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TRUPACT-II RESIDUE PIPE PAYLOAD CONTAINER

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ABSTRACT

This paper summarizes the project to develop, test and certify a new payload container for the TRUPACT-II, a Type B packaging for the shipment of transuranic waste. The new payload container will provide segregation of plutonium waste materials within the TRUPACT-II. This segregation of fissile contents will support a new criticality safety analysis that may allow an increase in the TRUPACT-II Pu-239 Fissile Gram Equivalent (FGE) limit from 325 grams to 2800 grams. The need for this project was brought about by the end of the Cold War and the resulting shift in value of plutonium residues from providing recoverable Defense Program material to being considered disposable waste. This paper will not cover many of the details of the project but will instead aim to provide a general picture of all the project activities.

INTRODUCTION

Before 1989, plutonium at Rocky Flats was processed, machined and assembled into components to meet the production demand for nuclear weapons. Residues were the by-products from manufacturing and recovery operations and contained relatively low quantities of plutonium. Any amount of plutonium that could be economically recovered from the various process residues was returned to the production stream for production of additional plutonium parts. Waste materials contained levels of Pu low enough that even the high demand for Pu could not justify recovering. It was in this time period that the TRUPACT-II packaging was certified by the Nuclear Regulatory Commission (NRC) for use by the DOE complex to ship transuranic (TRU) waste to the new Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico. The TRUPACT-II was certified for a total contents limit of 325 grams of Pu-239 Fissile Gram Equivalent (FGE) based on a very conservative criticality safety model. In the pre-1989 time period this limit was not considered to be a serious impediment to the shipping of TRU waste.

Today the situation is different. Rocky Flats has process residues containing approximately 3000 kilograms (kg) of plutonium that are no longer needed. Handling these residues as waste, which they now are, puts a severe limit on the ability of the TRUPACT-II to efficiently transport these new waste forms under a 325 FGE limit. An additional problem that is presented by these residues is radiation exposure to personnel. One class of residues contains substantial amounts of Americium 241 since one of the operations previously performed at Rocky Flats was the recycling of plutonium from "site-return" pits to extract the gamma radiation-emitting Am-241.

DESIGN APPROACH

The TRUPACT-II consists of a stainless steel/foam outer containment vessel and a second inner removable containment vessel designed for fourteen 55-gallon waste drums. (See Figure 1). The criticality analysis for the TRUPACT-II assumed that the waste drums could leak fissile material in a hypothetical accident and conservatively assumed that all fissile material could agglomerate under ideal moderation and reflection. This formed the basis for the 325 FGE limit presented in the TRUPACT-II Safety Analysis Report for Packaging.

As an alternative to this scenario a robust pipe container was designed to fit in each 55-gallon drum. The pipe container would contain the fissile material in the hypothetical accidents and allow a criticality model consisting of fourteen separate 200 gram quantities of Pu-239 rather than a single mass. In addition, the pipe container would provide needed shielding to reduce the dosage from some of the residues, particularly salt residues containing extracted Am-241. The pipe containers are not intended to be containment vessels - the TRUPACT-II provides double containment. The pipe containers serve a criticality and shielding function, but they also were vented to satisfy hydrogen gas generation concerns.

Another requirement which the WIPP and Rocky Flats assume will be met by the pipe container is to provide immobilization or control of dispersible materials.

