TRUPACT-I, A Contact-Handled Transuranic Waste Transportation System*

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ABSTRACT

In the late 1970's, the Department of Energy (DOE) initiated a program to develop an efficient, safe, reliable and cost effective transportation system for the carriage of contact-handled transuranic waste within the DOE complex. The system developed (TRUPACT-I) consists of two major assemblies: the containment system and the outer protective structure. The containment system prevents the release of TRU nuclides in excess of regulatory limits. The outer protective structure protects against the structural and thermal loadings imposed during normal and accident conditions. A fully-loaded truck version of TRUPACT-I will weigh 22.7 tonnes (50,000 lbs) and has a payload of 7.7 tonnes (17,000 lb). TRUPACT-I has been designed to accommodate a variety of material handling equipment such as lift trucks, powered roller conveyors and possibly air pallet systems. The prototype will be fabricated and tested during late FY 84. A three unit minifleet will be operated during FY 85 and FY 86 to gain operational experience.

INTRODUCTION

Since early in the Atomic Age, the Department of Energy and its predecessor agencies, the Atomic Energy Commission and the Energy Research and Development Administration, have had the statutory responsibility to design, develop, test and produce nuclear weapons for our nation's defense. This activity generates transuranic waste by-products that require transportation for placement in temporary storage, to provide additional processing of the wastes, or to place them into a demonstration or permanent disposal facility. Because of the elements that may be present and the long term potential hazard, there are stringent requirements for packaging, transport, and storage of these wastes to limit releases to the environment.

In response to the need to transport the transuranic wastes a program was initiated in the late 1970's at the Sandia National Laboratories (SNL) by the Department of Energy to develop an efficient, safe, reliable, and cost-effective transportation system for the carriage of contact-handled transuranic (CH-TRU) waste within the DOE complex. As the development effort advanced, GA Technologies, Inc. was selected to provide the detailed design of the packaging.

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The first packaging developed for transportation of the transuranic waste has been named TRUPACT-I (TRansUranic PACkage Transporter). TRUPACT-I will be a Type B packaging. This system will be transportable by either truck or rail (bimodal) and is now planned to become operational in the first quarter of fiscal year 1985 when the initial operational unit is delivered. Early development efforts were reported in the "Proceedings of the Fifth International Symposium of Packaging and Transportation of Radioactive Materials", May 7-12, 1978, Las Vegas, Nevada (USA) and updates on the progress were presented at the sixth and seventh symposiums. The most recent paper presented is published in "Proceedings of the Seventh International Symposium on Packaging and Transportation of Radioactive Materials", May 15-20, 1983, New Orleans, Louisiana (USA). This paper provides an overview and an update of progress on the design and on details of equipment to be used for interfacing with shipping and receiving facilities.

PACKAGE CONTENTS

Transuranic materials are radioactive elements with an atomic number greater than uranium. Typically, transuranic waste consists of articles such as paper, filters, rags, protective clothing, tools, and other similar items contaminated by small amounts of plutonium. Transuranic wastes contain

radioactive materials that have long half-lives and represent a potential hazard for thousands of years. CH-TRU wastes are materials which are usually contaminated with small amounts of plutonium and associated daughter products. These small amounts (greater than 100 nanocuries/gram) are usually in the form of oxides and are embedded, trapped, or otherwise attached to a variety of non-radioactive host or parent materials. Defense CH-TRU wastes (for which TRUPACT-I is designed) result from two basic sources: defense-related activities in facilities operated for the DOE and those other experimental and reactor research programs sponsored by the DOE. The wastes produced by these activities consist of by-products from production operations and from reclamation processes used to recover plutonium from contaminated equipment and materials.

TRU wastes are generally described by the characteristics of their host materials. The contaminants may be bound in concrete, embedded in rags or paper, attached to the surface of tools and machinery, or exist in residues (precipitates, sludges) from recovery processes. The actual contaminants are typically fine particles, but they are usually well attached to their hosts and are therefore relatively immobile.

The TRU wastes are typically sealed in plastic bags, which in turn are often placed within cans or other receptacles and are subsequently placed in sealed, lined drums or boxes identified as waste containers. These procedures organize handling of the wastes in making them ready for transport and storage, add to the protection of plant personnel, and reduce the possibility of release of the contaminants. By definition, the dose rate at the surface of a CH-TRU waste container may not exceed 200 mRem/hr. The characteristics of the principal waste containers to be transported in TRUPACT-I are presented in Table 1.

