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TRU WASTE TRANSPORTATION PACKAGE DEVELOPMENT*

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Contact-handled transuranic (CH-TRU) waste is generated at numerous locations in the United States as a by-product of defense related programs. Some of these facilities are incapable of storing large quantities of waste and must periodically transport Type B quantities to other Department of Energy (DOE) sites. At some time in the future the majority of the existing waste will be placed in a federal waste repository. CH-TRU waste will require transportation from its present storage locations to the repository. If processing is required prior to disposal, an additional transportation step will be added for those sites which cannot process their own waste.

The Transportation Technology Center at Sandia National Laboratories is responsible for the development of new generation transportation systems to be utilized in the management of defense related CH-TRU waste. The development program places particular emphasis on the compatibility of transportation hardware with both waste generating and receiving facilities. An initial design concept has been completed and scale models are being fabricated and tested. Concurrent structural analysis, thermal analysis, and material test programs are being conducted to support the design effort. This paper presents a summary of the activities involved in the development program and a brief overview of the progress to date.

A list of the inventory of the transuranic waste at a number of DOE sites[1] in the United States is given in Table 1. Both the buried and retrievably stored waste as well as the projected annual storage rates are given for each site. The buried waste mentioned in the table was accumulated at the sites prior to 1970. In 1970 the United States Atomic Energy Commission initiated a policy whereby TRU waste with actinide activities greater than 10 n Ci/gm must be retrievably stored. Much of the stored waste and buried waste (were it retrieved and packaged) indicated in Table 1 is CH-TRU. Since there is a possibility the buried material will be exhumed, packaged, and handled along with the stored waste, the need for safe, cost-effective transportation hardware is obvious. Even if only the stored waste is sent to a repository, the waste volumes involved are still formidable.

Retrievably stored CH-TRU waste typically consists of plutonium contaminated metal scrap, sludge, paper, filters, and other materials resulting from weapons production and reprocessing operations. The activity of the waste is low with the maximum dose rate at the surface of a container of CH-TRU being less than 200 mrem/h. Most of the waste has a plutonium content of less than 18 Ci/m^3.

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Table 1. Inventory and Storage Rates of Transuranic Waste at DOE Sites

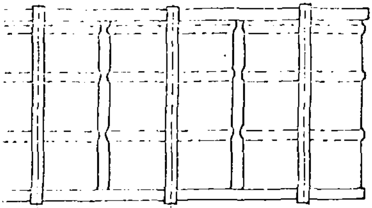
Site	Inventory (m^3) Buried	Inventory (m^3) Stored	Estimated 5 Year Storage Rates (m^3/year)
Oak Ridge National Laboratory	6300	1200	70
Los Alamos Scientific Laboratory	11500	3500	550
Savannah River Plant	27000	2400	150
Nevada Test Site	5700	240	25
Hanford Site	225000	8000	1400
Idaho National Engineering Laboratory	57000	40000	2800

The stored waste is contained primarily in steel drums and fiberglass reinforced plywood (FRP) boxes, although a small amount is being stored in rectangular steel boxes known as M-3 bins. Table 2 itemizes some of the waste units with which the new generation transportation systems will need to be compatible. The term "six-pack" in the table refers to a proposed efficient method of handling six 200-litre (55-gallon) steel drums. In this method a rectangular array of six drums is placed between two welded steel frames (a frame being placed at the top and bottom of the drum array) and the assembly is then banded together into a unit with steel strapping. A side view of an assembled six pack is shown in Figure 1. Also shown in Figure 1 is a side view of the modular box. The modular box is currently being developed at Sandia. It is constructed of corrugated sheet metal and is meant to serve as a primary waste container or as an overpack for up to six damaged or otherwise unserviceable 200-litre drums. Used as a primary waste container, the modular box is obviously more efficient volume wise (i.e., can contain more waste) than the six drums it replaces. The box is also estimated to be less expensive than six drums with rigid polyethylene liners. The modular box is scheduled to be tested to Type A requirements (IAEA Safety Series No. 6) during the 1981 fiscal year. Once the box is approved, it will be recommended as the new standard container for CH-TRU waste.

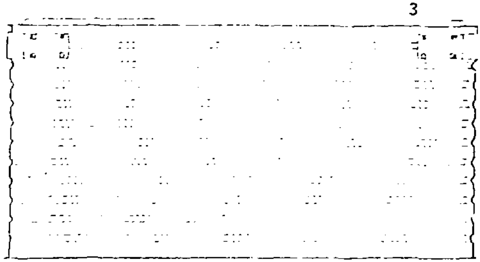
When the Type-A containers are assembled into groups large enough to be transported efficiently, Type-B quantities of some radionuclides (particularly plutonium) may be present in the accumulated volume. Type-B packaging is therefore required and the TRUPACT must provide double containment as specified by the

Table 2. Containers of Waste Requiring Transport

Container	Container Dimensions (m, LxHxW)	Container Mass (kg)
Six-Pack	1.3 x 1.0 x 1.9	2300
Modular Box	1.3 x 1.0 x 1.9	4500
FRP Box	1.2 x 1.3 x 2.1	2300
M-3 Bin	1.2 x 1.8 x 1.5	1500



Six Pack



Modular Box

Figure 1. Six-Pack and Modular Box CH-TRU Containers

United States Nuclear Regulatory Commission as well as provide structural and thermal protection to the waste in accident environments as specified in Appendix B, Hypothetical Accident Conditions, of 10CFR71. (These accident environments are equivalent to those found in IAEA Safety Series No. 6.) No radiation shielding or internal heat removal mechanism is necessary for this waste.

