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A SHIPPING CONTAINER FOR TRITIATED WATER

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INTRODUCTION

A reusable shipping container for Type B and large quantities of tritiated water has been designed and tested at Mound Facility. An inner and an outer container are used for shipping up to 100,000 Ci of tritium in water absorbed on molecular sieve, silica gel or commercial clay absorbent. The package is commonly called configuration-5 of the model AL-M1 shipping containers. It is the newest member of the AL-M1 family which currently also includes configurations 1 and 3. These other configurations are both for plutonium-239 and uranium-235. The common feature uniting the AL-M1 family is the 55-gal outer drum assembly which is the same for all configurations. The inner containers are quite dissimilar.

A "Safety Analysis Report for Packaging" or SARP was prepared to qualify the new shipping container for DOT/DOE approval.[1] That document is a formal safety analysis of all three AL-M1 insulated drum shipping container configurations. Together these are officially identified as USA/9507/BLF (ERDA-AL). The Certificate of Compliance has been issued and the SARP has been submitted to NRC for review. This report deals mainly with a description of the configuration-5 inner container.

In addition to the prototype used in testing, thirteen of these containers have been fabricated. One is retained at Mound Facility and twelve will be used at Sandia Laboratories, Livermore, to collect tritiated wastewater. This wastewater will be shipped to Mound for recovery or disposal of the tritium.

PACKAGE DESCRIPTION

The AL-M1 configuration-5 shipping container is shown in Figure 1. The complete package consists of three main assemblies - the insulating outer drum, the insulating spacer and the inner container. In addition to the descriptions contained in the SARP [1], detailed engineering drawings of the AL-M1 containers are available from Mound Facility. For the configuration-5 these are:

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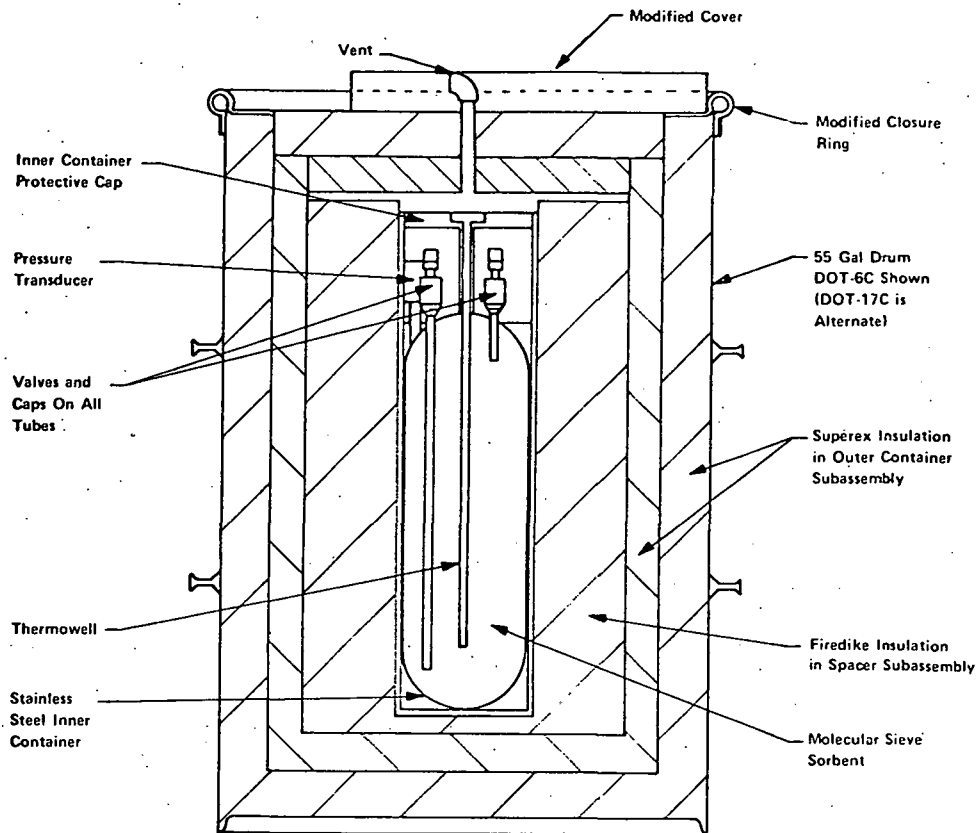


FIGURE 1 - Sketch of AL-M1 configuration-5.

