TRUPACT-III SHIPMENT OF OVERSIZED BOX INVENTORY OF CH-TRU WASTE

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ABSTRACT

Several U.S. Department of Energy (DOE) sites have contact-handled (CH) transuranic (TRU) waste inventories that were packaged in large boxes in the past. These boxes are too large to be accommodated by the packagings currently licensed for TRU waste shipment and are considered "oversized." It is estimated that more than 15,000 oversized boxes are currently in retrievable storage at the DOE TRU waste generator and storage sites. The Savannah River Site (SRS) is currently storing a significant portion of this inventory of oversized boxes (~3,700 cubic meters). SRS will be a primary user of the TRUPACT-III packaging for shipment of CH-TRU waste in oversized boxes to the Waste Isolation Pilot Plant (WIPP).

The TRUPACT-III packaging is being developed as a Type B packaging to provide a safe means of transporting existing CH-TRU waste inventories packaged and stored in oversized boxes. A certification application for the packaging is currently under preparation for submittal to the U.S. Nuclear Regulatory Commission (NRC). The TRUPACT-III Payload Requirements and Compliance Document, which is currently being prepared, defines the authorized contents for the packaging and focuses on establishing appropriate requirements for the safe transport of the existing inventory of oversized boxes.

Using historical descriptions of waste generation processes and other records of past site practices, physical, nuclear, chemical, and gas generation properties of existing oversized boxes may be estimated. Therefore, the TRUPACT-III certification application prescribes a compliance methodology for oversized boxes that relies primarily on the use of existing records and database information (knowledge of process). The SRS plans to formally evaluate such information to prepare a waste summary data package for each waste population of oversized boxes that can be grouped together. Each waste summary will present the data and technical justifications demonstrating compliance with the transportation requirements for a defined waste population. As this information may be compiled prior to configuration of the waste into payload containers authorized for TRUPACT-III transport, the information will be supplemented by data that is specific to the final payload containers. For example, weight and surface dose rate must be evaluated for compliance based on the final loaded payload container. The resulting data package documenting compliance with the final TRUPACT-III transportation requirements will be a combination of the data package of records and database information and payload-container-specific data.

This paper discusses the TRUPACT-III certification application and its anticipated implementation by SRS for the characterization and shipment of oversized box inventories to the WIPP.

INTRODUCTION

Several DOE sites have CH-TRU waste inventories that were packaged in oversized boxes that are too large to be accommodated by the packagings currently licensed for CH-TRU waste shipment (i.e., TRUPACT-II and HalfPACT). Approximately 24 percent (by volume) of the existing DOE CH-TRU waste inventory is packaged in oversized boxes. This estimate corresponds to more than 15,000 boxes.

The DOE sites with the majority of this inventory of oversized boxes are Idaho National Engineering and Environmental Laboratory, Hanford, Los Alamos National Laboratory, and SRS. Sites with a smaller fraction of oversized boxes are the Nevada Test Site, Oak Ridge National Laboratory, Lawrence Livermore National Laboratory, and Rocky Flats Environmental Technology Site.

The oversized inventory in storage at the DOE sites consists of boxes that are nominally 1.2 x 1.2 x 2.1 meter (m) (4 x 4 x 7 feet), 1.5 x 1.5 x 2.4 m (5 x 5 x 8 feet), or larger. The largest rectangular box that potentially could be transported in a TRUPACT-II is approximately 1.2 x 1.2 x 1.7 m (4 x 4 x 5.5 feet). In addition to the current inventory of oversized boxes, it is anticipated that ongoing or planned site activities will result in the generation of additional oversized boxes (e.g., decontamination and decommissioning of site facilities).

The TRUPACT-III packaging is being designed to provide a safe means of transporting CH-TRU wastes primarily packaged in oversized boxes. This design offers a practical, cost-effective alternative to designing and building radiological facilities for size reduction and repackaging. The use of the TRUPACT-III for the shipment of oversized boxes is consistent with ALARA (*as-low-as-reasonably-achievable*) considerations associated with waste packaging and transportation activities that minimize workers' radiation exposure. A schematic of the proposed TRUPACT-III packaging is shown in Fig. 1.

