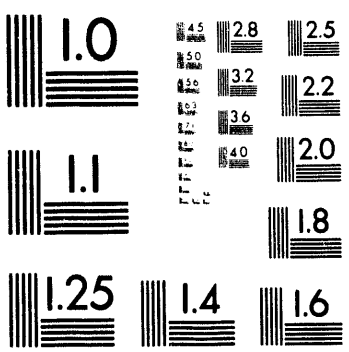
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WIPP WASTE ACCEPTANCE CRITERIA AND TRANSPORTATION SYSTEM

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1.0 ABSTRACT

The Waste Isolation Pilot Plant (WIPP), located near Carlsbad, New Mexico, USA, is a US Department of Energy (DOE) facility designed as a permanent repository for transuranic wastes in the center of a 2,000-foot-thick salt bed situated 2,150 feet underground. Construction of the facility started in 1975, under a congressional act of site selection. In 1979, demonstration of safe disposal at the WIPP was authorized by Public Law 96-164. The operational philosophy and practice at the facility are: 1) start clean - stay clean, 2) meet or exceed regulatory requirements, and 3) control radiation exposure levels to as low as reasonably achievable (ALARA). Strict safety measures must be taken in the areas of waste preparation, transportation, and facility operation.

Work supported by the U.S. Department of Energy

under DOE Contract No. DE-AC04-86AL31950

DOE/WIPP 91-033C

The Waste Acceptance Criteria (WAC) for the WIPP were initially developed by a DOE Steering Committee. The purpose of the WAC was to provide performance criteria to ensure public health and safety as well as the safe handling of radwaste at the WIPP. Requirements in the Resource Conservation and Recovery Act (RCRA) and the US Nuclear Regulatory Commission (NRC) and recommendations from the DOE, the State of New Mexico, and other program participants served as guideline for the development of the WAC. In 1985, the Waste Acceptance Criteria Certification Committee (WACCC) was established to implement site waste certification activities.

A specially designed Transuranic Package Transporter-II (TRUPACT-II) was manufactured and has been certified by the NRC for safe transportation. It is worth noting that the TRUPACT-II, with some minor modifications, could be an excellent transporter for other types of radwastes. The WIPP project also utilizes a digital two-way communications satellite tracking system, which is monitored 24 hours per day by the DOE TRANSCOM Control Center (TCC) at Oak Ridge, Tennessee, and the WIPP Central Monitoring Room. Through the tracking system, information on radwaste transportation vehicle location and bill of lading is available to the WIPP, DOE generator sites, and state and tribal governments. In order to respond to an unlikely event of transportation accident, emergency response teams formed by local fire fighters, police department staff, medical personnel, and civilian volunteers have been trained to perform emergency response tasks.

This paper describes the development and implementation of the WAC in detail. It also addresses the design and test of the TRUPACT-II, the transportation tracking system, and the training/coordination of the transportation emergency response team.

2.0 WASTE ACCEPTANCE CRITERIA AND THEIR IMPLEMENTATION

2.1 Waste Acceptance Criteria

Criteria for the acceptance of radwastes at the WIPP were documented by the WAC Steering Committee in its May 1980 report (Reference 1). A series of revisions consistent with the intent of the original report were subsequently published to incorporate the results of ongoing project activities, the comments and suggestions from all WIPP project participants, and the applicable regulatory requirements. The most recent revision of WIPP-DOE 069, which is expected to be approved in November, 1991, identifies the criteria and requirements that set forth strict parameters that must be met by generator and storage sites before wastes may be shipped to and emplaced at the WIPP (Reference 2). The established criteria, in the form of quantitative guidelines, will also allow waste generating sites to plan future facilities for waste preparation that will produce waste forms compatible with the WIPP waste emplacement and isolation requirements.

The criteria and requirements are derived from four sources: WIPP Operations and Safety, TRUPACT-II and proposed remote-handled (RH) Cask Transportation, the RCRA, and the WIPP Performance Assessment (PA). Currently, all parameters necessary for full certification of contact-handled (CH) waste have been defined. Specific RH waste transportation requirements will be defined when the RH Cask Safety Analysis Report for Packaging (SARP) receives approval by the NRC. Table 1 summarizes the limiting parameters derived from all of the applicable criteria and requirements which regulate the safe handling and preparation of CH waste packages.

2.2 Waste Acceptance Criteria Certification Committee (WACCC)

The WACCC was established as a standing committee by DOE Order 5820.2A (Reference 3). The responsibility of the WACCC is to:

a. Develop and maintain the WAC which is the criteria used to certify compliance of waste being shipped to the WIPP.

b. Provide the mechanism to assure that all transuranic (TRU) waste shipped between TRU waste generator/storage sites and to the WIPP meets all applicable criteria. Criteria include requirements for shipment and transportation in NRC certified packages and all other applicable criteria for the receipt of waste at the WIPP.

