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Reclamation of Radioactive Material Packaging Components

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ABSTRACT

Radioactive material packages are withdrawn from use for various reasons; loss of mission, decertification, damage, replacement, etc. While the packages themselves may be decertified, various components may still be able to perform to their required standards and find useful service. The Packaging Technology and Pressurized Systems group of the Savannah River National Laboratory has been reducing the cost of producing new Type B Packagings by reclaiming, refurbishing, and returning to service the containment vessels from older decertified packagings. The program and its benefits are presented.

Background

Radioactive Material (RAM) packages are required to fulfill three basic functions; provide containment of the contents, provide a minimally acceptable dose rate to the workers and members of the public, and assure subcriticality of the contents under normal conditions of transport and hypothetical accident conditions. These packages are required to meet these standards as single packages and/or arrays of packages. To meet these requirements, packages typically consist of content containers, packing materials, a containment vessel, shielding components, an overpack, an overpack lid, and closure, lifting and/or tie-down hardware. The packaging configuration is defined in the Safety Analysis Report for Packaging (SARP) [Ref. 1] and the Certificate of Compliance (CoC) documents how the package meets the safety requirements and conditions specified in Title 10 of the Federal Code of Regulations. [Ref. 2] The SARP identifies safety functions of each of these components and specifies their condition and characteristics in performing those functions. Packaging components will degrade with time, heat, radiation, exposure to incompatible materials or gases, and moisture. The SARP must identify the degradation mechanisms and rates for each component and the margins of safety of each against its function. The SARP must define how much that component can degrade before it has to be repaired, refurbished, or replaced. At some point in time, the cost of maintenance, for a component or package, exceeds the cost of replacement. An individual package may be decertified because some component of the packaging can no longer perform its function. While an entire package may be retired, most of the individual components of the package may still be fully functional and usable.

Radioactive material packages may also be withdrawn from use for various other reasons; loss of mission, lack of an Owner or Sponsor, replacement with a "better" design, or due to a change in the regulations.

The Chalfant style containment vessel (CV) was designed in the 1970s and various sizes of the design have been used in a series of packages designed and certified by the Savannah River Site. A typical Chalfant CV is shown in Figure 1. The design is robust, easy to manufacture, provides a high degree of containment, and is scalable both in diameter and length to meet specific content needs. Since the Chalfant CV provides a "leaktight" closure, it can handle a wide range of the contents without consideration of release rates.

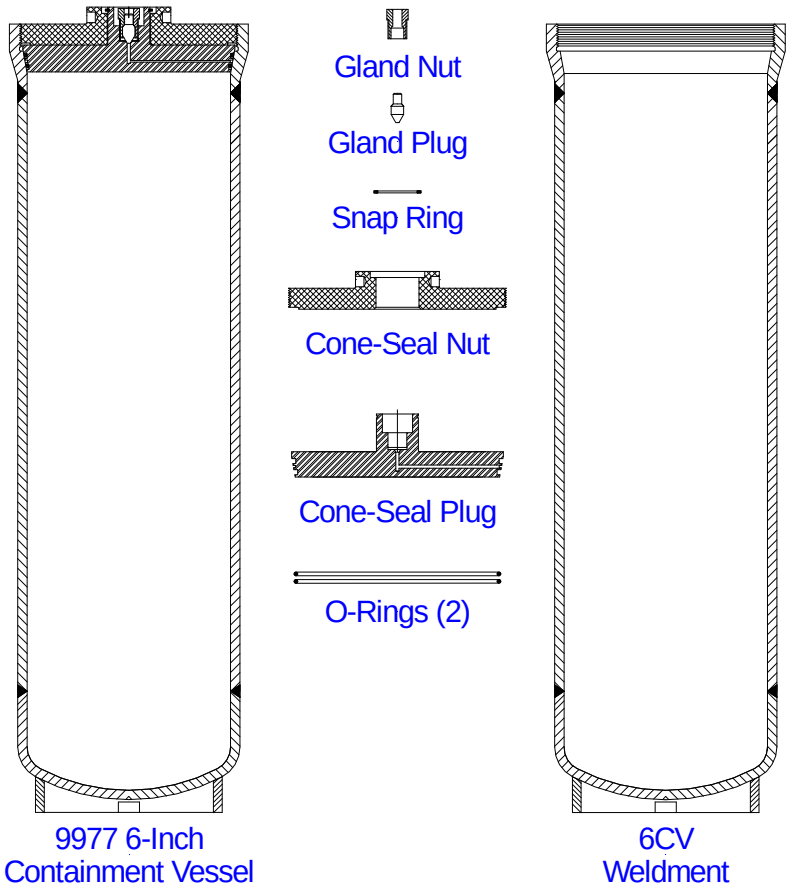

Figure 1 – Typical Chalfant Containment Vessel – Assembled (left) and Components (center & right)

When early requirements for the shipment of plutonium specified two high-quality containment systems, the 9975 Packaging was designed and used two different sized Chalfant CVs in a nested configuration to provide this "double containment"; a 5-inch diameter unit as the primary (PCV) and a 6-inch diameter unit as the secondary containment (SCV). Early in the certification process for the 9975 a design change to the overpack was required in order for the packaging to pass the 10CFR71.73 drop-test requirements. A group of some 30 packages had already been

fabricated to the initial, non-certifiable, design. Rather than rework these packages and verify that they met the performance requirements, they were certified by the Savannah River Site DOE for material "on-site" material transfers within the SRS site. These packagings were given a new designation (the "Model DDF1") so as not to differentiate them from the 9975. After ten years of service (2001 to 2010) the DDF1s were no longer needed for on-site material transfers and were scheduled to be recycled.

