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A SHIPPING CONTAINER FOR HEAT GENERATING NUCLEAR MATERIALS

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ABSTRACT

Special shipping containers are required for heat generating nuclear materials which are neutron emitters with gross alpha contamination potential. A review is made of the special requirements; and the design, testing and experience of a unique shipping container assembly used at the Savannah River Plant.

INTRODUCTION

Plutonium-238 oxide is shipped routinely from the Savannah River Plant to Mound Laboratory. The SRP-developed containers used for these shipments were designed to:

◇ Survive severe accident conditions without failure of the primary closures.

◇ Be simple to assemble, transport, unload, and reuse.

◇ Dissipate the 0.55 watt per gram of ^{238}Pu generated by alpha decay.

◇ Allow the oxide, with its high alpha-contamination potential, to be removed in metal containers from process glove boxes; and permit no external alpha contamination. (The containers are put in casks that must remain uncontaminated; plastic bags normally used for removal from glove boxes would melt from the product heat.)

◇ Provide shielding for the neutrons emitted by reactions between alpha particles and oxygen in the oxide.

Department of Transportation Permit No. 5320 authorizes use of this container for ^{238}Pu.

CONTAINER DESCRIPTION

The shipping assembly consists of three parts; a primary container (150 c.c. capacity), a secondary container which receives the primary container directly from the process line, and a shielded shipping cask. The assembly is designed to be reusable with parts of one unit interchangeable with any other.

The primary container is a stainless steel cylinder with a removable cap at each end. A seal is maintained between the caps and container body by "Inconel," nickel plated, inert gas filled, O-rings. Figure 1.

The secondary container is designed to receive the primary container from a breech-loading mechanism in the process line. The secondary container has one open end and it is sealed with a 60 Durometer "Silastic" O-ring between an end plug and the container body. A final seal is maintained by a screw cap with a 50 Durometer "Cohrlastic 500" gasket over the end of the secondary container. Figure 2. Both containers (primary and secondary) are sandblasted to improve heat transfer by increasing the emissivity of their surfaces.

A one-unit shipping cask receives the two-container assembly. The cask includes a neutron shield constructed of high-density polyethylene through which aluminum fins (in contact with the pressure vessel) extend for heat dissipation. Figure 3. Conventional insulation techniques cannot be used to protect the assembly from fire while in transit, because heat generated by the product must be dissipated to avoid exceeding the desired centerline temperature. Diameter of the primary container may be limited to control centerline temperature as needed by the customer.

CONTAINER LOADING

A batch of product in the primary container generates enough heat to melt or burn through a conventional polyvinylchloride bag. For this reason the container cannot be removed from the production line using conventional bag techniques. A breech-loading device (Figure 4) is used to transfer the primary container from the main process cabinet into the secondary container which is positioned in a relatively clean loadout cabinet. Figure 5.

The end plug of the secondary container is decontaminated to less than 10,000 d/m smearable in the loadout cabinet. Final decontamination is completed in an adjacent hood where the end cap is placed on the assembly. The assembly is then placed in a water shield for radiation protection and dissipation of heat while awaiting calorimetric analysis of the production batch. After analysis the container assembly is placed in the shipping cask.

CONTAINER TESTING

Fire and impact tests conducted by Du Pont showed that the container would survive severe accident conditions without loss of product from the primary container.

In two simulated fire tests it was demonstrated that the primary container maintained a tight seal at 925°C while subjected to pressures of 800 psi. When cooled below 350°C, and with pressure again applied, the seals held above 1500 psi. There were no detectable dimensional changes after the tests.

In the impact test, the assembly (containing luminescent zinc sulfide) was dropped 35 feet from the top of an angle iron guide set 5° off the vertical. The angle iron guided the container in its fall so that the end fitting was impacted on a concrete-backed 1/2" steel plate. Under ultraviolet light no powder was found in the threads of the end caps or on the outside of the primary container. The tests indicated that there was no significant damage to the container and that the bottom honeycomb in the cask assembly absorbed about 75% of the impact force.

CONTAINER EXPERIENCE

The assembly has been used successfully since August 1965 in shipping production batches from the Savannah River Plant to Mound Laboratory where an identical breech-loading principle is used to introduce the primary container into the Mound process line.

No unusual contamination or radiation problems have occurred in these shipments. There has been some damage to threads on the various parts of the assembly; this has been minimized by "chasing" threads on the primary container between shipments and by the use of a "Teflon" spray lubricant on the threads of both containers. Interchangeable parts are stocked at the Savannah River Plant for use as they are needed.

