

**OPTIMIZATION OF THE TRANSURANIC WASTE TRANSPORTATION
PROGRAM – KEEPING THE PIPELINE FULL**

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ABSTRACT

The objective of the Transuranic (TRU) Waste Transportation Program is to implement a waste transportation system that will fill the Waste Isolation Pilot Plant pipeline and ensure shipment of all waste in a safe, cost-effective manner in compliance with all governing requirements and fulfilling site milestones and closure schedules. The TRU Waste Transportation Optimization Plan (1) describes the strategy to achieve this desired end-state, including multiple initiatives being pursued to resolve TRU waste shippability issues. Transportation optimization for TRU waste addresses waste shippability with respect to the limits on size, weight, gas generation, and fissile loading of containers as well as the mode of transportation. A detailed evaluation of inventory packaging needs based on waste shippability, along with a cost-benefit analysis of the available options and payload expansion and research development initiatives (e.g., the TRUPACT-III shipping packaging), will determine the optimum end-state for the transportation of the waste from each of the U.S. Department of Energy sites. This optimization will determine the TRU waste transportation fleet size, the mix of packagings, and the mode of transportation that will most efficiently fill the WIPP pipeline.

INTRODUCTION

The Waste Isolation Pilot Plant (WIPP), located in southeastern New Mexico, is an underground geologic repository for the disposal of transuranic (TRU) wastes generated from defense-related activities at several U.S. Department of Energy (DOE) sites and some non-DOE sites across the United States. After successfully meeting several regulatory milestones involving multiple regulatory agencies, the WIPP began accepting waste for permanent disposal in March 1999.

Since the opening of the WIPP in 1999, nearly 600 shipments of contact-handled (CH) TRU waste have been made to date from five different DOE sites. The WIPP is expected to receive approximately 37,000 shipments of TRU waste over its projected 35-year operating life.

The current baseline and potential options for CH-TRU waste shipments to the WIPP are as follows:

- The TRUPACT-II represents the current baseline shipping container for the transportation of CH-TRU wastes. The current fleet consists of 39 TRUPACT-IIs with a ramp up to more than 60 TRUPACT-IIs expected.
- The HalfPACT, a smaller, lighter version of the TRUPACT-II designed for the shipment of heavier payloads, was licensed by the U.S. Nuclear Regulatory Commission (NRC) in December 2000. Production of HalfPACTs as part of the CH-TRU transportation fleet is currently underway, with delivery of the first unit expected in Spring 2002.

There are two Type B shipping containers that can be used for the transportation of remote-handled (RH) TRU waste, the 72-B cask (baseline) and the 10-160B cask. The NRC licensed the 72-B Cask in March 2000, and approved the 10-160B cask for the shipment of RH-TRU waste from Battelle Columbus Laboratories in March 2001

A detailed evaluation of inventory packaging needs based on TRU waste shippability, along with a cost-benefit analysis of the available options, will determine the optimum transportation resources required for the removal of TRU waste from each of the DOE sites. This optimization will determine the TRU waste transportation fleet size, the mix of packagings, and the mode of transportation. A logic diagram for transportation optimization implementation is presented in Figure 1 and contains the key components discussed in the following sections.

Shipping Packaging Needs

The attributes of the TRU waste inventory and transportation system that determine waste shippability and drive packaging needs are waste classification, size, weight, gas generation, fissile gram equivalent (FGE), dose rate, and mode of transportation. The packaging needs are different based on whether the waste to be shipped is CH-TRU or RH-TRU. If the surface dose rate of the payload container is less than or equal to 200 mrem/hour, the waste is CH-TRU (with no additional shielding required in the shipping package). If the dose rate at the surface of the payload container is greater than 200 mrem/hour, the waste is RH-TRU, and additional shielding must be provided by the shipping package to meet transportation limits for dose rates.

