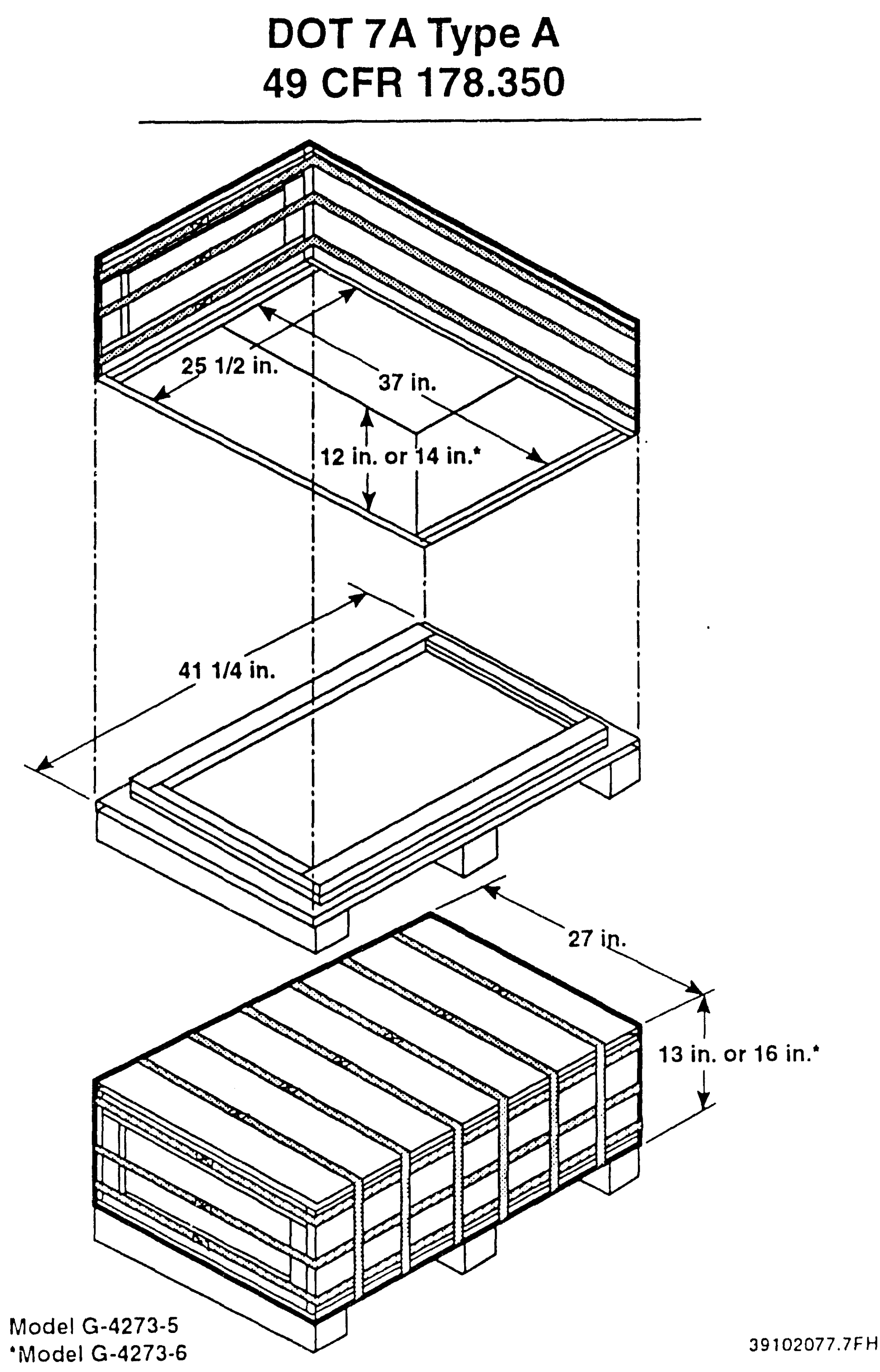
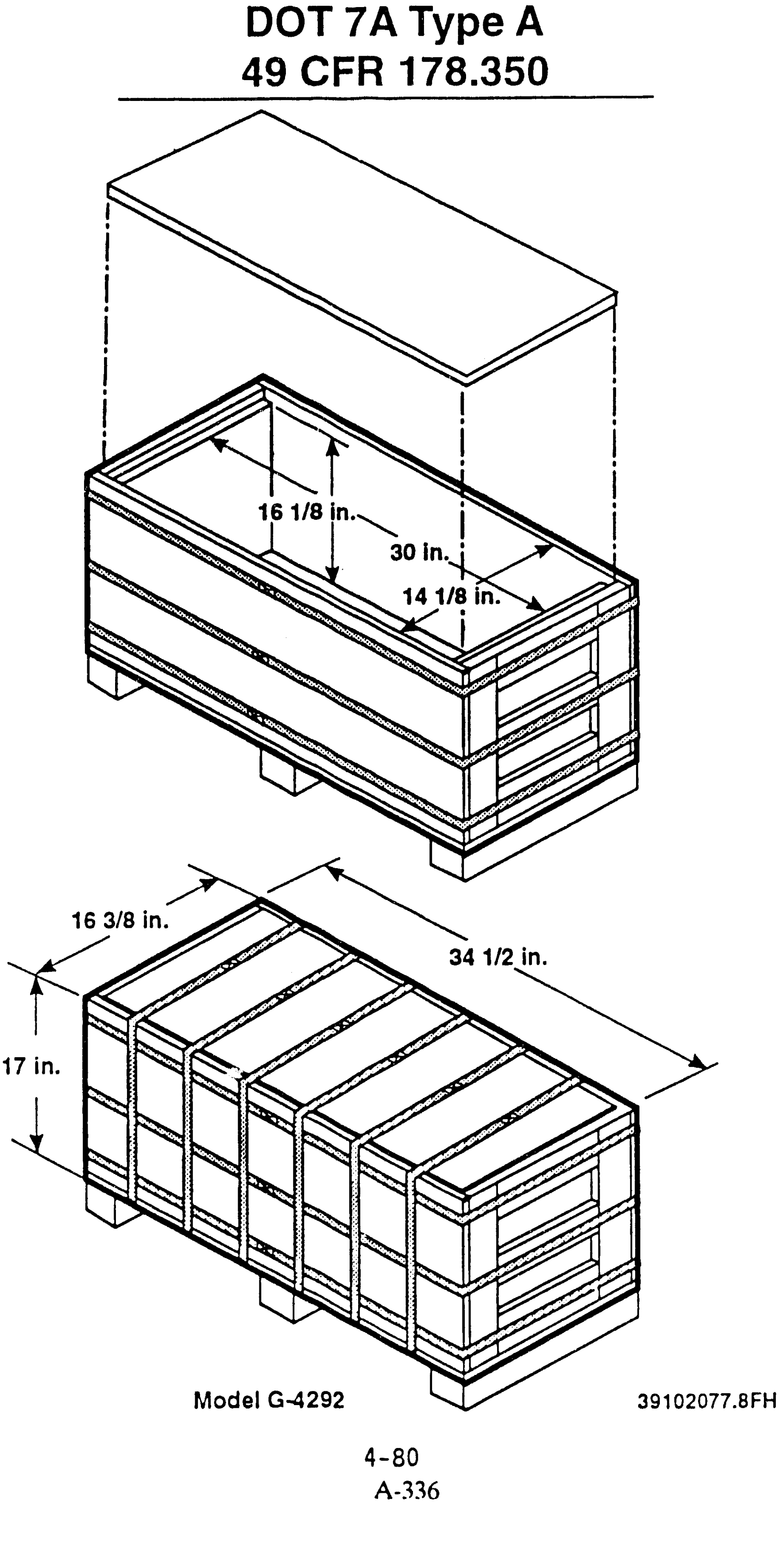


Figure 4-25. WMCO Family of Banded, Wooden Boxes (contents restricted, see Section 4.12.3).



4.12 WMCO FAMILY OF BANDED, WOODEN BOXES (DOCKETS: MLM, 89-09-7A, 09/90)

4.12.1 Package Description

Dimensions and Weights

Model	External dimension				Internal dimension			Empty weight (lb)	Authorized gross weight (lb)
	Width (in.)	Length (in.)	Height (in.)	Skid (in.)	Width (in.)	Length (in.)	Height (in.)		
G-4214	16.38	34.50	10.0	4.00	14.13	30.00	8.38	70.0	1,260
G-4245	12.25	18.50	10.0	3.13	10.00	14.00	8.50	25.0	225
G-4255	25.63	35.00	10.0	3.50	24.13	30.75	8.00	107.0	1,470
G-4273-5	27.00	41.25	13.0	3.38	25.50	37.00	12.00	132.0	3,035
G-4273-6	27.00	41.25	16.0	3.38	25.50	37.00	14.00	146.0	3,540
G-4292	16.38	34.50	17.0	3.38	14.13	30.00	16.13	85.0	1,330

Materials/Method of Construction

Drawing No. G-4292 OOF-5500-X-00491, Rev. 9	
Drawing No. G-4214 OOF-5500-X-00431, Rev. 19 OOF-5500-X-01490, Rev. 3	
Sides and ends	1.125-in. thick white pine
Bottom	1-in. hardwood
Lids	2, 0.5-in. plywood
Banding	See drawing - 1.25-in. steel
Skids	3 wooden, 3.625 in. or 4 in.
Drawing No. G-4245 OOF-5500-X-00460, Rev. 3	
Lid	1, 0.5-in. plywood
Banding	2 vertical and 2 horizontal
Skids	3.25 in.
Drawing No. G-4255 OOF-5500-X-00468, Rev. 5 OOF-5500-X-00470, Rev. 0	
Drawing No. G-4273 OOF-5500-X-00471, Rev. 14 OOF-5500-X-00472, Rev. 7 OOF-5500-X-00473, Rev. 4	
All construction	0.75-in. exterior grade plywood
Skids	3 wooden, 3.625 in. or 4 in.

4.12.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

4.12.2.1 Physical Form

4.12.2.1.1 Solids Only. Restricted to Material Form No. 3 only. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements.

- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.443, Contamination control.)

4.12.2.1.2 Maximum Gross Weight. See the Dimensions and Weights table in Section 4.12.1.

4.12.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

4.12.2.3 Radiological. The decrease in distance to the center of the package as a result of exposure to a 4-ft drop was estimated for each model as follows:

Four-Foot Drop Test Estimates

Model	Decrease in distance to center (in.)
G-4214	6
G-4245	3
G-4255	6
G-4273-5	12
G-4273-6	13
G-4292	6

These estimates were based on comparison with damage that occurred during testing of similar packages. The shipper shall ensure that the radiation level at any surface of the packaging would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such deformations would occur.

4.12.3 Restrictions/Specifications

The loaded package must be banded as shown in Figures 4-21 through 4-25.

The following three possible approaches are acceptable with respect to addressing inleakage and ensuring that there is no transport of radioactive materials out of the packaging.

- Securely enclose the radioactive contents within the box (e.g., wrap and seal in plastic, etc.) so that any inleaking water cannot come in contact with the radioactive material.

- Seal the box using GEOCEL or its equivalent. If the box is reused, it must be re-coated with at least one coat to cover the seal areas before each shipment.

- Ensure that there is no loose or removable contamination that could be entrained in any liquid and that the radioactive material is not soluble in the liquid. Thus, even if the liquids come in contact with the radioactive material, there could be no transport from the package.

NOTE: There are other possible approaches; however, if an alternative approach is chosen, the basis for the choice must be supported and documented. Using one of these alternatives or an equivalent method allows these wooden boxes to meet this requirement.

For heavy, bulky materials (e.g., concrete chunks, motors, and pumps), equipment or materials with sharp corners or protrusions, or material/ containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

4.12.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-3.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-3.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-5.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. Water spray tests conducted on all packagings demonstrated that this test did not affect the ability of the packaging to meet other Type A test requirements. With the actions required in Section 4.12.3, Restrictions/Specifications, these packagings also satisfy this test requirement with respect to potential inleakage of water. See Appendix D, Table D-5.
Free drop	Pass. All packages were subjected to 4-ft free drop tests with no loss of contents. See Appendix D, Table D-13.
Corner drop	Not required.
Compression	Pass. One package of each type was subjected to the compression test. There was no distortion or loss of contents. See Appendix D, Table D-25.
Penetration	Pass. One package of each type was subjected to the penetration test. Minor indentations and some cracking of the wooden lids were noted, but there was no loss or dispersal of contents. See Appendix D, Table D-32.

4.12.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/inspection criteria*
Lid/body interface Sealing surface	Vendor qualifications and experience	Functional: • Ease of lid application • Mating surfaces flat and smooth, no foreign matter • Geometry, as specified Acceptable conditions:
	Joints/seams	• Dimensions, as specified • Glued
	Closure	• Nail-type and spacing • As specified, nail or screw • Caulking on lid • Steel banding of proper size and location
	Vendor qualifications and experience	Vendor data as appropriate. Lot tests/inspections as appropriate by shipper.

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

4.12.6 Additional Information

Evaluation and testing of the subject packaging took place at MLM in 1989. Westinghouse Hanford developed the final report and other documentation as part of Docket 89-09-7A. A complete test report is available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

4.12.6.1 Primary Users

Site/Contact/Phone	Address
Feed Materials Production Center (FMPC) C. E. Block COMM/FTS 513-738-6469	Westinghouse Materials Company of Ohio (WMCO) P.O. Box 398704 Cincinnati, OH 45239-8704

Figure 4-26. ORNL Y-12 Series C Wooden Boxes (contents restricted, see Section 4.13.3).

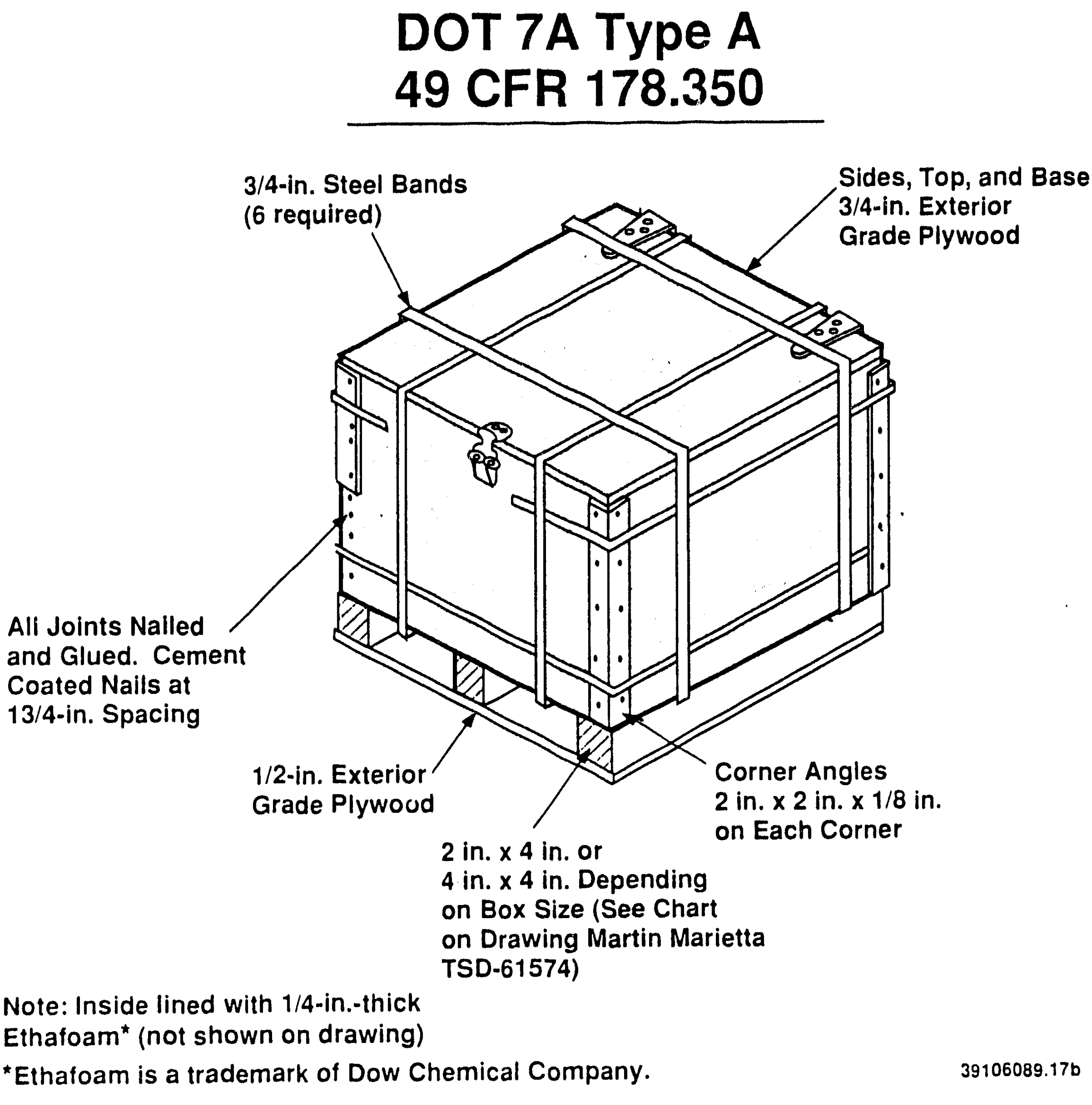
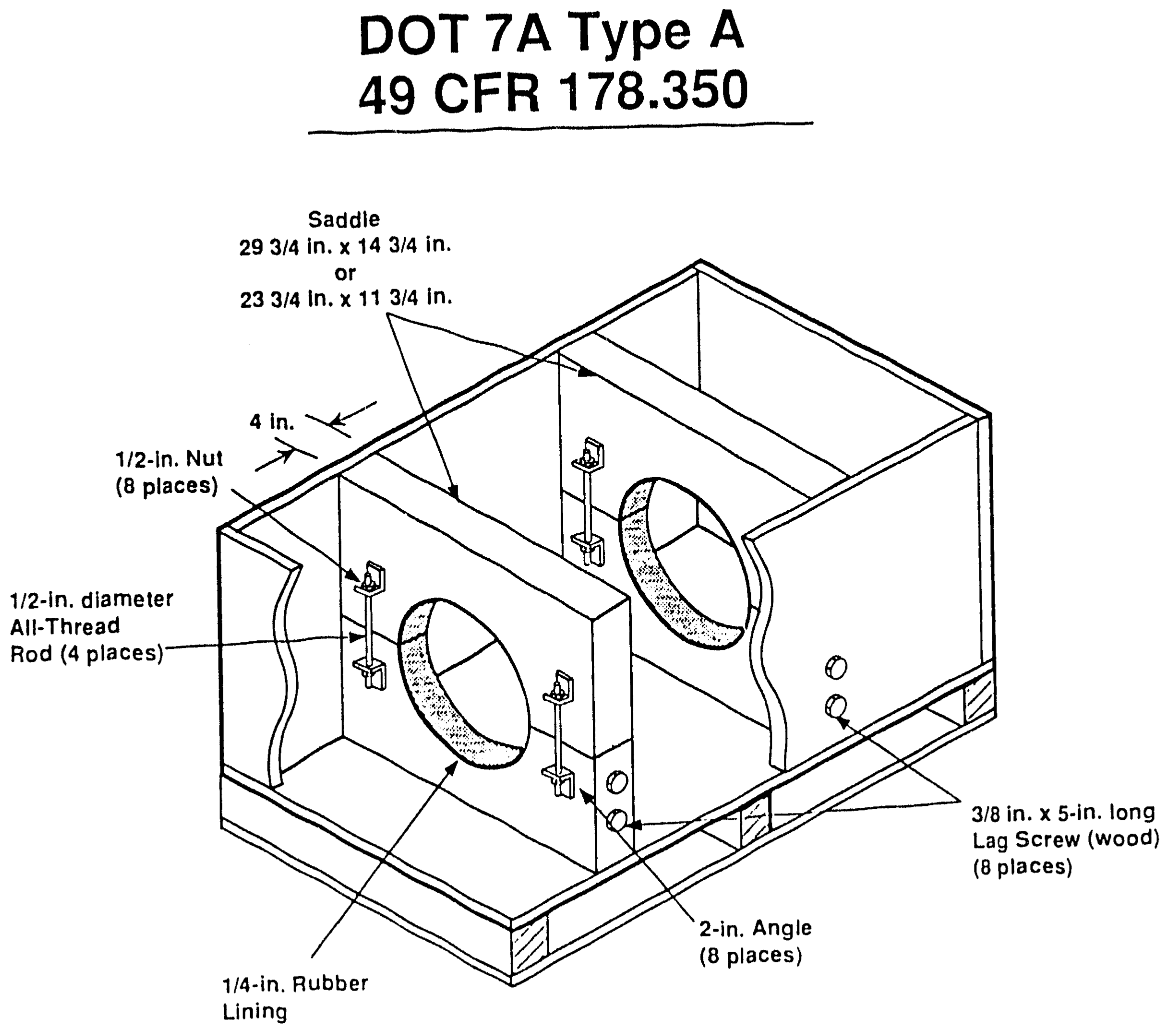


Figure 4-27. ORNL Y-12 Series C Wooden Boxes.



Note: 1. Brace contents front and back to keep from shifting.

2. Saddles made of 4 pieces of 1-in.-thick plywood glued together.

39104048.2

4.13 ORNL Y-12 SERIES C WOODEN BOXES (DOCKETS: 89-01-7A, 10/90; 90-19-7A, 08/91)

4.13.1 Package Description

Dimensions and Weights

Model		Length (in.)	Width (in.)	Height (in.)	Weight (lb)
C-1	Exterior	49.500	25.500	29.500	130
	Interior	48.000	24.000	24.000	
C-2	Exterior	67.500	31.500	35.500	200
	Interior	66.000	30.000	30.000	
C-3	Exterior	79.500	31.500	35.500	230
	Interior	78.000	30.000	30.000	
C-280	Exterior	50.375	18.875	18.875	130
	Interior	48.875	17.375	14.000	
C-400	Exterior	49.500	25.500	30.000	142
	Interior	48.000	24.000	25.500	
C-600	Exterior	35.500	31.500	35.500	212
	Interior	34.000	30.000	30.000	
C-1000	Exterior	79.500	31.500	35.500	236
	Interior	78.000	30.000	30.000	

Materials/Method of Construction

Major components	Material
Sides, walls, ends, top, and bottom	.75-in. exterior grade plywood
Base sheet (bottom of skid)	.50-in. exterior grade plywood
Joint/seams	Nailed and glued
Top	Hinged and closed with Link-Lock Latch #2
Skids - total of 3	4-in. x 4-in. lumber
Corner angle	Aluminum angle, 2 in. x .13 in.
Foam	.50-in. Ethafoam*
Banding	Steel, .75 in. x .03 in.

NOTE: See MMES Drawings No. T2E-146358 (C-1, -2, and -3) and No. T2E-123911 (C-230, -400, -600, and -1000).

*Ethafoam is a trademark of Dow Chemical Company.

4.13.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

4.13.2.1 Physical Form

4.13.2.1.1 Solids Only. Restricted to Material Form No. 3 only. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements.

- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.443, Contamination control.)

4.13.2.1.2 Maximum Gross Weight

Weights

Model	Weight (lb)
C-1	1,130
C-2	1,700
C-3	2,230
C-280	280
C-400	400
C-600	600
C-1000	1,000

4.13.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

4.13.2.3 Radiological. The decrease in distance to the center of the package as a result of the 4-ft drop testing was as follows:

Four-Foot Drop Test Results

Model	Decrease in distance to center (in.)
C-1	2.125
C-2	5.500
C-3	5.000
C-280	0.750
C-400	0.750
C-600	0.750
C-1000	0.750

The shipper shall ensure that the radiation level at any surface of the packaging would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such deformations would occur.

