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Adapting a Certified Shipping Package for Storage Applications

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ABSTRACT

For years shipping packages have been used to store radioactive materials at many DOE sites. Recently, the K-Area Material Storage facility at the Savannah River Site became interested in and approved the Model 9977 Shipping Package for use as a storage package. In order to allow the 9977 to be stored in the facility, there were a number of evaluations and modifications that were required. There were additional suggested modifications to improve the performance of the package as a storage container that were discussed but not incorporated in the design that is currently in use. This paper will discuss the design being utilized for shipping and storage, suggested modifications that have improved the storage configuration but were not used, as well as modifications that have merit for future adaptations for both the 9977 and for other shipping packages to be used as storage packages.

BACKGROUND

The 9977 Shipping Package, as shown in Figure 1, was designed by the Savannah River National Laboratory (SRNL) for the shipment of radioactive materials (RAM). The package was originally meant to be a replacement for the DOT 6M Specification Package. Although the 9977 can be utilized for many of the same contents that were shipped in the 6M, the 9977 is mainly being used for the transport of plutonium bearing contents. Additionally, the 9977 has recently been reviewed for approval as a long-term storage package within the K-Area Material Storage (KAMS) facility at the Savannah River Site (SRS).

For a package to be used for RAM storage in the KAMS facility it is required that the package be included in the facility's Documented Safety Analysis (DSA). Additionally, since the 9977 will not be unpackaged once it is delivered to the KAMS facility, the storage configuration will need to match the shipping configuration. In order to get the 9977 included in the DSA, some new configurations were necessary to be incorporated into the package. First, the package was being developed to store up to two DOE-STD-3013 containers within its containment vessel (CV). In order to place two 3013 containers into the CV of the 9977, two modifications were necessary.

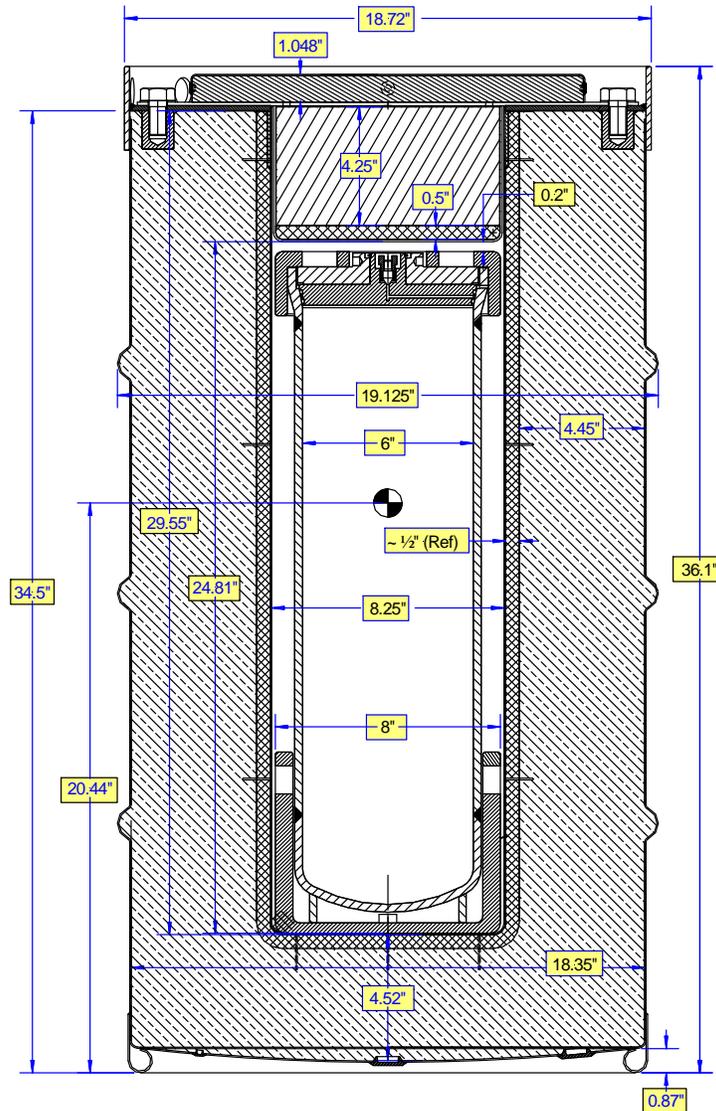


Figure 1, 9977 Shipping Package Original Approved Design

DISCUSSION

Necessary Modifications

When there are two 3013 containers in the 9977, the total heat load within the package could reach up to 38 Watts. Placing an aluminum heat dissipation sleeve (HDS) in the volume external to the CV, within the drum liner, and in-between the top and bottom load distribution fixtures will allow the content decay heat to be uniformly carried out of the package during Normal Conditions of Transport (NCT). The HDS is shown in Figure 2. This modification is necessary to keep the o-ring temperatures within the temperature limit that prevents them, over long periods of time, from degrading and leaking.