The WACCC consists of a chairman and two separate support groups: the Waste Technology Group (WTG) and the Audit/Surveillance Group (ASG). Figure 1 shows the WACCC structure. Interfaces are indicated with dashed lines. The WACCC chairperson, A DOE staff member, has the responsibility and authority for overall management of the WACCC, including, but not limited to granting or suspending the generator site certification for shipment of transuranic waste to the WIPP (Reference 4).

The WTG is the technical side of the WACCC and is responsible for the development of the WAC and apprising the chairperson on the acceptability of generator sites WAC compliance plans after they have been compared to the WAC. The makeup of the WTG is, a manager with a staff of technical experts who have expertise in areas such as health physics, waste operations, quality assurance, nondestructive assays and testing, waste packaging, analytical chemistry, data validation, waste characterization data bases, and PA.

The ASG is the oversight organization of the WACCC and is responsible for performing audits and surveillance on generator sites compliance plans. The makeup of the ASG is, a manager with a staff of auditors who have expertise in the same areas as the staff in the WTG. Based on the results of the audits/surveillance, the lead auditor will recommend to the chairperson to grant or suspend the sites certification for shipment of transuranic waste

to the WIPP. As a minimum, each generator site is audited on an annual basis.

3.0 DESIGN AND TEST OF TRUPACT-II

3.1 Design of TRUPACT-II

TRUPACT-II is a reusable shipping package for CH TRU waste; designed in accordance with 10 CFR Part 71 Type B packaging requirements (Reference 5). The package is a right circular cylinder in shape, with a domed top and a flat bottom; external dimensions are 240 cm in diameter and 309 cm high. The capacity of each TRUPACT-II is 3,182 kg of waste loaded into fourteen 55-gallon drums or two 1.9 cubic meter Standard Waste Boxes. The design challenge for the TRUPACT-II was to maximize payload and to minimize handling time, so that radiation exposures to the public and operators will be reduced to levels ALARA. The use of a flexible stainless steel/foam design for impact and puncture protection as well as thermal insulation has resulted in a dramatic payload increase compared to traditional hard cask designs. The selection of a rotating lock ring design, instead of a conventional bolted closure, to attach the head to the body enables waste handlers to open a TRUPACT-II and load/unload the contents in less than one hour (Reference 6).

Outer Containment - The outer level of containment in TRUPACT-II is provided by a 4.8 - 6.4 mm thick stainless steel pressure vessel

consisting of a cylindrical body, two ASME torispherical (flanged and dished) heads, and a set of closure rings which join together to form a double O-ring bore seal. This outer containment vessel (OCV) is surrounded by a layer of rigid closed-cell polyurethane foam approximately 25 cm thick and an external 6.4 - 9.6 mm thick stainless steel protective outer skin. Fork lift pockets are provided for handling. The cavity between the containment vessel and the outer skin is lined with a thin layer of ceramic fiber insulation prior to pouring the polyurethane foam (Figure 2). The foam is an excellent impact-energy absorber which also retards heat input during the hypothetical fire accident condition. The foam is flame-resistant and self-extinguishing; thus, minor tearing of the exterior stainless steel skin is acceptable. The stainless steel/ceramic fiber/foam sandwich construction of the outer containment assembly (OCA) forms a tough, puncture resistant and impact absorbing shell which cushions and insulates both containment vessels and their contents during normal and hypothetical accident conditions of transport.

Inner Containment - Nested concentrically inside the OCV is a separate and removable stainless steel inner containment vessel (ICV). Like the OCV, the ICV consists of a cylindrical body, two flanged and dished heads and a set of closure rings with elastomer O-ring bore seals. The ICV usable interior volume is 184 cm in diameter and 192 cm high. Energy absorbing honeycomb spacers are located in the upper and lower heads to protect the heads from impact by the contents during the hypothetical accident free drop.

Closure - A unique feature is the method of retaining the head to the body (Figure 3). The head and body have mating tongue and groove joints at the elastomer O-ring seal gland, the body has external lugs which align with internal lugs on the lock-ring. Rotating the lock-ring 10° locks/unlocks the head to/from the body. Both ICV and OCV use the same design; except the OCV uses a sheet metal actuator ring to reach the outside of the vessel.

Pressure - Both the OCV and the ICV are designed to withstand 345 kPs (50 psig) of internal pressure. Each is tested "leaktight" per ANSI 14.5 (a leakage rate of 10E-7 cc/sec or less) for normal and hypothetical accident conditions of transport (Reference 7).