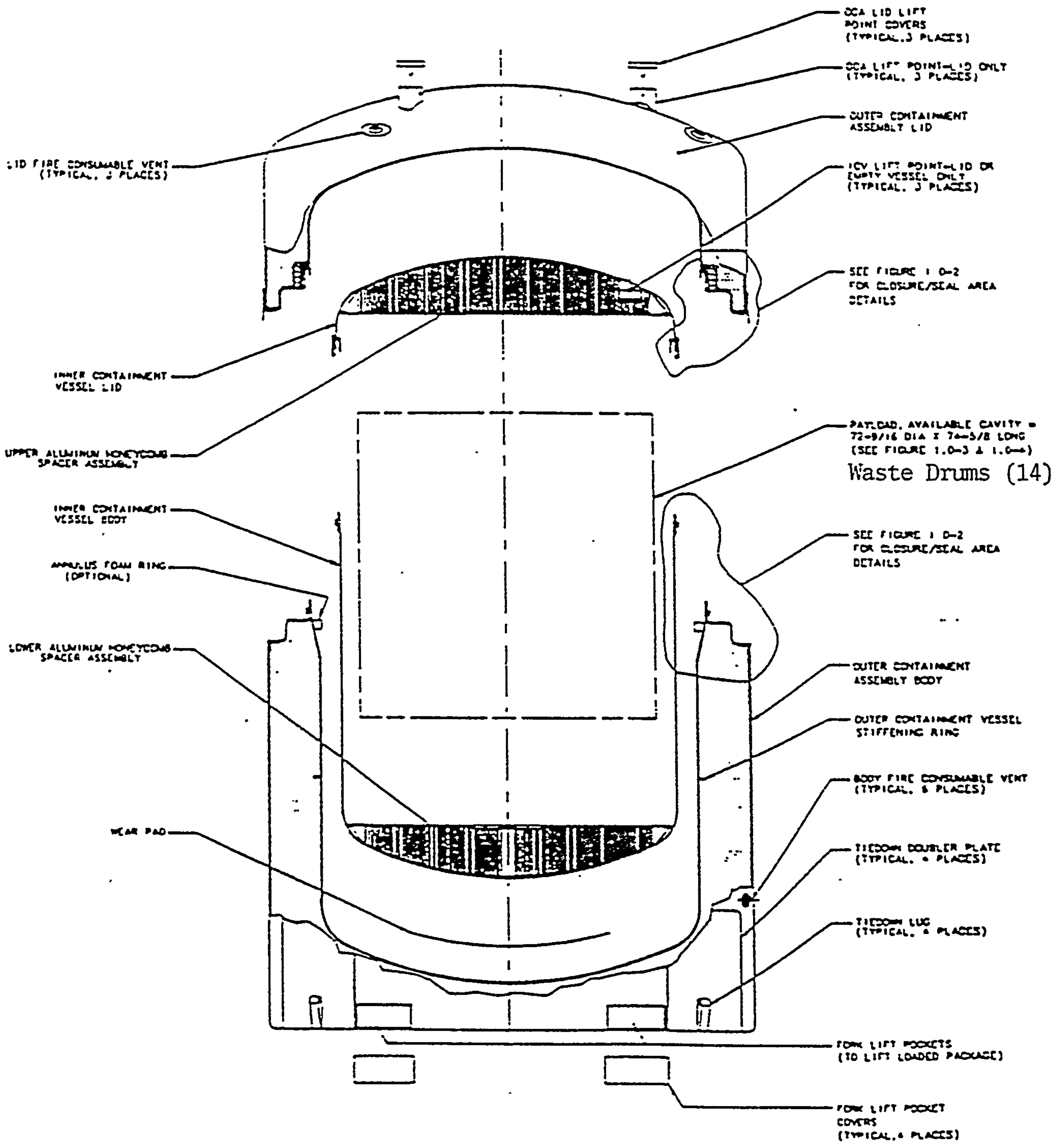
OCA LID LIFT POINT COVERS (TYPICAL, 3 PLACES)
OCA LIFT POINT-LID ONLY (TYPICAL, 3 PLACES)
OUTER CONTAINMENT ASSEMBLY LID
ICV LIFT POINT-LID OR EMPTY VESSEL ONLY (TYPICAL, 3 PLACES)
SEE FIGURE 1.0-2 FOR CLOSURE/SEAL AREA DETAILS
LID FIRE CONSUMABLE VENT (TYPICAL, 3 PLACES)
INNER CONTAINMENT VESSEL LID
UPPER ALUMINUM HONEYCOMB SPACER ASSEMBLY
PAYLOAD, AVAILABLE CAVITY = 72-9/16 DIA X 74-5/8 LONG (SEE FIGURE 1.0-3 & 1.0-4)
Waste Drums (14)
INNER CONTAINMENT VESSEL BODY
ANNULUS FOAM RING (OPTIONAL)
SEE FIGURE 1.0-2 FOR CLOSURE/SEAL AREA DETAILS
LOWER ALUMINUM HONEYCOMB SPACER ASSEMBLY
OUTER CONTAINMENT ASSEMBLY BODY
OUTER CONTAINMENT VESSEL STIFFENING RING
BODY FIRE CONSUMABLE VENT (TYPICAL, 6 PLACES)
WEAR PAD
TIEDOWN DOUBLER PLATE (TYPICAL, 4 PLACES)
TIEDOWN LUG (TYPICAL, 4 PLACES)
FORK LIFT POCKETS (TO LIFT LOADED PACKAGE)
FORK LIFT POCKET COVERS (TYPICAL, 4 PLACES)

FIGURE 1

PIPE CONTAINER DESIGN

The 304L stainless steel pipe containers were designed in two sizes - 6-inch diameter (see Figure 2) to accommodate most of the residues to a 200 gram capacity and a similar 12-inch container to allow more capacity for the residues that have lower Pu concentration. The containers utilize standard pipe sizes, - schedule 40 for the 6-inch and schedule 20 for the 12-inch; 150 lb weldneck flanges that are drilled and tapped and also machined for an o-ring seal; and 150 lb blind flange closures that are machined to seal against the o-ring.