4.13.3 Restrictions/Specifications

The boxes shall have at least two coats of a standard exterior grade paint.

Note that the banding requirements change for various boxes. Band the boxes per drawing requirements.

Separations of 3/8 in., 3/4 in., and 3/4 in. occurred in boxes C-400, C-600, and C-1000, respectively, as a result of the drop test. Each shipper must ensure that the contents are of a size and form that could not escape through separations of this size.

The following three possible approaches are acceptable with respect to addressing inleakage and ensuring that there is no transport of radioactive materials out of the packaging.

- Securely enclose the radioactive contents within the packaging (e.g., wrap and seal in plastic, etc.) so that any inleaking water cannot come in contact with the radioactive material.
- Seal the box using GEOCEL or its equivalent. If the box is reused, it must be re-coated with at least one coat to cover the seal areas before each shipment.
- Ensure that there is no loose or removable contamination that could be entrained in any liquid and that the radioactive material is not soluble in the liquid. Thus, even if the liquids come in contact with the radioactive material, there could be no transport from the package.

NOTE: There are other possible approaches; however, if an alternative approach is chosen, the basis for the choice must be supported and documented. Using one of these alternatives or an equivalent method allows these wooden boxes to meet this requirement.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

4.13.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-3.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-3.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-5.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. This test was conducted on multiple test units and there was no inleakage of water. See Appendix D, Table D-5.
Free drop	Pass. Multiple test units were subjected to the 4-ft drop in varying orientations with successful results. See Appendix D, Table D-13.
Corner drop	Not required.
Compression	Pass. This test was conducted using a test unit for each model with successful results. See Appendix D, Table D-25.
Penetration	Pass. Penetration bar was dropped on the top center and on the latches with successful results. See Appendix D, Table D-32.

4.13.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/inspection criteria*
		Functional:
Body		• Materials of construction - Thickness - Type - Quality
Nailing		• Nail spacing and type as specified
Banding		• Width of banding
		• Banding materials
		• Number of bands
		• Location
	Joints/seams (cover-body interface)	• Fasteners as specified
		• Mating surfaces flat and smooth and free of foreign materials
	Surface preparation	• Appropriate paint/or equal
	Closure (hinges and latches)	• Size, material, number screws and location similar
	Cushioning and gaskets	• Thickness
		• Material as specified
		• Division of materials per drawing (C-280)
		Acceptable conditions:
		• Dimensions and materials
		• Lack of dents, no deformation of sealing surface
		• Geometry as specified
		• Gasket provides seal
		• Bands as specified

*These criteria apply to first time use and to reuse as a DOT-7A Type A packaging.

4.13.6 Additional Information

Evaluation and testing of the subject packagings took place at Westinghouse Hanford in 1990 and 1991 as part of DOT-7A Program Dockets No. 89-01-7A and No. 90-19-7A. Mound Laboratory conducted testing of the C-280, -400, -600 and -1000 models. Westinghouse Hanford completed testing of the C-1, -2, and -3 models in October 1990. Complete test reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

4.13.6.1 Primary Users

Site/Contact/Phone	Address
ORNL E. N. Turner COMM/FTS 615-576-2688	Martin Marietta Energy Systems, Inc. P.O. Box Y Oak Ridge Y-12 Plant Oak Ridge, TN 37830

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Appendix A.4.4

Fiberboard Containers

5.0 FIBERBOARD CONTAINERS

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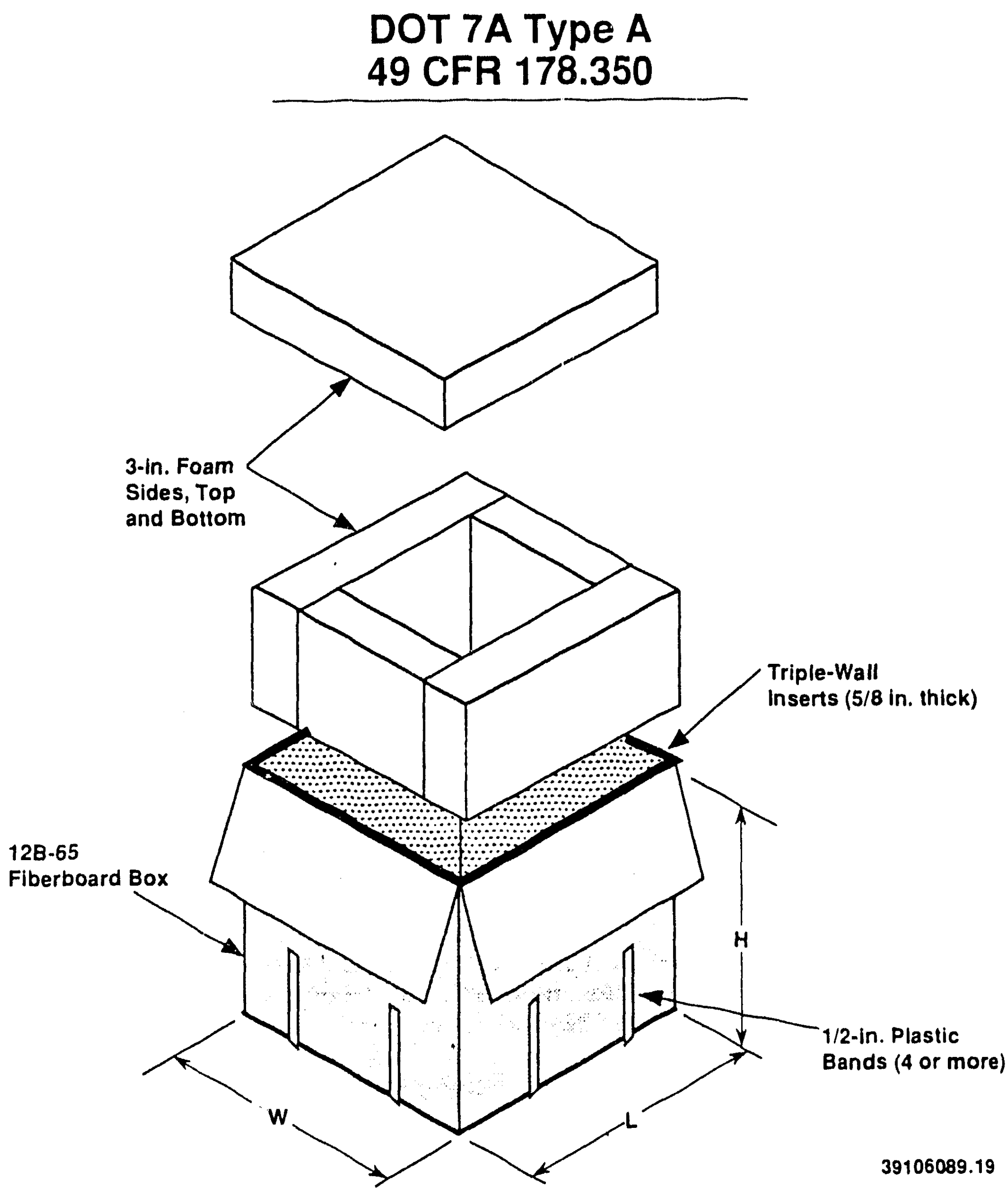
Figure 5-1. DOT Specification 12B Fiberboard Box (contents restricted, see Section 5.1.3).



5.1 12B-65 FIBERBOARD BOXES

5.1.1 Package Description

Dimensions and 4-ft Drop Test Results

Dimensions	Height (in.)	Width (in.)	Length (in.)	Decrease in distance from corner to center of package(in.)
1	8	12	12	0.250
2	12	12	12	0.500
3	12	12	28	0.500
4	16	16	16	0.750
5	8	18	18	0.500
6	12	18	18	0.500
7	27	18	18	0.500
8	8	20	20	0.750
9	12	20	20	0.500
10	12	24	24	0.375
11	24	24	24	0.500
12	8	16	16	0.500
13	12	16	16	0.750

Materials/Method of Construction

Fiberboard Box	12B-65 (49 CFR 178.205)
Banding	0.5-in. plastic strapping was used for test purposes; however, any better (or equivalent) banding may be used
Tape (see Section 5.1.6.2)	3-in. plastic tape (or equivalent) or stapled seams and closure
Foam	3-in. thick
Triple-Wall supports (see Section 5.1.6.2)	An inner tri-walled fiberboard liner to provide support during the compression test (0.567 in. thick)

5.1.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

5.1.2.1 Physical Form

5.1.2.1.1 Solids Only. One material form is authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements (e.g., RTV, etc.)

- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.433, Contamination control.)

5.1.2.1.2 Maximum Gross Weight

- 65 lb.

5.1.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

5.1.2.3 Radiological. The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level prior to the test) as a result of the decrease in distance to the center of the package resulting from the 4-ft drop test. This decrease in distance for each package is given in the Dimensions and 4-ft Drop Test Results table in Section 5.1.1.

5.1.3 Restrictions/Specifications

Contents must be of a size that would not move through the 1.25-in.-diameter hole resulting from the penetration test bar.

Water-resistant tape is required.

Triple-Wall support or equivalent on all sides and ends is required.

Banding with 0.5-in. plastic or equivalent is required.

The following two possible approaches are acceptable with respect to addressing inleakage and ensuring that there is no transport of radioactive materials out of the packaging.

- Securely enclose the radioactive contents within the box (e.g., wrap and seal in plastic, etc.) so that any inleaking water cannot come in contact with the radioactive material.

- Ensure that there is no loose or removable contamination that would be entrained in any liquid and that the radioactive material is not soluble in the liquid. Thus, even if the liquids come in contact with the radioactive material, there could be no transport from the package.

NOTE: There are obviously other possible approaches; however, if an alternative approach is chosen, the basis for the choice must be supported and documented. The use of one of these alternatives or an equivalent method allows these wooden boxes to meet this requirement.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

5.1.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

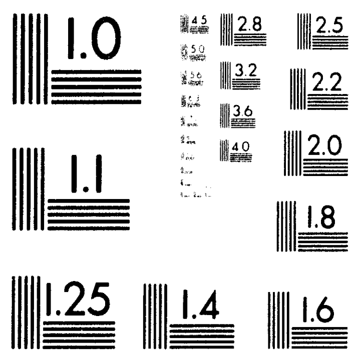
Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-4.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-4.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-7.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. Packaging passes only when specified plastic tape is used. This test was conducted prior to each test. See Appendix D, Table D-6.
Free drop	Pass. Packaging passes only when specified plastic tape is used. Note: Each package must be analyzed with respect to the 20% radiation level increase criterion. See Appendix D, Table D-15.
Corner drop	Each size packaging was subjected to this test with no loss of contents. See Appendix D, Table D-21.
Compression	Pass. This test was conducted for 24 hr with five times the gross weight and, when the Triple-Wall supports were used, this test had no significant effect on the packaging. See Appendix D, Table D-26.
Penetration	Pass. The bar routinely penetrated the outer fiberboard surface but, considering the restricted contents, this is not significant. See Section 5.1.3, Restrictions/Specifications, and Appendix D, Table D-33.

5.1.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
	Lid or cover/body interface	Functional: • Ease of lid application • Mating surfaces flat and smooth, no foreign matter • Geometry, as specified
Sealing methods/ materials	Materials, as specified	Acceptable Conditions: • Tape, water resistant • Staples, type and spacing • Thickness • Composition • Corrugations • Surface treatment, etc. • Dimensions, as specified
	Vendor experience and qualification	Vendor Data/Certification: • Marking • Test data • Type A certification document as appropriate Lot test/ inspections as appropriate by shipper.

*These criteria apply to first time use and reuse as a DOT-7A Type A packaging.


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0

5.1.6 Additional Information

Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

5.1.6.1 Primary Users

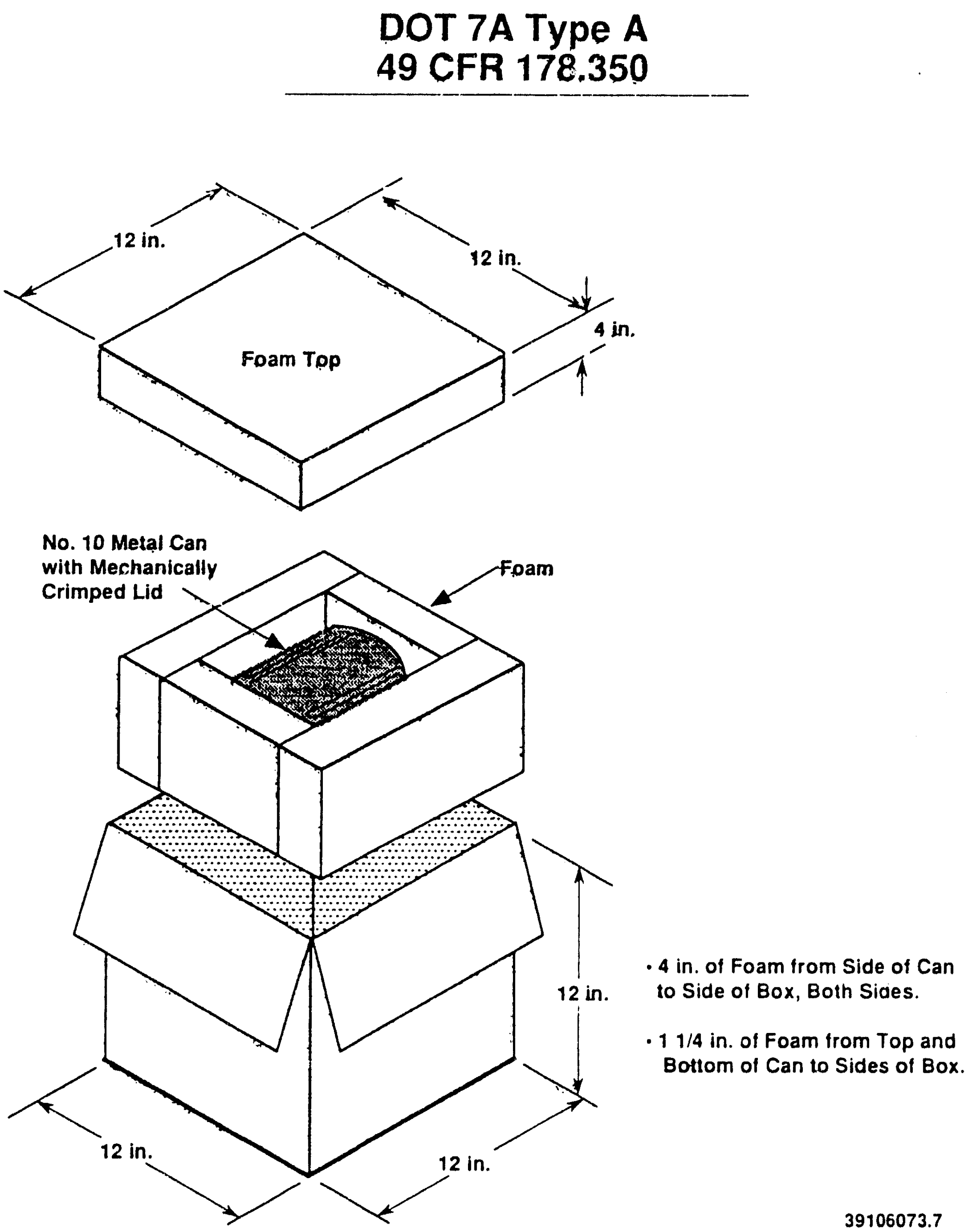
Site/Contact/Phone	Address
MMES H. E. Crowder COMM/FTS 615-574-2689	Martin Marietta Energy Systems, Inc. P. O. Box Y Oak Ridge Y-12 Plant Oak Ridge, TN 37830

5.1.6.2 Suppliers

- Tape--Polyken Industrial Tape, #837 Clear, 3 in.
  Kendall, Ployken Division
  Boston, MA 02101

- Triple-Wall
  Lewisburg Container Corporation
  Lewisburg, OH

Figure 5-2. LLNL Fiberboard Box.



5.2 LLNL 12B-10 FIBERBOARD BOX

5.2.1 Package Description

Dimensions

Height (in.)	Width (in.)	Length (in.)
12	12	12

Materials/Method of Construction

Fiberboard box	12B-65 (49 CFR 178.205)
Foam cushioning	4-in. minimum--sides, top, and bottom
No. 10 metal can	Mechanically sealed
Tape	2-in. fiber reinforced paper tape*

*This particular tape withstood the 1-hr water spray test with no significant effects.

5.2.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

5.2.2.1 Physical Form

5.2.2.1.1 Solids Only. Three material forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements (e.g., RTV, inner bag, etc.).

- **Material** Form No. 1: Solids--any particle size.
- **Material** Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.).
- **Material** Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.433, Contamination control.)

5.2.2.1.2 Maximum Gross Weight

- 10 lb.

5.2.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

5.2.2.3 Radiological. The 4-ft drop test caused deformations of the package resulting in small decreases in the distance from the exterior to the center of the package. The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such deformations would occur.

5.2.3 Restrictions/Specifications

Contents must be of a size that would not move through the 1.25-in.-diameter hole resulting from the penetration test bar.

Water-resistant tape is required.

5.2.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-4.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-4.
49 CFR 173.412, Additional requirements for Type A package	Meets applicable requirements. See Appendix C, Table C-7.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. This test was conducted prior to the tests shown below. This test by itself had no significant effect. Because of the sealed metal inner container, the potential inleakage of water will not adversely affect the performance. See Appendix D, Table D-6.
Free drop	Pass. This test was conducted on a top corner with only a minor crumbling of the impacted corner. After each test the metal can was inverted in water in a vacuum chamber and subjected to a reduced pressure. No bubbles were detected, indicating positive containment. See Appendix D, Table D-15.
Corner drop	Pass. The packaging would pass by analysis and comparison to tests on similar packagings. See Appendix D, Table D-21.
Compression	Pass. This test was conducted at 100 lb for 24 hr with no detectable effect. See Appendix D, Table D-26
Penetration	Pass. This test was conducted on the side (impacted sealed end of can) and on the top of the box (impacted side of can). In each case the bar penetrated the box, but the foam prevented major damage to the can. In each case there was a dent approximately 0.5 in. in the can. After each test the metal can was inverted in water in a vacuum chamber and subjected to a reduced pressure. No bubbles were detected, indicating positive containment. See Appendix D, Table D-33.

5.2.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
	Lid or cover/body interface	Functional: • Ease of lid application • Mating surfaces flat and smooth, no foreign matter • Geometry, as specified • Closure "secure"
Sealing methods/materials	Materials, as specified	Acceptable Conditions: • Tape, water resistant • Staples, type and spacing • Thickness • Composition • Corrugations • Surface treatment, etc. • Dimensions, as specified • Test seals conducted for can sealer • Testing of metal can seal as appropriate Vendor Test/Certification: • Marking • Test data • Type A evaluation documentation as appropriate Lot tests/inspections as appropriate by shipper

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

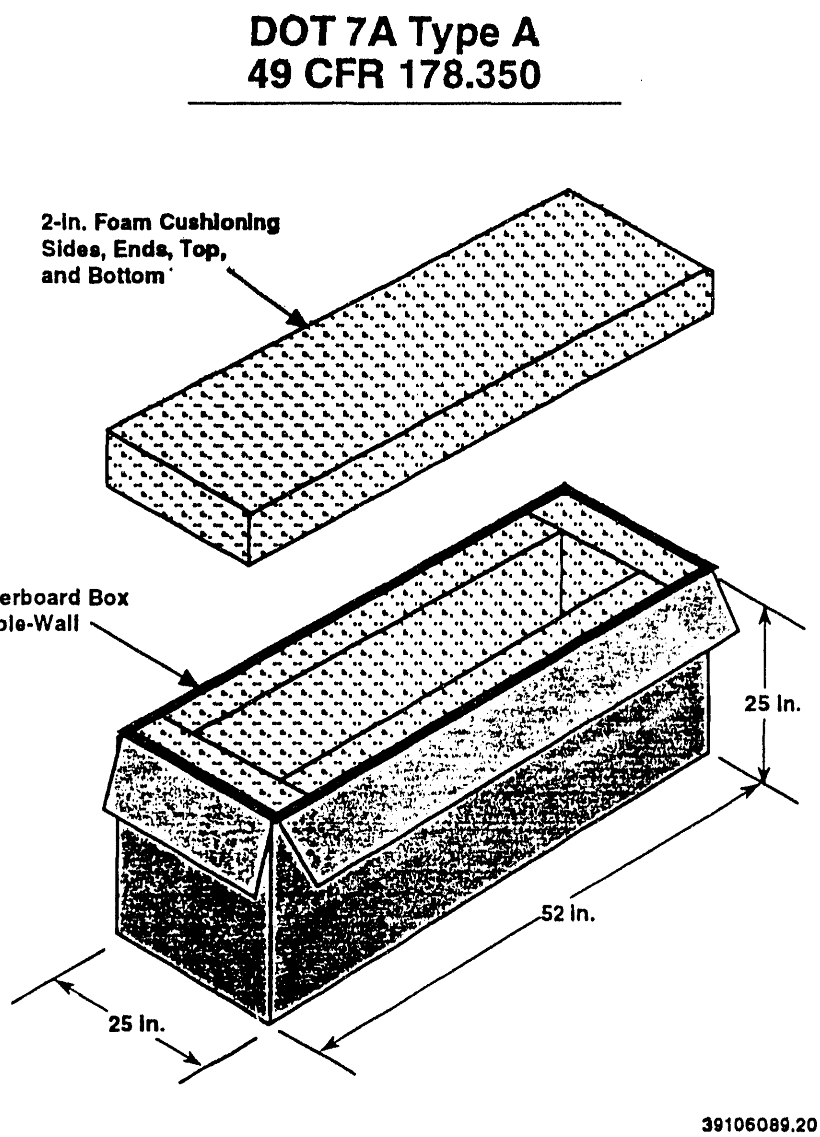
5.2.6 Additional Information

Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2

5.2.6.1 Primary Users

Site/Contact/Phone	Address
LLNL Steve Chin COMM/FTS 510-422-0470	University of California Lawrence Livermore National Laboratory P.O. Box 808 Livermore, CA 94550

Figure 5-3. Tri-Wall Package Fiberboard Box.



5.3 TRI-WALL FIBERBOARD BOX

5.3.1 Package Description

Dimensions

Height (in.)	Width (in.)	Length (in.)
25	25	52

Materials/Method of Construction

Tri-Wall fiberboard box	0.5 in. thick (see Section 5.3.6.2)
Urethane foam inserts	2 in. thick
Banding	Tested with 0.5-in. plastic bands 2 around sides and ends 2 around top and ends 2 around top, sides, and bottom Any equivalent or better banding is authorized
Taped closure	3-in. plastic tapes (or equivalent, see Section 5.3.6.2)

5.3.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

5.3.2.1 Physical Form

5.3.2.1.1 Solids Only. One material form is authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements (e.g., RTV, etc.).

- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.433, Contamination control.)

5.3.2.1.2 Maximum Gross Weight

- 350 lb
  - Packaging = 75 lb
  - Net contents = 275 lb.

5.3.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

5.2.2.3 Radiological. The 4-ft. drop test caused deformations of the package resulting in small decreases in the distance from the exterior to the center of the package. The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such deformations would occur.