Thermal - The thermal design rating of the package is 40 watts internal decay heat maximum. This relatively low internal heat load is dissipated entirely by passive heat transfer. Computer models were developed to predict maximum temperatures resulting from the regulatory assumptions and internal heat generated by the payload. The predicted average drum centerline temperature is 73° C for normal conditions of transport with a 40 watt internal decay heat evenly distributed among 14 drums, plus the regulatory solar load.

3.2 Test of TRUPACT-II

Compliance with 10 CFR Part 71 requirements was demonstrated by both analysis and test. Normal conditions of transport: 1) heat,

2) cold, 3) reduced external pressure, 4) increased external pressure, 5) vibration, 6) water spray, 7) free drop, and 8) penetration were all analyzed. Hypothetical accident conditions of transport: 1) free drop, 2) puncture, and 3) thermal were tested; 4) immersion was analyzed. Analysis and test were performed for initial hypothetical accident conditions between -29° and +38° C. A SARP was submitted to the NRC (Reference 8). On August 31, 1989, the NRC issued Certificate of Compliance No. 9218 for the TRUPACT-II package.

Engineering Tests - Numerous bench tests were conducted to verify the performance of a variety of components associated with the TRUPACT-II design. These test included characterizing the strength and thermal properties of the polyurethane foam, and comparing the sealing capability of various O-ring materials at temperatures between -29° and +204° C Foam/stainless steel combinations were tested in 3/10 scale to developing the outer shell for optimum puncture resistance and minimum weight. Free drop and puncture tests were performed on both 1/2 and 3/4 scale models to confirm the puncture resistance of the OCA outer body and domed head. A full scale mock-up of the sealing area was destructively tested to demonstrate the effectiveness of the seal design during gross distortion of the head/body closure. A full scale TRUPACT-II engineering prototype was tested, prior to the start of full scale certification testing, to demonstrate the general worthiness of the design to withstand multiple sequences of the hypothetical accident conditions and a fully engulfing pool fire.

Certification Tests - Three full scale TRUPACT II packages, each loaded with 3,200 kg of concrete in 14 drums, were tested at Sandia National Laboratories (SNL). The tests were used to: 1) confirm the drop and puncture bar performance features, 2) demonstrate the O-ring seal performance at cold temperatures, 3) prove the effectiveness of the O-ring seals after drop and puncture tests, 4) demonstrate the ability of the ICV to survive payload impacts and 5) demonstrate performance during a fully engulfing pool fire. The full scale tests consisted of free drops through a distance of 9 m followed by free drops of 1 m onto a 15.2 cm diameter puncture bar; sketches of drop orientations follow. After undergoing multiple free drops and puncture bar impacts, two of the packages were suspended over a pool containing approximately 30,000 liter of JP-4 (jet fuel) which burned for more than 30 minutes. The external skin temperature exceeded 800°C during the fire. The maximum seal temperature was 127°C, which was well below allowable limits for the materials used.

Initial Conditions - Hypothetical accident condition tests were conducted at ambient temperature on the first unit. The second and third units were chilled to -29°C prior to the first drop and again prior to the final leak test. The first and second units were preheated to 49°C before the pool fire.

Leaktightness - In order to demonstrate that there will be no release of contents during normal or hypothetical accident conditions of transport both ICV and OCV must remain leaktight;

this is commonly referred to as "double containment". The test program was originally divided between two packages. On the first test unit both the ICV and OCV were leaktight. On the second test unit the OCV was leaktight but the ICV was not due to a test induced problem with debris interfering with the ICV on a third test unit and its effectiveness was demonstrated by repeating the second test unit sequence, except for the pool fire. Both the OCV and the ICV were leak tested before and after each test sequence. At the conclusion of the tests, all containment boundaries were observed to be leaktight.

4.0 TRANSPORTATION TRACKING SYSTEM

The WIPP integrated transportation system consists of the TRUPACT-II, a specially designed trailer, a lightweight tractor, a satellite-based shipment tracking system, and uniquely qualified and highly trained drivers. In June of 1989, the National Academy of Sciences (NAS) reviewed the transportation system and concluded that "the system proposed for transportation of TRU Waste to WIPP is safer than that employed for any other hazardous material in the United States today and will reduce risk to very low levels" (Reference 9).

Waste shipments from the ten generator sites to the WIPP are to cover a 25 year period and will utilize routes covering approximately 18,000 km in 20 states. Tracking of the shipment is therefore a crucial factor of the integrated transportation system.