The containers have a filtered vent in the lid to prevent possible hydrogen gas buildup from radiolysis of organic material in the residue packaging while retaining particulates of fissile material. The filter is the Nuclear Filter Technology 013 carbon composite filter that is used in the DOE complex for filtering drums and other radioactive waste containers.

The pipe containers are centered in the drums using cane fiberboard (Celotex) and plywood. This packing serves as an impact limiter in the hypothetical accident drops.

Weights of the 6-inch and 12-inch pipe container/drum assemblies are 345 lbs and 530 lbs gross, respectively with net contents weight of 65 lbs and 165 lbs respectively.

SHIELDING

Some typical Molten Salt Extraction residues loaded to a 200 gram limit in a 55-gallon drum can easily exceed the 200 millirem/hour drum surface dose limit.

The 6-inch and 12-inch pipe containers provide 0.280 inch and 0.250 inch respectively of steel for shielding of the 60 Kev gamma radiation from Am-241. It is estimated that the worse case loadings using the pipe container will produce no more than about 10 millirem/hour combined gamma and neutron dosage at the drum surface. Incorporated in the design of the pipe containers is a 3/16 inch thick shielding plate under the filter opening to prevent radiation streaming through the filter media.

CRITICALITY

A series of criticality analyses modeled the pipe container packaging configuration to find the highest K-effective value possible. The model looked at 200 grams of Pu-239, homogeneously mixed with water in each of the fourteen pipe containers. Additional conservatism was added by assuming that the drums and fiberboard disappeared, allowing close packing of the pipe containers with maximum water moderation and reflection. Keno Va was used to perform the analyses in various geometric configurations of the pipe containers along with other variables of fuel mixture and location within the pipe containers. The maximum K-effective determined was less than 0.9 for the 6-inch containers and less than 0.8 for the 12-inch containers.

TESTING

After discussing the proposed testing with the NRC, it was decided to perform both a top drop and a side drop with full interaction from other drums that would be present in the TRUPACT-II package. Rather than drop complete TRUPACT-II containers (at $300,000 each), the top drop was performed by strapping two drums end to end as they would be positioned in the package. Three top drops, consisting of (1) two 6-inch containers, (2) two 12-inch containers and (3) a 12-inch container on top of a 6-inch container, were done. These drops qualified not only 6-inch and 12-inch container loading of the TRUPACT-II, but a mixed loading of seven 6-inch and seven 12-inch containers. The side drop was performed by dropping an uncertified but functional TRUPACT-II inner containment vessel with seven of the 6-inch pipe container/drum assemblies and seven of the 12-inch assemblies. These drops demonstrated a worse case than if the entire TRUPACT-II with its impact-absorbing foam liner had been dropped.