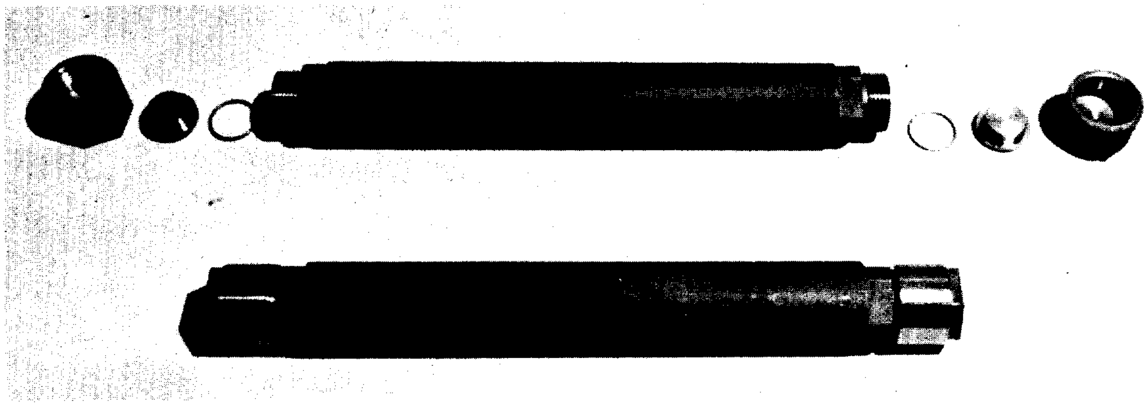

FIGURE 1. PRIMARY CONTAINER; EXPLODED VIEW AT TOP. Overall length, approximately 14.4".

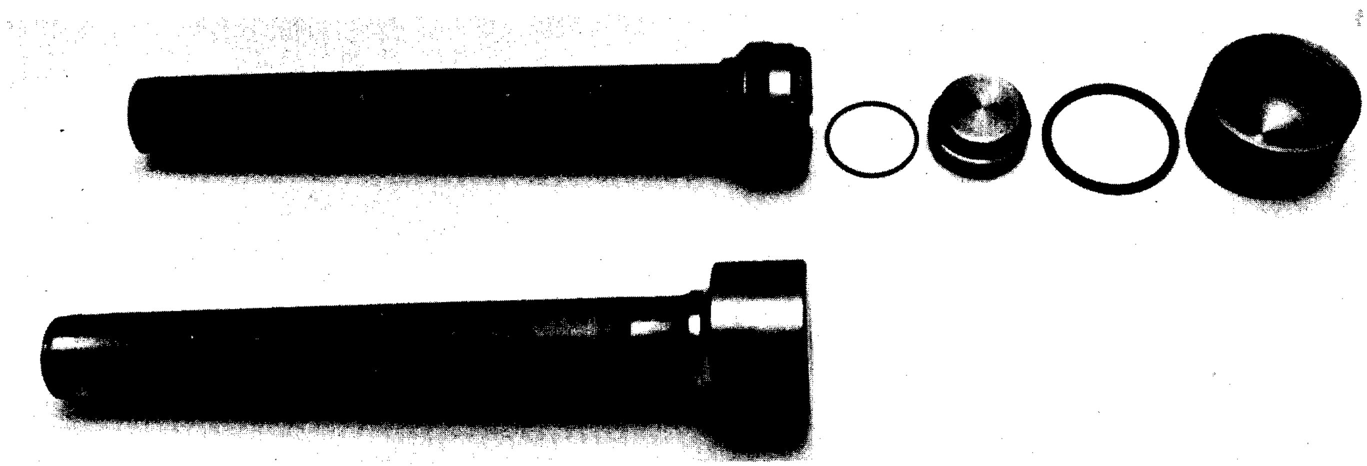

FIGURE 2. SECONDARY CONTAINER; EXPLODED VIEW AT TOP. Overall length, approximately 16.5".