A unique tracking/communication capability is accomplished by a satellite-based system referred to as Transportation Communications (TRANSCOM), via a personal computer (PC) and modem, the system provides the WIPP site, the ORNL TCC, the generator sites, states, and Indian tribes with the ability to monitor the location and status of all shipments 24 hours a day. The WIPP site and TCC have a two-way satellite communication capability, as well as mobile phone communication with the drivers. In addition, all users of the TRANSCOM system have access to emergency information, advance shipment schedules, and a bill of lading for each shipment.

To further ensure safety, shipment monitors at the WIPP site also keep abreast of enroute weather conditions via the "Weather Channel" and a commercial PC-based system, KAVOURAS, which provides hourly updates of weather along transportation routes. Information available includes: trucking hazards at present, for the next 24 hours and the next 3-5 days; route conditions citing visibility and weather (rain, sleet, snow, etc.); wind direction and velocity; and snow depth. Additionally, the monitor has access to the drivers, state and local law enforcement agencies, and the generator site traffic managers which enable them to make rational decisions regarding shipments that may be affected by inclement weather.

5.0 EMERGENCY RESPONSE

Although the chances of having an accident are calculated to be 1.37 in one million per mile that the WIPP trailer travels and

historically not one fire fighter, law enforcement officer, or emergency medical technician has been injured as a direct result of radioactive material in any transportation accident in the U.S., establishment of an excellent emergency response capability is still one of the top priority items in WIPP's task list. Tremendous efforts have been devoted to forming emergency response teams and to training the team members.

Training courses conducted by the WIPP and sponsored by the DOE, State government, and local emergency response agencies were provided to First Responders in areas along the transportation routes (Reference 10). The First Responders are local emergency personnel, such as law enforcement officers, fire fighters, and emergency medical technicians who must take immediate actions during the first 30 minutes or so of the accident response to preserve life, property, and the environment.

They have a thorough knowledge of the WIPP Project; radiological hazards; materials being shipped to the WIPP; the transportation system; and the specific actions required to protect themselves, the victim if there is any, the public, and the environment after the occurrence of an unlikely accident that results in a release of radioactive material.

For response under the DOE Radiological Assistance Program (RAP), the U.S. is divided into eight regions. Each region has several Radiological Assistance Teams (RATs), which are formed by

radiological protection experts. Major activities of a RAT are to 1) assess severity and potential radiological impact, 2) perform radiation measurements and surveys, 3) inform on-scene commander of findings, 4) maintain chronological events and decisions log of the DOE activities, 5) provide assistance with decontamination, and 6) request further assistance or back up support. A typical RAT usually consists of 2 to 6 radiological health physicists and could bring to the scene of a WIPP shipment two dual frequency portable radios, several beta/gamma monitors, and a couple alpha monitors. After the initial radiological response, the DOE would also send transportation and public affairs support as needed. Other federal agencies such as the Federal Emergency Management Agency (FEMA) and the Environmental Protection Agency (EPA) also have response capabilities. (However, the likelihood of a response based on past experience with radioactive material transportation accidents is slim.)

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ACKNOWLEDGMENTS

The authors would like to thank Messrs. C. D. Morissette, S. Mugno, B. Spooner, and S. C. Kouba for the valuable information and comments they provided during the preparation of this paper. Mr. T. Reed's assistance in the review/approval process is also appreciated. Special thanks go to the Department of Energy WIPP Project Office (WPO) and the Westinghouse Waste Isolation Division management team for their strong support.