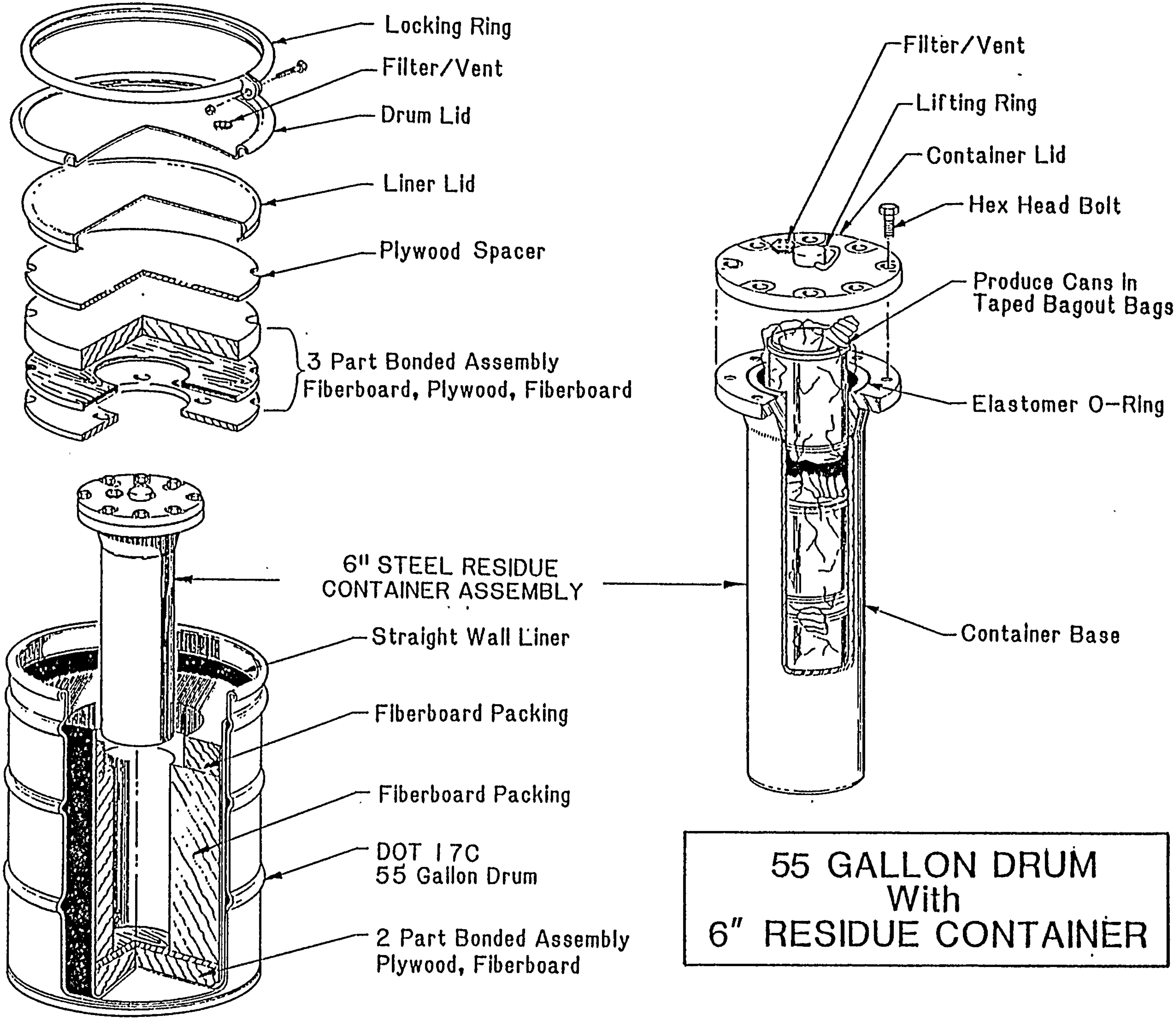
Locking Ring
Filter/Vent
Drum Lid
Liner Lid
Plywood Spacer
3 Part Bonded Assembly
Fiberboard, Plywood, Fiberboard
6" STEEL RESIDUE
CONTAINER ASSEMBLY
Straight Wall Liner
Fiberboard Packing
Fiberboard Packing
DOT 17C
55 Gallon Drum
2 Part Bonded Assembly
Plywood, Fiberboard
Filter/Vent
Lifting Ring
Container Lid
Hex Head Bolt
Produce Cans In
Taped Bagout Bags
Elastomer O-Ring
Container Base
55 GALLON DRUM
With
6" RESIDUE CONTAINER

FIGURE 2

The purpose of the testing was to demonstrate that the pipe containers would maintain containment of fissile material to the degree necessary for support of the criticality evaluation. The TRUPACT-II already provides double containment as an NRC certified shipping container so the pipe container is not bound to a typical 10CFR71 containment analysis. Use of a surrogate material such as cinnamon to simulate plutonium oxide was considered for the testing but it was decided that a more quantitative method would be required. It was decided to perform a leak test using a helium mass spectrometer leak detector before and after the drop tests to show adequate containment. The test containers had a leak test port installed in the lids to allow connection to the leak detector. The filter opening was sealed with vacuum putty to facilitate the test. Acceptance criteria was chosen to be 10^{-3} cc/sec since this leak rate has been shown to be acceptable from a containment criterion in other plutonium shipping containers. After the post-drop leak test the filters were removed and re-certified at the factory to original flow rate and filtering specifications.

RESULTS AND STATUS

All testing was performed at Sandia/Albuquerque and completed in March 1995. It could be argued that only the bottom containers in the drop tests needed to be leak-tested but for conservatism, all pipe containers except the top three of both 6-inch and 12-inch in the side drop were subjected to leak tests. Surprisingly, the vacuum putty on the filters was sufficient to make the containers leak tight (10^{-7} cc/sec), and both pre-drop and post-drop leak rates for all containers tested were in this range.

It is planned to submit test data and an application to the NRC to allow the pipe container as an authorized TRUPACT-II payload container.

REFERENCES:

1. TRUPACT-II SARP, NRC Docket No. 9218, Revision 14, October 1994

2. TRUPACT-II Certificate of Compliance No. 9218, Revision 6, March 3, 1995

3. Rocky Flats Residues (RFR) Criticality Analyses, D. J. Ammerman, Sandia National Laboratories, Albuquerque, NM and J. D. Smith, GRAM Inc. May 31, 1994

4. Recommended Sizes for the Pipe Component Testing Program, Michael A. Rivera and Jack L. Long, July 26, 1993

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