TABLE 1
Principal CH-TRU Waste Containers

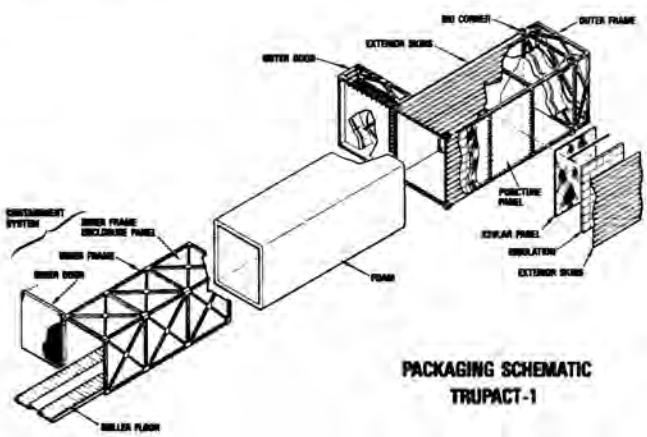
Container	Range of Package Weights, kg(lbs)	Packaging Dimensions, m(ft) Length x Width x Height	Pu Content Mass, gm Ave.	Pu Content Mass, gm Max.	Activity, Ci Ave.	Activity, Ci Max.	Max. Heat Dissipation Watts
DOT-17C/17H 55 Gal. Drum	43.6 to 610 (100 to 1400)	.61 dia.x.89 (24 dia.x35)	8	200	3.4	85	10
DOT-7A (RF or FRP) Box	436 to 2180 (1000 to 5000)	2.13x1.22x1.32 (84x48x52)	(1)	350	5.5	140.5	113
DOT-7A Box with Overpack		2.34x1.37x1.37 (88.5x54x54)	13	350	5.5	140.5	113
Reference Truck (DOT-7A Replacement Box		1.73x1.37x.98 (68x54x38.5)	(2)	350	(2)	140.5	45
Modular Box (Sandia)	262 to 4360 (600 to 10,000)	1.89x1.28x.98 (74.5x50.5x38.5)	11	350	5.5	140.5	60
Six DOT-17C/17H Drums in a Modular Box or Six-Pack	262 to 3749 (600 to 8600)	1.88x1.25x.90 (73.88x49.25x 35.5)	46	1200	20.4	510	60

NOTES: (1) DOT-7A Box is combustible and requires overpack for shipment to WIPP.
(2) Design being developed, no containers currently exist.

In some cases, the waste containers are vented with a high efficiency particulate filter to accommodate gases generated by ionizing radiation. A number of other types and sizes of containers have been utilized to store CH-TRU waste but they are used for only a small fraction of the total TRU waste volume and consequently, are not addressed here.

PACKAGE DESCRIPTION

The TRUPACT-I configuration is illustrated in the exploded isometric drawing in Figure 1. The packaging consists of two major assemblies: 1) the containment system, and 2) the outer protective structure.



PACKAGING SCHEMATIC
TRUPACT-1

Figure 1. TRUPACT-I Packaging Schematic

Containment System

The function of the containment system is to prevent the release of TRU nuclides in excess of acceptable regulatory limits for normal conditions of transport and hypothetical accident conditions. The containment system construction utilizes a 4.8 mm (3/16-inch) welded stainless steel liner because of its low-temperature ductility, superior corrosion resistance and ease of decontamination. The liner is attached to and supported by a diagonally reinforced inner frame assembly constructed of 76 mm (3 inch) square stainless steel tubing.

The containment system is made secure by closing and bolting into place a hinged 100-mm (4-in.) thick door which has a tubular stainless steel framework, stainless steel face plates, and an aluminum honeycomb core. This door is sealed with three concentric elastomeric seals. Thirty-six 19 mm (3/4-inch) diameter high strength bolts and 15 locating pins secure the door in place. The door also houses sealed quick-disconnect fittings for testing the seals and sampling the cavity atmosphere. A series of vents located along the top of the door permit the containment system pressure to equalize with the ambient surroundings as a result of changes induced by altitude variation, thermal effects and/or contents gas generation. Since the controlling factor for the design of the containment system is the retention of respirable size (<10 μm) particulates, these vents are protected by particulate trapping filters which

restrict release of TRU contaminants during transport.