5.3.3 Restrictions/Specifications

Contents restricted to solid objects with no significant dispersible or removable contamination.

Contents must be of a size that would not move through the 1.25-in.-diameter hole resulting from the penetration test bar.

Water resistant tape is required.

The following two possible approaches are acceptable with respect to addressing inleakage and ensuring that there is no transport of radioactive materials out of the packaging.

- Securely enclose the radioactive contents within the box (e.g., wrap and seal in plastic, etc.) so that any inleaking water cannot come in contact with the radioactive material.
- Ensure that there is no loose or removable contamination that would be entrained in any liquid and that the radioactive material is not soluble in the liquid. Thus, even if the liquids come in contact with the radioactive material, there could be no transport from the package.

NOTE: There are obviously other possible approaches; however, if an alternative approach is chosen, the basis for the choice must be supported and documented. The use of one of these alternatives or an equivalent method allows these boxes to meet this requirement.

For heavy, bulky materials (i.e., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

5.3.4 49 CFR 178.350 Regulatory Requirements

Testing/Analysis Results

49 CFR 173.24, Standard requirements for All packages	Meets applicable requirements. See Appendix A, Table A-4.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-4.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-7.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	Pass. Packaging passes only when specified plastic tape is used. This test was conducted prior to each test. See Appendix D, Table D-6.
Free drop	Pass. The tests were conducted with the box impacting on the top corner. The only effect was a crumbling of the impacted corner. The maximum decrease in distance was 1.75 in. This is not expected to be significant; however, each shipper must make this determination. See Appendix D, Table D-15.
Corner drop	Not required.
Compression	Pass. This test was conducted at greater than 2,500 lb for 24 hr with no significant effect on the package geometry or loss of contents. See Appendix D, Table D-26.
Penetration	Pass. This test was conducted on the top (middle) and on one side (middle). In each case the bar penetrated the top and side wall, hence the Restriction in Section 5.3.3. See Appendix D, Table D-33.

5.3.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
	Lid or cover/body interface	Functional: • Ease of lid application • Mating surfaces flat and smooth, no foreign matter • Geometry, as specified
Sealing methods/materials	Materials, as specified	Acceptable Conditions: • Tape, water resistant • Staples, type and spacing • Thickness • Composition • Corrugations • Surface treatment, etc. • Dimensions, as specified
	Vendor experience and qualification	Vendor Test/Certification: • Marking • Test data • Type A certification document, as appropriate Lot tests/inspections as appropriate by shipper.

*These criteria apply to first time use and to reuse as a DOT-7A Type A packaging.

5.3.6 Additional Information

Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

5.3.6.1 Primary Users

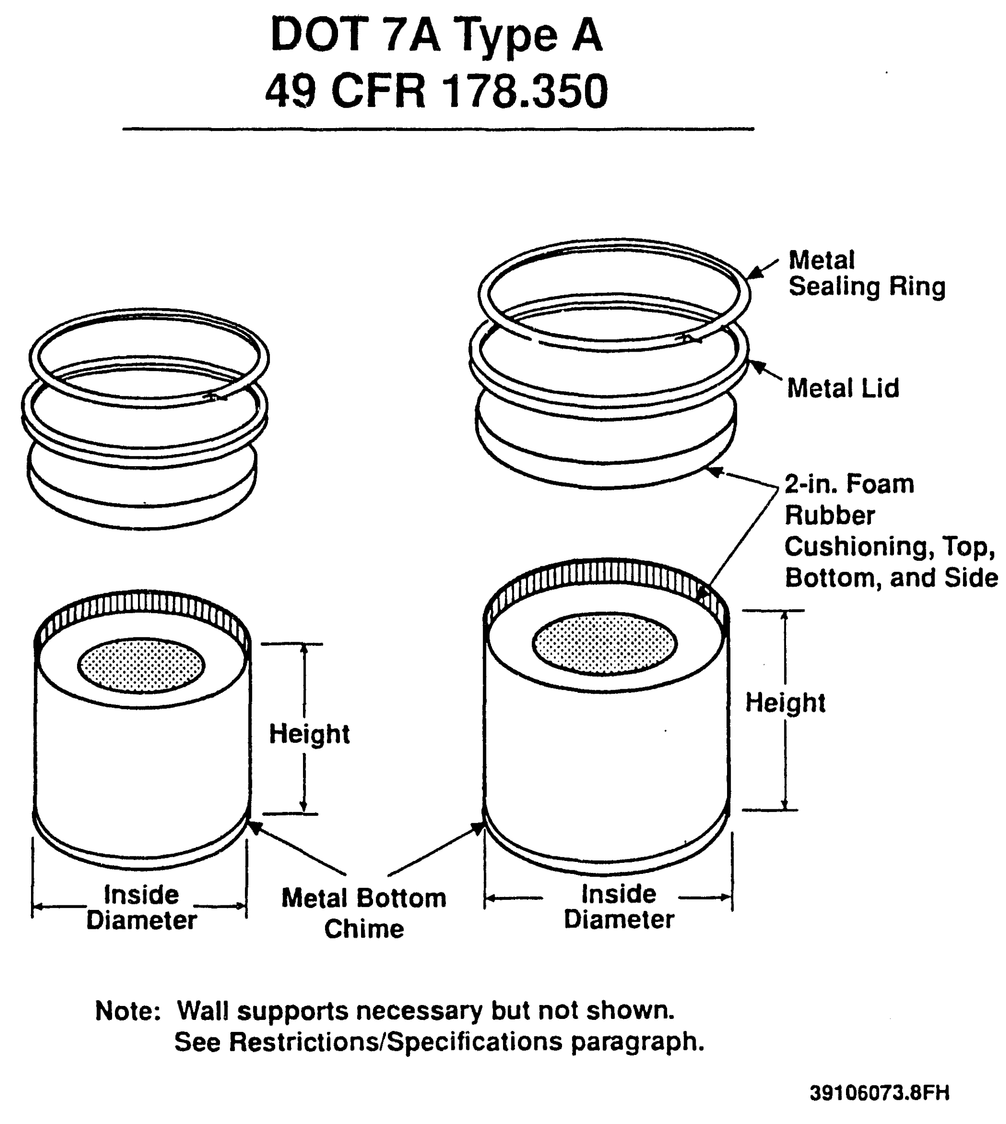
Site/Contact/Phone	Address
MMES H. E. Crowder COMM/FTS 615-576-9100	Martin Marietta Energy Systems, Inc. P. O. Box Y Oak Ridge Y-12 Plant Oak Ridge, TN 37830

5.3.6.2 Suppliers

- Tape--Polyken Industrial Tape, #837 Clear, 3 in.
  Kendall, Polyken Division
  Boston, MA 02101

- Tri-Wall
  Gould Southern

Figure 5-4. DOT Specification 21C Fiberboard Drum.



5.4 DOT-21C FIBERBOARD DRUM

5.4.1 Package Description

Dimensions and 4-ft Drop Test Results

Dimensions	Height (in.)	Diameter (in.)	Decrease in distance from corner to center of package (in.)
1	10.00	16.0	Bottom 0.75
2	15.50	16.0	Bottom 0.50
3	21.25	16.0	Top 1.00
4	9.75	20.5	Bottom 1.00
5	13.25	20.5	Bottom-chime 1.50
6	27.25	22.0	Bottom-chime 0.50

Materials/Method of Construction

Sides, walls, and bottom	Fiberboard (49 CA⁰ 178.224)
Supports	Fiberboard Triple-Wall (See Section 5.4.6.2)
Top	Metal
Closure	Metal ring with lever style closure with gasket
Metal chime at bottom edge	
Gasket required	

5.4.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

5.4.2.1 Physical Form

5.4.2.1.1 Solids Only. One material form is authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements (e.g., RTV, etc.).

- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.433, Contamination control.)

5.4.2.1.2 Maximum Gross Weight

- 115 lb.

5.4.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

5.4.2.3 Radiological. The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level prior to the test) as a result of the decrease in distance to the center of the package resulting from the 4-ft drop test. This decrease in distance for each package is given in the Dimensions and 4-ft Drop Test Results table in Section 5.4.1.

5.4.3 Restrictions/Specifications

Contents must be of a size that would not move through the 1.25-in.-diameter hole resulting from the penetration test bar.

Triple-Wall supports (minimum of five 1-in. pieces on opposite sides of the package).

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

5.4.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirement	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-4.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-4.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-7.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	<u>Pass</u>. This test was conducted prior to all the tests shown below. This test by itself had no significant effect on the packagings and there was no evidence of inleakage of water. See Appendix D, Table D-5.
Free drop	<u>Pass</u>. This test was conducted on the top closure ring and bottom chime with no loss of contents and only a crumpling of the edge. The side drop had little detectable effect. Note the 20% radiation level analysis required in Section 5.4.3, Restrictions/ Specifications. See Appendix D, Table D-16.
Corner drop	<u>Pass</u>. This test was conducted on each package with no effect. Thus, these packages are authorized at all weights ≤ 115 lb. See Appendix D, Table D-22.
Compression	<u>Pass</u>. This test was conducted with five times the gross weight for 24 hr, and when the Triple-Wall supports (required) were used, this test had no significant effect on the packaging. See Section 5.4.3, Restriction/ Specifications. See Appendix D, Table D-26.
Penetration	<u>Pass</u>. The bar penetrated the side walls about 50% of the time, but, considering the restricted contents, this should not be of significance. See Section 5.4.3, Restrictions/Specifications. See Appendix D, Table D-33.

5.4.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface Sealing surface	Vendor qualifications and experience	Fiberboard containers are not reusable Functional: • Ease of lid application • Closure ring size • Geometry, as specified Acceptable Conditions: • Lack of dents, no deformation of sealing surfaces • Dimensions, as specified • No sharp edges
Gasket		• Gasket size, material, geometry, adhesives, as specified
Body and chime	Material thickness Composition	Lot tests by shipper as appropriate and/or vendor data/certification: • Marking • Test data • Type A certification document as appropriate
	Protective coating application	Visual: • Surface/coating as specified

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

5.4.6 Additional Information

Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

5.4.6.1 Primary Users

Site/Contact/Phone	Address
MMES H. E. Crowder COMM/FTS 615-574-2689	Martin Marietta Energy Systems, Inc. P. O. Box Y Oak Ridge Y-12 Plant Oak Ridge, TN 37830

5.4.6.2 Suppliers

Triple-Wall
Lewisburg Container Corporation
Lewisburg, OH

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Appendix B

Waste Containers/Storage Casks

Appendix B.1	Waste Containers
Appendix B.2	High Integrity Containers (HICs)
Appendix B.3	Filter Canisters
Appendix B.4	Storage Casks

Appendix B.1

Waste Containers

CHEM-NUCLEAR DISPOSAL LINERS
DIMENSION AND VOLUME

Liner Composition	Liner Size/Type*	Empty Weight (lbs.)	Height (Inches)	Diameter (Inches)	Max. Internal Vol. (Cu.Ft.)	Usable Vol. (Cu.Ft.) Dewater/Solid	Disposal Volume
Carbon Steel	L1-13	500	51.375	25	12.5	12/NA	14.6
	L3-55	945	109.25	34	52.9	52/NA	57.4
	L6-80 HT	1000	57	58	82.9	NA	87.2
	L6-80 CHT	1150	57	58	82.9	NA/80	87.2
	L6-80 In-Situ	3500	57	58	49.8	NA	87.2
	L6-80 FR	1050	57	58	82.9	77/NA	87.2
	L6-80 FP/FEDX	1225	57	58	82.9	75/NA	87.2
	L7-100 HT	1300	40	74.5	94.1	NA	100.9
	L7-100 CHT	1450	40	74.5	94.1	NA/89	100.9
	L8-120 HT	1200	74	61	120.2	NA	125.2
	L8-120 CHT	1350	74	61	120.2	NA/117	125.2
	L8-120 In-Situ	4200	74.5	61	80.3	NA	126
	L8-120 FR	1250	74	61	120.2	114/NA	125.2
	L8-120 FP/FEDX	1325	74	61	120.2	112/NA	125.2
	L14-170 TVA Custom	1450	73.25	69	151.3	NA/147	158.5
	L14-170 HT	1550	71.375	74.5	172.7	NA	180.1
	L14-170 CHT	1750	71.375	74.5	172.7	NA/168	180.1
	L14-170 In-Situ [redacted]	T B D	74	74.5	66.1	NA	186.7
	L14-170 FR	1600	71.375	74.5	172.7	163/NA	180.1
	L14-170 FP/FEDX	1750	71.375	74.5	172.7	160/NA	180.1
	L14-195 HT	1650	79	76	199.6	NA	207.4
	L14-195 CHT	1850	79	76	199.6	NA/195	207.4
	L14-195 In-Situ	6300	78.5	76	138.5	NA	206.1
	L14-195 FR	1700	79	76	199.6	190/NA	207.4
	L14-195 FP/FEDX	1850	79	76	199.6	187/NA	207.4
	L21-300 HT	2200	108	82	320.6	NA	330.1
	L21-300 FP/FEDX	2450	108	82	320.6	303/NA	330.1
	24" x 72" PV	530	72	24	16.5	14/NA	18.8

NOTE: Steel Liners

A. Cement liners are for 0 filters. For 3 filters add 15 lbs. For 6 filters add 25 lbs.

B. For remote grapple rings add:

14-195 - 93 lbs.
14-170 - 91 lbs.
8-120 - 74 lbs.
7-100 - 91 lbs.
6- 80 - 71 lbs.

*See attached standard codes

PACIFIC NUCLEAR

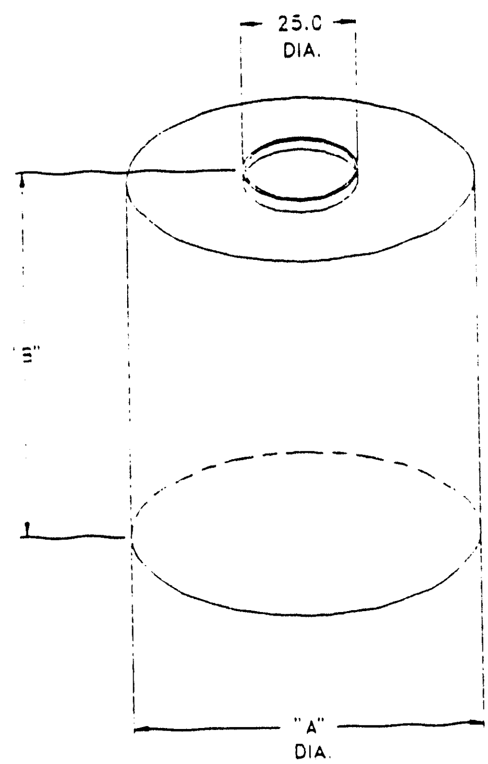
CARBON STEEL LINER

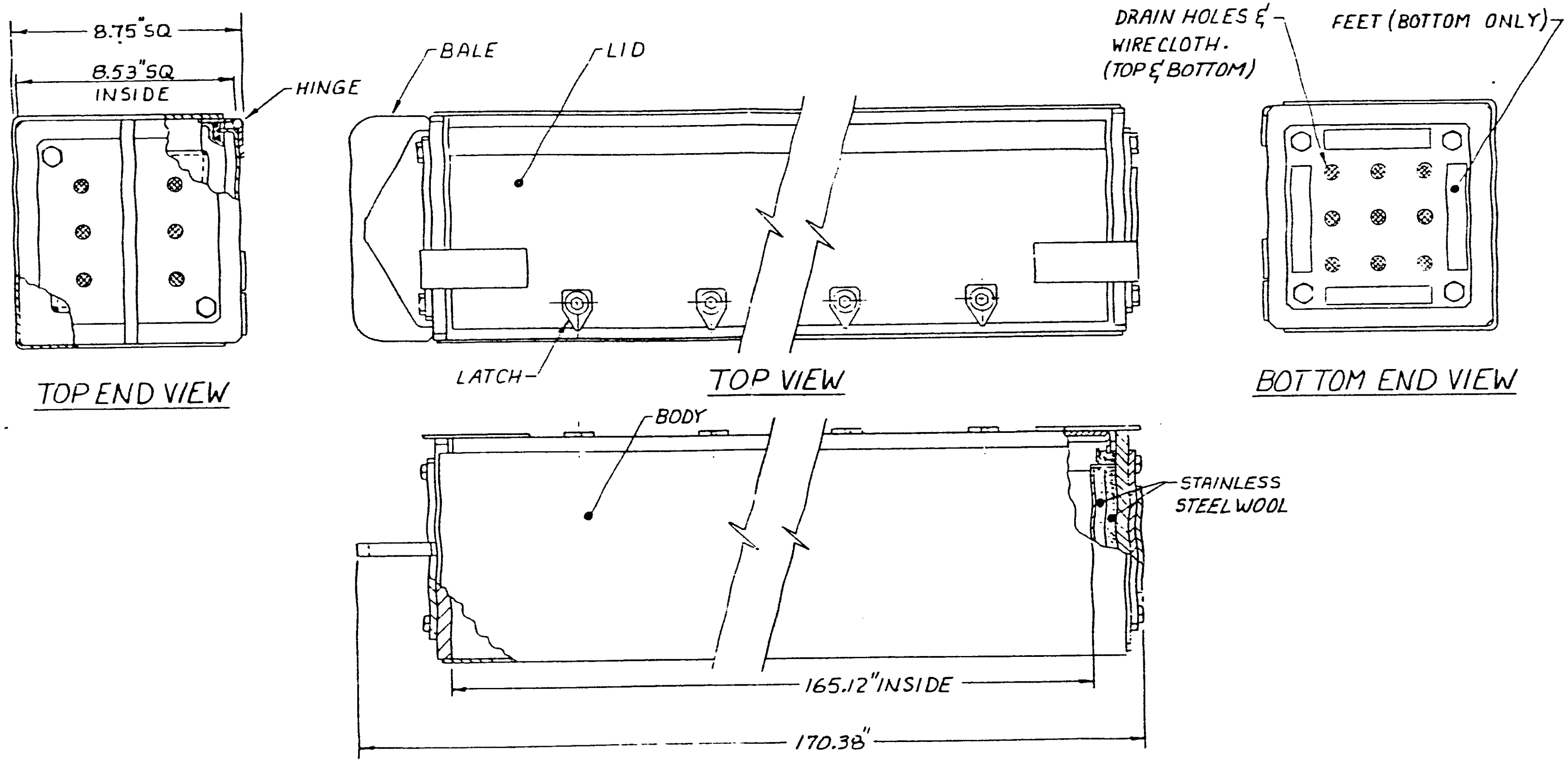
Carbon Steel Liners
w/Snap-On Lids

Container Model	Dimensions (Ins.)		Container Wt. (Lbs.)		Internals Wt. (Lbs.)			Volume (Cu. Ft.)		
Ref. Doc.	A-Dia	B-Ht	Tare	Gross	Bead	Powdex	Solid.	Empty (Int.)	Burial	Solid.
ES-50 X-20-221D	47.25	51.0	250	4,200	TBD	TBD	150	49.3	52.0	46.8
ES-142 X-20-266D	63.5	69.75	1,100	10,000	65	180	TBD	122.2	128.3	TBD
ES-190 X-20-225D	72.5	71.0	1,285	16,800	75	190	TBD	162.4	170.2	TBD
ES-210 X-20-224D	74.75	78.25	1,475	18,000	75	200	230	191.0	199.4	185
ES-210 X-20-224D	74.75	78.25	1,475	20,000	75	200	230	191.0	199.4	185
* ES-210 X-20-224D	74.75	78.25	1,475	25,000	75	200	230	191.0	199.4	185

TBD = To Be Determined

• OPTION: 4 Point Lift Lug





SIDE VIEW

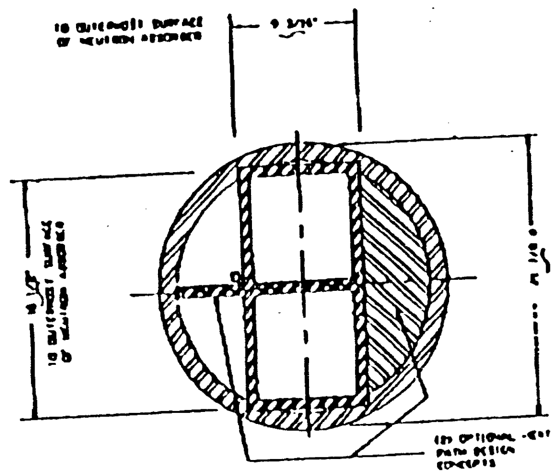
NOTES:

1. USEABLE VOLUME ≅ 6.8 FT^3
2. SIDE LOADING
3. APPROVED BY C.N.S.I. AND STATE OF SOUTH CAROLINA FOR USE AT BARNWELL BURIAL SITE.
4. MATERIAL - STAINLESS STEEL
5. HANDLING AND LOADING TOOLS ALSO AVAILABLE.

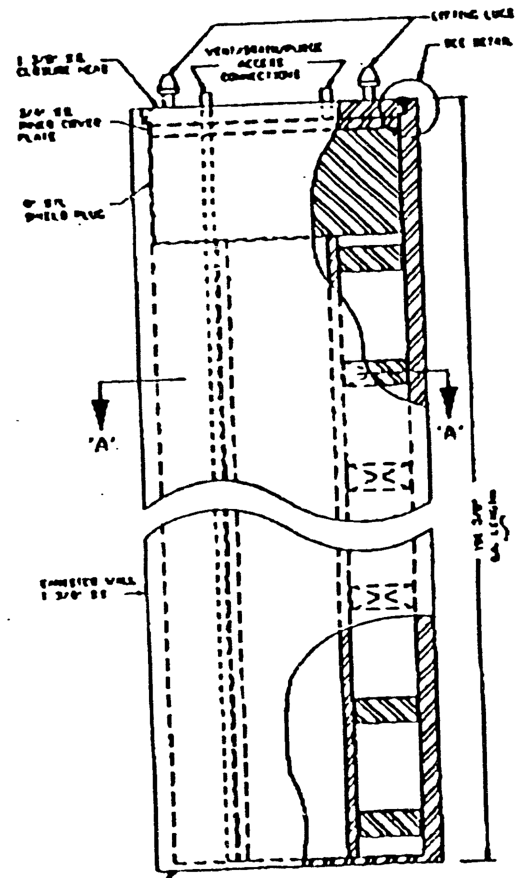
TRANSNUCLEAR, INC.
HAWTHORNE, N.Y.