<u>Item</u>	<u>Drawing No.</u>
Insulating drum assembly	AYD 740425
Insulating spacer	AYD 740626
Inner container	AYD 740198

The drum is a DOT 17C, 55-gal 16 gauge steel drum with modified cover and closure ring. The drum assembly is insulated with Superex and lined with stainless steel forming a cylindrical cavity 15-in. in diameter and 25-in. high. The insulating spacer fits into this cavity. This spacer consists of a glued stack of Fire-dike insulation lined with stainless steel which forms the cavity for the inner container.

A photograph of the configuration-5 inner container is shown in Figure 2. It is a cylindrical vessel nominally 6 5/8-in. outside diameter by 23 7/8-in. overall height when assembled. It is made of 316L stainless steel for compatibility with tritium and corrosion resistance.

The container has a removable cover as is shown in Figure 3. This cover is held in place by the bail (also shown removed in Figure 3), which is screwed onto a threaded center post which projects through the cover. The bail also serves as a handle for manual lifting of the assembled container. The cover has two self-sealing quick-disconnect fittings on top for connection to tritium monitors; this permits checking for possible contamination under the cover before it is removed. The cover has two purposes: physical protection of the valves, fittings, and pressure transducer at the top of the primary containment vessel; and provision of secondary tritium containment for these same elements. For this latter purpose, the cover is sealed with o-rings. There are four such o-rings: one face seal at the bottom circumference of the cover, one near the top of the post, and two sealing the quick-disconnect fittings in their wells at the top of the cover.



FIGURE 2 - The assembled AL-M1 configuration-5 inner container.

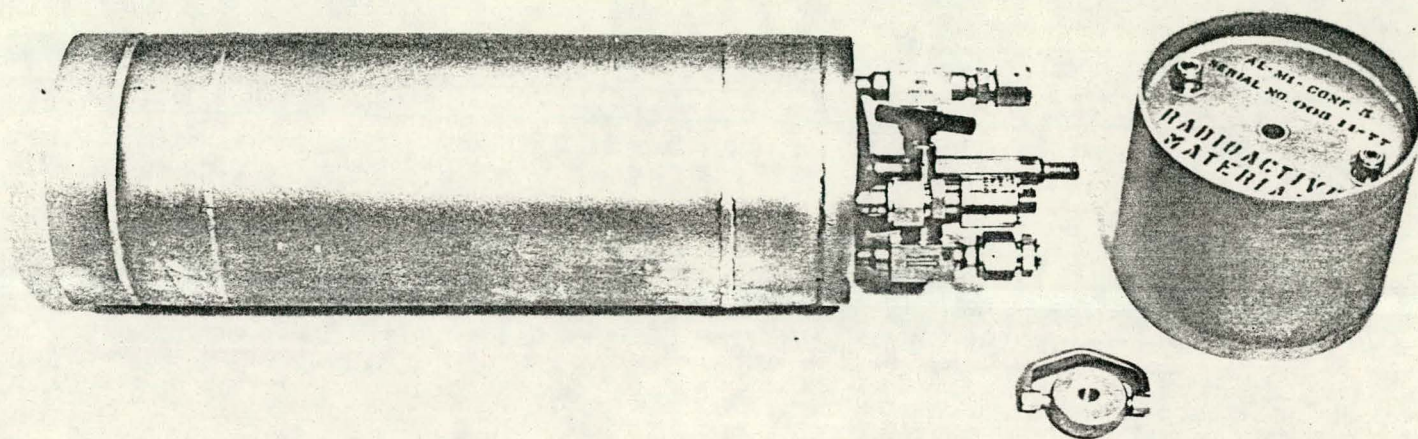


FIGURE 3 - The disassembled AL-M1 configuration-5 inner container showing the cover and bail removed.