The TRUPACT-III Safety Analysis Report (SAR) is being developed for submittal to the NRC. The TRUPACT-III Payload Requirements and Compliance Document (TRUPACT-III PRCD) is being prepared as part of the TRUPACT-III SAR to define the authorized contents and to specify payload requirements and payload compliance methodology.

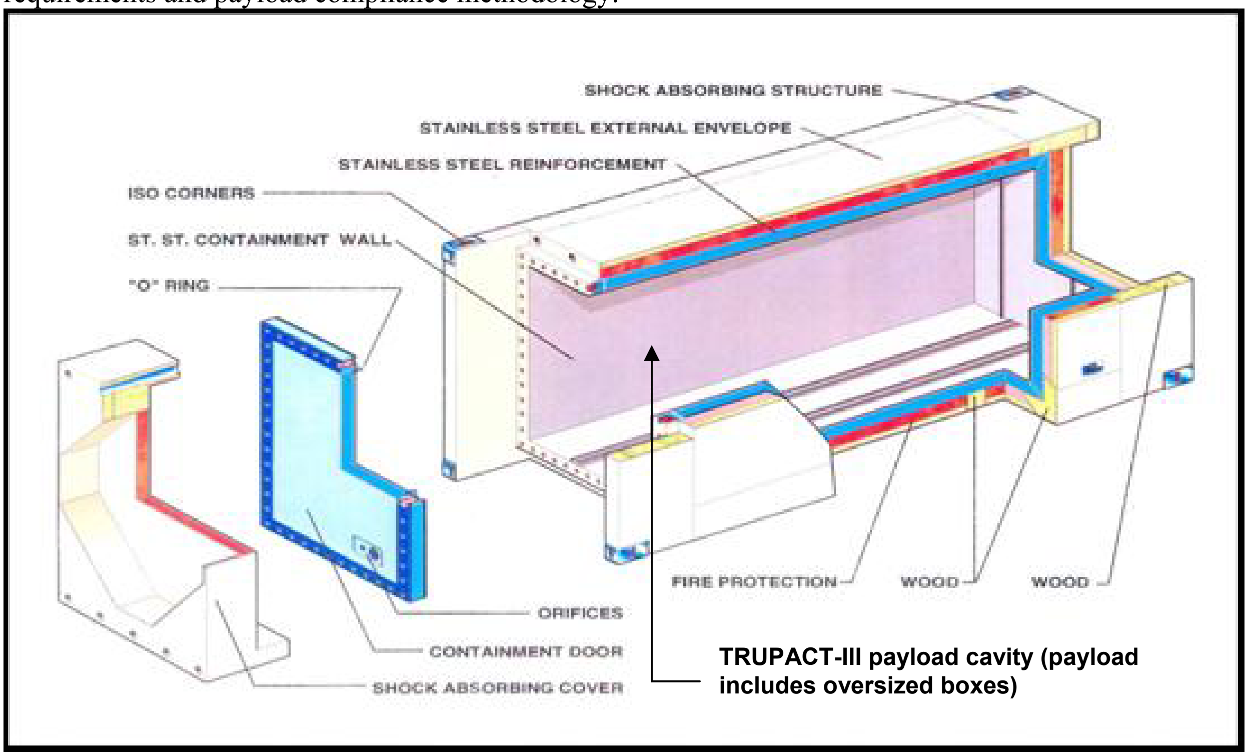

Fig. 1 Proposed TRUPACT-III Packaging**.**

TRUPACT-III PAYLOAD COMPLIANCE METHODOLOGY

The proposed methodology for demonstrating compliance of TRUPACT-III payload properties with the TRUPACT-III PRCD was developed to be consistent with existing knowledge of the current inventory of oversized boxes. This methodology is described below.