TN-8L WASTE LINER

Small MPC - Preliminary Concept



SECTION 'A-A'
ARRANGEMENT OF 2 PWR SNF ASSEMBLIES IN MULTIPURPOSE LWT (LEGAL WEIGHT TRUCK) CANISTERS



ELEVATION VIEW
SNF ASSEMBLIES IN MULTIPURPOSE LWT CANISTERS

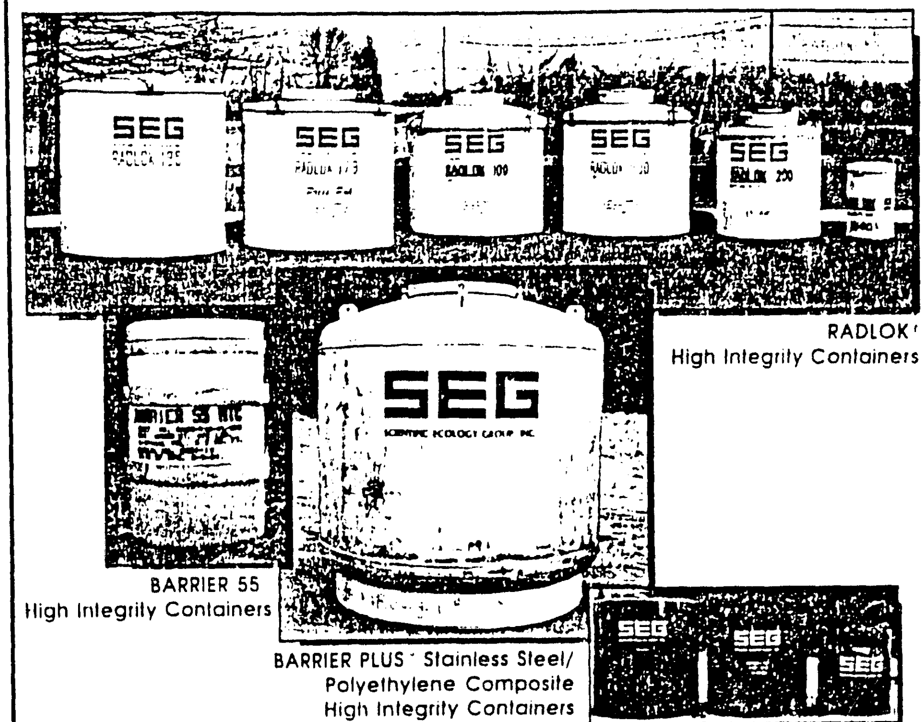
OCRWM multi-purpose canister concepts

SEG

SCIENTIFIC ECOLOGY GROUP, INC.

The World Leader In Radwaste Processing and Management

Radwaste Containers



RADLOK® High Integrity Containers

BARRIER 55 High Integrity Containers

BARRIER PLUS™ Stainless Steel/ Polyethylene Composite High Integrity Containers

Steel Radwaste Containers

SEG offers all the attractive alternatives to waste packaging.

The Scientific Ecology Group designs, manufactures, and inventories an extensive selection of specialized and regulatory-approved radwaste disposal containers. These SEG containers have the flexibility to accomodate the installation of various internal mixers and custom underdrains that are needed to meet the individual waste stream processing requirements of our customers.

SEG quality standards are built into every disposal container.

From the ASME-qualified welding in our steel liners to the composite construction of our stainless steel BARRIER PLUS™ series - and everything in between - SEG is committed to quality fabrication and reliability that meet or exceed the standards of the industry.

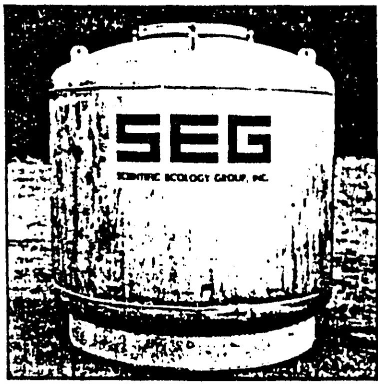
SEG Radwaste Containers are perfectly compatible to our own SEG fleet of shipping casks, as well as other industry casks.

Thoroughly tested, inspected and approved, each SEG Radwaste Container delivered fully complies with all pertinent state burial and NRC regulations. Furthermore, all SEG containers that are supplied with underdrains have a direct verification feature to assure that minimum regulatory performance standards for dewatering are exceeded.

For more information contact:
SEG
P.O. Box 2530
1560 Bear Creek Road
Oak Ridge, TN 37830
(615) 481-0222

SEG is a wholly owned subsidiary of WESTINGHOUSE

An easy reference of various IN-STOCK SEG containers follows:

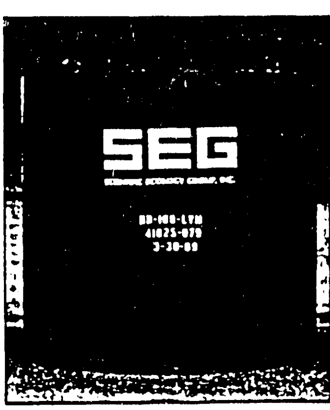


BARRIER PLUS™
Stainless Steel/Polyethylene Composite

MODEL #	INTERNAL VOL. (CF)	CASK MODEL
179	158	170/190/215
131	114	135/142
118	100	120

RADLOK® and BARRIER 55™
Polyethylene

MODEL #	INTERNAL VOL. (CF)	CASK MODEL
195	173	215
179	157	170/190/215
100 (163)	126	170/190
500 (136)	111	135/142
200 (73)	57	200 (82)
55 (8.5)	6.5	ALL
B 55 (9.2)	6.5	ALL



Standard SEG Liners

MODEL #	CASK MODEL
208	215
182	170/190
136	135/142
76	200 (82)

SEG
SCIENTIFIC ECOLOGY GROUP INC

A wholly owned subsidiary of WESTINGHOUSE

Volume in parentheses reflects burial or cavity volume in CF.

Appendix B.2

High Integrity Containers (HICs)

PACIFIC NUCLEAR

ENVIRALLOY HIC

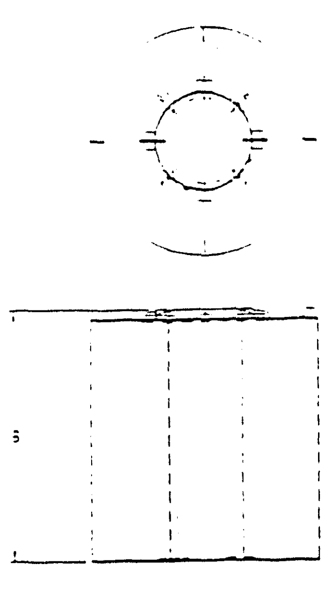
Container Model (1)	Dimensions (Ins.)		Container Wt. (Lbs.)		Internals Wt. (Lbs.)		Volume (Cu.Ft.)	
	A-Dia	B-Ht	Tare	Gross	Bead	Powdex	Empty (Int.)	Burial
EA-50-A	46.5	50.75	(2) 1,500	4,200	TBD	TBD	44.9	49.9
EA-142-A	64.0	70.25	2,960	10,000	65	180	120.9	130.8
EA-140-A	64.0	71.25	2,985	15,000	TBD	TBD	122.6	132.7
EA-190-A	73.5	71.63	3,825	20,000	75	190	163.2	175.9
EA-210-A	75.25	78.5	4,240	20,000	75	200	188.5	202.0
EA-50-C	46.5	50.75	1,560	4,200	N/A	N/A	42.4	49.9
EA-142-C	64.0	70.25	2,990	10,000	N/A	N/A	109.2	130.3
EA-140-C	64.0	71.25	3,015	15,000	N/A	N/A	111.1	132.7
EA-190-C	73.5	71.63	3,950	20,000	N/A	N/A	147.9	175.9
EA-210-C	75.25	78.5	4,395	20,000	N/A	N/A	175.0	202.0

NOTES: (1) Series Nomenclature
A: 24" opening
C: Full open bolted top

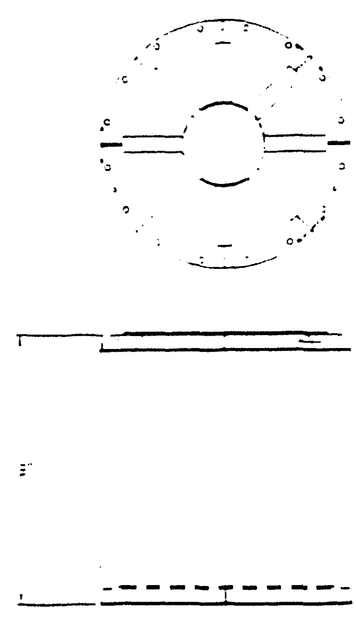
(2) Hanford-design weights shown; Barnwell designs slightly less (tare only)

Reference Document TP-07
N/A = Not Applicable
TBD = To Be Determined

SERIES "A" CONFIGURATION



SERIES "C" CONFIGURATION

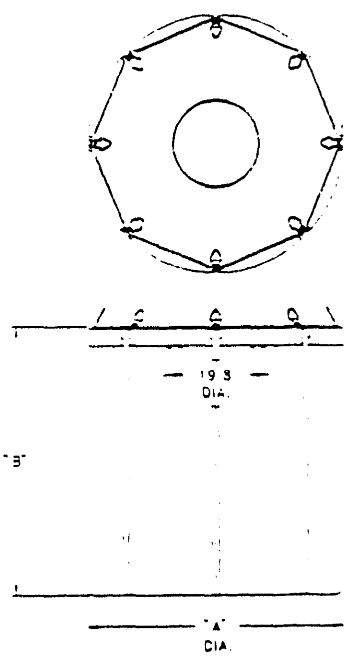


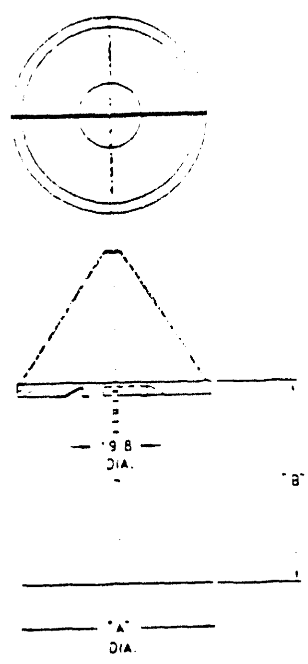
PACIFIC NUCLEAR

POLYETHYLENE HIC

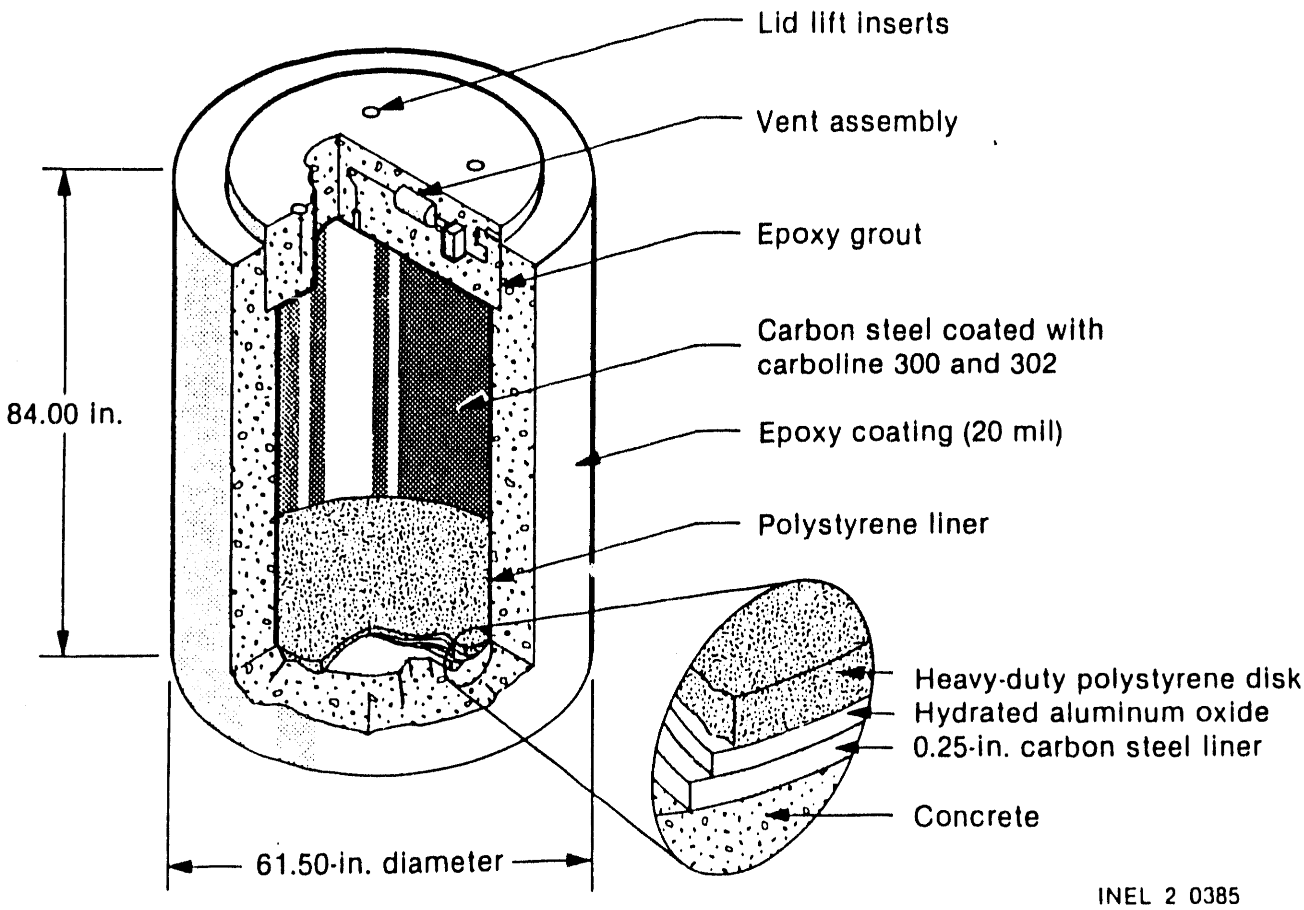
Container Model	Dimensions (Ins) A-Dia	Dimensions (Ins) B-Ht	Container Wgt. (Lbs.) Tare	Container Wgt. (Lbs.) Gross	Internals Wgt. (Lbs.) Bead	Internals Wgt. (Lbs.) Powdex	Volume (Cu.Ft.) Empty (Int.)	Volume (Cu.Ft.) Burial
EL-50	47.0	51.0	500	4,200	TBD	TBD	41.0	51.0
EL-142	64.5	70.0	650	8,250	65	180	113.6	132.4
EL-190	73.5	71.0	800	11,950	75	190	150.6	174.3
EL-210	75.5	78.0	900	13,000	75	200	176.7	202.1

Reference Document X-20-2300
TBD = To Be Determined





Chem-Nuclear Polyethylene HICs - Dimensions and Volumes					
Empty Size/Type Polyethylene HICs	Weight (Lbs.)	Height (In.)	Diameter (in.)	Internal Usable Vol. (cu ft.)	Disposal Volume
PL6-80 MT	500	56.5	57	73.3	83.4
PL6-80 MTIF	525	56.5	57	64.1	83.4
PL6-80 FR	550	56.5	57	73.3	83.4
PL6-80 FP/FEDX	625	56.5	57	73.3	83.4
PL8-120 MT	600	73.5	60	107.6	120.3
PL8-120 MTIF	625	73.5	60	95.8	120.3
PL8-120 FR	650	73.5	60	107.6	120.3
PL8-120 FP/FEDX	725	73.5	60	107.6	120.3
PL14-170 MT	800	71.5	72.5	150.3	170.8
PL14-170 MTIF	850	71.5	72.5	134.9	170.8
PL14-170 FR	850	71.5	72.5	150.3	170.8
PL14-170 FP/FEDX	1,000	71.5	72.5	150.3	170.8
PL14-195 MT	850	78	74	171.4	194.1
PL14-195 MTIF	900	78	74	154.6	194.1
PL14-195 FR	900	78	74	171.4	194.1
PL14-195 FP/FEDX	1,050	78	74	171.4	194.1
PL14-215 MT	1,200	78.375	76	189.2	205.8
PL14-215 MTIF	1,250	78.375	76	171.7	205.8
PL14-215 FR	1,250	78.375	76	189.2	205.8
PL14-215 FP/FEDX	1,400	78.375	76	189.2	205.8
PL21-300 MT	1,100	108	80	285.1	314.2
PL21-300 MTIF	1,175	108	80	262.1	314.2
PL21-300 FR	1,150	108	80	285.1	314.2
PL21-300 FP/FEDX	1,350	108	80	285.1	314.2

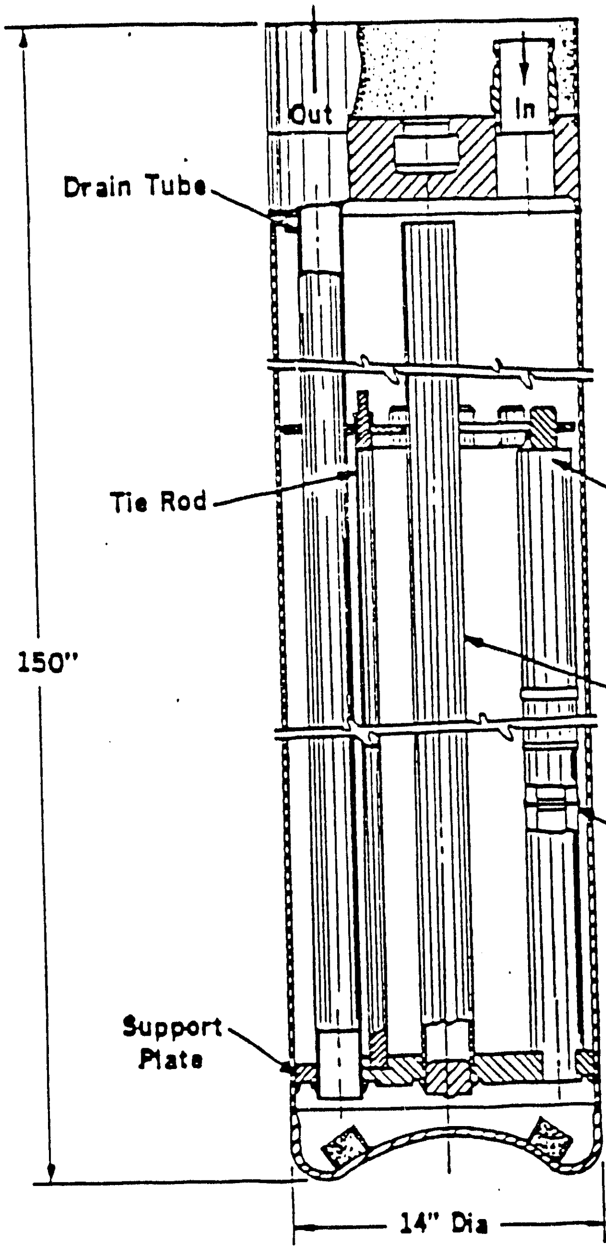


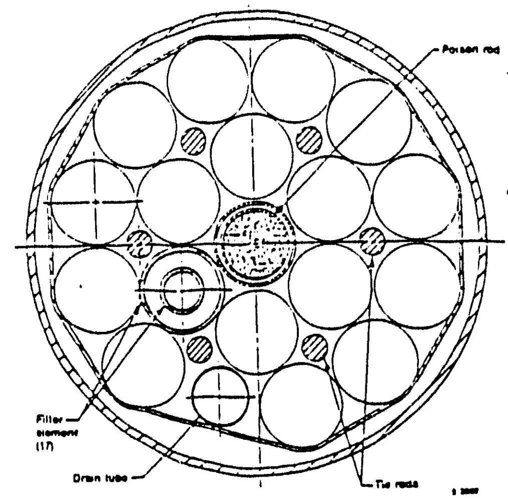
High integrity containers used for disposal of TMI-2 wastes

Appendix B.3

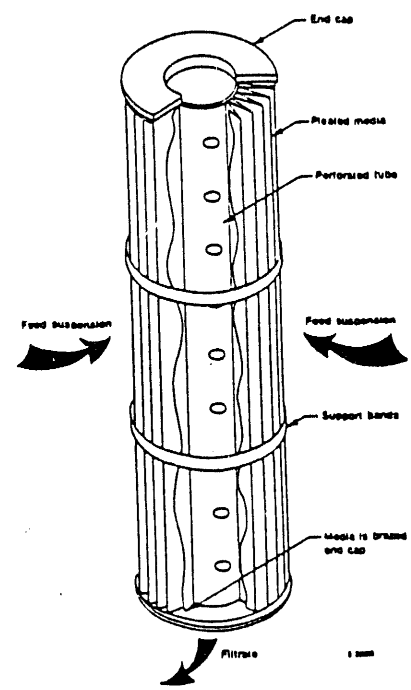
Filter Canisters

TMI-2 Filter Canister





Cross section of the TMI-2 core debris filter canister at midplane.



TMI-2 core debris filter canister module.

Filter canisters were used in the vacuum removal system to remove particles 850 μ and smaller from the flow stream. These canisters were also used in the defueling water cleanup system for the same purpose. In either system, water containing small fines entered the filter canister through an inlet nozzle on the upper head. The slurry flowed down into a full-diameter mixing chamber that was 30.5 cm (12 in.) long at the top of the canister. From the chamber, the slurry flowed down and around filter bundles consisting of a stack of 17 filter elements. Each filter element was made of sintered stainless steel filter media with corrugated pleats around a perforated core tube. The water flowed from the outside through the filter media and into the center tube, which directed the filtered water down into the lower head. The flow then went up a drain tube and out a nozzle on the upper head.

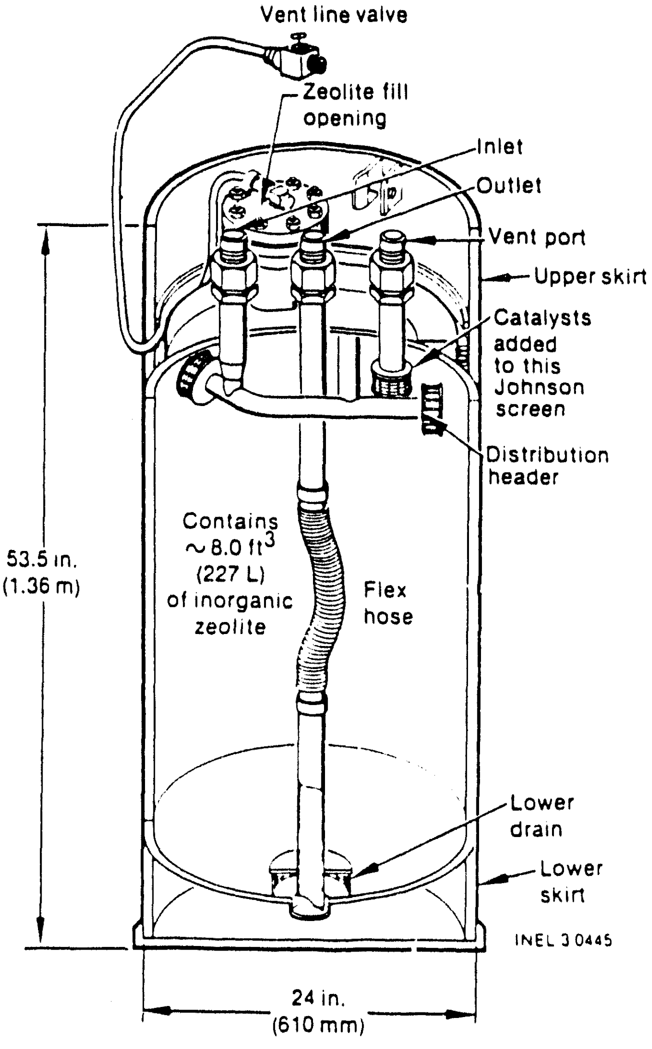
SDS Vessels

The Submerged Demineralizer System (SDS) was used at Three Mile Island Unit 2 (TMI-2) to process the access generated waste and remove radionuclides, principally cesium and strontium. The SDS vessels contained an inorganic ion absorption medium (demineralizer) called zeolite and were submerged in the TMI-2 spent fuel pool for radiation shielding, hence the name " Submerged Demineralizer System." The system pumped radioactive water through the zeolite beds in the vessels, leaving the radioactive contaminants, predominately ^{137}Cs and ^{90}Sr, bound in the structure of the zeolites. Each vessel was loaded with about 8 ft^3 of a mixture of two types of zeolites -- Linde IE-95 and Linde A-51.