Outer Protective Structure

The function of the outer protective structure is to protect the containment system from the structural and thermal loadings imposed as a result of the hypothetical accident conditions defined in 10CFR71.73 (1). The outer protective structure of TRUPACT-I consists of the outer frame assembly, the outer door, and rigid poured-in-place polyurethane foam which fills the door and space between the outer frame assembly and the containment system.

The outer framework is constructed of square stainless steel tubing to create the basic structure in a manner very similar to the inner frame. The length of the frame is divided into three bays, plus an additional length of framework on the closed end of the outer frame needed to accommodate the greater package deformations associated with a center-of-gravity-over-corner 9-m (30 ft.) drop. The length of the frame bays was selected so that the spacing on the ISO corner castings conforms to that for a standard 6.0-m (20-ft.) cargo container.

Puncture protection panels span the three bays on each side of the frame, and the closed end and door to completely surround the containment system. A 3.8-mm (0.15-in.) plate of 301 stainless steel welded into each bay of the outer frame provides in-plane stiffness to the framework and is the inner component of a 2-layer composite puncture protection system. The outer barrier of the puncture protection system consists of 30 layers of Kevlar*, 21-mm (0.78in.) thick, in the side walls and 44 layers of Kevlar, 31-mm (1.2 in.) thick, in each end wall. The Kevlar layers are bonded together to form semirigid mats. Individual mats are placed into each frame bay and bolted to the stainless steel backing plate. The high energy absorption-to-weight ratio produced by incorporating Kevlar into the design gives the packaging greater payload than would be achievable with an all metallic construction (2).

The rigid foam used in the assembly of TRUPACT-I is an important structural component of the system. It provides strength to the assembly, positions system components, bonds components to one another, provides energy absorption during impact and puncture, and provides thermal protection in a fire. The foam is a poured-in-place, heat-resistant, char-forming material with a nominal density of 96.0 kg/m^3 (6 lb/ft^3). There are approximately 813 mm (32 in.) of foam in each packaging end and 190 mm (7.5 in.) in the walls of TRUPACT-I.

A 25-mm (1.0 in.) blanket of 0.1 g/cm^3 (6 lb/ft^3) insulation placed outboard of the puncture panels reduces the heat input during thermal exposure. A 0.31-mm (0.012-in.) thick corrugated stainless steel outer skin is placed over the outer surface of the framework to provide weather and additional thermal protection.

*Kevlar is a registered trademark of E. I. duPont de Nemours Co. for Polyaramid fibers.

The construction of the outer door is nearly identical to that of the closed end of the body of the packaging with the addition of provisions for attachment. The edge of the outer door which contacts the outer frame contains a rapid actuating closure mechanism. This mechanism consists of a series of 36 pins which engage a locking plate and are moved by a worm-gear-actuated drive system operated from a single location. In addition to the actuated pins, the outer door frame is connected to the outer frame by 19 longitudinal shear pins, shear keys on the four sides of the frame, and a continuous stainless steel hinge assembly. An elastomeric seal between the outer door and the frame provides weather protection to the internal components of the package.

Size and Weight Limits

Table 2 summarizes the dimensions and weights of the TRUPACT-I. The useful inside dimensions, which make allowance for dunnage and a cargo handling floor, result in a useful cargo volume of approximately 19.4 m^3 (685 ft^3).

TABLE 2
TRUPACT-I DIMENSIONS AND WEIGHTS

Overall dimensions:	Inside dimensions:	Useful inside dimensions:[a]
Length 7.6 m (25 ft 1 in)	Length 5.8 m (19 ft 2 in)	Length 5.7 m (18 ft 10 in)
Width 2.4 m (8 ft 0 in)	Width 1.9 m (6 ft 2 in)	Width 1.7 m (5 ft 8 in)
Height 2.7 m (9 ft 0 in)	Height 2.2 m (7 ft 2 in)	Height 2.0 m (6 ft 5 in)

Weight	
Gross Vehicle Weight	36.3 tonnes (80,000 lb)
Empty packaging	15.0 tonnes (33,000 lb)
Cargo capacity	7.7 tonnes (17,000 lb)
Gross weight	22.7 tonnes (50,000 lb)

[a] Useful dimensions are smaller than nominal inside dimensions to ensure clearance around waste containers, and they take into consideration variations due to manufacturing tolerances of packaging and containers.

