

SYSTEMS FOR REMOTE-HANDLED TRANSURANIC WASTE TRANSPORTATION TO WIPP

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ABSTRACT

The volume of remote-handled (RH) transuranic (TRU) waste managed by the U.S. Department of Energy (DOE) is estimated to be 4,027.3 cubic meters (m³). The majority of this waste is stored at the Oak Ridge National Laboratory (2,253.5 m³) and the Hanford site (900 m³), with smaller quantities stored at other DOE sites, and is destined for permanent disposal at the Waste Isolation Pilot Plant (WIPP). The large and small quantity RH-TRU waste sites have waste management goals that require waste removal under aggressive schedules.

RH-TRU waste disposal at WIPP is pending certification by the U.S. Environmental Protection Agency and New Mexico Environment Department approval of a modification to the WIPP Hazardous Waste Facility Permit. The permit modification includes process descriptions for RH-TRU waste-handling activities associated with shipping packages to be received at WIPP.

TRU waste may be transported to WIPP only in packages approved by the U.S. Nuclear Regulatory Commission (NRC). The baseline approach to RH-TRU waste transportation to WIPP uses the 72-B Cask, a Type B packaging certified by the NRC for the transport of RH-TRU waste. It is anticipated that the 72-B Cask will be available for shipments to WIPP in 2002 [1].

Based on the need to expedite transportation from specific sites, a second packaging has been investigated. The 10-160B Cask, a Type B commercial shipping cask, was certified by the NRC for the transport of low-level waste. An application for the addition of RH-TRU waste from one small quantity site (Battelle Columbus Laboratories [BCL]) as authorized contents for the 10-160B Cask was reviewed and approved by the NRC in 2001. Mock demonstrations of RH-TRU waste shipments using the 10-160B Cask have been completed at BCL and WIPP. The successful demonstrations have provided evidence to justify the 10-160B Cask as a viable option for RH-TRU waste transportation to WIPP.

INTRODUCTION

The volume of remote-handled (RH) transuranic (TRU) waste managed by the U.S. Department of Energy (DOE) is estimated to be 4,027.3 cubic meters (m³) [1]. The majority of this waste is stored at the Oak Ridge National Laboratory (2,253.5 m³) and the Hanford site (900 m³), with smaller quantities stored at other DOE sites.

The RH-TRU waste inventory is destined for permanent disposal at the Waste Isolation Pilot Plant (WIPP). RH-TRU waste disposal at WIPP is pending certification by the U.S. Environmental Protection Agency and New Mexico Environment Department approval of a modification to the WIPP Hazardous Waste Facility Permit. The WIPP is currently scheduled to begin receiving RH-TRU waste shipments in 2002 [1].

RH-TRU WASTE TRANSPORTATION PACKAGINGS

TRU waste may be transported to WIPP only in packages approved by the U.S. Nuclear Regulatory Commission (NRC). The baseline approach to RH-TRU waste transportation to WIPP uses the 72-B Cask, a Type B packaging certified by the NRC for the transport of RH-TRU waste. The 72-B Cask is a Type B packaging certified by the NRC and designed to transport one RH-TRU waste canister either directly loaded with waste or overpacking three 55-gallon drums. The 72-B Cask consists of a cylinder with inner and outer containment vessels protected by impact limiters at both ends. The inner vessel is made of stainless steel and provides an inner containment boundary and a cavity for the payload.

The 72-B Cask was licensed by the NRC on March 3, 2000, based on the review of an application that included Revision 1 of the 72-B Cask Safety Analysis Report (SAR) [2]. Since that time, additional applications have been made to expand the authorized contents of the 72-B Cask. The currently approved 72-B Cask Certificate of Compliance (C of C) [3], which is based on Revision 2 of the 72-B Cask SAR, allows the shipment of RH-TRU waste generated by the following sites, which are expected to be the first sites to use the 72-B Cask for the transport of RH-TRU waste:

- Battelle Columbus Laboratories (BCL)
- Energy Technology Engineering Center
- Los Alamos National Laboratory
- Oak Ridge National Laboratory.