The SDS filter system processed or reprocessed more than 2,000,000 gallons of accident generated water contaminated with 364,000 curies of cesium and strontium and 694,000 curies with daughter products. Radioactive loading on the expended zeolites were generally much higher than those for organic ion exchange wastes generated at normal commercial nuclear power plants.

Before the SDS vessels could be shipped, radiolytic gas production in the vessels had to be checked and quantified. In some vessels, H_2 and O_2 gases from radiolytic decomposition of water were being generated at rates that could have reached flammable gas concentrations during shipment, which is prohibited by Federal Regulation 49 CFR 173.21. To control the gas generation, a catalyst was inserted into each sealed vessel to recombine the radiolytic gasses back into water. The vessels were vacuumed dried to enhance catalyst system performance.

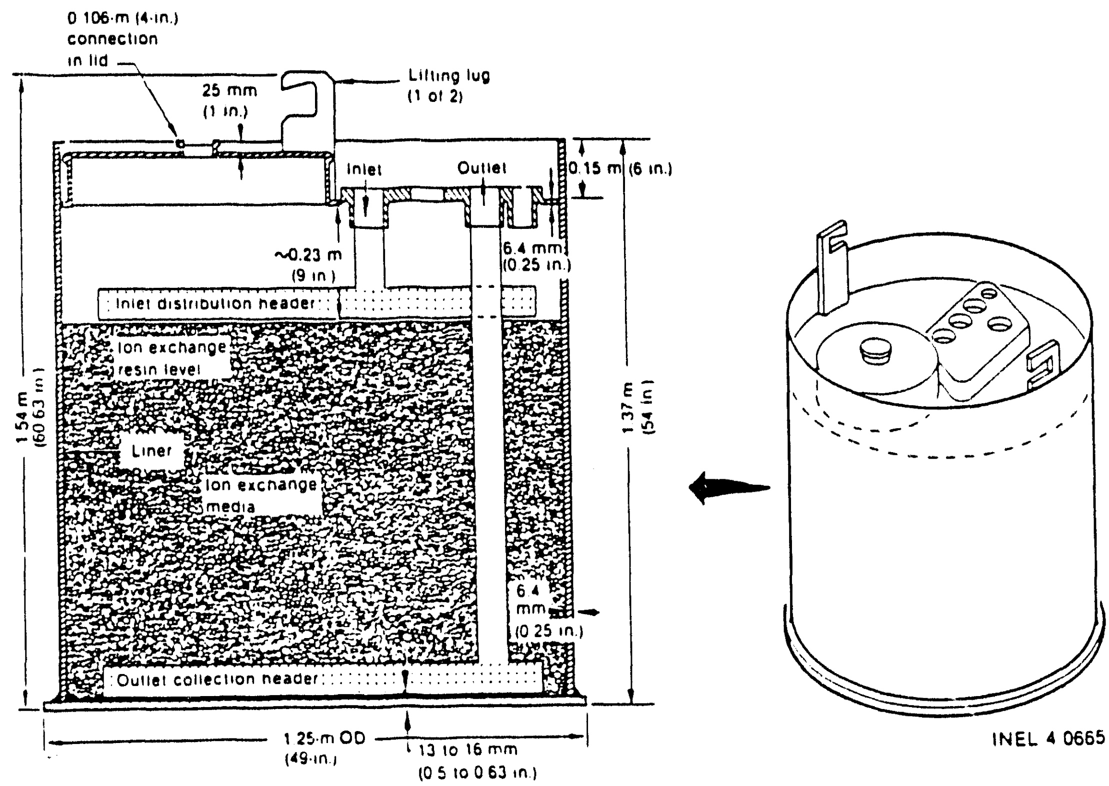
(A more detailed description of the SDS Vessels can be found in report by G. J. Quinn, J. O. Henrie and J. Greensborg, Submerged Demineralizer System Vessel Shipment Report, GEND-035, June 1984.)



EPICOR-II Prefilter

Each EPICOR-II prefilter liner is a cylinder 1.2 m (48 in.) in diameter by 1.4-m (54-in.) high, fabricated from 6.4-mm (1/4-in.) welded steel (Figure 1). Each liner contains ~850 m^3 (30 ft^3) of ion exchange media which are either organic resins or organic resins and zeolite absorbers. An inlet header system was used to spread unprocessed water over the top of the ion exchange media, while an outlet header system collected water processed through the ion exchange media. Each liner is coated inside and out with Phenoline 368 paint to protect it against corrosion. Metallurgical examination of two prefilter liners, performed as part of the EPICOR-II Research and Disposition Program, has shown that the estimated life of the liners before failure by corrosion is greater than 50 years. An EPICOR-II liner weighs 635 kg (1400 lb) empty and ~1542 kg (3400 lb) when loaded with resin. Resin loadings range from 585 kg (1290 lb) to 880 kg (1940 lb).

In processing water from the Auxiliary and Fuel Handling Buildings of TMI, each prefilter collected radionuclides consisting mostly of Cs-137, -134, and their daughter products; small amounts of Ru-106, Rh-106, Sr-90, Co-60, and Ba-137; and trace amounts of U-238 and some transuranic elements. Hydrogen gas is generated in the prefilters from radiolytic degradation of demineralizer materials and radiolysis of water. To prevent buildup of that gas, a plug was removed remotely from the vent port of each prefilter upon arrival at INEL. Removal of the vent plug allowed the gas to exit continuously from the prefilter during storage.



Appendix B.4

Storage Casks

CASTOR-1C

(1) Type	Storage
(2) Manufacturer/Vendor	GNSI
(3) Capacity (assys)	
(a) Intact SF	16 BWR
(b) Consolidated Fuel Rods	21 BWR
(4) Weight (tons)	
(a) Loaded	81.1
(b) Empty	76.6
(5) Thermal	
(a) Design Heat Rejection (kW)	14.4 (intact) 15.6 (consolidated)
(b) Peak Clad Temperature (^oC)	365 (intact) 348 (consolidated)
(6) Shape	Rounded Square
(7) Dimensions	
(a) Overall Length (in)	216.9
(b) Overall Cross Section (in)	68.1
(c) Cavity Length (in)	179.5
(d) Cavity Cross Section (in)	26.2
(e) Wall Thickness, w/o fins (in)	17.3
(f) Cooling Fin Length (in)	4.7
(g) Lid Thickness (in)	21.7
(h) Bottom Thickness (in)	17.6
(i) Basket Length (in)	172.0
(j) Basket Cross Section (in)	25.2
(k) Thickness of Basket Spacers	0.4
(8) Neutron Shield	
(a) No. Rods	80
(b) Rod Diameter (in)	2.4
(c) Side Thickness (in)	-
(d) Lid Thickness (in)	2.4
(e) Bottom Thickness (in)	1.6
(9) Materials of Construction	
(a) Cask Body	Nodular Cast Iron (Ni-Plated Inside)
(b) Basket	Borated SS
(c) Neutron Shield	Polyethylene
(10) No. Cooling Fins	48
(11) Cavity Atmosphere	He
(12) Cavity Pressure (psia)	11.8
(13) Outside Surface Dose (mR/hr)	20 av./200 max
(14) Maximum Leak Rate (l/s)	10^{-7}

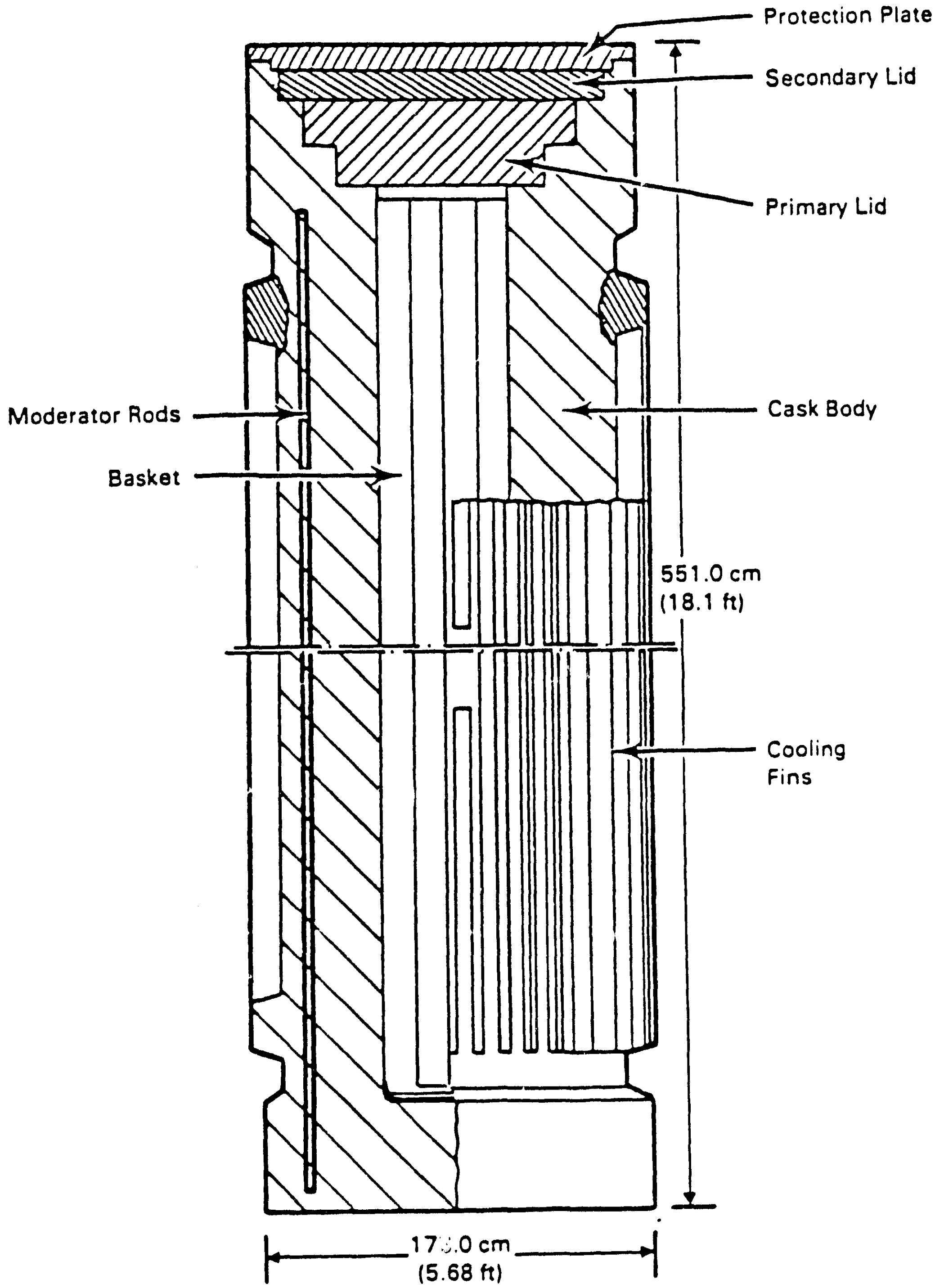
(15) Licensing Status NRC approved TSAR for storage Spring 1985 (10CFR71)

(16) Comments A single CASTOR-1C cask is available in the U.S. and is currently at the TVA Browns Ferry Plant.

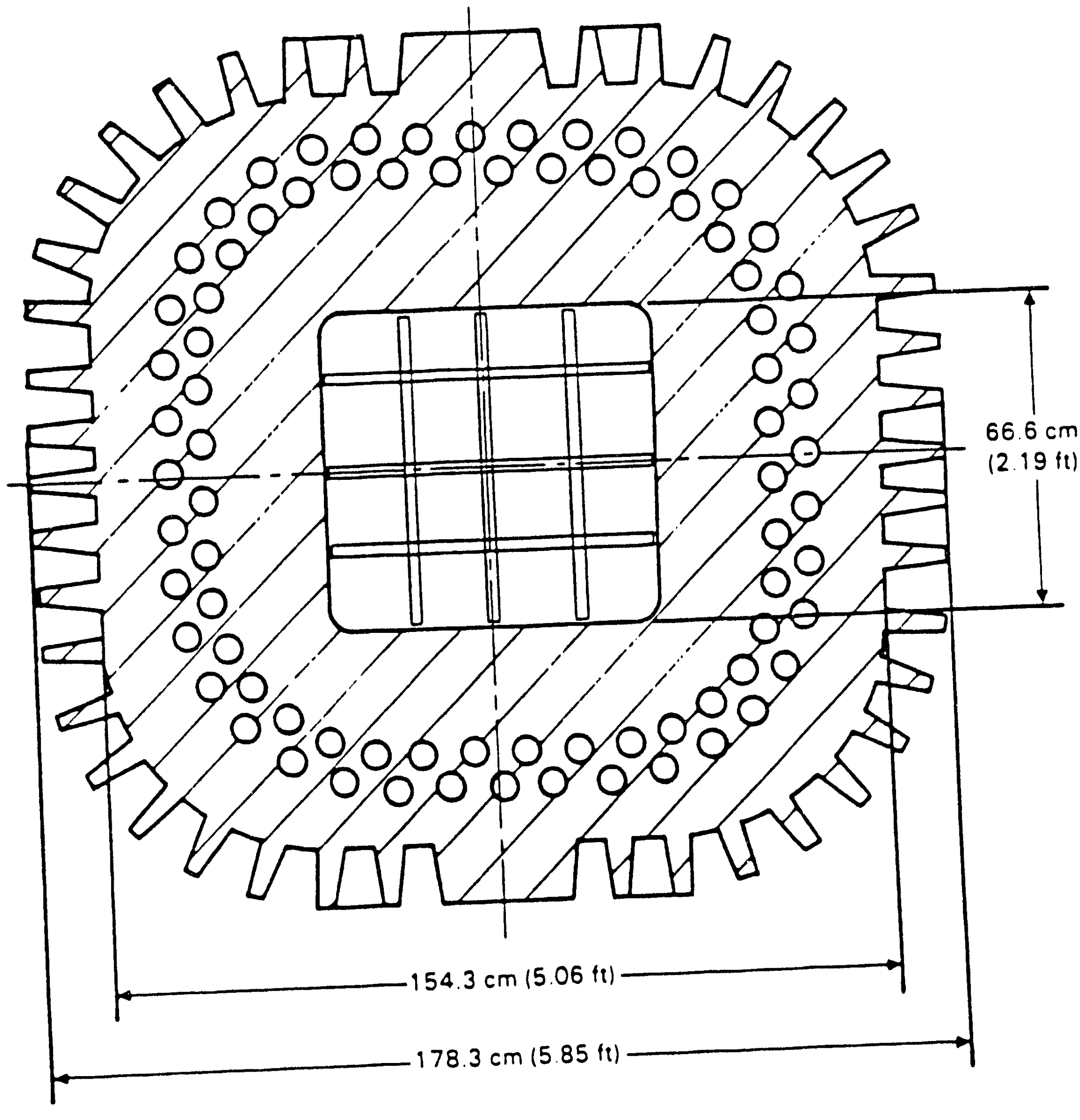
References

(1) D. R. Rector et al, Castor-1C Spent Fuel Storage Cask Decay Heat, Heat Transfer, and Shielding Analyses, PNL-5974, December 1986

(2) D. R. Rector et al, COBRA-SFS Thermal - Hydraulic Analysis of the CASTOR-1C and REA-2023 BWR Storage Casks Containing Consolidated Spent Fuel, PNL-5802, December 1986



ELEVATION VIEW OF THE CASTOR-1C CASK



CROSS SECTION OF THE CASTOR-1C CASK

CASTOR V-21

(1) Type	Storage
(2) Manufacturer/Vendor	GNSI
(3) Capacity (assys)	
(a) Intact SF	21 PWR
(b) Consolidated Fuel Rods	42 PWR
(4) Weight (tons)	
(a) Loaded	117
(b) Empty	102
(5) Thermal	
(a) Design Heat Rejection (kW)	28 (intact) N/A (consolidated)
(b) Peak Clad Temperature (^{o}C)	365 (intact-horizontal) 352 (intact-vertical)
(6) Shape	Cylindrical
(7) Dimensions	
(a) Overall Length (in)	192.4
(b) Overall Diameter (in)	93.9
(c) Cavity Length (in)	163.5
(d) Cavity Diameter (in)	60.1
(e) Wall Thickness, w/o fins (in)	15.0
(f) Cooling Fin Length (in)	N/A
(g) Lid Thickness (in)	15.0
(h) Bottom Thickness (in)	18.1
(i) Basket Length (in)	161.8
(j) Basket Diameter (in)	60.0
(k) Thickness of Basket Spacers	N/A
(8) Neutron Shield	
(a) No. Rods	N/A
(b) Rod Diameter (in)	2.4
(c) Side Thickness (in)	-
(d) Lid Thickness (in)	None
(e) Bottom Thickness (in)	None
(9) Materials of Construction	
(a) Cask Body	Nodular Cast Iron (Ni-Plated Inside)
(b) Basket	SS/Borated SS
(c) Neutron Shield	Polyethylene
(10) No. Cooling Fins	73
(11) Cavity Atmosphere	Helium
(12) Cavity Pressure (psia)	N/A
(13) Outside Surface Dose (mR/hr)	200 max.
(14) Maximum Leak Rate (l/s)	N/A

(15) Licensing Status NRC approved TSAR for storage in Fall 1985.

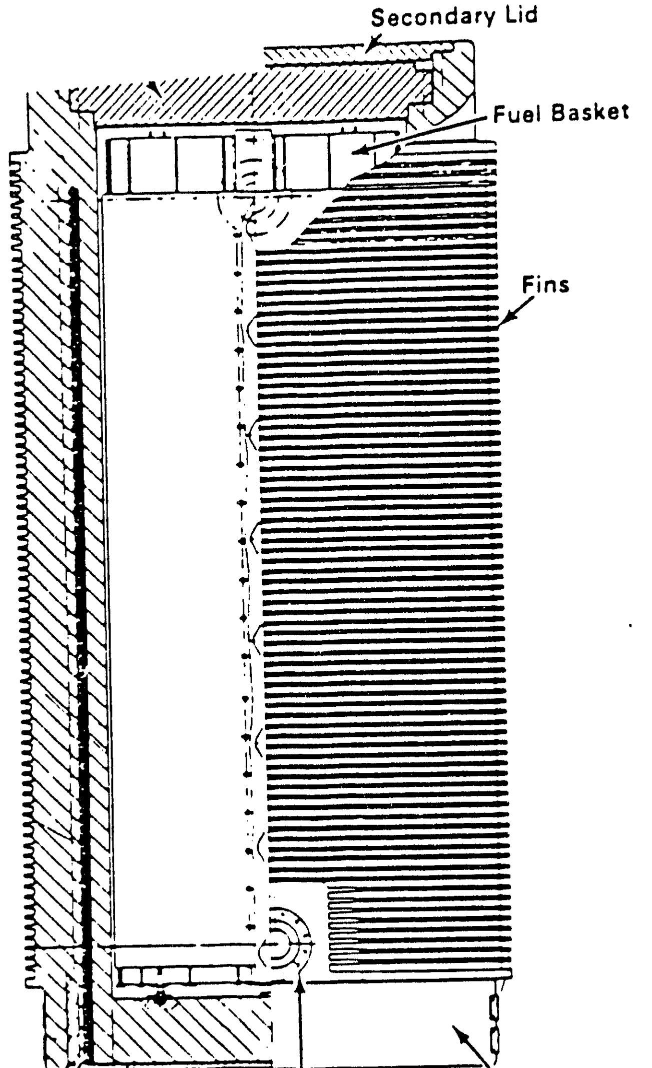
(16) Comments A CASTOR V/21 was successfully tested at INEL. Five (5) casks ordered by Virginia Power Surry Station (Independent Spent Fuel Storage Installation). GNSI is pursuing transportation licensing effort.

References

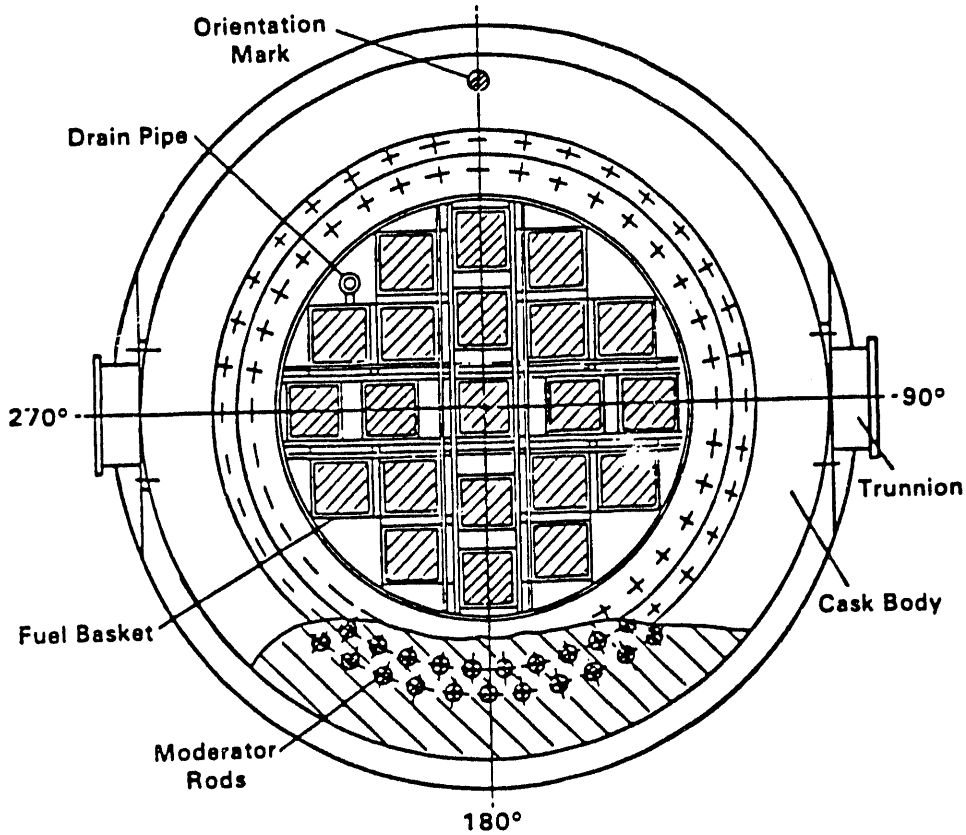
(1) Electric Power Research Institute, The Castor-V/21 PWR Spent-Fuel Storage Cask: Testing and Analyses, EPRI NP-4887, November 1986

(2) Robert T. Anderson and Victor J. Barnhart, Castor V Spent Fuel Cask 1985-1986 Status Update, INMM Spent Fuel Storage Seminar III, Washington, D.C., January 1986

N/A means not available.