- For waste that is generated and packaged using documented procedures (e.g., newly generated waste), data collected by visual examination during the packaging process can provide the basis for compliance evaluations. Such compliance data may include video/audio documentation and/or information recorded in hardcopy form (e.g., payload container packaging log) from waste generation and/or packaging activities. In addition, site packaging procedures may be designed to ensure compliance with specific requirements. Therefore, for new waste packaged in oversized boxes, compliance can be ensured through the application of process controls exercised during waste generation and the use of procedures for waste packaging that specifically address the TRUPACT-III PRCD. This methodology is the same as that typically implemented by sites shipping smaller containers of newly generated CH-TRU waste in the TRUPACT-II.

- For previously packaged waste already in storage, originating process data and knowledge of the waste pertaining to the physical, chemical, nuclear, and gas generation properties of the waste may be the primary basis for compliance evaluations. The history, facility missions, waste management practices of the sites employed at the time the waste was generated, along with historical data collected during waste generation and/or packaging and storage may be used to determine the properties of the waste. Such data, referred to as records and database information (knowledge of process), may be used to evaluate compliance of the waste with the TRUPACT-III PRCD. This method of compliance will typically be used for the evaluation of existing oversized boxes. If records and/or database information (knowledge of process) is not available or is inadequate to demonstrate compliance with the TRUPACT-III PRCD, additional data must be collected.

As proposed by the TRUPACT-III PRCD, compliance of TRUPACT-III payload properties with the requirements must be formally documented under the following categories:

- Container and Physical Properties
- Nuclear Properties
- Chemical Properties
- Gas Generation Properties.

An example of the application and documentation of the compliance methodology for an existing CH-TRU waste population packaged in oversized boxes is shown below.

APPLICATION OF METHODOLOGY

As proposed by the TRUPACT-III PRCD, each site must formally summarize relevant records and database information (knowledge of process) and document the determinations of compliance on a waste-population basis. The site must ensure that the documented record for each waste population is reasonable (e.g., the information supports the intended use), technically correct (e.g., conclusions drawn are correct), and defensible (e.g., any conflicting information is documented and resolved).

The SRS currently stores a significant portion of the oversized box inventory (~3,700 cubic meters) and will be a primary user of the TRUPACT-III packaging. An example of the information summary demonstrating compliance with the requirements of the TRUPACT-III PRCD follows. The example is based on an existing SRS waste population packaged in oversized boxes.

Waste Summary

The SRS waste population used in this example consists of 36 large steel storage containers (commonly referred to as "black boxes") containing a total of 194 inner plywood boxes [1]. The inner plywood boxes will be removed from the black boxes and packaged in TRUPACT-III payload containers (standard large boxes) for shipment in the TRUPACT-III. The black boxes themselves are not proposed for TRUPACT-III shipment. All plywood boxes will be placed as contents in TRUPACT-III payload containers. Figure 2 shows a black box and its inner plywood boxes.

Fig. 2 Black box and contents

The waste contained in the inner plywood boxes consists of heterogeneous debris contaminated with heat-source Pu-238 and Np-237. The debris consists of discarded personnel protective equipment (plastic suits, breathing air hose, gloves, boots, etc.) and decontamination and removal (D&R) metal debris (ventilation duct, steel grating, glovebox sections, piping, empty steel vessels, scrap material, etc.).

Waste Source

This waste population was generated at SRS from a D&R effort conducted in the "old" HB-Line (OHBL) facility. During the period from 1963 through 1984 [2], the OHBL facility mission was as follows:

- Dissolution of uranium, plutonium, and neptunium scrap materials for recovery
- Conversion of neptunium solutions into Np-237oxide product
- Conversion of Pu-238 solutions into heat-source Pu-238 oxide product material.