An application for Revision 3 of the 72-B Cask SAR will be submitted to the NRC for review during Fiscal Year (FY) 2001. This application authorizes the 72-B Cask shipment of waste generated or stored by Idaho National Engineering and Environmental Laboratory and the Hanford site. This application proposes payload expansion initiatives that were developed in response to transportation needs comprehensively identified by the DOE complex as well as those identified for specific sites or wastes. Proposed 72-B Cask payload expansion initiatives in Revision 3 of the 72-B Cask SAR include the following:

- Specification of higher decay heat limits to account for matrix depletion and the use of dose-dependent G values (gas generation potential) for waste containers meeting specific criteria.

- Allowance for limited mixing of containers (e.g., 55-gallon drums) with different waste types with different bounding G values and resistances in the RH-TRU waste canister.
- Additional options to demonstrate compliance with flammable volatile organic compounds (VOC) concentration limits using process knowledge, including the Flammability Assessment Methodology Program, which is used to determine shippability of waste containers with flammable VOC concentrations greater than 500 parts per million if a flammable gas/VOC mixture lower explosive limit is met.
- Addition of headspace gas sampling as an allowable compliance method to determine hydrogen gas generation rates for containers that are to be shipped before reaching steady-state conditions.
- Addition of methods for specific waste forms for demonstrating compliance with hypothetical accident condition (HAC) dose rate requirements including the development of a Controlled Self-Shielding Payload Case. The Controlled Self-Shielding Payload Case demonstrates compliance with HAC dose rate standards provided that the payload configuration requirements specified in the 72-B Cask SAR are met.
- Addition of methods for specific waste forms for demonstrating compliance with the 72-B Cask payload criticality requirements including the development of the Low Enriched Uranium Case. This case involves waste containers containing material that is primarily uranium (in terms of the heavy metal component) and waste matrix material distributed throughout the canister in such a manner that the maximum enrichment of uranium does not exceed 0.96% U-235 fissile equivalent mass in any location of the material.

The 10-160B Cask has recently been developed as an option for the transportation of RH-TRU waste to WIPP. The 10-160B Cask, which is certified by the NRC as a Type B shipping cask, was originally intended for use by the utility market as a low-level waste transportation cask in response to changing transportation regulations for greater than Type A quantities. The 10-160B Cask is a cylindrical carbon steel and lead shielded, single-containment-shipment cask designed for the transport of a single 160 cubic foot container (liner) or ten 55-gallon drums. Two 5-drum pallets can be stacked in the cask.

On February 27, 2001, the NRC issued a revision to the C of C for the 10-160B Cask to include RH-TRU waste [4]. The C of C for the 10-160B Cask allows the shipment of RH-TRU waste from BCL only as specified in Appendix 4.10.2.1 of the 10-160B Cask SAR, Attachment A, "Remote-Handled Transuranic Content Codes and Chemical Lists for Battelle Columbus Laboratories" [5]. Similar documentation must be prepared for NRC review for any RH-TRU waste from additional sites to be authorized for 10-160B Cask shipment. A Transportation Management Plan is currently under preparation to define the use of the 10-160B Cask for site shipments of RH-TRU waste to WIPP. In addition, a recent application to increase the maximum quantity of radioactive material to 3,000 times a Type A quantity (as opposed to 2,000 times a Type A quantity) in the 10-160B Cask was approved by the NRC [4] on August 10, 2001.

TRANSPORTATION PARAMETERS FOR RH-TRU WASTE PACKAGINGS

Transportation parameters for both the 72-B and the 10-160B Casks are provided for comparison in Table 1.

