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SPECIAL FORM ENCAPSULATION FOR RADIOACTIVE MATERIAL SHIPMENTS
FROM OAK RIDGE NATIONAL LABORATORY

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ABSTRACT

Special Form encapsulation has been used at Oak Ridge National Laboratory to ship radioactive solids for the past fifteen years. A family of inexpensive stainless steel containers has been developed and tested to meet the USA Department of Transportation (DOT) and the International Atomic Energy Agency (IAEA) regulations concerning radioactive material shipments as Special Form.

INTRODUCTION

Oak Ridge National Laboratory (ORNL) under the direction of the U.S. Department of Energy (DOE) distributes radioactive material for medical, industrial, and research activities on a worldwide basis. Shipments containing approximately 5 MCi of radioactive gases, solids, and liquids are made each year in 3,000 individual packages. The major radioisotopes involved in these shipments include ^{90}Sr , ^{137}Cs , ^{147}Pm , ^{192}Ir , ^{85}Kr , tritium, ^{47}Ca , ^{244}Cm , ^{238}Pu , ^{241}Am , ^{243}Am , ^{237}Np , and small quantities of short-lived fission products.

In 1965 ORNL instituted a regulation requiring all radioactive liquid shipments containing greater than 3 Ci beta/gamma or 1 mCi alpha to be converted to a solid and shipped in welded stainless steel containers which could be opened by the recipient with a standard tool. This action resulted in the design of a family of stainless steel powder containers that meet the present day DOT and IAEA regulations for Special Form. All Special Form containers described in this paper passed the tests prescribed in *Safety Series No. 6, Regulations for the Safe Transport of Radioactive Materials, 1973 Revised Edition*, International Atomic Energy Agency, Vienna, 1973.

DISCUSSION

A Special Form powder container (Type I) was developed for the shipment of millicurie quantities of alpha materials and curie quantities of beta/gamma materials. These containers are very adaptable to hot cell or glove box operations and are used for the majority of the ORNL Special Form shipments. The Type I container consists of an inner 304L stainless steel cylinder 50.8 mm (2.0-in.) long by 15.9 mm (0.625-in.) diam. The container wall is 0.9 mm (0.035-in.) thick and the inside bottom of the container has a conical depression to aid in the removal of small quantities (milligrams) of radioactive material. The internal volume of the inner capsule is 6.2 cm³. A press-fit cap seals the radioactive powders in the liner and allows the inner capsule to be decontaminated to less than 0.005 microcuries/100 cm².

The Type I outer container is fabricated from 19 mm (3/4-in.) 304L stainless steel tubing which has a 0.9 mm (0.035-in.) wall thickness. The outer shell is 76.2 mm (3.0-in.) long and is sealed with a press-fit plug. This unit is inert

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gas tungsten arc (GTA) welded by a Quality Assurance approved welding program using a fixed electrode and a rotating chuck. The weld is visually inspected and then tested for leaks using the ethylene glycol-vacuum leak test method as described in ANSI N14.5-1977. If the container passes the leak test, it is then cleaned to a smear tolerance of less than 0.0005 microcuries/100 cm² and placed in approved shipping containers for transport to the customer.

If greater integrity is required for the shipment of plutonium or for the fabrication of radioactive sources, the inner container is GTA welded, cleaned and leak tested before insertion in the outer capsule. This system provides double containment and an additive leak test rate for the assembled package of greater than 10^{-10} STD cm³/sec.

For shipments of large quantities of radioactive powders (up to 0.5 Kg), the Type II, III, and IV Special Form containers were developed with internal volumes of 25, 70, and 326 cm³ respectively. This design maximized the internal volume and minimized the cost by using standard 304L stainless steel tubing for fabrication of the containers. These units have been used for the past fifteen years to ship gram quantities of cesium-137 chloride, strontium-90 titanate, americium-241 oxide, plutonium-238 oxide, neptunium-237 oxide, and curium-244 oxide.

All of the previously described containers have been tested in service and are compatible with the customer's facilities for opening the container and dispensing the radioactive powders. A standard tubing cutter is used in glove boxes or manipulator cells to remove the container plugs and an experienced operator can open the container in less than five minutes.

Additional Special Form containers were evolved from the original design when glove box preparation of the shipment became a personnel exposure problem due to the larger quantities of americium-241 and promethium-147 required by the customer. Special Am-1 and Pm-1 containers were designed to ship gram quantities of these radioisotopes. The walls of the inner container were increased to 6 mm (0.24-in.) to provide shielding for the beta component of the americium-241 and the promethium-147. This innovation reduced the hand exposure to operating personnel by a factor of five and increased the integrity of the package for shipment.

CONCLUSIONS

Approximately ten thousand of these containers have been shipped by ORNL to domestic and international customers with no adverse results reported due to shipping conditions or customers processing the containers. The ORNL Special Form containers continue to meet the changing regulations for the packaging and shipment of radioactive material.

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