In 1984, process operations in the OHBL facility were suspended, and the D&R effort commenced. All D&R work that resulted in the CH-TRU waste documented herein was guided and carried out using detailed plans [3] and special procedures [4]. Each procedure described the required steps for discrete D&R activities, as well as waste packaging details and verifications. All black boxes from the D&R effort were shipped from the OHBL facility to the SRS TRU waste storage facility during the period 1986 through 1991.

Original Packaging

The 36 black boxes, which are fabricated from carbon steel and measure 7- x 12- x 18-feet (nominal), contain a total of 194 inner plywood boxes that contain CH-TRU waste. CH-TRU waste too large to fit into 208-liter (55-gallon) drums was packaged in plywood boxes in accordance with special procedures. The plywood boxes were specifically sized to accommodate waste items, equipment, and other debris resulting from the D&R effort and to efficiently fill available space within the black box (see Fig. 2). As waste was removed from the facility, it was bagged/wrapped in plastic for contamination control prior to placement in a plywood box. As generated, plywood boxes were placed in a black box. Once filled, the black box lid was replaced and bolted closed. Some black boxes were vented with up to 12 Nuc-Fil® filtered vents. Others have been stored in an unvented condition.

Payload Containers

The plywood boxes in this waste population will be removed from their current storage location in black boxes and will be placed in payload containers meeting the specifications of the TRUPACT-III PRCD (i.e., standard large box [SLB]1, SLB2, or SLB3). SLBs are constructed of metal and closed with an elastomeric gasket.

The plywood boxes will be packaged into an SLB payload container that is selected based on the size and the number of plywood boxes to be packaged together. Each SLB will be labeled with a unique container identification number. Each SLB will be visually inspected prior to transport to ensure that the payload container is in good and unimpaired condition (e.g., no significant rusting and is of sound structural integrity). Compliance with the payload container maximum weight limits will be documented prior to transport.

Each payload container will be fitted with one or more filter vent(s) that provide a total minimum hydrogen diffusivity of 7.4×10^{-4} mole per second per mole fraction.

These operations will be performed and documented under controlled procedures.

Waste Attributes

The CH-TRU waste packaged inside the plywood boxes consists of solid organic and inorganic materials [5]. Additionally, though present in smaller amounts, some black boxes contain plutonium and/or neptunium scrap not suitable for recovery. This material is packaged in small cans that are inside 18.9-liter (5-gallon) metal buckets or drums.

Smith and Hootman [2] indicate that decontamination solutions (i.e., contaminated waste water) were pumped to a facility adjacent to the OHBL facility and discarded into the SRS high-level waste tanks for later disposition. Additionally, Sujka and King [4] indicate that D&R procedures required verifications to ensure free liquids were either removed or absorbed and that potentially corrosive liquids were neutralized. The total volume of liquid in the SLBs containing this waste population will be less than 1 percent (volume) of the SLB.

Nuclear Properties

All waste contained in the black boxes described herein was manifested by the generator with varying amounts of heat-source Pu-238 and Np-237 contamination. The most prevalent radionuclide, by mass, is Pu-238. The radionuclide content and isotopic distribution may vary considerably on a box basis [5]. The quantity of radionuclides in each payload container (i.e., SLB) containing plywood boxes will be determined using nondestructive assay equipment, techniques, and procedures. Either each plywood box to be placed in a given SLB will be assayed and summed or each loaded SLB will be assayed (using assay equipment designed for large containers) to determine the radionuclide quantities in each SLB. All assays and subsequent calculations of radionuclide distribution and fissile gram equivalent (FGE) values will be conducted under controls and procedures [6]. Assay results will be used by the site Transportation Certification Official to ensure that FGE limits for each loaded payload container and TRUPACT-III are met.

The external radiation dose of each payload container will be measured by survey and confirmed to be less than or equal to 200 millirem per hour at the surface.

Chemical Properties

Administrative controls at the OHBL facility and the plans/procedures governing the recovery and production operations at the OHBL facility precluded the presence of materials that have the potential for adverse chemical reactions [5].