Table 1, Comparison of Transportation Parameters for the 72-B and 10-160B Casks

Parameter	72-B Cask	10-160B Cask
Payload	1 RH-TRU waste canister (may overpack three 55-gallon drums)	Ten 55-gallon drums
Maximum Total Weight of Contents	8,000 lbs.	14,500 lbs.
Maximum Gross Weight (packaging and contents)	45,000 lbs.	72,000 lbs. ^a
Gas Generation Requirement	Hydrogen concentration limited to 5% by volume in any layer of confinement during the maximum 60-day shipping period	Hydrogen concentration limited to 5% by volume in any layer of confinement during the maximum 60-day shipping period
Criticality Limit	≤325 Pu-239 fissile grams equivalent	Contents may include fissile material provided the mass limits of Title 10, Code of Federal Regulations, Section 71.53 (10 CFR 71.53) are not exceeded
Activity Limit	Individual radionuclide activity limits are established to ensure compliance with the hypothetical accident condition dose rate limit (1 roentgen equivalent man per hour at 1 meter as specified by 10 CFR 71.51) ^b	Type B quantity of radioactive material not to exceed 3,000 times Type A quantity
Total Pressure Limit	Maximum design internal pressure of 150 pounds per square inch gauge (psig)	Package design limit of 31.2 psig
Cask Decay Heat Limit	50 watts (W)	100 W
Plutonium Limit	None	20 Ci
Flammable VOC Concentration Limit	500 parts per million (ppm)	500 ppm

^a An overweight permit is required to transport the 10-160B Cask.

^b Specific curie limits for individual radionuclides provided in Table 12-1 of Appendix 1.3.7 of the 72-B Cask SAR [2].

As both packages are licensed by the NRC, similar waste characterization is required for transportation in either the 72-B Cask or the 10-160B Cask:

1. Physical and Chemical Properties

- Characterization of physical and chemical properties of the payloads requires the collection of data to determine the absence of the same prohibited items (i.e., liquids, sealed containers, pyrophoric materials, explosives, corrosives, compressed gases, and chemically incompatible materials).
- Waste packaging for both casks requires that containers be filtered and that sharp or heavy objects be packaged to protect the container from puncture.

2. Gas Generation Properties

- Both casks require compliance with a limit on the concentration of flammable VOCs.
- The NRC imposes a limit on flammable gas concentrations (i.e., the hydrogen generated must be limited to a molar quantity that would be no more than 5% by volume of the innermost layer of confinement if present at standard temperature and pressure). For both casks, compliance with the limit is accomplished either analytically (through compliance with a container decay heat limit) or by testing (to measure the container gas generation rate).

3. Nuclear Properties

- To determine compliance with 5% limit on hydrogen concentration using the analytical method (i.e., decay heat), shipment in the 72-B or 10-160B Cask requires determining the radionuclide composition of each waste container.
- Radionuclide composition must also be known in order to determine compliance with the criticality limits of both casks.
- For the 10-160B Cask, the total quantity of plutonium must also be determined.

If available, knowledge of the process generating the waste may be used to characterize the physical, chemical, gas generation, and nuclear properties of the RH-TRU waste as required for transportation.

If process knowledge (e.g., records and database information or administrative and procurement controls) is not sufficient, the following allowable methods may be used by the RH-TRU waste sites to ensure that the payload container is compliant with each transportation parameter requirement:

- Visual Examination
- Visual Inspection
- Radiography
- Sampling Program
- Measurement.

For the 72-B Cask, the implementation of characterization methods must be directed by a site-specific compliance program. The 72-B Cask SAR requires the written documentation of this program and the specific characterization methods to be used by a site in a program-specific Remote-Handled Transuranic Waste Authorized Methods of Payload Control (RH-TRAMPAC) document. The program-specific RH-TRAMPAC also directs the documentation of compliance

certification for 72-B Cask transportation on a Payload Transportation Certification Document. This RH-TRAMPAC must describe how the site-specific program will ensure compliance with Appendix 1.3.7, RH-TRAMPAC, of the 72-B Cask SAR [2], which defines requirements for any authorized payload and comprehensively describes all allowable compliance methods. The program-specific RH-TRAMPAC and its implementation are audited by the DOE-Carlsbad Field Office (CBFO) for adequacy in ensuring compliance with the 72-B Cask authorized payload requirements.