FIGURE 4 - The top of the primary containment vessel of the AL-M1 configuration-5 inner container. The two valves with capped disconnect fittings, the pressure transducer, the center post, and the circumferential o-ring face are shown.

Figure 4 shows the top of the primary containment vessel. The two valves are of the bellows type with metal seats and stems, and are attached to metal gasketed disconnect fittings. These fittings are used for connection to external systems for loading and unloading tritiated water; they are capped for shipment. Also during shipment, the valves are closed, with the seats "facing" the vessel for protection against possible bellows failure. The pressure transducer is attached with a disconnect fitting. Removal of the transducer gives direct access to the interior of the vessel.

Figure 5 is a cross-sectional sketch of the inner container showing the inlet and outlet tubes. The thermocouple well is also shown. The interior of the primary vessel is filled with a granular or pelletized solid adsorbent for water. To date, the containers have all been filled with about 5.6 kg of type 13X molecular sieve pellets.

TRITIUM CONTENTS

The quantity of tritium to be shipped in each configuration-5 container is arbitrarily limited to a maximum of 100,000 Ci or about 10 g of tritium. This quantity does not generate enough heat from radioactive decay (3.3 W) to cause any significant temperature rise in the inner container.

In addition to this limitation on total tritium, the quantity of tritiated water is limited. The quantity of water to be shipped is determined by weight difference between the filled and unfilled package. For three common materials evaluated as sorbents, the allowed maximum quantities of water are shown in Table 1. No free liquid is allowed.

The column labeled "sorbent quantity" indicates the minimum weight of sorbent which should be loaded into the inner container. The column labeled "maximum allowed water loading" represents quantities which ensure that no free liquid will exist within the container. In actual tests, equivalent quantities resulted in loaded sorbents which did not cling to container surfaces and retained the normal free-flowing properties of dry granular solids.

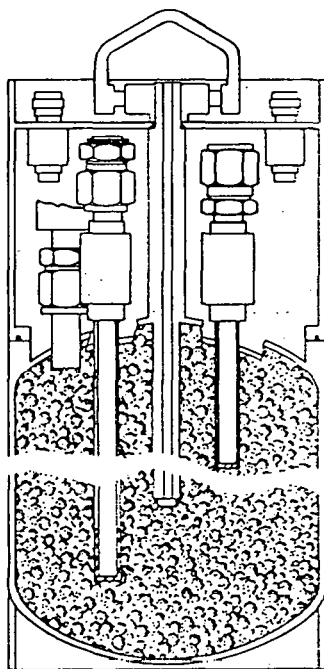


FIGURE 5 - Sketch of the AL-M1 configuration-5 inner container.

Table 1
WATER LOADING LIMITS FOR THREE SORBENTS

<u>Sorbent Material</u>	<u>Sorbent Quantity (kg)</u>	<u>Maximum Allowed Water Loading (g)</u>
Molecular Sieves 4A, 5A, or 13X	5.6	2000
Silica Gel	6.4	2000
Commercial Clay Absorbent ^a	4.2	2500

^aA typical montmorillonite clay, Florco, from the Floridin Company, Pittsburgh, Pa., was tested.

The formation of helium-3 from natural tritium decay amounts to a generation rate of less than four liters/year for 100,000 Ci of tritium. With a void volume of 20% in the sorbent, the pressure in the 10-liter inner container would thus rise only about 30 psi in one year.

The tritium must be in the form of tritiated water (HTO); organic compounds, e.g., decontamination solvents such as alcohol, must not be present in amounts greater than 1% of the water content of the package. This limitation ensures that excessive pressure buildup due to radiolysis will not occur over long storage periods.