Ignitable and reactive materials are not expected to be present in the waste. Corrosive liquids also are not anticipated due to liquid waste absorption procedures that go back to the early 1970s. Generators have been required to absorb free liquids since at least 1977 using Celite (diatomaceous earth), soda ash, or Oil-Dri in a 3:1 ratio [5]. These procedures were in place at the time the boxes were packaged.

Reactivity

No reactive metals (e.g., Na, P, Mg, or Ca) were used as pure metal in the OHBL facility. Hydrazine mononitrate (used as a dissolution process catalyst) was identified as an SRS HB-Line process chemical through the mid-1980s. However, because it was liquid, it would not have been placed in CH-TRU waste containers without being absorbed. Hydrazine mononitrate in this form would not be considered to be reactive. Potentially air-reactive resins used in HB-Line processes were not packaged as CH-TRU waste, but were sent to the SRS H-Canyon for disposal [5].

Ignitability

During OHBL facility operation and prior to commencement of the D&R effort, some oxidizers are known to have been used throughout the time period of waste generation in operating areas where CH-TRU waste was generated or handled. Nitric acid in particular was used extensively as a process chemical, as were hydrogen peroxide, iron nitrate, permanganates, and aluminum nitrate. Hydrogen peroxide was used for Pu-239 processing (probably in scrap recovery). OHBL facility personnel recall using a procedure that required neutralization of acids and, possibly, of such oxidizers. A 1974 procedure for handling radioactive waste gave special instructions for "wet solid waste," which consisted of acid-soaked sponges, rags, atomic wipes, or polypropylene cloths. Such waste was to be rinsed with water to remove any product and acid and packaged with diatomaceous earth to absorb moisture. SRS personnel also used a polypropylene felt, tested in 1965, for cleaning to minimize fire hazards due to oxidation of cellulosics. In one 1983 source, flammable liquids were listed as not present in the HB-Line operating areas. This is consistent with the previously mentioned prohibition on free liquids in CH-TRU waste containers. Additionally, all process lines and vessels in the OHBL facility were flushed and drained before the D&R effort began [5].

The black boxes have been safely managed in storage in accordance with site protocols for approximately 13 years. These black boxes have been observed to meet site requirements for safe storage. Based on requisite safety evaluations and routine inspections, SRS has not observed any evidence of box pressurization or other potential for risk due to chemical incompatibilities among the waste while in storage [5].

Pyrophorics

As stated above, this waste is contaminated with Np-237 oxide product and heat-source Pu-238 oxide product material. Because the radioactive contaminant is present in the oxide form, this waste will not approach the TRUPACT-III limit of 1 weight percent of radioactive pyrophoric materials per payload container. As of 1988, and as indicated by procedures used prior to 1988, there were no routine CH-TRU waste streams at SRS that contained pyrophoric materials. Additionally, under the certification program instituted in 1986, any pyrophorics were required to be treated to be non-pyrophoric prior to packaging as CH-TRU waste. No other radioactive pyrophorics are expected to be present in this waste population [5].

Non-radioactive pyrophorics were not present in HB-Line operating areas. Potentially air-reactive resins used in HB-Line processes were not packaged as CH-TRU waste, but were sent to the SRS H-Canyon for disposal. Under the CH-TRU waste certification program in place during the period of waste generation, any potentially pyrophoric materials were identified in operating procedures and were required to be segregated and labeled non-certifiable [5].

Explosives

As of 1988, and as indicated by procedures used prior to 1988, there were no routine CH-TRU waste streams at SRS that contained pyrophoric materials or explosives. The existence of small explosive charge squibs in the OHBL facility fire suppression system is known. According to personnel that worked in the OHBL facility, these were replaceable (approximately 5 year frequency) from outside of the gloveboxes and, therefore, if they were disposed as waste, would not have been sufficiently contaminated to be CH-TRU waste.