While the 10-160B Cask SAR defines the requirements for authorized payloads and allowable compliance methods, it does not require the separate documentation of site-specific implementation program in a document equivalent to the RH-TRAMPAC. Rather, the site-specific implementation program is provided as part of the application for review by the NRC. As such, any site planning to use the 10-160B Cask to transport RH-TRU waste must participate in the preparation of documentation that defines implementation specific to the characterization processes used at the site. NRC approval of the application ensures that the program implementation described in this documentation is adequate. The program may be audited by the DOE-CBFO to ensure consistency with the documentation applicable to the site.

As such, the characterization of RH-TRU waste for transport in the 72-B or 10-160B Cask is determined by the site provided that the parameters defined in the respective SARs and C of Cs are met. As the extensive use of any existing, reliable process knowledge is allowed, transportation compliance involves a straightforward characterization process. The majority of DOE sites currently possess process knowledge or other data that may be used to demonstrate transportation compliance.

RH-TRU WASTE HANDLING PROCESS

The receipt of RH-TRU waste canisters at WIPP in a 72-B Cask was considered in the design of the WIPP handling facility. The facility is also equipped to handle 55-gallon drums that are received in a 10-160B Cask. The drums received at WIPP in the 10-160B Cask are transferred, in the WIPP Hot Cell, to a disposal canister that will accommodate up to three 55-gallon drums.

The BCL, the only site currently authorized to use the 10-160B Cask for RH-TRU waste transportation, leased the cask in 2000 to demonstrate its potential as an RH-TRU waste transportation cask. The BCL, in cooperation with WIPP, conducted a mock demonstration of an RH-TRU waste shipment in September 2000. Waste-handling activities at the BCL site were simulated using available equipment and approved procedures to load the 10-160B Cask and prepare it for transport to the WIPP. The cask was then transported by truck along a DOE-approved shipping route to the WIPP, where WIPP personnel simulated unloading the cask.

The BCL also plans to conduct an operational readiness review demonstration at the West Jefferson, Ohio, site during the first quarter of FY2002 before shipping RH-TRU waste in the 10-160B Cask. For the performance of the demonstration and subsequent use, the BCL plans to purchase the cask and trailer as government-owned equipment. The demonstration, using procedures and equipment required for remote loading of waste containers into the cask, will be conducted in cooperation with a similar review at the WIPP site during FY2002. These demonstrations will be conducted under the direction of a cask supervisor and will include using existing equipment and facilities at the

respective sites to unload/load drum pallets from the 10-160B Cask. While the BCL plans to performed loading using existing equipment in an enclosed facility, the 10-160B Cask could be offered to other small quantity sites without loading facilities to demonstrate the capability of mobile loading equipment (cranes, etc.). Each demonstration will serve as a technical dry run of applicable implementation procedures and process descriptions to be developed in cooperation with the BCL and WIPP for unloading/loading the cask and should be complete by the third quarter of FY2002. The demonstration may also provide an opportunity for emergency response training in the transportation corridor states.

SUMMARY

A transportation system comprised of the 72-B and the 10-160B Casks is currently in place to support shipments to WIPP. Because the NRC application process for payload expansion for the two casks is well-defined and established, site needs with respect to transportation can be addressed well ahead of proposed schedules for shipment to WIPP. In addition, because the characterization required to ensure compliance with transportation parameters is uncomplicated (e.g., use of process knowledge), transportation-related issues should not be responsible for any site delays in filling the shipment pipeline once WIPP is authorized to receive RH-TRU waste.

REFERENCES

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