CASTOR V/21 PWR SPENT FUEL STORAGE CASK



CASTOR V/21 CASK CROSS SECTION

TN-24

(1) Type	Storage
(2) Manufacturer/Vendor	Transnuclear Inc.
(3) Capacity (assys)	
(a) Intact SF	24 PWR, 52 BWR
(b) Consolidated Fuel Rods	48 PWR, 104 BWR
(4) Weight (tons)	
(a) Loaded	100
(b) Empty	77
(5) Thermal	
(a) Design Heat Rejection (kW)	24
(b) Peak Clad Temperature (°C)	375
(6) Shape	Cylindrical
(7) Dimensions	
(a) Overall Length (in)	186.8 (198.5 w/protective cover)
(b) Overall Diameter (in)	92.4 at trunnions; 88.5 at outer shell
(c) Cavity Length (in)	163.2
(d) Cavity Diameter (in)	51.2
(e) Wall Thickness (in)	9.5
(f) Cooling Fin Length (in)	-
(g) Lid Thickness (in)	10.5
(h) Bottom Thickness (in)	10.25
(i) Basket Length (in)	162
(j) Basket Diameter (in)	57
(k) Thickness of Basket Spacers (in)	0.4
(8) Neutron Shield	
(a) No. Rods	None
(b) Rod Diameter (in)	None
(c) Side Thickness (in)	5.38
(d) Lid Thickness (in)	2.75
(e) Bottom Thickness (in)	2.75 (horizontal storage)
(9) Materials of Construction	
(a) Cask Body	SA350, Gr. LFI
(b) Basket	Boron SS w/copper plate
(c) Neutron Shield	Polyester Resin
(10) No. Cooling Fins	None
(11) Cavity Atmosphere	Nitrogen or He
(12) Cavity Pressure (psia)	33.9 (initial)
(13) Outside Surface Dose (mR/hr)	60
(14) Maximum Leak Rate (atm-cc/sec)	6.5×10^{-7}

(15) Licensing Status Topical Report under review.

References

(1) Communication C. Pennington (Transnuclear) to E. Johnson (JAI), September 1, 1987

REA-2023

(1) Type	Storage	
(2) Manufacturer/Vendor	Mitsubishi Heavy Industries	
(3) Capacity (assys)		
(a) Intact SF	24 PWR; 52 BWR	
(b) Consolidated Fuel Rods	48 PWR; 104 BWR	
(4) Weight (tons)		
(a) Loaded	98 (w/intact BWR assemblies)	
(b) Empty	84	
(5) Thermal		
(a) Design Heat Rejection (kW)	44.6 (intact BWR) 41.6 (consolidated BWR)	
(b) Peak Clad Temperature (^oC)	304 (intact BWR) 324 (consolidated BWR)	
(6) Shape	Cylindrical	
(7) Dimensions	BWR	PWR
(a) Overall Length (in)	192.6	182
(b) Overall Diameter (in)	87.6	93
(c) Cavity Length (in)	177.2	166.7
(d) Cavity Diameter (in)	61	66
(e) Wall Thickness (in)	13.25	13.5
(f) Cooling Fin Length (in)	-	-
(g) Lid Thickness (in)	8	8
(h) Bottom Thickness (in)	7.25	7.25
(i) Basket Length (in)	N/A	N/A
(j) Basket Diameter (in)	61	66
(k) Thickness of Basket Spacers		
(8) Neutron Shield		
(a) No. Rods	None	
(b) Rod Diameter (in)	None	
(c) Side Thickness (in)	6 (6.25 w/cover)	
(d) Lid Thickness (in)	None	
(e) Bottom Thickness (in)	None	
(9) Materials of Construction		
(a) Cask Body	Lead/SS	
(b) Basket	SS w/Boral Inserts	
(c) Neutron Shield	Glycol/Water	
(10) No. Cooling Fins	None	
(11) Cavity Atmosphere	He	
(12) Cavity Pressure (psia)	N/A	
(13) Outside Surface Dose (mR/hr)	20 max.	
(14) Maximum Leak Rate (1/s)	N/A	

(15) Licensing Status TSAR submitted to NRC by REA. NRC questions not answered as yet.

(16) Comments One cask was procured by DOE and used in a testing program at GE Morris IL plant. Cask is now at INEL and may be used for lag storage in connection with PCDP.

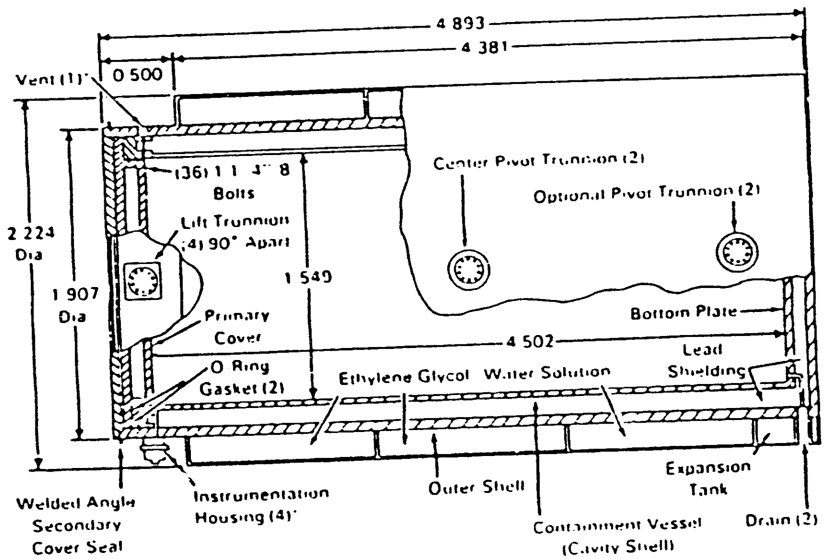
References

(1) D. R. Rector et al, COBRA-SFS Thermal-Hydraulic Analyses of the CASTOR-IC and REA-2023 BWR Storage Casks Containing Consolidated Spent Fuel, PNL-5802, December 1986

(2) Ridihalgh, Eggers and Associates, Inc., Topical Report for the 2023 Dry Storage Cask for BWR Spent Fuel, April 1983

(3) W. J. Wooley Co., Specifications for the REA-2023, 1983

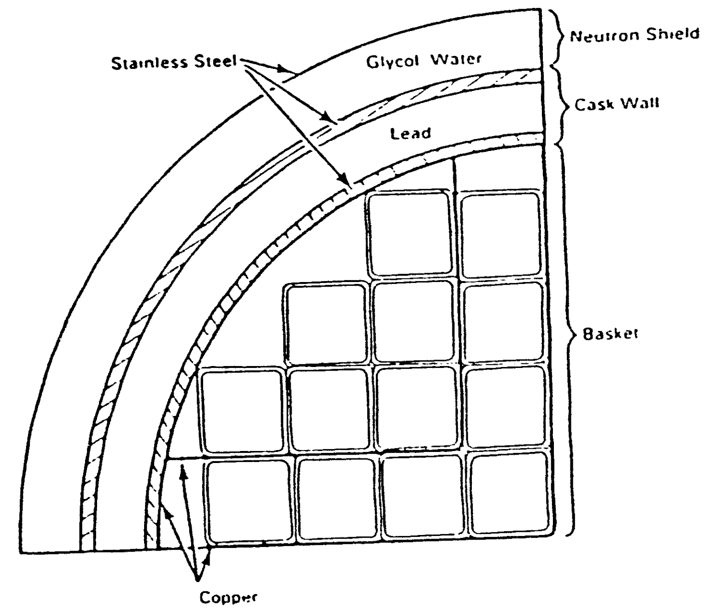
N/A means not available.



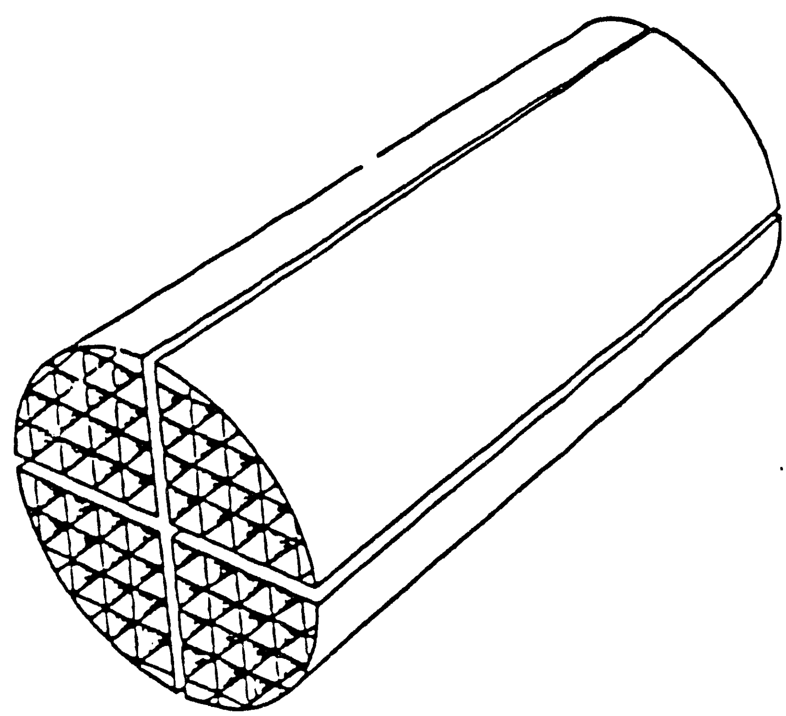
Dimensions are in Meters

*Rotated From True Position

REA 2023 BWR SPENT FUEL STORAGE CASK



CROSS-SECTION OF REA 2023 CASK AND BWR SPENT FUEL BASKET



52-ASSEMBLY BWR BASKET FOR REA 2023 CASK

NUPAC CP-9D

(1) Type	Concrete Storage Cask
(2) Manufacturer/Vendor	Nuclear Packaging Inc.
(3) Capacity (assys)	
(a) Intact SF	9 PWR
(b) Consolidated Fuel Rods	18 PWR
(4) Weight (tons)	
(a) Loaded	88
(b) Empty	80
(5) Thermal	
(a) Design Heat Rejection (kW)	5.4
(b) Peak Clad Temperature (°C)	290
(6) Shape	Cylindrical
(7) Dimensions	
(a) Overall Length (in)	214.5
(b) Overall Diameter (in)	102
(c) Cavity Length (in)	173
(d) Cavity Diameter (in)	35 (33 square)
(e) Wall Thickness (in)	34.5
(f) Lid Thickness (in)	15.8
(g) Bottom Thickness (in)	27
(h) Basket Length (in)	173
(i) Basket Diameter (in)	33
(8) Materials of Construction	
(a) Cask Body	Reinforced Concrete
(b) Basket	Steel
(c) Neutron Shield	Concrete/RX-277
(9) No. Cooling Fins	None
(10) Cavity Atmosphere	Inert
(11) Cavity Pressure (psia)	1 atm.
(12) Outside Surface Dose (mR/hr)	20 max.
(13) Maximum Leak Rate (l/s)	10^{-7}

(14) Licensing Status Topical Report submitted.

(15) Comments This cask must be dry loaded and, therefore, needs a transfer cask and shield collar for its use. It contains shield plugs in the top of each of the basket cavities. This cask may also be unloaded underwater (CP-9W) and thus needs no transfer cask, shield collar, or shield plugs.

At present this is a design concept only; no casks have been manufactured as yet. However, NUPAC is commercially bidding on the use of these casks to meet utility storage requirements.

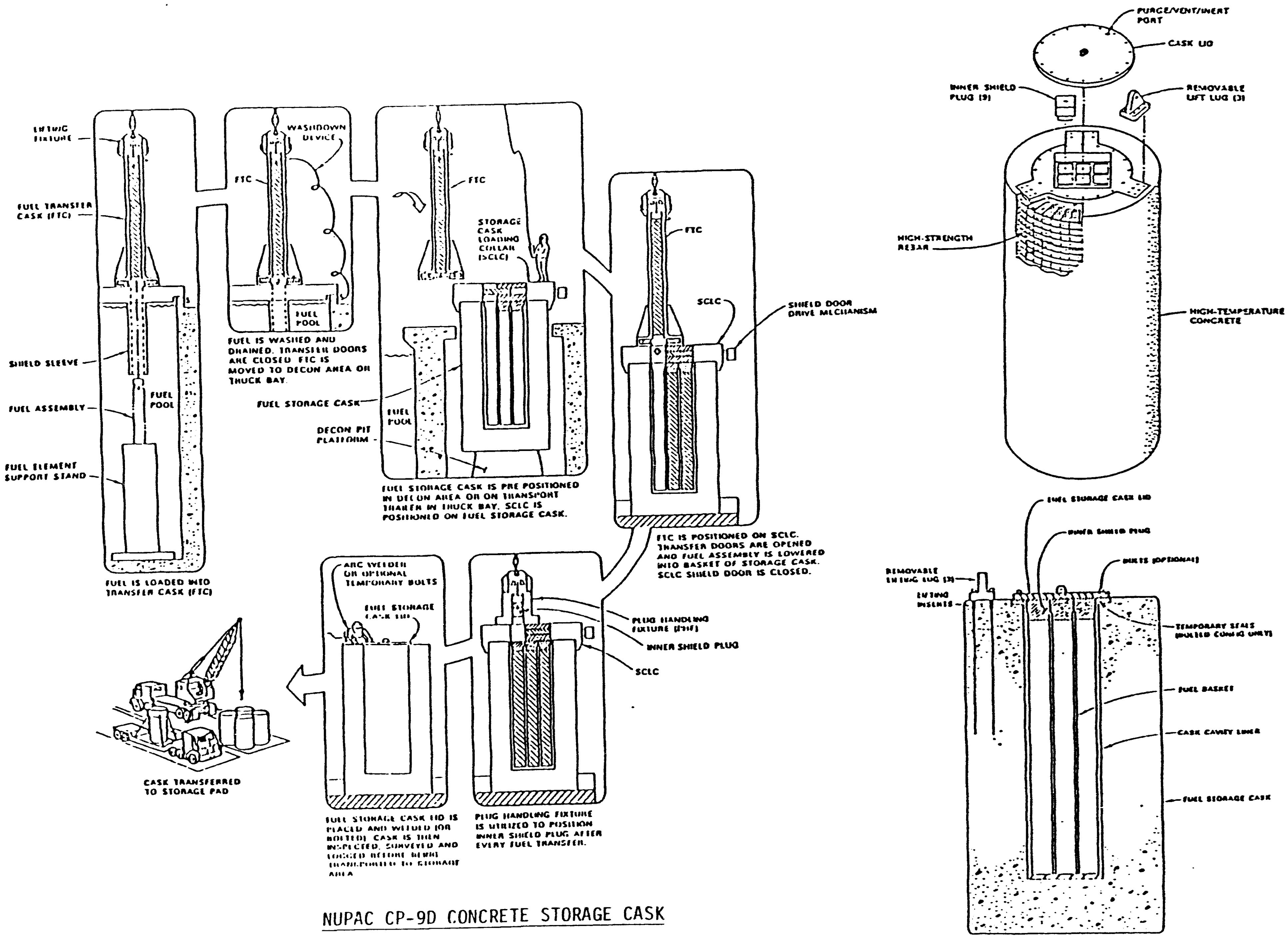
A similar cask with a capacity for storing 25 BWR assemblies is being designed.

References

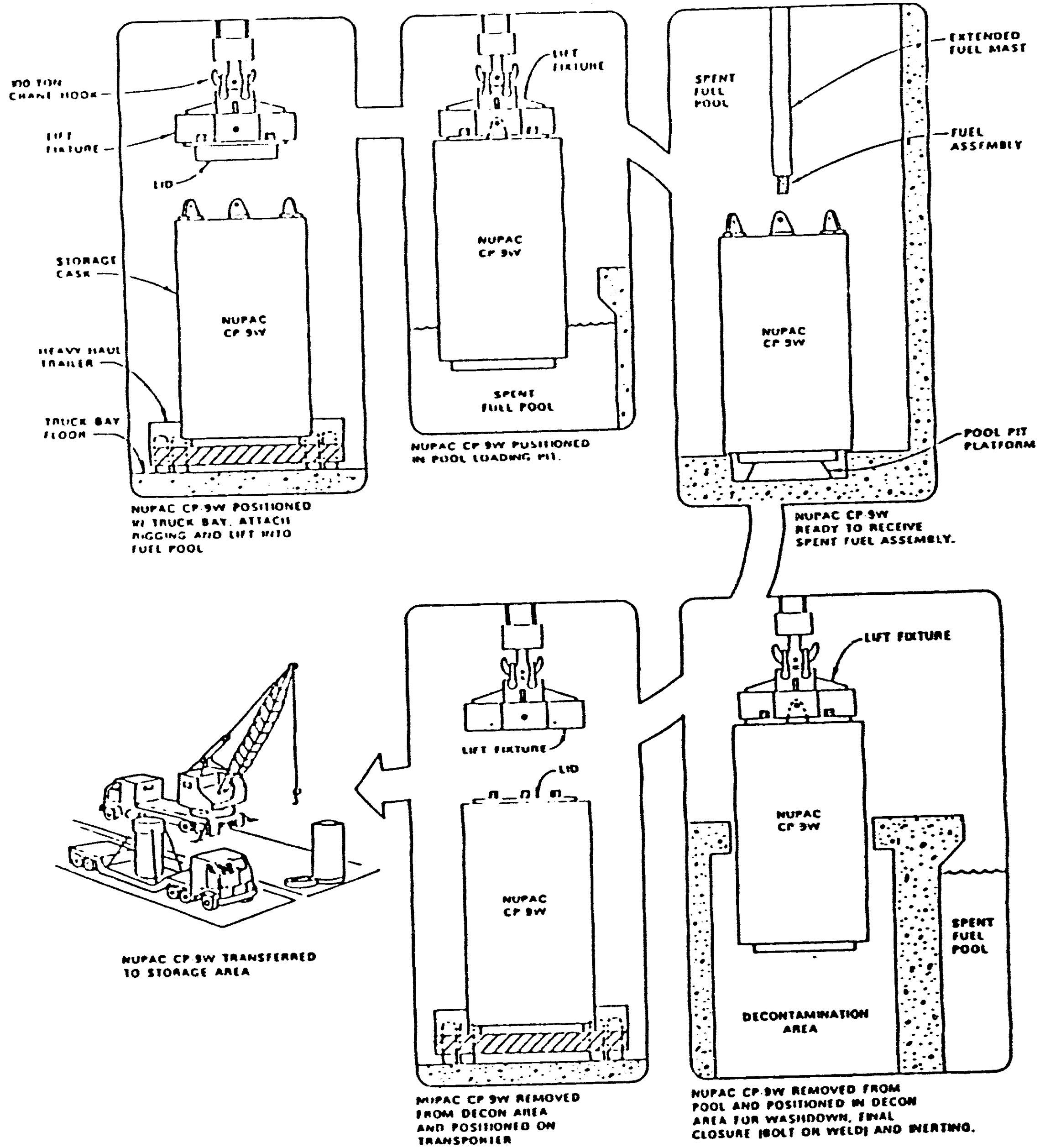
(1) Philip A. Craig, At-Reactor Spent Fuel Storage in Concrete Casks, INMM Spent Fuel Storage Technology Seminar IV, Washington, D.C., January 1987

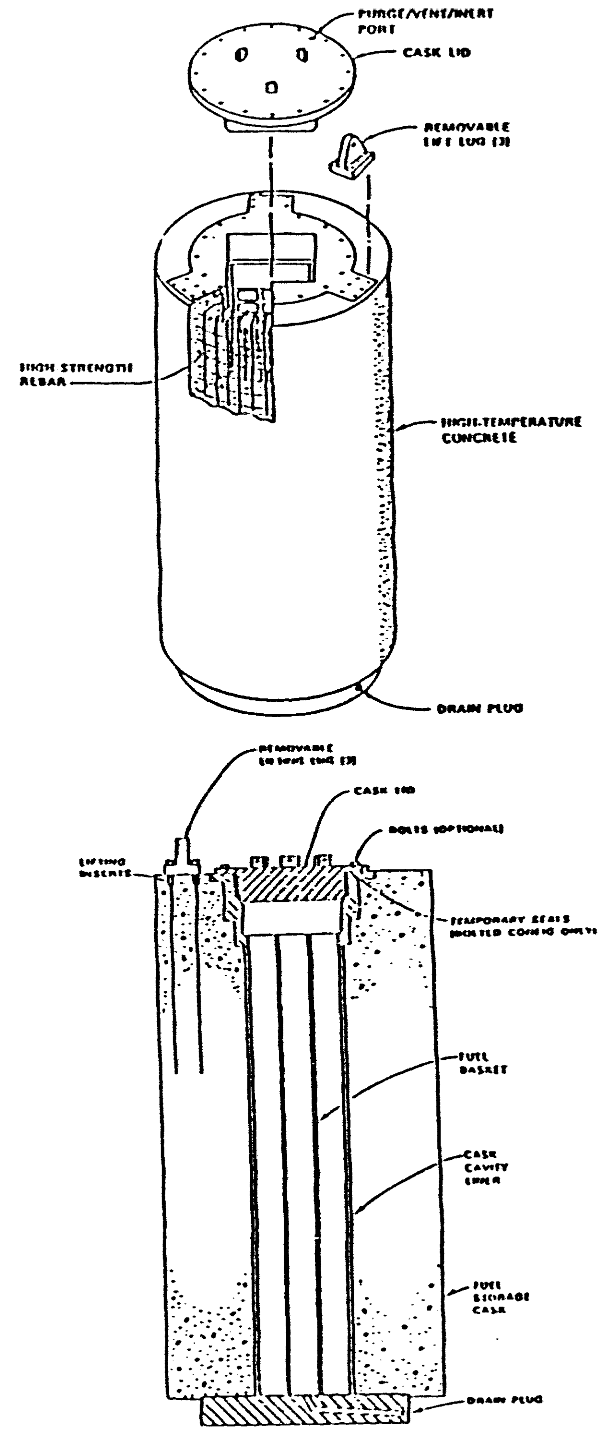
(2) Topical Safety Analysis Report for the NUPAC CP-9 Concrete Storage Cask, TP-08, Rev. 1, November 1987

(3) Personal communication, Philip A. Craig, NUPAC, January 25, 1988.