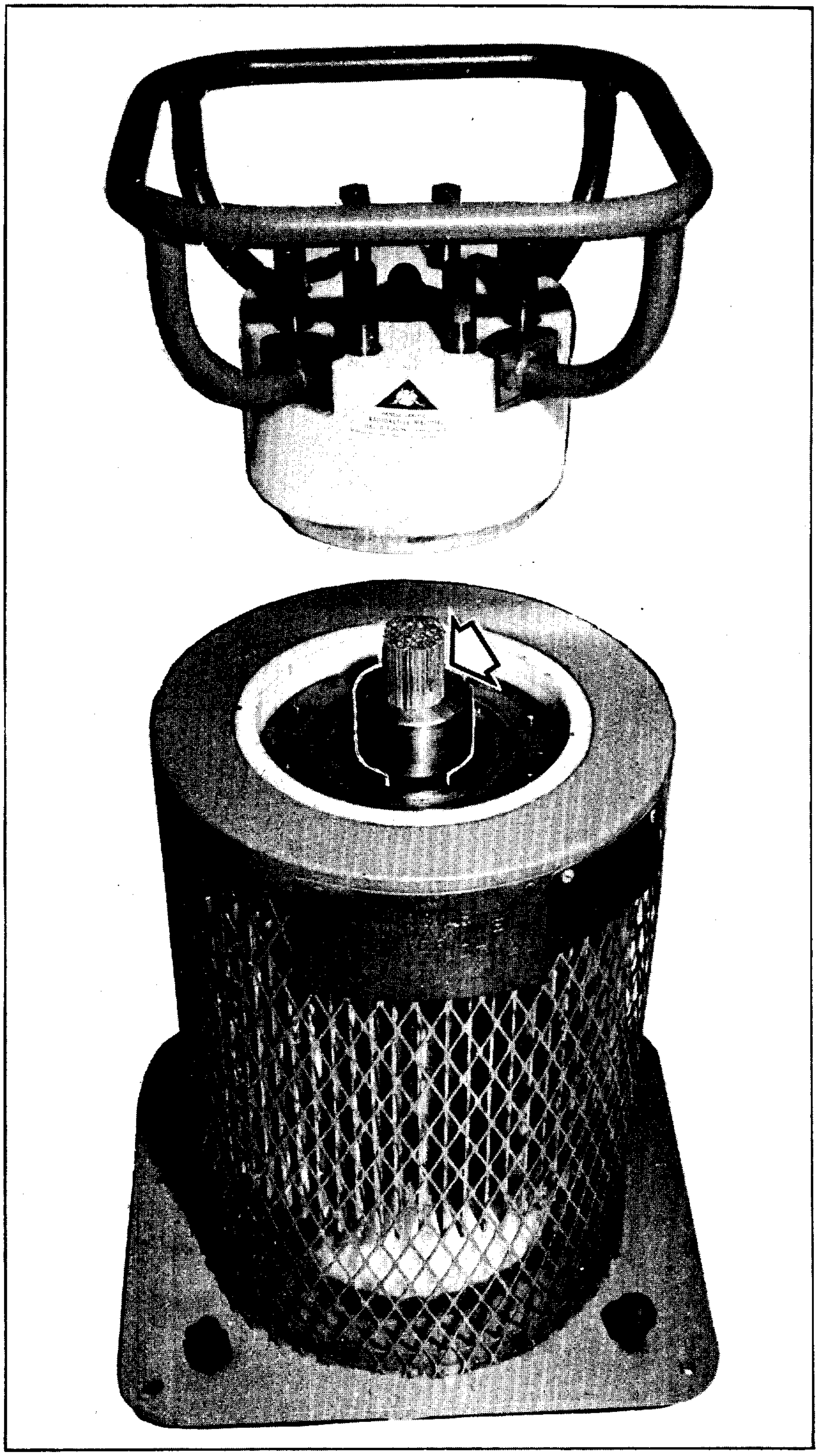

FIGURE 3. SHIPPING CASK WITH COVER UNBOLTED AND REMOVED. Arrow indicates top of container assembly surmounted by an aluminum shock block. Overall height, approximately 38''.

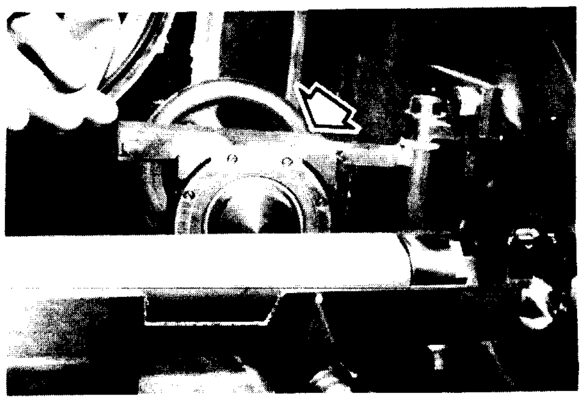

FIGURE 4. VIEW INSIDE MAIN PROCESS CABINET SHOWING PRIMARY CONTAINER IN ITS HORIZONTAL CRADLE. Arrow indicates breech lock in open position holding plug closure of secondary container. This container lies out of view to the right of bulkhead, see figure 5.

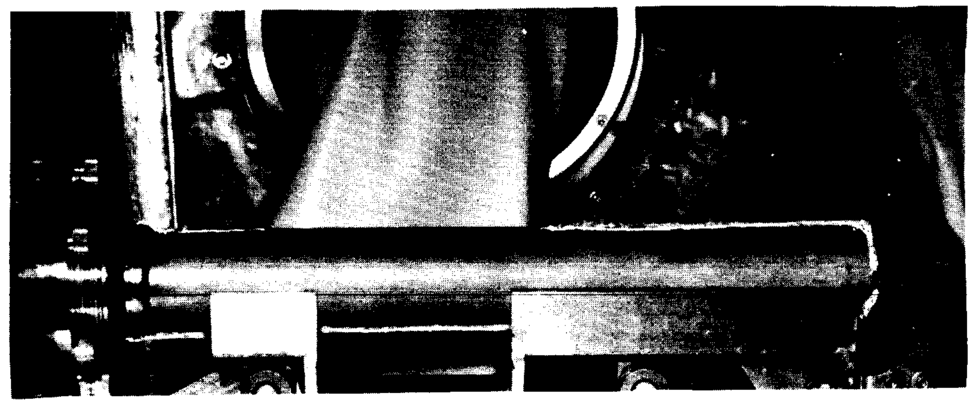

FIGURE 5. VIEW INSIDE ADJACENT LOADOUT CABINET. Secondary container lies in its horizontal cradle ready to receive primary container from figure 4.