Model 9977 Packaging

The Model 9977, shown in Figure 2, is a new single containment style RAM packaging that uses a 6-inch Chalfant CV which is nearly identical to the Secondary Containment Vessels (SCVs) in the DDF1 and the 9975. In 2010 the National Nuclear Security Administration (NNSA) had the programmatic need to procure thirty four (34) new 9977 Packagings for site-to-site material shipments. With the availability of the DDF1 Packagings, it was determined that 6–inch SCVs from the DDF1s could be reclaimed, refurbished, and recertified as 6CVs in the 9977. Later, a number of 9975 SCVs also became available and were added to the reclamation program.

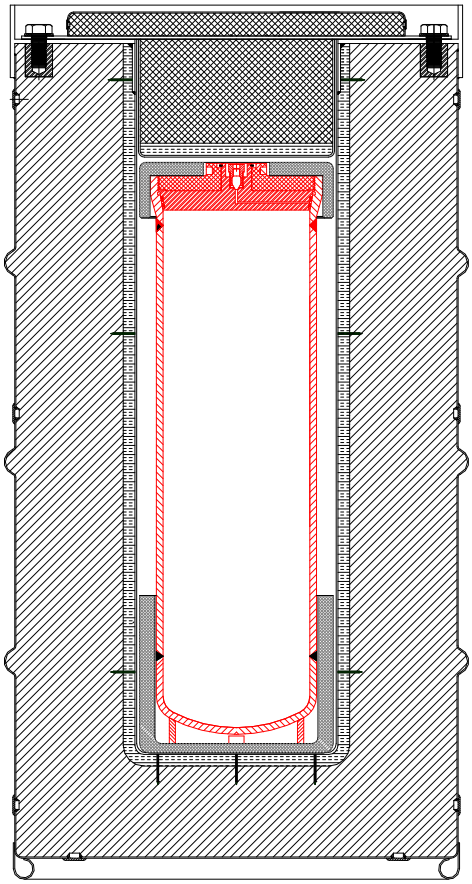

Figure 2 – The 9977 Packaging with 6-inch Chalfant Containment Vessel (highlighted red)

Reclamation

To determine the usability of the DDF1, and 9975, SCVs as containment vessels in the 9977 6CVs, the designs were reviewed verses the certified 9977 configuration. The review established that the SCVs were designed to the same configuration and dimensions, used the same materials certified to the same ASME Code requirements, were tested and examined to the same requirements, and had the same Quality Assurance (QA) requirements and documentation.

Four (4) differences were found between the 9977 6CVs and the 9975/DDF1 SCV designs:

1) The 6CVs have an additional chamfer on the Cone-Seal Plug Gland Nut and Plug well to aid installation of the test-port leakage rate test fitting.
2) The 6CVs have a specified maximum outside diameter to the CV Weldment (the pipe to pipe-cap weld) to accommodate its installation within a Load Distribution Fixture.
3) The specific markings, information, and location of the CV serial numbers are different, and
4) The drafting conventions for the component dimensioning and tolerances were different.

The QA documentation of the SCVs that were candidates for reclamation were collected and verified to be complete. The DDF1 and 9975 SCVs were disassembled and cleaned. The SCVs were then surveyed by the SRS Radiological Protection group to confirm that they were not contaminated. The Cone-Seal Plugs were removed and the chamfer machined in the Plug well. The outside diameter of the Weldment was verified using a Go/No-Go gage and machined as necessary to be with the maximum diameter. If the machining process for reducing the weld bead removed any base metal from the Weldment (pipe or pipe-cap), the Weldment was both dye-penetrant inspected for weld flaws and the CV assembly was hydrostatically tested per the ASME Code to verify its structural integrity. Each CV was then cleaned and re-assembled, a new set of O-Rings was installed, and the assembly was leakage-rate tested in accordance with the Periodic Maintenance requirements of the 9977 SARP. When the CV passed the total reclamation modification and fabrication tests, and had competed the Periodic Maintenance testing, it was assigned a serial number aligning it to a new 9977 Packaging. For QA traceability purposes the old DDF1/9975 Serial Numbers were not removed but were left readable. The old Serial Number was single lined through and the new Serial Number was applied in compliance with the 9977 design. The 9977 Serial Number marking requires that the Drawing Number and its Revision Number be included in the number. For these CVs, the original DDF1/9975 drawing information was retained as it is their fabrication basis.

QA and Documentation

Since the QA documentation was identical between the three designs, the original documentation was preserved. A new cover sheet was produced for each reclaimed CV's documentation which listed the original drawings and package Serial Number along with the newly assigned 9977 Serial Number. The reclaimed CV documentation was added to the QA documentation for the Overpack Assemblies and the entire QA Documentation package for the new 9977 Packaging was submitted into the SRS Records Management System.

Cost Savings

The question remains as to the benefits of component reclamation. The costs for new components are a highly volatile quantity, varying with the current cost of materials and labor and the number of items purchased at a given time (economies of scale). At the time and in the quantities the new 9977s were ordered, each 6CV cost approximately $7000. The cost to reclaim the SCVs also varied with the amount of modification and testing that each required to be recertified. But, the average cost to reclaim an SCV was $3000. Ultimately, not every candidate SCV was re-certifiable. A total of 24 DDF1 and 9975 SCVs were reclaimed as 6CVs for a cost savings of approximately $106,000.

References

1 Abramczyk, G. and Blanton, P. S., *Safety Analysis Report for Packaging Model 9977*, S-SARP-G-00001, Revision 2, (August 2007).

2 *Packaging and Transportation of Radioactive Material*, Code of Federal Regulations, Title 10, Part 71, Washington, DC (December 2006).