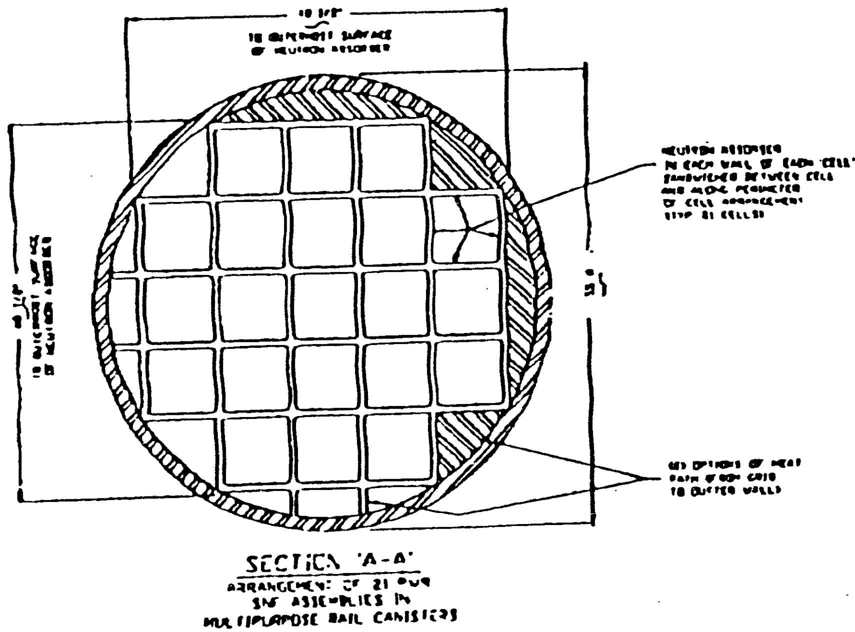
NUPAC CP-9D CONCRETE STORAGE CASK

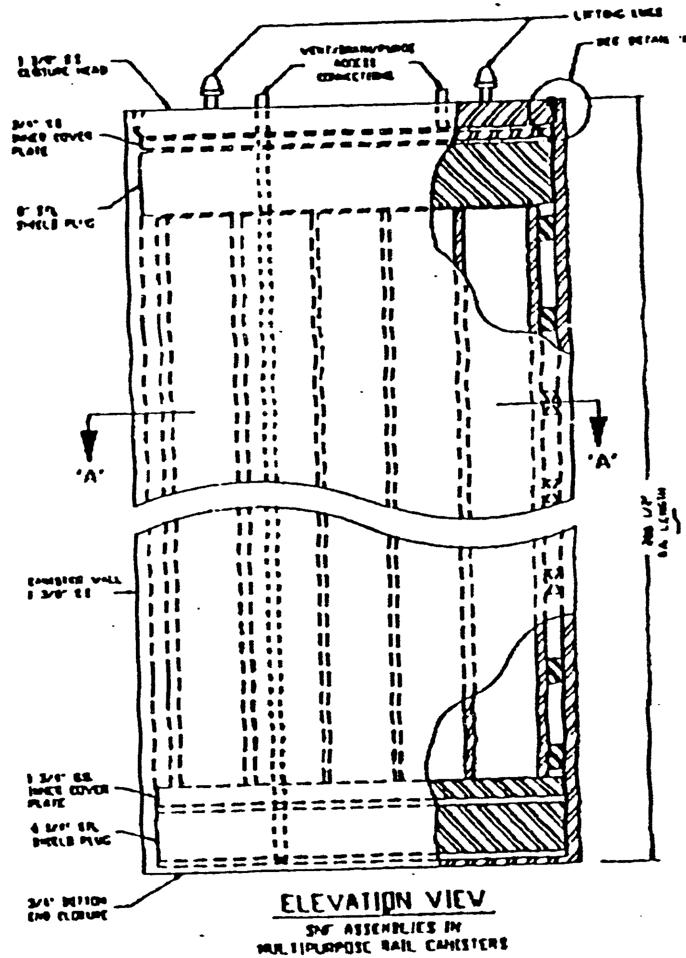




NUPAC CP-9W CONCRETE STORAGE CASK

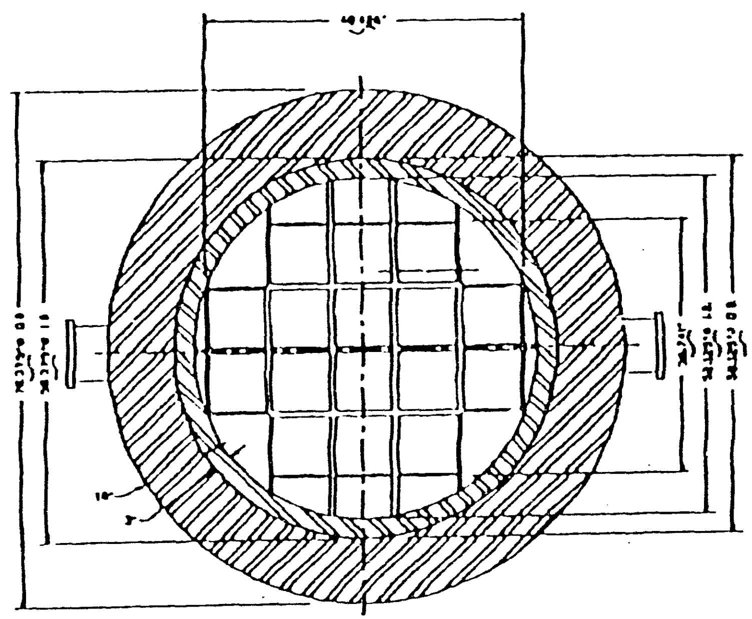
Large MPC - Preliminary Concept





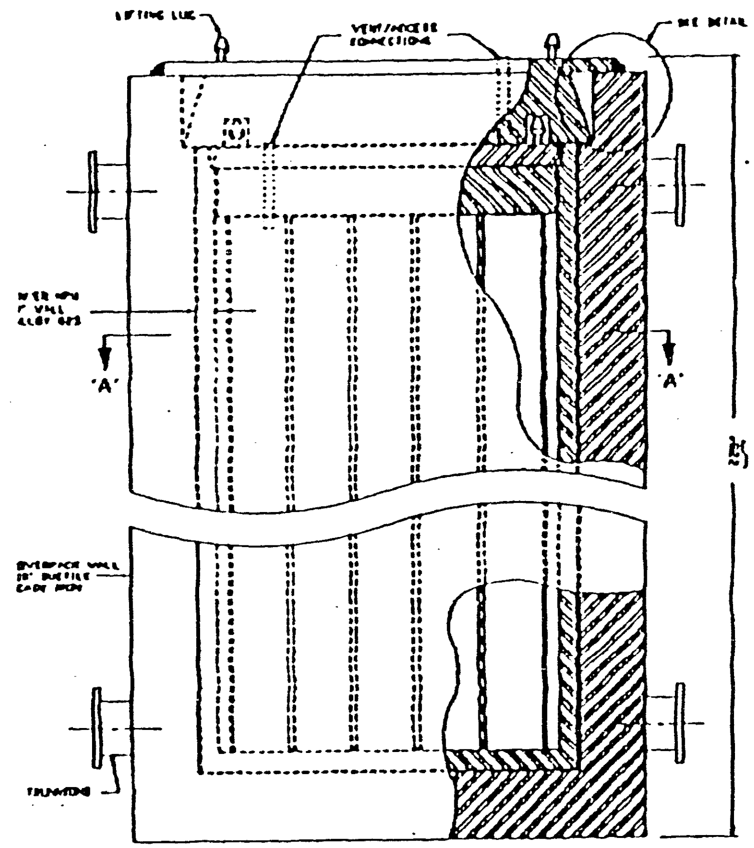
OCRWM multi-purpose canister concept (1 of 2)

Large MPU - Preliminary Concept



SECTION VIEW 'A-A'

ARRANGEMENT OF 16 PWR SNF ASSEMBLIES IN MULTI-PURPOSE UNIT



ELEVATION VIEW

OCRWM multi-purpose canister concept (2 of 2)

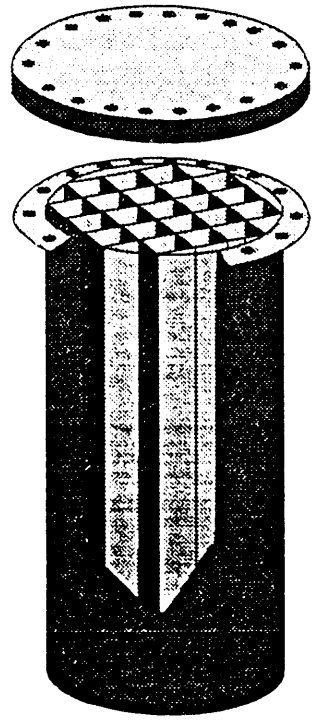


Figure 1.
UCS Inner Container

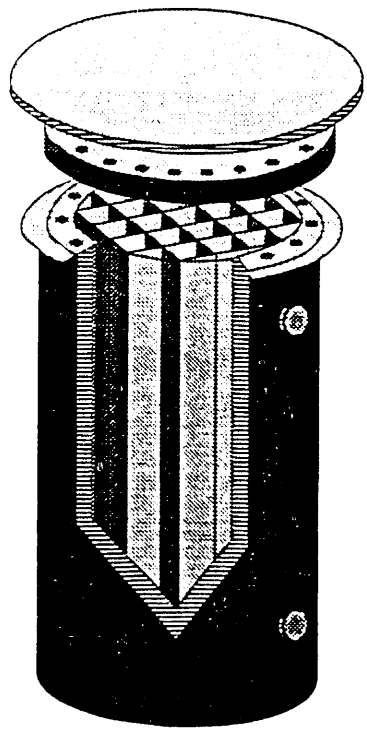


Figure 2.
Disposal Over Pack

Conceptual design of the Virginia Power universal container for spent nuclear fuel storage. (No specific details available)

MC-10

(1)	Type	Storage
(2)	Manufacturer/Vendor	Westinghouse
(3)	Capacity (assys)	
	(a) Intact SF	24 PWR, 49 BWR
	(b) Consolidated Fuel Rods	(N/A; prototype only)
(4)	Weight (tons)	
	(a) Loaded	119.8
	(b) Empty	102.8
(5)	Thermal	
	(a) Design Heat Rejection (kW)	13.5 (intact)
	(b) Peak Clad Temperature (°C)	336 (intact)
(6)	Shape	Cylindrical
(7)	Dimensions	
	(a) Overall Length (in)	194.8
	(b) Overall Diameter (in)	107.9
	(c) Cavity Length (in)	164.1
	(d) Cavity Diameter (in)	68
	(e) Wall Thickness (in)	10.0
	(f) Cooling Fin Length (in)	-
	(g) Lid Thickness (in)	13.5
	(h) Bottom Thickness (in)	11.0
	(i) Basket Length (in)	N/A
	(j) Basket Diameter (in)	N/A
	(k) Thickness of Basket Spacers (in)	0.4
(8)	Neutron Shield	
	(a) No. Rods	None
	(b) Rod Diameter (in)	None
	(c) Side Thickness (in)	3.0
	(d) Lid Thickness (in)	2.5
	(e) Bottom Thickness (in)	2.5
(9)	Materials of Construction	
	(a) Cask Body	Low Alloy/Forged Steel
	(b) Basket	SS Grid/SS Storage Cell/ Boral Plates
	(c) Neutron Shield	BISCO NS-3
(10)	No. Cooling Fins	24
(11)	Cavity Atmosphere	He
(12)	Cavity Pressure (psia)	35
(13)	Outside Surface Dose (mR/hr)	100 max.
(14)	Maximum Leak Rate (l/s)	10^{-10}

(15) Licensing Status TSAR submitted to NRC. License approved September 1987.

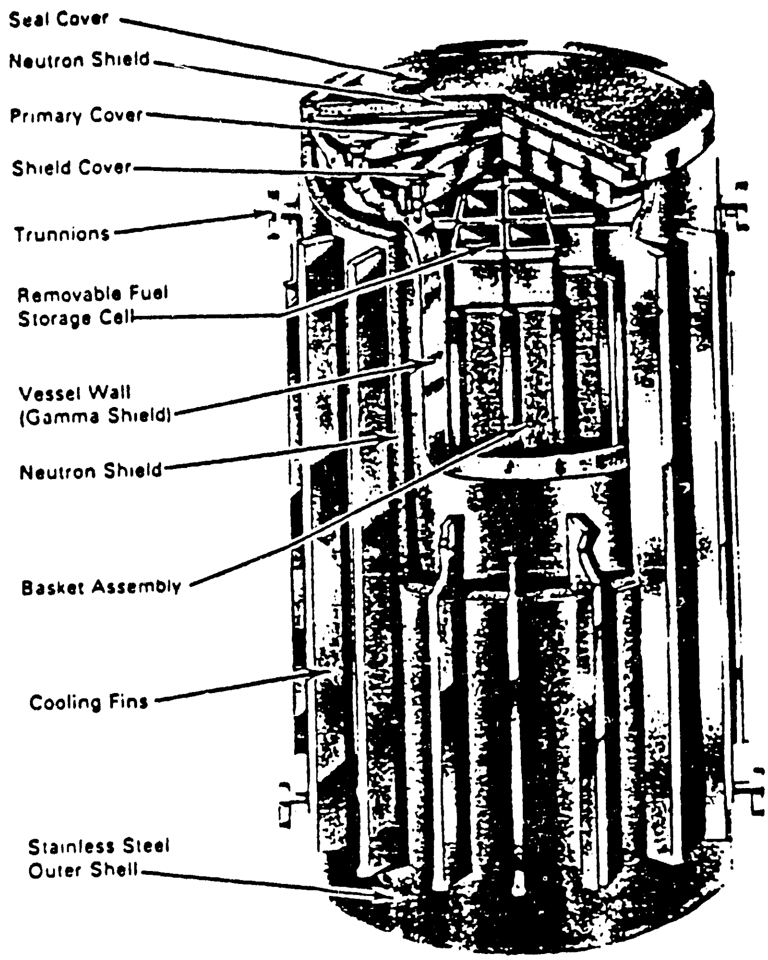
(16) Comments One cask is in existence at INEL and has been successfully tested there using Surry spent fuel. The major differences between this prototype and the licensed version are the exterior cooling fins (consolidated fuel) and aluminum basket.

References

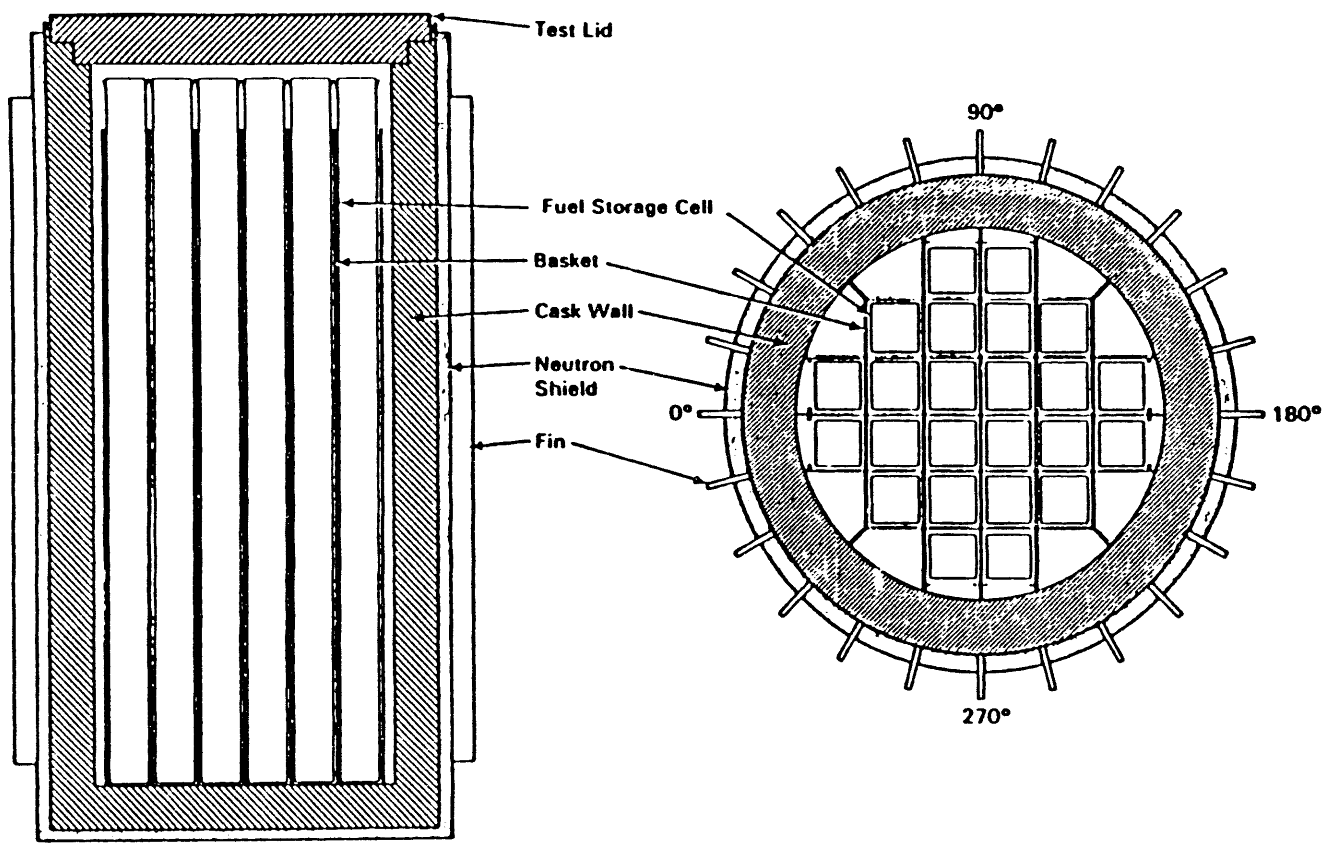
(1) Electric Power Research Institute, The MC-10 PWR Spent Fuel Storage Cask: Testing and Analyses, EPRI NP-5268, July 1987

(2) Letter P. I. Fuhrman (W) to E. R. Johnson (JAI), February 4, 1988.

N/A means not available.



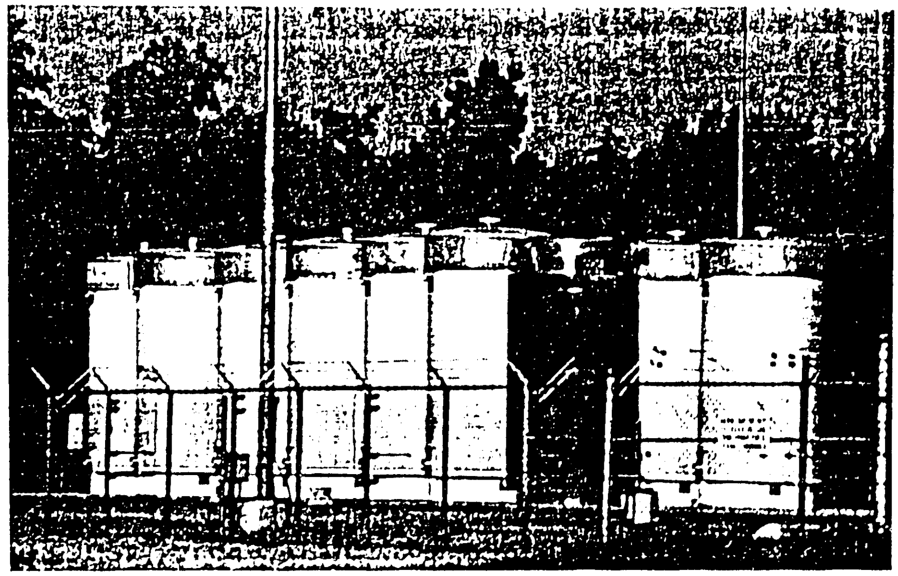
MC-10 SPENT FUEL STORAGE CASK



MC-10 CONTAINMENT VESSEL AND CROSS SECTION

procedure development, licensing support and public information programs. SEG can even design and manage the construction of the storage facility, including concrete storage pads, lighting and security system.

For solutions to your Spent Fuel Management problems, call on the Scientific Ecology Group. Call SEG.



MC-10 METAL CASKS FOR DRY STORAGE OF SPENT FUEL ARE BETTER THAN CONCRETE!

- Operationally simpler.
  - No system-to-system transfers required.
  - No canisters to weld.
- Competitive total life cycle costs
- Lower personnel radiation exposures

Basket assembly that assures criticality control even with unirradiated fuel.

CAPACITY

- 24 PWR assemblies.
- 52 BWR assemblies.
- Fuel burnups up to 35,000 MWD/MTU.

Heat dissipation up to 15 kw.

STRUCTURAL INTEGRITY

- Cask Body: SA 508 class 4b forged steel vessel meets fracture toughness requirements for transportation casks.
- Basket: Stainless steel "egg crate" design with Boral™ plates for criticality control.

REGULATORY

- NRC Certificate of Compliance No. 1001.
- Approved for use under General License, Subpart K of 10CFR72.

TO RESOLVE SPENT FUEL MANAGEMENT PROBLEMS, CALL:

SEG
P.O. Box 2530
1560 Bear Creek Road
Oak Ridge, TN 37830
(615) 481-0222

— OR —

Nuclear Waste Technology
2400 Ardmore Blvd.
Pittsburgh, PA 15221
(412) 636-5877

SEG

A wholly owned subsidiary of WESTINGHOUSE

Appendix C

Sealed Radiation Sources

Appendix C.1	**Typical Sealed Sources and Uses**
Appendix C.2	**Examples of Nonreturnable and Returnable Packaging**
APPENDIX C.3	**Conceptual of 55-gallon Drum for Seal/Device Source for Storage and Transport**

Appendix C.1

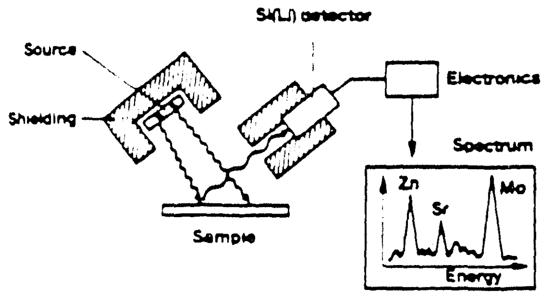
Typical Sealed Sources and Uses

X-ray fluorescence

Technique

Primary radiation from the radioisotope source excites atoms of the elements present in the sample, removing electrons from the sub-shells round the nucleus. X-rays characteristic of each element are emitted as electrons from the outer shells and move to fill the gaps created in inner shells. The shell from which the electron is removed determines the series of X-rays produced. The intensity of the X-ray is indicative of the concentration of the particular element in the sample. Since radioisotopes emit specific radiations, a limitation results on the range of elements whose characteristic X-rays can be excited. Thus a series of nuclides is employed in order that excitation of all elements from silicon to uranium can be achieved.

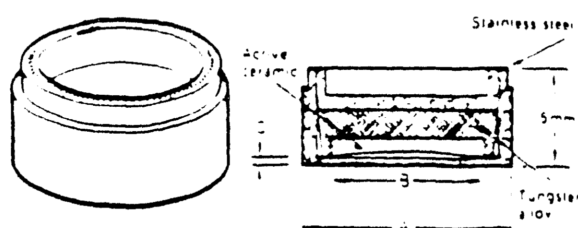
Geometry



Applications

- Alloy analysis for checking stock, scrap sorting and checking components.
- In mining, analysis of material excavated from pits, and cores, chippings and slurries from drilling operations.
- Analysis of electroplating solutions.
- General chemical analysis.

Source



Capsule dimensions and Safety performance testing

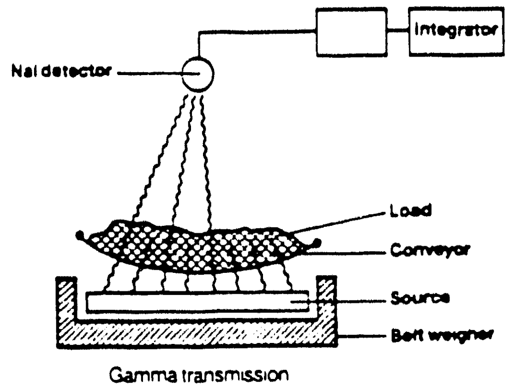
Capsule	Overall diam. A' mm	Active diam. B' mm	Window thickness C' mm	Safety performance testing ANSI/ISO Classification	IAEA special form	NRC model no.
[illegible]	8	[illegible]	[illegible]	[illegible]C64545	GB 3 S	AMC [illegible]
[illegible]	10.8	[illegible]2	0.2–0.25	[illegible]C64444	GB 4 S	AMC [illegible]
[illegible]	10.8	[illegible]	[illegible]	[illegible]C64444	GB 4 S	AMC [illegible]

Thickness gauging

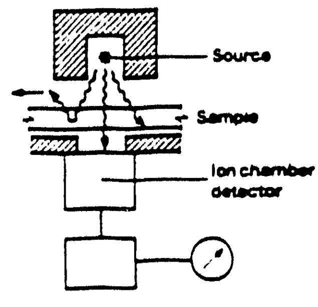
Transmission thickness technique

The source and the detector are placed on opposite sides of the material to be measured. Gamma or beta radiation transmitted through the sample is then directly related to the sample thickness, provided the density of the material is constant.