The total pressure in the configuration-5 inner container several months after loading and sealing would (at normal conditions) be roughly the sum of three partial pressures. These partial pressures would be due to: 1) air or inert gases trapped in the container at the time of loading; 2) helium-3 decay product; and 3) hydrogen from radiolysis. At that time the pressure could be expected to be 15 to 20 psig.

During accident fire conditions this pressure would rise for two reasons. First, the heating of the gaseous contents would increase the absolute partial pressures. Second, the vapor pressure of the sorbed water would become significant at the elevated temperature. A configuration-5 container which is loaded and sealed and then subjected to Type B hypothetical accident fire conditions several months later is expected to have a maximum internal pressure of substantially less than 100 psig. The exact magnitude of this pressure depends upon several variables.

The configuration-5 inner containers are made of 316L stainless steel to provide maximum resistance to corrosion. However, they are not intended to contain corrosive agents, and the user must ensure that none are introduced. In particular, halogen compounds, e.g., decontamination and degreasing solvents, are to be avoided. These include, but are not necessarily limited to, halogenated hydrocarbons such as Freon propellants and solvents like trichloroethylene. Hence, halogenated compounds which can be introduced into water or decomposed should not be used in systems which will generate tritiated water to be loaded into these containers.

For loading (filling), the inner container is attached to the filling system with Cajon fittings. The inner container is loaded either by admitting tritiated water directly or by passing air, containing the HTO, through the dry sorbent. Direct loading with water is done slowly, because sorbency is exothermic. Figure 6 shows the pressure drop across the sorbent bed when loading is done with moist air at various flow rates.

After loading, the valves to the container are closed with a torque wrench. Before being disconnected from the filling system, the tubing and Cajon fittings above the valves are kept under vacuum until dry. Blind Cajon nuts (caps) are attached to each Cajon fitting to provide secondary containment. The surface of the container is then decontaminated, allowed to dry, and probed with a tritium monitor for leakage or surface offgassing. If tritium is observed, the

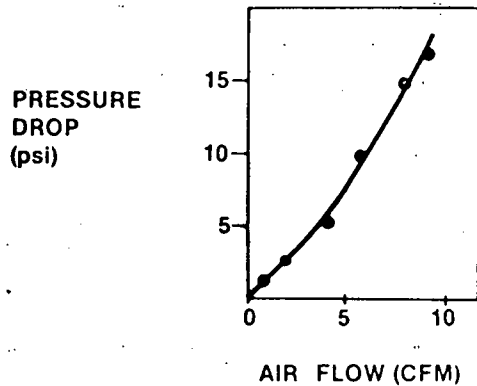


FIGURE 6 - Pressure drop vs flow for loading AL-M1 configuration-5 inner container by admitting moist air.

decontamination procedure is repeated. If no tritium is detected with the monitor, then surface wipes are taken. Further decontamination is performed as needed until these wipes are below 1000 dis/min beta. No leakage is permitted.

The protective cover is attached to the configuration-5 inner container to protect the valves and transducer from physical damage. Through the quick-disconnect fittings, the leakage from the cover and also from the container is determined by pressurizing the cover to 20 psig. No change in pressure should be observed after 30 min. The pressure is then released through a tritium monitor. If a tritium concentration reading greater than $180 \mu\text{Ci}/\text{m}^3$ is obtained, the cap must be removed in order to look for a leak or to repeat the decontamination. The test is then repeated.

If the external surface of the capped configuration-5 inner container yields a surface wipe count of less than 1000 dis/min beta, the container is inserted into the insulated sleeve which is already in place in the outer 55-gal drum assembly.

For unloading after shipment, a configuration-5 inner container is removed from the insulating sleeve and checked for contamination. It is then assayed by calorimetry and stored in a hood until removal of the tritiated water is begun. The pressure is monitored if the container is not emptied within 30 days after filling.

REFERENCE

1. R. A. Watkins et al., "Safety Analysis Report for Packaging (SARP): USA/9507/BLF (ERDA-AL), Model AL-M1," MLM-2447, Mound Facility, Miamisburg, Ohio, September 30, 1977.