Another modification was to insert a 1/2-inch liner within the CV, see Figure 2. This liner, called the 3013 Spacer, is used as a criticality control feature. During the single-package-flooded

scenario, the material (10 Kg of plutonium oxide) within the CV could, in very conservative conditions, assemble into a critical configuration, (i.e., $k_{\text{eff}} > 1$). In order to eliminate that possibility and meet the Code of Federal Regulations for shipment of the material, this liner was incorporated eliminating the potential for the criticality.

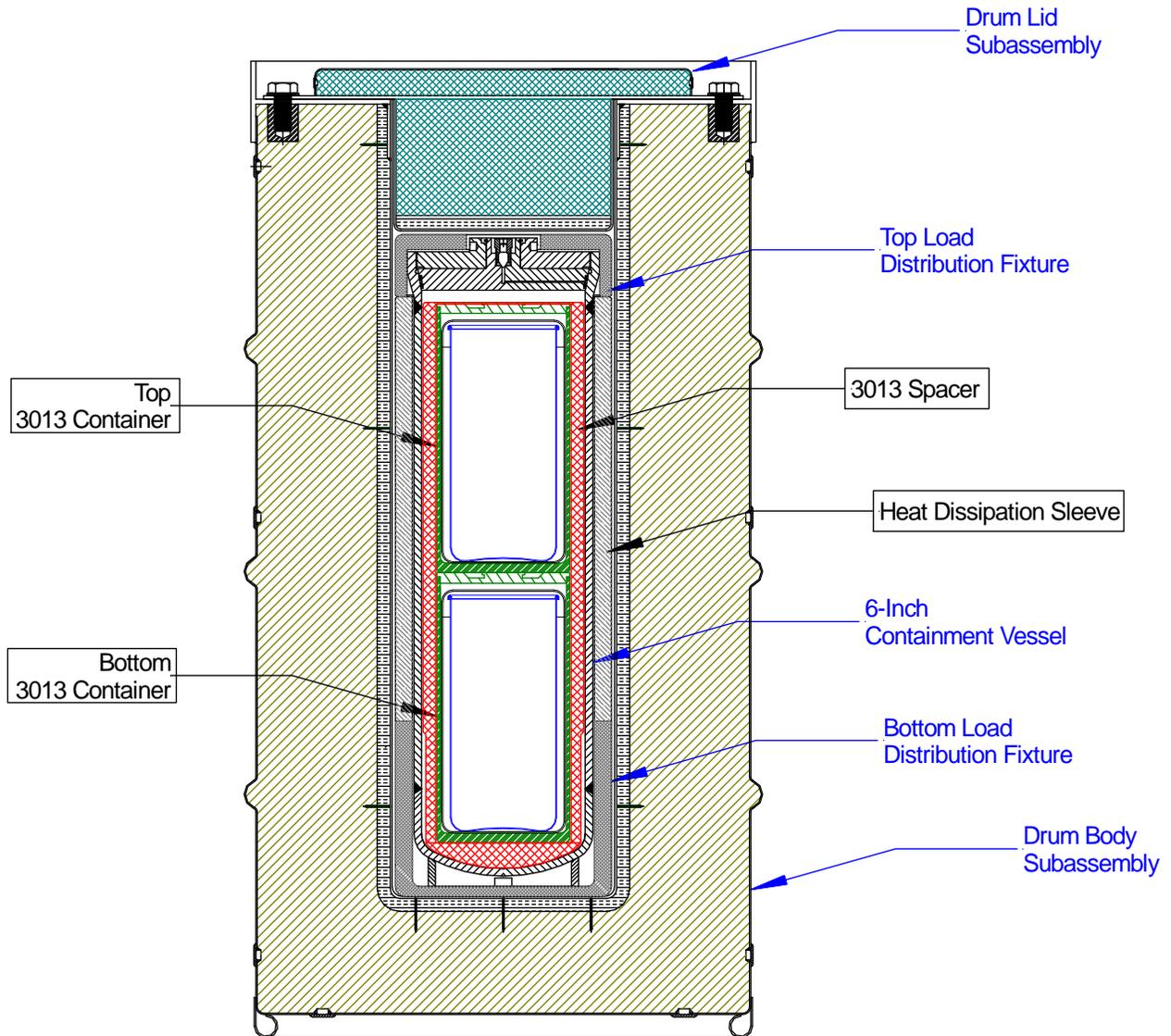


Figure 2, Modified 9977 Shipping Package for Two 3013 Containers Configuration

There is an ongoing evaluation of the materials of construction for the 9977 Shipping Package. The o-rings in the 9977 CV are the same as the o-rings within the 9975 Shipping Package Containment Vessels. These o-rings are constructed of an elastomeric material called Viton. The specific Viton compound used in these o-rings is either Viton GLT or Viton GLT-S. Both of these materials are currently being tested in an ongoing environmental program at SRNL. The

purpose of the testing program is to predict if the o-rings are capable of maintaining their seal within the CV with increased temperature and after having been closed within shipping packages for periods of time longer than is accepted by the standards governing elastomeric seals.

Additional Modifications Not Implemented

The final design of the modified 9977 configuration, as discussed and as shown in Figure 2, included the two new inserts previously discussed. Both of these inserts are made of 6061-T6 aluminum, which has certain properties that make it an ideal choice for use in a shipping package. However, during the design modification phase of the addition of the Dual 3013 Configuration to the 9977 package other materials were considered for these inserts. Other design options for other configurations with differing materials were considered as well.

Consideration was given to use a different alloy of aluminum for the HDS that is external to the CV. 7075 aluminum has strength properties that rival and in some cases are better than stainless steel. These properties were thought to have been necessary for the 9977 to pass some of the required facility testing for storage packages. The use of the 7075 aluminum would not have added much overall weight, but would have increased the overall strength of the HDS while providing nearly the same capability to conduct the heat out of the package. 7075 aluminum was also considered for use inside of the CV for similar reasons.

Other materials were also considered for the HDS as well as the 3013 insert. The materials considered included those that provided both strength and had enhanced impact absorbing properties. One of these materials was the same foam that is used internal to the packages Drum Body. It was quickly decided that the foam does not have properties necessary to pass the additional facility testing and it is not have the heat conductance required for it to be capable of moving the decay heat out of the package