Geometry



Gamma transmission



Beta transmission

Applications

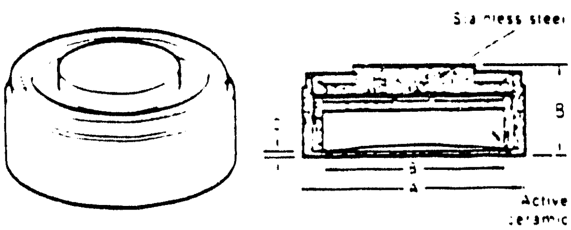
Gamma gauging

- Thickness gauging of sheet metal, glass, plastic, and rubber at thickness too large for beta sources, e.g. greater than 500mg/cm²
- Belt weighing, giving mass (kg. m) flowing on conveyor belt.

Beta Gauging

- Thickness gauging of thinner plastics, thin sheet metal, rubbers, textiles and paper, e.g. 1 – 1000mg/cm²
- The weighing of cigarettes
- Measurement of dust and pollutant levels on filter paper samples e.g., 0.1 – 200 mg/m² dust

Source



Capsule dimensions and Safety performance testing

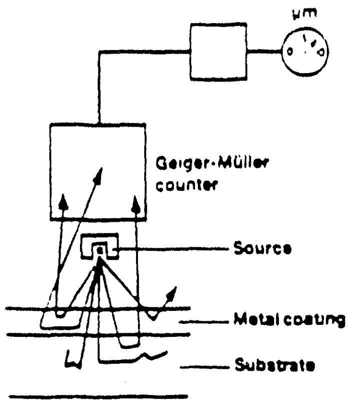
Capsule	Overall diam. A mm	Active diam. B mm	Window thickness C mm	Safety performance testing ANSI/ISO classification	IAEA special form	NRC model no.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Thickness gauging

Beta backscatter thickness technique

The intensity of beta radiation which is scattered back from the samples is related to sample thickness and atomic number.

Geometry

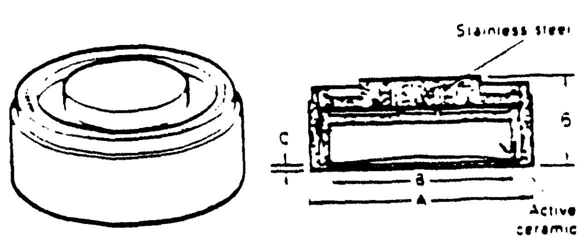


Beta backscatter thickness gauging

Applications

- The thickness gauging of paper, plastic and rubber on steel rolls.
- The measurement of a coating thickness on a substrate. Virtually any coating substrate combination providing there is sufficient difference in density or atomic number. Coating range < 1–100µm depending on source and materials.

Source



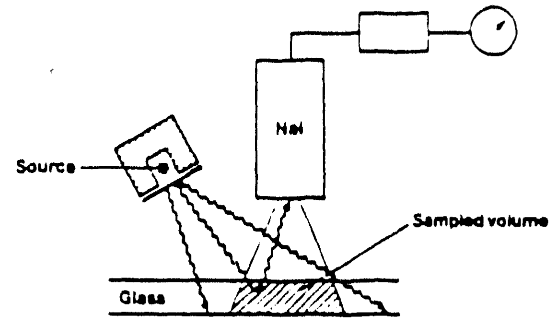
Capsule dimensions and Safety performance testing

Capsule	Overall diam. 'A' mm	Active diam. 'B' mm	Window thickness 'C' mm	Safety performance testing: ANSI/ISO classification	IAEA special form certificate no.	NRC model no.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	GB/38/S	AMC 16
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	GB/39/S	AMC [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	GB/40/S	AMC [illegible]
x 97	22	18	[illegible]	[illegible]	GB/41/S	AMC 18

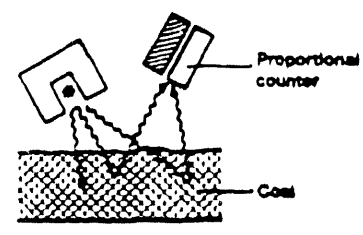
Gamma backscatter thickness technique

The intensity of back-scattered radiation from the sample is measured to give sample thickness or mean atomic number. Used for the measurement of substances of low Z for which transmission measurements are not sufficiently sensitive.

Geometry



Gamma backscatter thickness gauging



Mean atomic number (Z) gauging (i.e. where thickness is known).

Applications

Thickness gauging

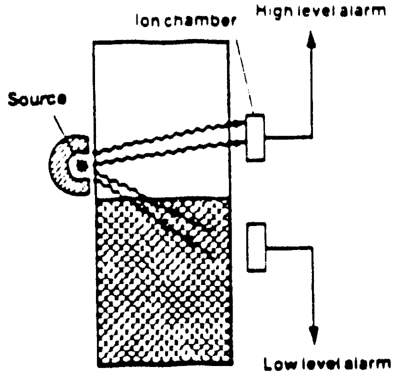
- Measurement of light alloys, glass, plastics, rubbers for which beta sources are not suitable e.g., greater than 500 mg/cm², and access only available from one side e.g., tube wall thickness gauging.

Level gauging

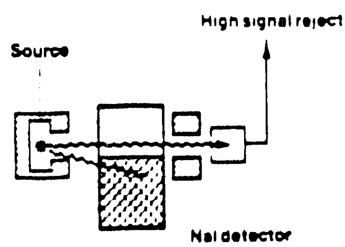
Gamma switching technique

The transmission of gamma radiation through a container is affected by the level of the contents. The intensity of the transmitted radiation is measured and used to activate switches when pre-set intensity levels are reached.

Geometry



Storage hopper level control



Can, package contents monitoring

Applications

Storage hopper level control

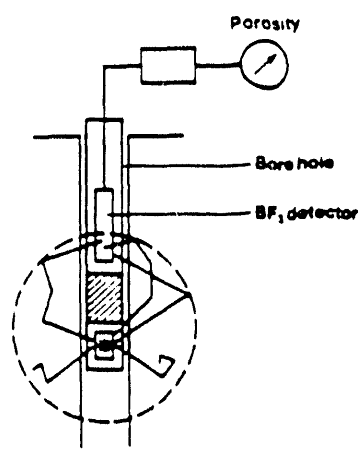
● Switch can be used to operate high level and low level alarms or pump switch control

Oil well logging

Neutron porosity logging technique

Fast neutrons emitted by a neutron source are slowed down by the formation and may undergo three interactions: 1) inelastic scatter, 2) elastic scatter, 3) absorption. Therefore, by collision with hydrogen atoms in the formation the neutron will be moderated to thermal or epithermal energies where it is soon captured by hydrogen nuclei and emits a secondary gamma ray. The detection of these three interactions by using different types of neutron detectors (BF_3 (thermal), ^3He (epithermal)) can be used to determine the hydrogen content of the formation. Since the majority of hydrogen in a formation generally exists within the pore space, the neutron flux will then be related to the porosity.

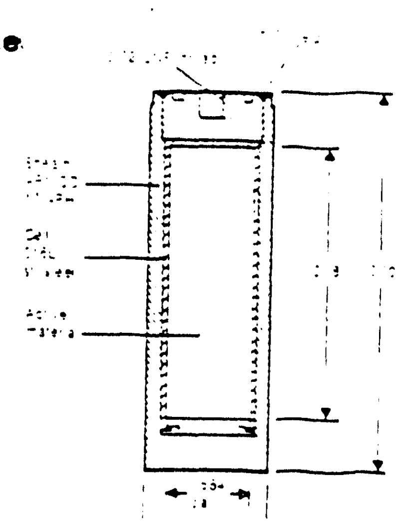
Geometry



Applications

- Determination of formation hydrogen content
- Formation porosity for oil and mineral logging

Source

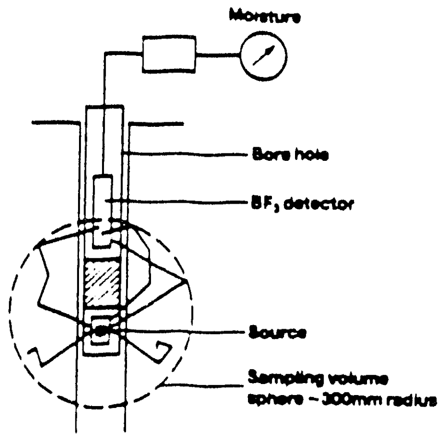


Moisture gauging

Technique

Fast neutrons emitted by the source are moderated by collision with hydrogen atoms in moisture contained in the material. These moderated or thermal neutrons are detected by a neutron detector (usually a boron trifluoride (BF_3) proportional counter) to give a measure of the concentration of hydrogen atoms.

Geometry

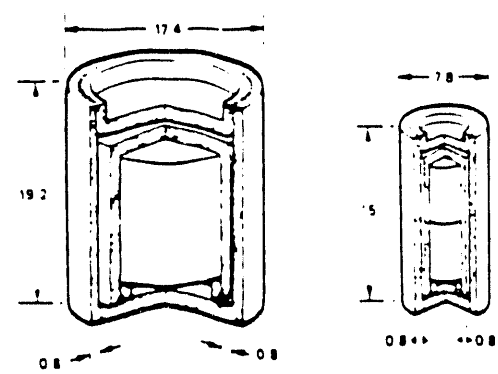


Applications

- Soil moisture content for agricultural and construction use
- Moisture content of materials in silos.
- Continuous moisture content gauging in raw material supplies e.g. gravel, wood chips etc.

Source

X.2 X.21



Safety performance testing

Capsule	ANSI/ISO classification	IAEA special form	NRC model no
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

Appendix C.2

Examples of Nonreturnable and Returnable Packaging

Packaging

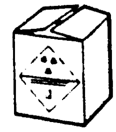
Examples of non-returnable packaging

300mm

01W1POP assembly

W1 lead pot
(sealed with adhesive tape)

Sealed 'P' can

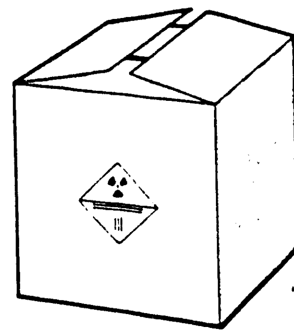


'P' carton

01W4FS assembly

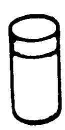
W4 lead pot
(sealed w· adhesive tape)

Sealed 'P' can

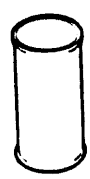


'X' carton

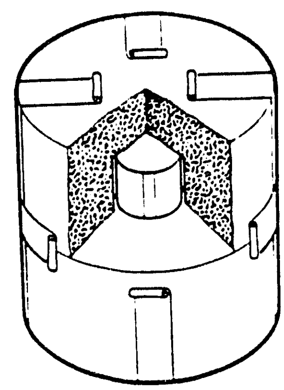
01WCROW assembly



WC lead pot
(sealed with adhesive tape)



Sealed 'R' can

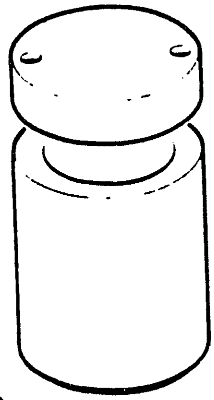


Expanded
Polystyrene
'W' drum

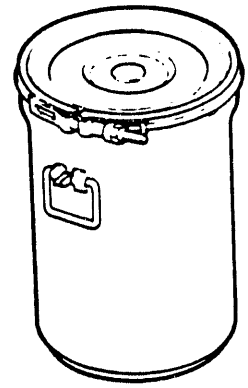
Examples of returnable packaging

JOILMCF assembly

Lead pot



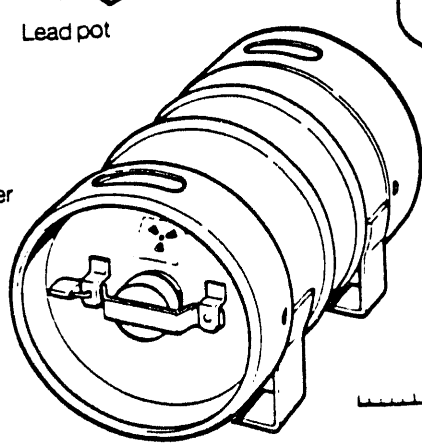
Cork liner



Steel drum

300mm

3206B
Neutron
container



300mm

Packaging

Returnable packaging

Nuclide	Max. allowed in type 'A' package (IAEA regs)			Returnable	
			Amersham code	J0CCSYL or 06665	J01LMCF
			IAEA type	A	B(U)
	A_1 special form	A_2 others	Weight kg	85	51
			Max T.I. value	6·9	3·5
				Maximum permitted content	
^{60}Co	7Ci 259GBq	7Ci 259GBq		225mCi 8·33GBq	200mCi 7·4GBq
^{137}Cs	30Ci 1·11TBq	20Ci 740GBq		18Ci 666GBq	12Ci 444GBq

Neutron sources

Nuclide	Max. allowed in type 'A' package (IAEA regs)			Non-Returnable			Returnable†				
			Amersham code	01W1POP	01W1PSX	01Q1ROW	*1943A (B20N)	*1825A (A50N)	*1940A (B50N)	*3009A	*3206B
			IAEA type	A	A	A	B(U)	A	B(U)	A	A or B(U)
	A_1 special form	A_2 others	Weight kg	0·5	1·7	3·5	201	272	450	1060	75
			Max T.I. value	0·5	3·3	6·2	7	8	10	8	6
				Max. permitted contents							
^{241}Am	8Ci 296GBq	8mCi 296MBq		0·25Ci 9·25GBq	2·0Ci 74GBq	4·0Ci 148GBq	19Ci 703GBq	—	78Ci 2·89TBq	—	18Ci 666GBq
^{252}Cf	2Ci (3·7mg) 74GBq	2mCi (3·7µg) 74MBq		0·2µg 4MBq	1·5µg 30MBq	3·0µg 60MBq	35µg 0·7GBq	225µg 4·5GBq	250µg 5GBq	1500µg 30GBq	23µg 0·5GBq

†Returnable containers are available for purchase. Details on request.

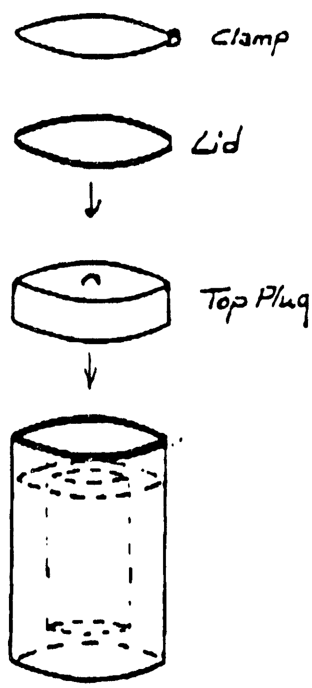
Returnable Packaging Demurrage

If sources are shipped in an Amersham returnable transport container then a demurrage charge will be levied if the container is not returned within 21 days of the original date of dispatch from Amersham Corporation. At the end of this period the customer will be invoiced for the full selling price of the container. If the container is subsequently returned the customer may be credited less the appropriate demurrage charges.

Appendix C.3

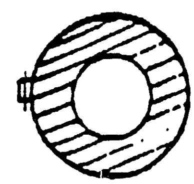
Conceptual 55-Gallon Drum for Seal/Device Source for Storage and Transport

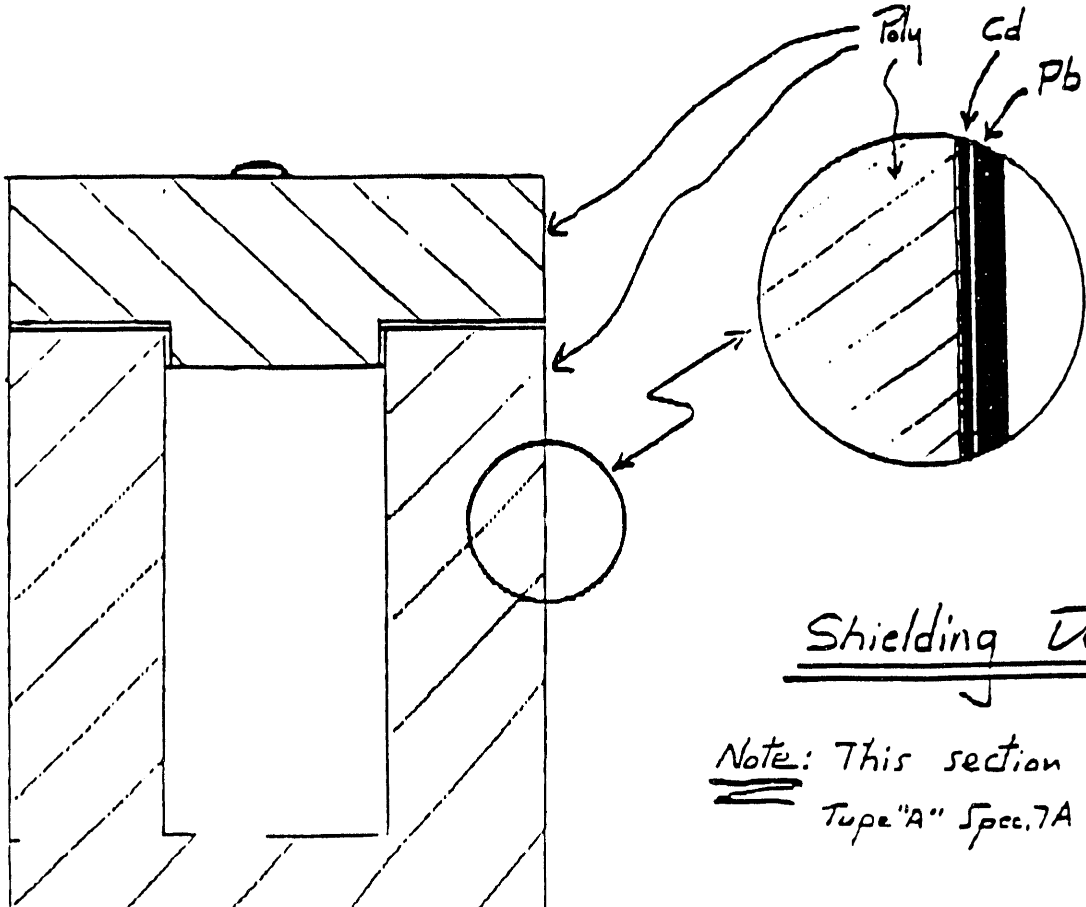
(Design conceptual by Bill Walker, Troxler Electronic, Inc.)



DOT TYPE "A"
SPEC 7A
55 Gal Drum

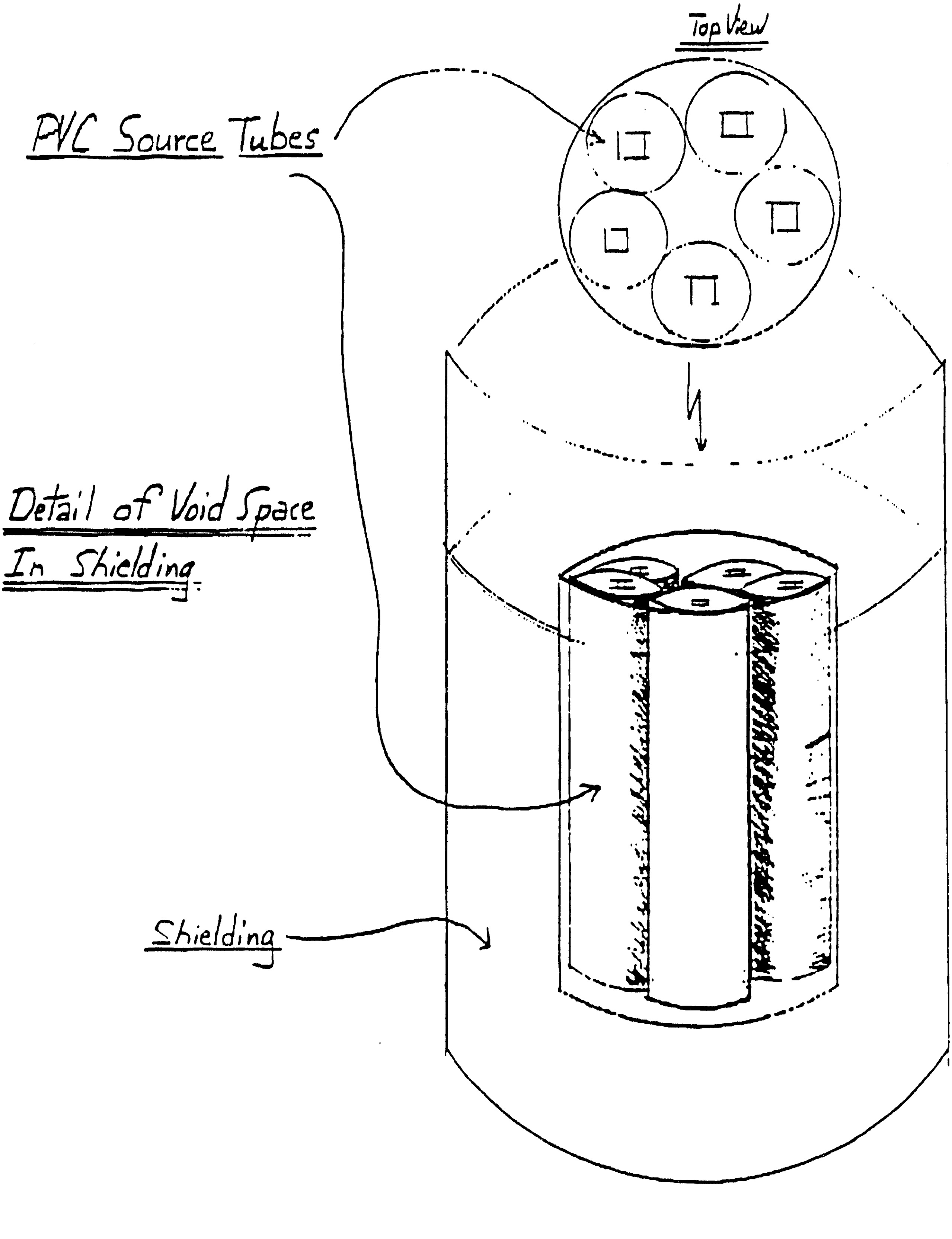
Top View - Barrel

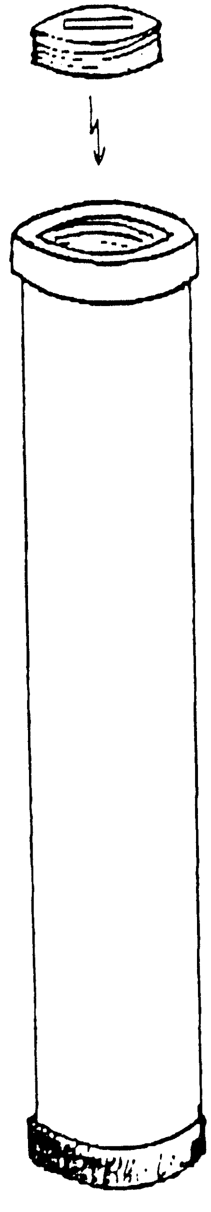




Shielding Detail

Note: This section made to fit Type "A" Spec. 7A 55 gal Barrel


Top View
PVC Source Tubes
Detail of Void Space In Shielding
Shielding



Detail
PVC Source Tube

Note: 1) Like sources inserted in tube & logged.
2) Metal Canister ' ' ld be of similar des.. - Normal Form Sources

DATE
FILMED
1 / 5 / 94

END