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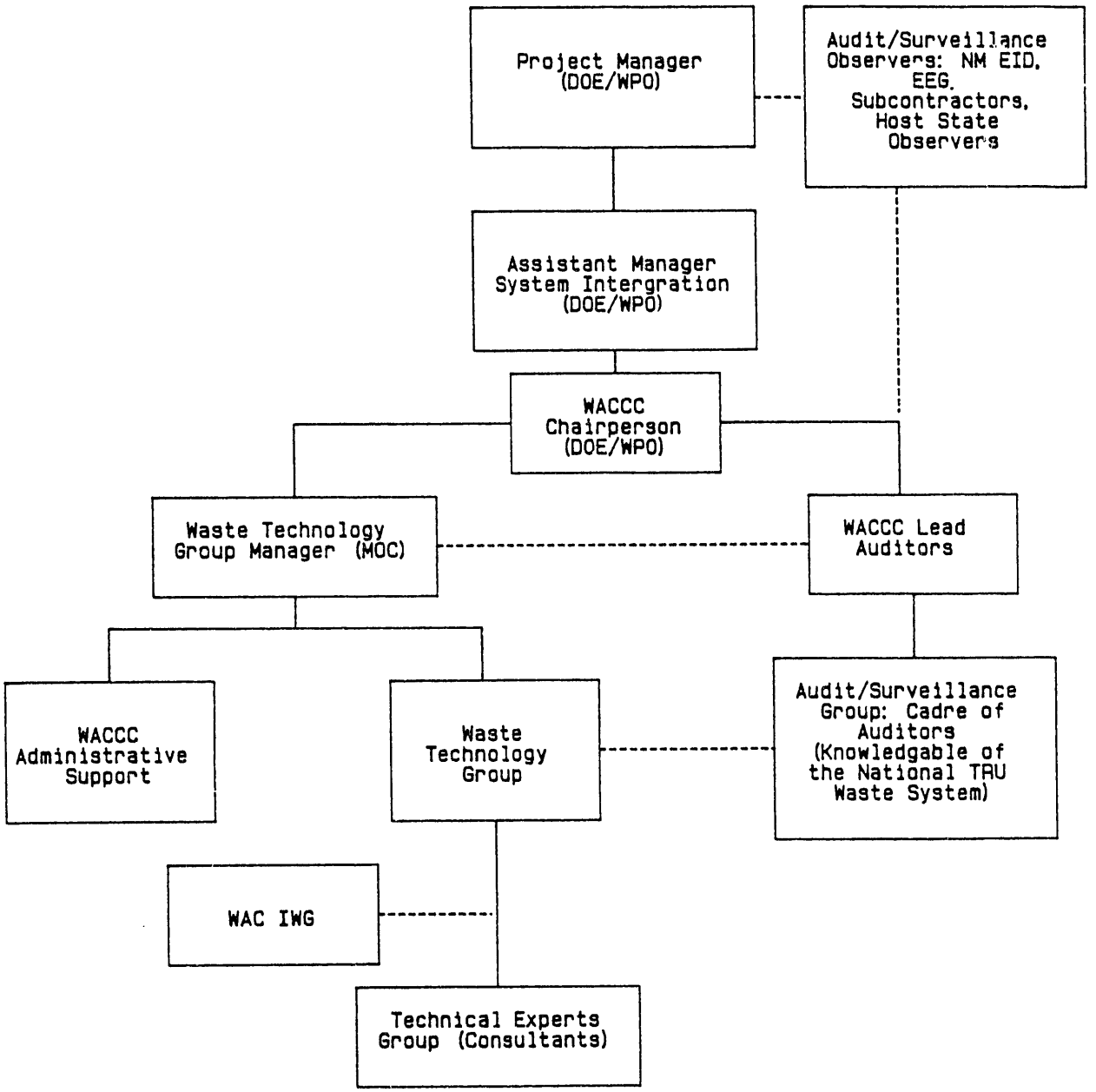