as is necessary. Another material considered was stainless steel. Stainless steel had good heat transfer properties and is very strong, but, unfortunately, is also very dense. The increased density of the stainless steel compared to aluminum makes the components too heavy. A package using the two sleeve components constructed of stainless steel would have either have exceeded the certified maximum weight for the package or a reduction of the RAM content weight below useful limits. For the same reason both lead and tungsten, which would have provided shielding, were considered, but eliminated, as materials of construction for the two sleeve components.

Possible Future Design Modifications

Storage packages in KAMS are under a surveillance program whose purpose is to find material degradation issues, should they exist, within the packages before the entire lot of packages becomes suspect. To that end, certain changes to the 9977 could be made that would allow the 9977 to be stored for long periods of time without the need for enrollment in a surveillance program. The 9977 does not contain Celotex™ which has been shown to be a problematic

material when stored for long periods of time. The 9977 instead incorporates polyurethane foam as an impact absorber and a thermal barrier. However, there are other materials that could be used within the 9977 that can provide similar impact resistance as well as equal or better thermal resistance and thermal conductivity (to remove heat from the package as mentioned earlier). The 9977 also could incorporate materials intended to allow the package to pass certain facility tests that would perform better than or equal to the heat dissipation and the criticality sleeves. Such materials could include carbon fiber or Kevlar which could both be easily fit into the 9977 package. Another material substitution possibility that would improve the ability of the 9977 to store RAM for long periods of time is the incorporation of metal o-rings. Currently the elastomeric o-rings used in the 9977 are being evaluated in the KAMS 9975 surveillance program. Metal o-rings would not degrade over any reasonable time with the heat loads that are allowed within the 9977. Finally one option to increase the ability of a package to be stored for long periods of time is to overpack the outer 9977 package into a larger even more robust package that is capable of withstanding the accidents that are described in the KAMS DSA. An overpack such as that would eliminate the requirements found on the 9977 and instead be a stand-alone package within the KAMS DSA.

Conclusions

The 9977 was tested and analyzed for storage within the KAMS facility DSA. The 9977 Shipping Package was determined to be an ideal candidate for inclusion within the KAMS DSA. Facility testing performed on the package showed that the 9977 can withstand impacts that are outside of the transportation accident sequence as well as those accidents within the transportation accident sequence. The KAMS DSA has been revised to include the 9977 with an increased RAM content as an option for long-term storage within the facility.