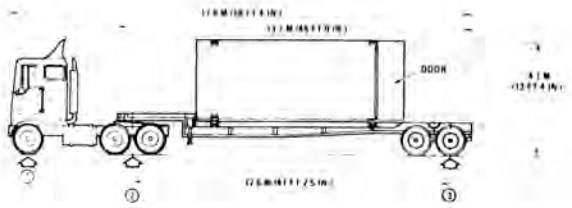
OPERATIONAL SUPPORT EQUIPMENT

Sites shipping or receiving TRU wastes via TRUPACT-I may perform loading/unloading operations with the package either on or off the transporter. The semitrailer is fitted with adjustable landing gear to permit loading operations with the tractor removed. When shipments are made via railcars it is currently planned that the TRUPACT-I will be loaded/unloaded with the package off the railcar.

TRUPACT-I TRANSPORT

The truck version of the TRUPACT-I system consists of the fully loaded package, weighing up to 22.7 tonnes (50,000 lb), and its transport vehicle, a tractor/semitrailer combination with a maximum gross vehicle weight (GVW) of 36.4 tonnes (80,000 lbs). The semitrailer is a step deck design with a full deck that might be used to haul other types of cargo. Figure 2 gives weight distribution and basic envelope dimensions for the truck and its package.

The 22.7 tonnes (50,000 lb) package may also be transported by railcar at a GVW of about 100,000 tonnes (220,000 lb).



UNIT	UNIT WT KG. (LB)	DISTRIBUTED AXLE LOADING KG. (LB)		
		(1) STEERING AXLE	(2) TANDEM DRIVERS	(3) TANDEM TRAILER AXLES
TRACTOR	7730 (17,000)	4090 (9000)	3640 (8000)	
TRAILER	5010 (11,021)	72 (158)	1390 (3056)	3550 (7813)
TRUPACT	22,730 (50,000)	538 (1184)	10,360 (22,752)	11,830 (26,024)
TOTALS	35,460 (78,021)	4700 (10,342)	15,380 (33,842)	15,380 (33,837)
ALLOWABLE	36,360 (80,000)	5455 (12,000)	15,450 (34,000)	15,450 (34,000)

Fig. 2. TRUPACT-I/Transporter Dimensions and Weights

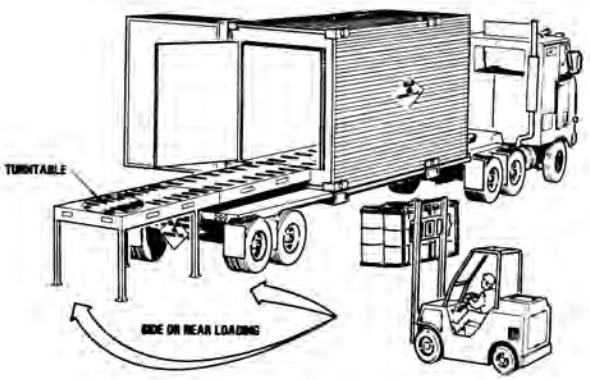


Figure 3. TRUPACT-I On-the-Truck Loading

With its semitrailer and tractor, TRUPACT-I complies with all weight and dimensional limits set by each of the fifty states for highway transport as of April 1983, except the 11.5-m (38-foot) limit on the king pin to rear axle distance imposed in California and the overall length limits imposed in eight states and the District of Columbia. Permits required for shipments in these states will be obtained as needed.