Figure 1. WACCC Structure

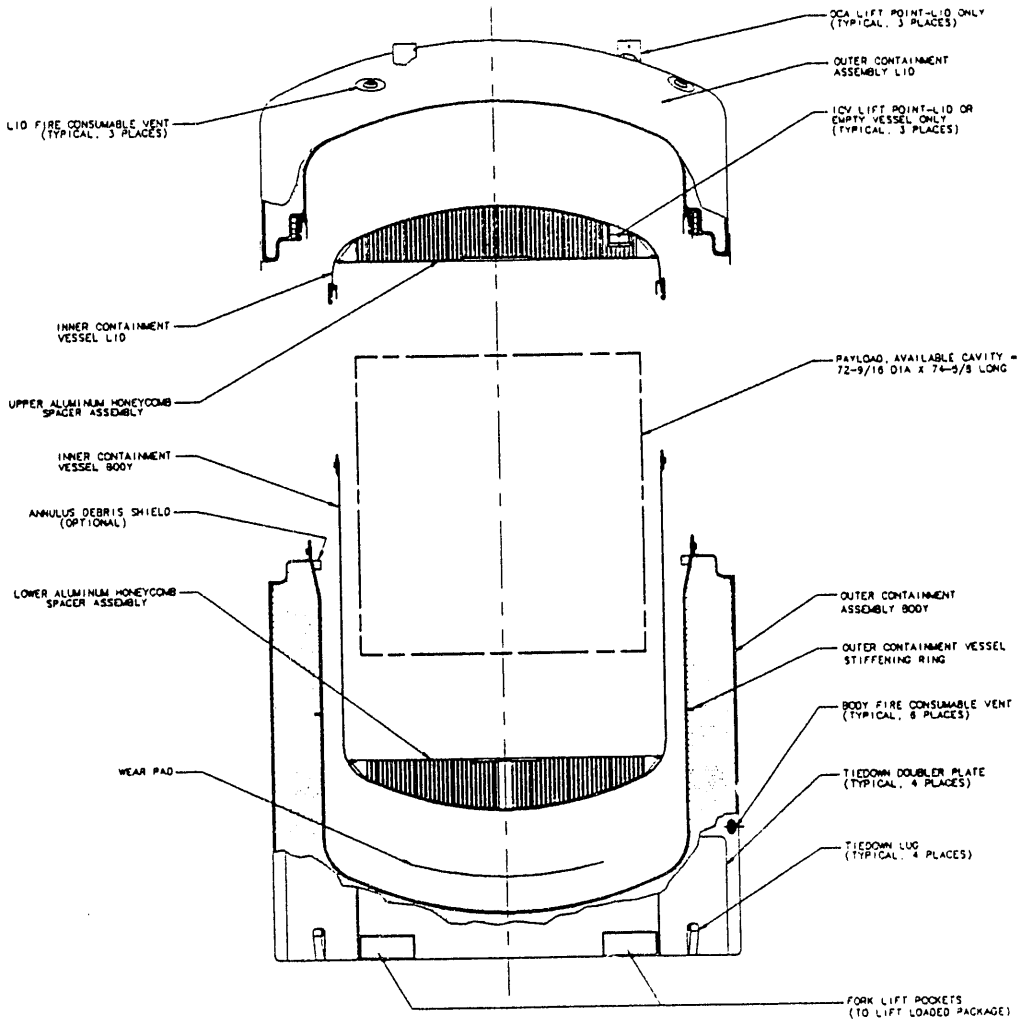

Figure 2. TRUPACT-II Configuration

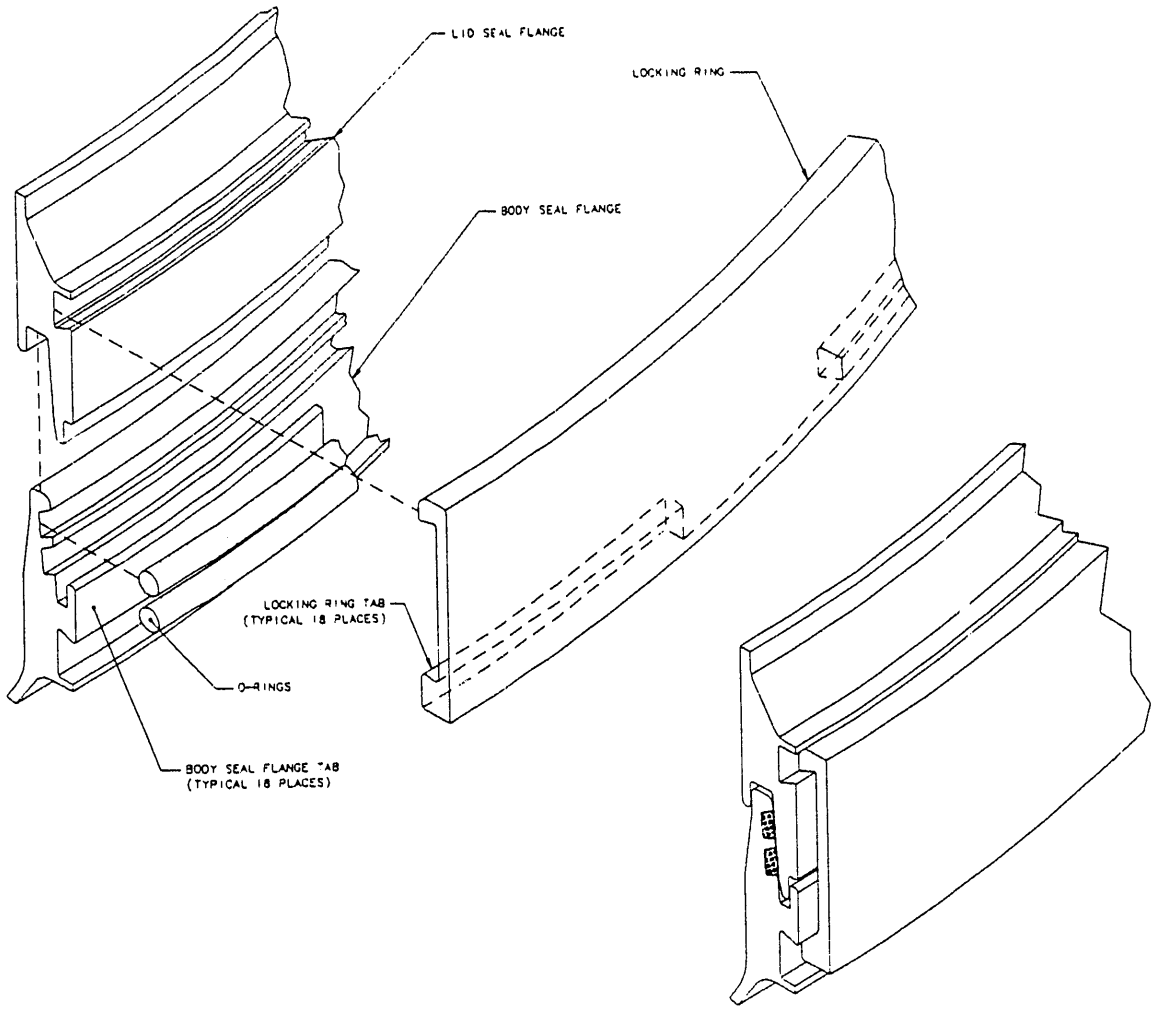

Figure 3. TRUPACT-II Containment and Seal

TABLE 1
SUMMARY OF WAC LIMITING PARAMETERS FOR CH-TRU WASTE

CRITERION/ REQUIREMENT AND SECTION	LIMITING PARAMETER(S)	SOURCE(S) OF LIMIT(S)
WASTE CONTAINER REQUIREMENTS/CRITERIA		
Waste Containers	• Containers shall be noncombustible, meet DOT Type A packaging requirements, and have a 20-year design life. • Current TRUPACT-II requirements limit acceptable containers to 55-gallon drums, standard waste boxes (SWBs), or SWB overpack of 55-gallon drums or test bins.	1 2
Waste Package Size	• Current TRUPACT-II limits are 55-gallon drums in two seven-packs, or two SWBs.	2
Waste Package Handling	• All packages shall be configured as specified in the TRUPACT-II SARP.	2
WASTE FORM REQUIREMENTS/CRITERIA		
Immobilization	• Waste materials shall be immobilized if >1% by weight is particulate material < 10 microns in diameter, or if >15% by weight is particulate material < 200 microns in diameter.	1
Liquids	• Only residual liquids; as a guideline, residual liquid in well-drained internal containers to be restricted to approximately 1 volume % of the internal container; aggregate amount of residual liquid < 1 volume % of external container.	1
Pyrophoric Materials	• No non-radionuclide pyrophorics permitted. Radionuclides in pyrophoric form are limited to <1% by weight in each waste package.	2,3
Explosives and Compressed Gases	• No explosives (49 CFR 173, Subpart C) are permitted. • No compressed gases are permitted.	1,2,3 2