Concepts for safe, cost-effective Type-B packagings that can handle drums or boxes are currently being developed and assessed. The leading conceptual design is known as the TRansUranic PACkage Transporter (TRUPACT). As illustrated in Figure 2, the TRUPACT is envisioned to be a large metal container consisting of inner and outer tubular steel frameworks which are separated by rigid polyurethane foam and sheathed with steel plate. To minimize the package weight and maintain ductility at low temperatures, a high-strength, low-alloy steel is used in both frames and the outer skin. The sides of the cargo compartment are constructed of carbon steel clad with stainless steel such that the stainless steel surface faces inward. This construction facilitates decontamination if required. The inner structure is made secure with a hinged, 13-cm-thick door that has a tubular steel framework and is filled with foam. This door is fitted with dual elastomeric seals and bolted in place during transport. The exterior door, which is attached to the outer frame with hinges, is 90 cm thick, utilizes a single elastomeric seal and

Figure 2. TRUPACT

is also bolted in place during transport. There is approximately 90 cm of foam in the package ends and 36 cm in the walls to provide impact energy mitigation and thermal protection.

Although making the TRUPACT transportable by rail and truck was a design goal early in the program, transportation constraints and payload maximization considerations suggested the need for a different version of the package for each mode. The rail transported TRUPACT has approximate external dimensions of 7.3 x 2.7 x 3.0 m (L x W x H) and an internal cargo compartment measuring 5.5 x 2.0 x 2.4 m. The smaller truck version measures 7.5 x 2.3 x 2.7 m externally and 5.7 x 1.5 x 2.0 m internally. Figure 3 illustrates the six-pack loading orientations to be used for each version. Six six-packs (or modular boxes) may be transported in the truck version of TRUPACT and eight can be accommodated in the rail version. The empty rail verson weighs 11 tonne and carries a maximum payload of 19 tonne. The truck version weighs 10 tonne and carries a 13 tonne payload. The weights and dimensions of the two TRUPACT versions are such that one truck TRUPACT may be transported by legal weight truck and two rail versions by one railcar (see Figure 4).

Concurrent with the structural analysis of the TRUPACT, full- and quarter-scale tests were completed on containers filled with various forms of simulated CH-TRU waste to assess the cargo response in accident environments as well as its effect on the response of the loaded TRUPACT. The tests were conducted in both static and dynamic environments. Static tests consisted of crushing individual drums and modular boxes. The dynamic tests involved dropping drums individually, in arrays, and in modular boxes from various heights. Modular boxes containing loose simulated waste were dropped singly and in arrays from 9 m. The data generated from these tests have led to the development of realistic analytical cargo models.

The vulnerability of the TRUPACT to puncture is being evaluated both analytically and experimentally for various wall configurations. Results of this investigation, together with information from the assessment of the mechanical and thermal response of candidate foams, are expected to require some modification of the existing wall cross sections to optimize punch resistance.

The structural response of the TRUPACT to the 9 m end-on, side-on, and center-of-gravity-over-corner drop tests has been evaluated analytically. Each case is being compared to the results of quarter-scale model drop tests as the tests are conducted. To date, comparisons have been made only with the end-on 9 m drop test. The extent of the damage sustained by the quarter scale model during this test is shown in Figure 5. The average reduction in length of the outer box was seen to be 3.2 cm, which corresponds to a full-scale crush of 12.8 cm. This agrees with the analysis which predicted a crush of 13.2 cm. The package has thus far performed satisfactorily and no significant changes to the design are expected as a result of the structural evaluation for impact environments. A detailed description of the TRUPACT structural analysis program may be found in the companion PATRAM '80 paper, "Contact-Handled Transuranic Transportation Systems Structural Analysis."

The TRUPACT conceptual design essentially is complete. Additional work on the conceptual design and thermal and puncture tests will be completed during 1981. Following DOE approval of the concept, a package of system specifications and drawings will be prepared and a contract placed in private industry for the completion of a detailed design in FY 1982. Activities during FY 83 and FY 84 will mainly involve construction, test, and possible redesign of ptototype hardware. Production units should be available in 1985. Figure 6 shows the current schedule for the remainder of the program.