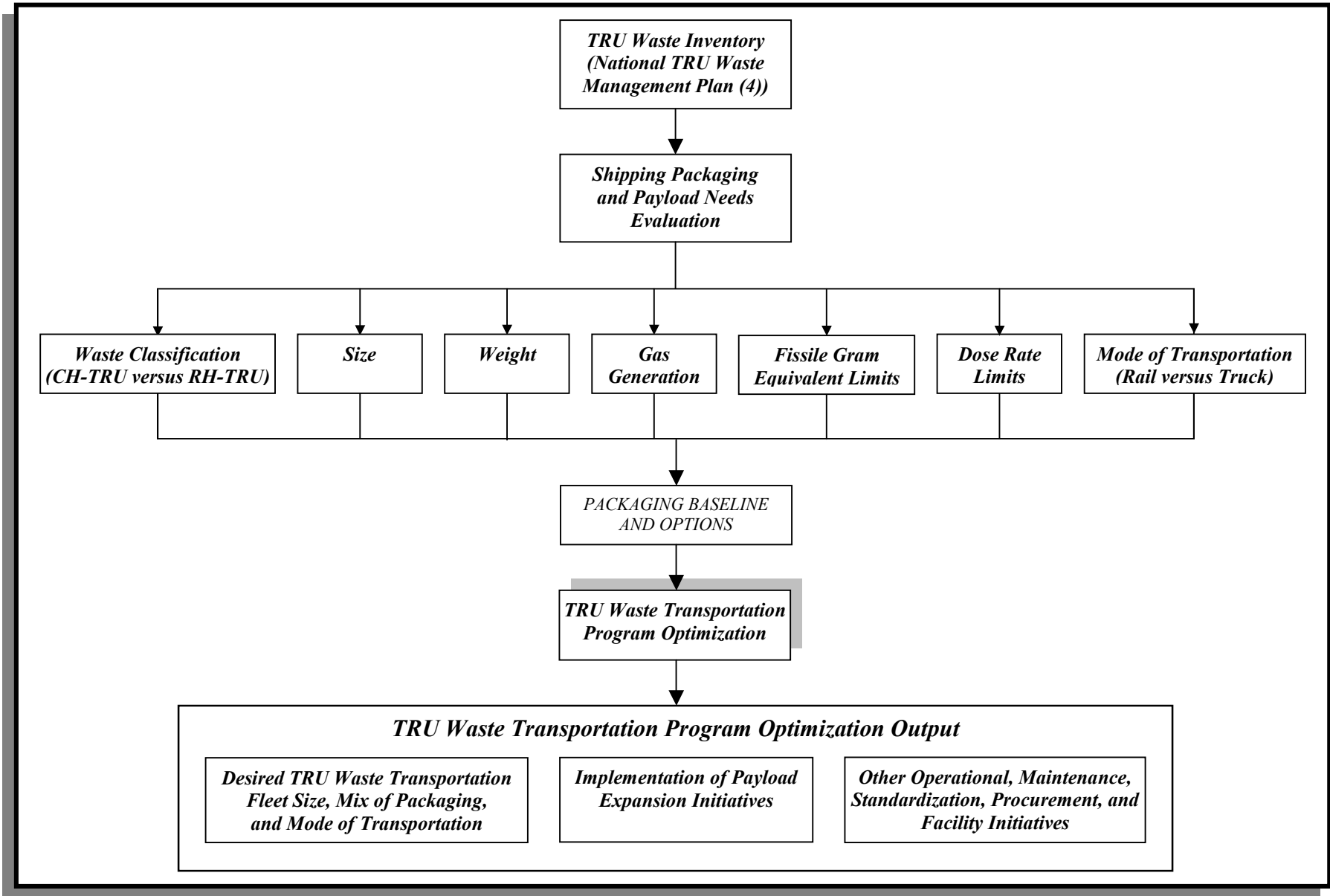


Fig. 1. TRU Waste Transportation Program optimization logic.

Size

The TRUPACT-II and the HalfPACT are NRC-certified packagings designed for the transportation of CH-TRU wastes to the WIPP. Approximately 24 percent (by volume) of the CH-TRU waste inventory located at several of the DOE sites is projected to exist in oversized containers (4- x 4- x 7-feet or even much larger) that are not transportable in the TRUPACT-II or the HalfPACT. Repackaging the entire oversized waste inventory into authorized containers (ten-drum overpacks, standard waste boxes, 55-gallon drums, etc.) would be necessary for the waste to be directly transportable in a TRUPACT-II or HalfPACT. This is neither a practical nor cost-effective option. The TRUPACT-III Initiative addresses the shipment of a portion of the waste inventory in oversized boxes that would not fit in the TRUPACT-II or HalfPACT (2).

The "TRUPACT-III Initiative Workshop" held February 13-14, 2001, at the DOE-Carlsbad Field Office (CBFO) identified key inventory attributes, characterization methods, and design parameters that would dictate the feasibility and effectiveness of a new packaging for oversized CH-TRU waste containers. One of the key recommendations from the TRUPACT-III Initiative Workshop was to perform a trade study that would evaluate different alternatives for the TRUPACT-III concept and make a recommendation to the DOE-CBFO on the path forward (2). A Subject Matter Expert (SME) Panel was convened by the DOE-CBFO to implement this recommendation and perform the TRUPACT-III trade study. The SME Panel concluded that the design of a TRUPACT-III shipping container for the shipment of large sized boxes is a viable, cost-effective, and preferable alternative to repackaging the all of the oversized TRU waste inventory and recommended that the DOE proceed with the design basis of a TRUPACT-III (3). Options considered feasible and effective by the SME Panel included the following:

- A packaging similar to the TRUPACT-II with internal cavity dimensions of 5.7- by 5.7- by 14.5-feet that would be capable of shipping two to 5.5- by 5.5- by 7-foot boxes. This packaging concept is intended for transport by rail. Truck transport would be possible with the use of oversize permits.
- A scale-up (33.5%) of the current TRUPACT-II with internal cavity dimensions of 5.7- by 5.7- by 8.2-feet. This packaging concept is primarily intended for transport by rail. Truck transport would be possible with the use of oversize permits.
- Use or modification of an existing package that currently is or is capable of being certified by the NRC. One viable option is the TN-GEMINI¹. The design is a rectangular, single-contained package with internal dimensions of approximately 6.0- by 6.5- by 14.5- feet. The TN-GEMINI has the same external dimensions as a 20-foot International Standards Organization (ISO) container and is shippable by truck or rail (overweight permits may be required for truck transport).