TRU Mixed Waste	• TRU wastes shall contain no hazardous wastes unless they exist as co-contaminants with transuranics. • Waste generators must determine if their waste is regulated by RCRA, and assign the applicable EPA hazardous waste code(s). • Generators must develop Waste Profile Plans (WPPs).	1 3 3

TABLE 1 (CONT.)
SUMMARY OF WAC LIMITING PARAMETERS FOR CH-TRU WASTE

WASTE FORM REQUIREMENTS/CRITERIA (Continued)

CRITERION/ REQUIREMENT AND SECTION	LIMITING PARAMETER(S)	SOURCE(S) OF LIMIT(S)
TRU Mixed Waste (Cont.)	• Generators must document procedures for sampling, analytical protocols, QA/QC guidelines, and other information called for in 40 CFR 265.13 and 264.13 in a site-specific Quality Assurance Project Plan (QAPjP).	3
	• All chemicals/materials in >1% by weight must be evaluated for compatibility within the waste form and with TRUPACT-II materials of construction.	2
	• Trace chemicals (<1 weight % limit) must total < 5% by weight of the waste in any package.	2
	• Characteristic ignitable (D001), corrosive (D002), and reactive (D003) wastes are not acceptable at WIPP.	1,3
	• Waste packages emplaced in WIPP during the experimental period shall not exceed 50% of the lower explosion limit in any layer of confinement.	3
	• Any waste container sent to WIPP or loaded into a bin destined for WIPP must meet the two times (2X) the maximum comparability requirement for 5 nonflammable VOCs as specified in the NMD.	3
	• Any waste container sent to WIPP must meet the ten times (10X) the average comparability requirement for 3 nonflammable VOCs as specified in the NMD.	3
	• Sludges should be analyzed for total VOCs and toxic metals specified in the NMD.	3
Specific Activity of Waste	• Waste shall be >100 nCi/g TRU, exclusive of added shielding, rigid liners, and the waste containers.	1