Corrosivity

Beginning in the early 1970s, residual chemicals disposed of in CH-TRU waste were required to be absorbed and/or neutralized. By 1989, SRS had tested absorbed/neutralized nitric acid and determined that it was non-hazardous for corrosivity. Also, as previously stated, CH-TRU waste containers were not to contain free non-residual liquids. As early as 1974, operating procedures and solid waste requirements required all acids to be neutralized. If acids were present on waste materials (e.g., on rags), the materials were rinsed with water and then neutralized before being packaged with absorbent and sealed separately.

Compressed Gases

During the D&R effort described above, 208-liter (55-gallon) drums of CH-TRU waste were also generated and shipped to the SRS TRU waste storage facility. As of October 1, 2003, 2,629 of these drums had been evaluated by radiography for prohibited items, including compressed gases or unpunctured aerosol cans. Fewer than 1% of the drums (3 of 2,629 drums) were observed to contain aerosol cans. Field data suggest that drums rarely contain more than three aerosol cans. This data may be reasonably extrapolated to the plywood boxes generated by the OHBL facility. It is unlikely that any plywood box will contain a significant concentration of aerosol cans. As previously stated, items that would fit within a 55-gallon drum were not packaged into the boxes. Aerosol cans were not primary components of the waste generated by the D&R effort. Any presence of aerosol cans in the plywood boxes will be only as items incidental to the waste primarily generated by the OHBL facility.

Gas Generation Properties

As previously described, the plywood boxes will be removed from the black boxes and placed into SLB1, SLB2, or SLB3 payload containers. The plywood boxes are considered to be the internal contents of the payload containers and must be evaluated in determining the applicability of the TRUPACT-III PRCD flammable gas generation compliance methodology to the payload containers of this waste population. Because the plywood boxes and any plastic bagging inside the plywood boxes do not prevent the release of gas, they are not sealed contents. As such, flammable gas generation limits may be met by determining and complying with the decay heat limit to be established for each SLB. For the determination of the appropriate payload container decay heat limit, SRS knowledge of process will provide estimates of the percent of combustible waste packaged in the SLB and the percent of available void volume inside SLB.

Review of waste records found that many plywood boxes contain 100 percent metal (i.e., iron based, aluminum, lead) while others contain only organic materials (i.e., plastic suits, plastic sheeting). The determination of the percent combustibles and void volume will be performed and documented under SRS controlled procedures. Using this information and the appropriate shipping period, the appropriate decay heat limit will be determined for each payload container in accordance with the TRUPACT-III PRCD.

Either each plywood box to be placed in a given SLB will be assayed and summed or each loaded SLB will be assayed to determine the decay heat loading of each SLB. The measured decay heat plus the appropriate measurement error will be compared to the payload container limit determined as described in the TRUPACT-III PRCD. Only SLBs with decay heat loadings less than or equal to the appropriate limit will be considered for TRUPACT-III shipment.

Payload Assembly

SRS will develop site-specific procedures for the performance of payload assembly in accordance with TRUPACT-III PRCD requirements. Following the development and approval of these procedures, payload assembly of the SLBs from this waste population will be completed for TRUPACT-III shipment.

SUMMARY

Following certification by the NRC, the TRUPACT-III packaging will offer a safe and cost-effective means to transport CH-TRU waste in oversized boxes without the need for size reduction and/or repackaging. The TRUPACT-III PRCD, submitted with the TRUPACT-III certification application, focuses on establishing appropriate requirements for the safe transport of oversized boxes. The proposed compliance methodology emphasizes the practicality of using available data that is appropriate for determining compliance with the TRUPACT-III PRCD transportation requirements. This methodology ensures that existing oversized boxes will be shippable (pending NRC approval) in the TRUPACT-III. As necessary, external measurements will be obtained to ensure that compliance is demonstrated for all requirements. The SRS waste summary discussed above provides a suitable example of the application of this methodology for demonstrating compliance with the TRUPACT-III PRCD.

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