Weight

The average payload weight that can be transported in a shipping container is governed by multiple weight limits, including the payload container weight, the shipping container weight, and the overall shipment weight. The HalfPACT was designed to accommodate the shipment of

heavier payload containers in the most efficient manner (i.e., maximizing payload volume per shipment). The average drum weight that can be transported in a fully loaded HalfPACT is 1,000 pounds, well above the average drum weight for a fully loaded TRUPACT-II of 312 pounds. Approximately 30 to 40 percent of the CH-TRU waste inventory may be affected by weight limits and could potentially be shipped more efficiently in the HalfPACT (4).

Gas Generation

The potential for flammable gas generation restricts the shipment of high-loaded waste forms [e.g., plutonium (Pu)-238 waste]. Revision 19 of the TRUPACT-II Safety Analysis Report includes payload expansion initiatives to address gas generation. However, a small percentage (~2%) of the CH-TRU waste inventory remains limited by gas generation issues. This waste primarily consists of ²³⁸Pu waste, solidified organic waste, and other high-loaded ²³⁹Pu wastes (4).

Gas generation limitations, while impacting a small fraction of the overall CH-TRU waste inventory, could result in significant volume expansion and high costs (\$1 to \$2 billion) associated with repackaging the Pu-238 and high-loaded Pu-239 wastes (2). Gas generation issues also impact the ability to ship solidified organic wastes from sites like the Rocky Flats Environmental Technology Site and the Idaho National Engineering and Environmental Laboratory. The strategy for addressing gas generation limitations consists of the following components:

- **Demonstrate the Absence of Hydrogen or Less Than 5% Hydrogen:** This strategy would comply with the current limit of 5% hydrogen by implementing a bag breaching technology (to ensure the release of hydrogen from the inner confinement layers) in conjunction with the use of hydrogen gas getters (to scavenge the hydrogen generated within the payload containers). Relief from the limits could also be achieved to a limited extent by using waste-specific characterization information to reduce the level of conservatism in the gas generation analysis.
- **Demonstrate the Absence of Oxygen:** This strategy would demonstrate safety by ensuring the absence of oxygen (by means of inerting, use of oxygen/hydrogen recombiners, bag breaching, or credit for naturally occurring recombination), without limiting the hydrogen. This option would challenge the current regulatory requirement of less than 5% hydrogen by using reasoned justifications and testing.
- **Demonstrate No-Consequence of Potential Flammability Event:** This strategy would ensure safety of shipment by demonstrating that the system is robust and safe under transportation conditions. This option would require the testing of a sealed system (e.g., ARROW-PAK™) and analysis to show that it will survive a potential flammability event. This option challenges the regulatory position limiting hydrogen to less than 5%.

Another option currently under review by the NRC is to use actual, operational shipping experience to take credit for a reduced shipping time for sites with close proximity to the WIPP. This shorter shipping period reduces the amount of gas generated during transportation.

FGE Limits

FGE limits applicable to payload containers and the packaging also impact shippability. The pipe component was an initiative that addressed FGE packaging limits for certain portions of the TRU waste inventory. As gas generation and wattage limits are increased, the packaging FGE limits (e.g., 325 grams for the TRUPACT-II) could be limiting for waste shipments that do not include pipe components. Other payload enhancements have the potential to increase the FGE limits based on packaging, waste form, and/or a new criticality analysis. Demonstration of a “no safety consequence” for accident scenarios based on a robust payload container/packaging has the potential to allow shipment of wastes with high fissile loading.

Dose Rate Limits

For specific RH-TRU waste forms, dose rate limits restrict the amount of waste that can be shipped (e.g., waste forms with neutron emitters). Different designs of pipe components, with specific shielding materials, are being developed to address the shipment of these wastes.

Mode of Transportation

The activities aimed at improving the current transportation framework include exploring alternative modes of transportation and alternative characterization techniques. Shipment of TRU waste by rail is still being considered as a viable option, as discussed in the Rail Infrastructure Report issued in 2001 (5). This report, based on recent input received from the railroads, concludes that rail shipments are a cost-effective and viable alternative to truck shipments provided characterized and shippable inventory is available at the sites.

SUMMARY

Optimization of shipments to the WIPP is needed to meet the objective of the TRU Waste Transportation Program to fill the waste transportation pipeline to the WIPP in a timely and cost-effective manner and to meet site closure schedules and milestones. Implementation of payload enhancements and technology initiatives underway will result in a transportation system that will efficiently fill the WIPP pipeline.

FOOTNOTES

1. The French competent authority has certified the TN-GEMINI as a Type B packaging in accordance with International Atomic Energy Agency rules.

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