TABLE 1 (CONT.)
SUMMARY OF WAC LIMITING PARAMETERS FOR CH-TRU WASTE

WASTE PACKAGE REQUIREMENTS/CRITERIA

CRITERION/ REQUIREMENT AND SECTION	LIMITING PARAMETER(S)	SOURCE(S) OF LIMIT(S)
Waste Package Weight	• Current waste package limits are 1000 lbs per 55-gallon drum, or 4000 lbs per SWB.	2
	• TRUPACT-II payload is limited to 7265 lbs.	2
	• TRUPACT-II is limited to 19,250 lbs total gross weight, with a total shipment GVW of 80,000 lbs.	
Nuclear Criticality (Pu-239 FGE)	• Accepted package limits, including two times the error, are: - < 200g/55-gallon drum - < 325g/SWB	2
	• The sum of the FGE of all packages in a TRUPACT-II payload shall be < 325g.	2
Pu-239 Activity	• Waste packages shall not exceed 1000 Ci of Pu-239 equivalent activity (PE-Ci).	1
Surface Dose Rate	• Drums or SWBs shall not exceed 200 mrem/hr surface reading, or 10 mrem/hr at 2 m.	1,2
	• Shielded containers are allowed for ALARA purposes only.	2
	• Neutron contributions of >20 mrem/hr shall be separately documented.	1
	• External dose rates on the loaded TRUPACT-II shall not exceed 200 mrem/hr surface, or 10 mrem/hr at 2 m.	2
Surface Contamination	• Removable package surface contamination shall not be >50 pCi/100 cm^2 alpha, and not >450 pCi/100 cm^2 beta/gamma.	1
Thermal Power	• Thermal (wattage) limits for individual waste packages, including the error, are contained in the TRUPACT-II SARP.	2
	• TRUPACT-II load limits are contained in the TRUPACT-II SARP.	2
	• TRUPACT-II design limit is 40 watts.	2

TABLE 1 (CONT.)
SUMMARY OF WAC LIMITING PARAMETERS FOR CH-TRU WASTE

WASTE PACKAGE REQUIREMENTS/CRITERIA (Continued)

CRITERION/ REQUIREMENT AND SECTION	LIMITING PARAMETERS(S)	SOURCE(S) OF LIMIT(S)
Gas Generation	• All waste packages shipped in TRUPACT-II shall be vented with one or more filters that meet specifications listed in the TRUPACT-II SARP.	2
	• All rigid liners shall be punctured or vented.	2
	• All confinement layers, such as bags, shall be closed only by a twist-and-tape or fold-and-tape method.	2
	• No sealed containers >1 gallon may be in the waste.	2
	• The maximum number of confinement layers shall be known.	2
	• Total flammable VOCs are limited to 500 ppm in the headspace gas of waste packages.	2
	• Chemicals/materials present in concentrations greater than one weight percent, shall conform to the allowable chemicals in each waste material type.	2
	• Real-time radiography or equivalent examination.	4
	• Visual characterization of solid waste for 10 waste material categories listed in QAPP.	4
	• Analysis of sludges for pH and major cations and anions listed in SNL Bin-Scale Test Plan.	4
	• Total alpha activity of waste on a container basis using methodology listed in QAPP.	4
Labeling	• A unique identification bar code label reasonably expected to last 10 years shall be affixed.	1,2
	• Each package shall have appropriate DOT labels.	1,2,3
	• Each package shall be marked with the shipping category.	2

TABLE 1 (CONT.)
SUMMARY OF WAC LIMITING PARAMETERS FOR CH-TRU WASTE

CRITERION/ REQUIREMENT AND SECTION	LIMITING PARAMETERS(S)	SOURCE(S) OF LIMIT(S)
DATA PACKAGE REQUIREMENTS/CRITERIA		
Data Package Certification	• A data package with certification shall be transmitted prior to shipment.	1
	• Documentation for certification of individual packages or a group of packages for shipment in each TRUPACT-II unit shall be submitted.	2
	• A hazardous waste manifest shall be utilized for each shipment of TRU mixed waste.	3
	• Information required by the WCPP shall be provided.	4
OTHER REQUIREMENTS/CRITERIA		
Additional Requirements	• All packages in a single TRUPACT-II shall belong to the same shipping category.	2
	• Each package shipped shall belong to one of the content codes defined in TRUCON.	2
	• Retrievably stored waste that has been unvented shall be vented and aspirated per the TRUPACT-II SARP.	2
	• Payload control procedures outlined in Section 7.4.3 of the TRUPACT-II SARP shall be followed.	2

Source(s) of Limit(s):

1 - WIPP Operations and Safety Criteria

2 - Transportation: Waste Package Requirements: TRAMPAC

3 - RCRA Requirements

4 - Performance Assessment Criteria

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