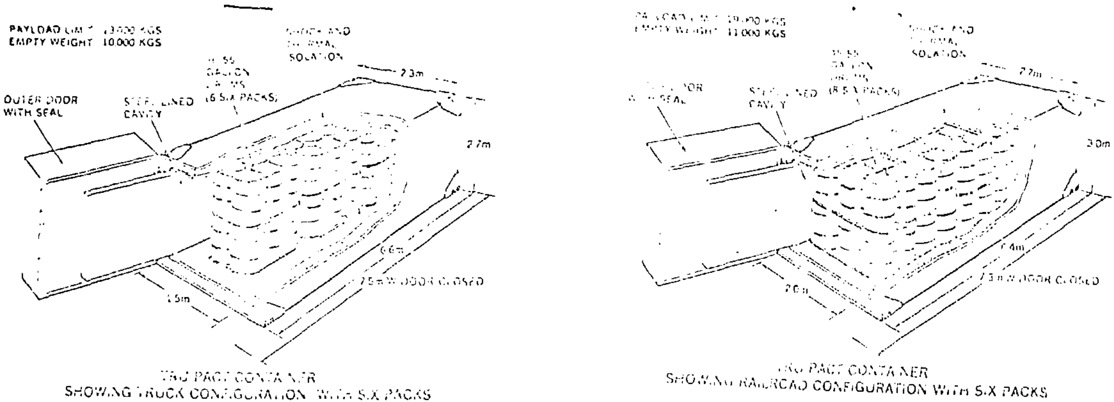


Figure 3. TRUPACT Truck and Rail Version

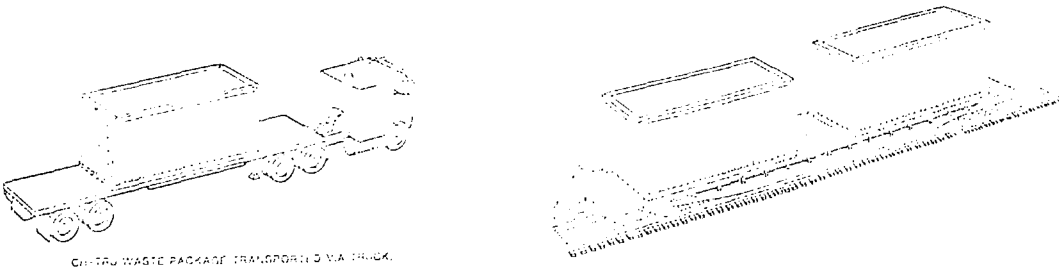
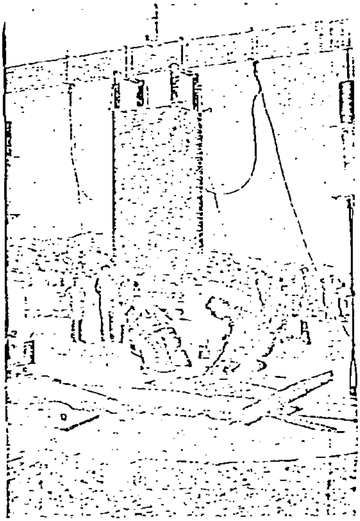
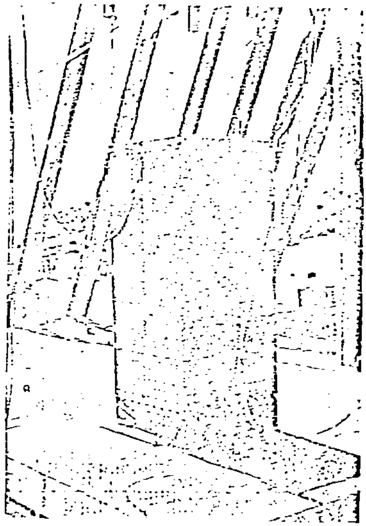


Figure 4. Configuration for TRUPACT Truck and Rail Transport



Quarter-Scale TRUPACT Being Readied for End-on 9 m Drop Test



Quarter-Scale TRUPACT Following End-on 9 m Drop Test

Figure 5. Quarter-Scale 9 m Drop Test of the TRUPACT

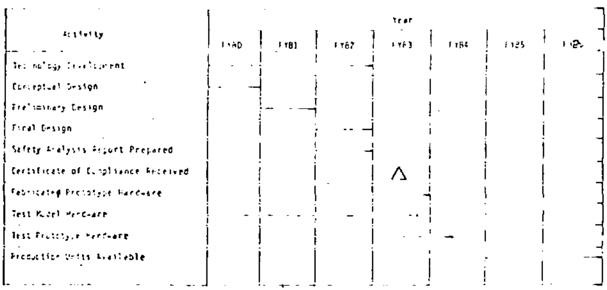


Figure 6. Schedule for CH-TRU Transportation System Development

REFERENCES

1. U.S. Department of Energy Acceptance of Commercial Transuranic Waste, DOE/AL/TRU-8001, Rockwell International-Rocky Flats Plant, Boulder, Colorado, February 1980.

2. H. C. Shefelbine, Preliminary Evaluation of the Characteristics of Defense Transuranic Waste, SAND78-1850, Sandia National Laboratories, Albuquerque, New Mexico, November 1978.