Figure 3 shows a typical arrangement for loading TRUPACT-I at sites where no loading dock is available and where the package remains on the semitrailer. With the outer and inner doors fully open, a portable platform is brought into place to mate with the floor of the inner cavity. As shown, a part of the platform rests on the rear deck of the semitrailer and a second segment is a freestanding platform containing a surface turntable. The top surfaces of the roller conveyors form a continuous assembly 12.2 m (40 ft.) long that extends from inside of TRUPACT-I to a distance 2.1 m (7 ft.) past the end of the semitrailer. Waste containers can be placed onto the platform from the rear or side as shown. An electric winch is mounted on the rear of the platform to aid in pulling the waste containers out of the package cavity. The freestanding platform has retractable casters attached to its legs so that it can be moved into position without a lift truck. When the casters are retracted, the platform is lowered onto its supporting legs. The portion of the unloading platform that rests on the semitrailer deck must be positioned using a lift truck. For loading with TRUPACT-I off the transporter, a smaller and lower platform similar to platform segment shown resting on the semitrailer deck in Figure 3 is used to interface with the inner cavity.

A lift truck deposits the waste containers on the platform from one side or the end, but because of the dimensions of the platform, the containers cannot always be set down in the center of the platform. The platform turntable allows the waste containers to be rotated and positioned on the center of the platform and then pushed forward into TRUPACT-I. Sites that prefer to load or unload TRUPACT-I from a loading dock can use the platform to provide a bridge from the dock to the inner cavity.

TRUPACT-I can also be loaded and unloaded while removed from its transporter. A crane or a freight container handling truck is used to lift the package from the semi-trailer or railcar using an ISO spreader for 6.0 m (20 ft.) freight containers to engage the lifting apertures on TRUPACT-I. Under current guidelines, powered lift trucks will not be permitted inside the inner cavity to perform normal loading/unloading operations because of their high wheel loads and potential for damage to the inner liner.

TRUPACT-I has been designed to accommodate a variety of material handling equipment and to minimize the need for special auxiliary equipment. Low volume sites will be able to load and unload the package with basic equipment such as lift trucks, cranes and hand tools. Higher volume sites may invest in more expensive handling hardware such as powered roller conveyors, and large container handling vehicles if needed. Fully palletized loads could reduce the time that packages and transport vehicles spend idle at the loading sites. The use of a full size removable pallet is not currently an option but may be offered in the future.

LOADING/UNLOADING PROCEDURES

The TRUPACT-I loading and unloading procedures are relatively simple and straight-forward.

Separate and detailed written loading and unloading procedures will be prepared for each step to (a) ensure that all steps are properly executed, (b) provide guidance in the event of abnormal conditions, and (c) guarantee that the recording and reporting requirements are met.

The loading procedure is summarized in the following seven steps:

(1) Receiving and external inspection
(2) Removal from the transporter
(3) Opening of packaging
(4) Internal inspection
(5) Loading waste containers into the containment
(6) Closing of packaging (including seal integrity tests)
(7) Replacement on transporter

Because the packaging can be loaded with a portable loading platform while on its transporter, steps (2) and (7) are optional.

The unloading procedure is summarized in the following six steps:

(1) Receiving and external inspection
(2) Removal from the transporter
(3) Cavity atmosphere sampling (if appropriate to contents)
(4) Opening of packaging
(5) Removal of waste containers from the containment cavity
(6) Closing of packaging

Step (2) is optional because the packaging can be unloaded with a portable loading platform while on its transporter

FUTURE ACTIVITY

Fabrication of a TRUPACT-I test prototype has been initiated with expected delivery in the 2Q-FY84. Regulatory testing of the package will be conducted at Oak Ridge National Laboratory and Sandia National Laboratories with a scheduled completion of 4Q-FY84. A working draft of the Safety Analysis Report for Packaging (SARP) has been completed and is being reviewed. A final SARP is scheduled for the publication in 4Q-FY84 following the prototype tests. Issuance of the certificate of compliance is expected during 4Q-FY84.

Preliminary operation of a three unit mini-fleet will be initiated in FY-85 and continue through FY-86. The results of this operational checkout will be used to optimize package handling, refine procedures, and provide a data base for macro-fleet operations.

REFERENCES

1. Code of Federal Regulations Title 10, Part 71 (10CFR71) "Packaging and Transportation of Radioactive Materials"

2. M. G. Vigil, J. E. Deveney, H. R. Yoshimura, T. A. Duffey, M. H. Cherish, and A. Zimmer, "Puncture Protection for the TRUPACT System," Proceedings of the 7th International Symposium of Packaging and Transportation of Radioactive Materials, New Orleans, LA, May 15-20, 1983.