A FLEXIBLE CASK DESIGN FOR TRANSPORTING HIGH-LEVEL AND OTHER WASTE

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SUMMARY

In the 1980s, the U.S. Department of Energy (DOE) initiated a project to develop a safe and efficient transportation system for defense high-level waste (DHLW) having the flexibility to transport other types of waste. General Atomics (GA) is responsible for the cask design, safety analysis and licensing and Sandia National Laboratories (SNL) provides technical oversight and test support. The cask design is complete, was successfully tested by SNL and the Safety Analysis Report completed. Recent effort has been focused on resolving the licensing issue of whether glassified waste qualifies to be shipped in a single containment cask and a number of limited shipment needs. These include transporting SRP waste for experimental and examination program needs and HLW canisters presently being poured at the West Valley Demonstration Project (WVDP) in West Valley, New York. Presently, the NRC is considering a rule change to 10 CFR Part 71.63b that would add glassified high-level waste as a waste form that is exempted from the separate inner container requirements when the authorized contents contains more than 0.74 TBq (20 ci) of Pu.

INTRODUCTION

DOE's objective is to develop a truck cask that represents the leading edge of cask technology that fully complies with all applicable DOE, Nuclear Regulatory Commission (NRC), IAEA, and Department of Transportation regulations. GA incorporated innovative features in the cask design, including impact limiters that are integral with the cask and a removable depleted uranium/stainless steel shield liner. The integral impact limiters reduce handling time and personnel exposure, will not separate from the cask and will not burn. The removable shield liner allows the licensee to modify the amount of shielding and the diameter of the cavity, if required, to transport different waste forms. The cask can accommodate SRP DHLW waste canisters, WVDP high-level waste canisters, research reactor fuel, remote-handled transuranic waste (RH-TRU) and any other waste that would fit into a cavity with a diameter of 63.5 cm (25 in.) to 81.25 cm (32.5 in.) and a length of 301 cm (118.5 in.) GA designed the cask to meet legal weight limits for unrestricted transport of 36,288 Kg (80,000 lb) in the USA. It consists of a cylindrically shaped cask made from 304 stainless steel, a removable gamma shield liner, honeycomb impact limiters on the sides of the cask, solid steel impact limiter cylinders at the top and bottom and an internal impact limiter to limit loads on the closure during an end impact.

Presently, the NRC is considering a rule change to 10 CFR Part 71.63b that would add glassified high-level waste as a waste form that is exempted from the separate inner container requirements when the authorized contents contains more than 0.74 TBq (20 ci) of Pu. This would be consistent with the regulations for other similar waste forms that are presently exempted. Once the proposed rule becomes effective, GA will resubmit the license application to the NRC.

CASK DESIGN SUMMARY

The DHLW shipping system is designed to meet a legal truck weight limit of 36,288 Kg (80,000 lb). It consists of a cylindrically-shaped cask that is tied down to a dedicated semitrailer and pulled by a standard tractor. Use of a standard tractor and a dedicated semi-trailer provides for an efficient and versatile system.

The DHLW shipping cask is designed to hold one canister of solidified HLW produced by the DWPF or WVDP. The canister contains sludge (minimum age of 5 years) and a supernate (minimum age of 15 years) in a borosilicate glass matrix. Subsequent to pouring the molten waste into the canister the outer surface is cleaned and decontaminated. The canister is sealed by fusion welding a plug into the opening at the top of the canister. The design basis canister is 61.0 cm (24 in.) in diameter by 299.7 cm (118 in.) long and has a loaded weight of 2356 kg (5195 lb). The canister material is Type 304L stainless steel. Each canister contains a maximum of 10,434 TBq (282,000 ci) of activity, has a surface radiation dose rate of 8900 rem/hr, and produces 750 W of decay heat.

The cask, as shown in Fig. 1, is 97.8 cm to 168.9 cm (38.5 in. to 66.5 in.) in diameter and 410.8 cm (161.75 in.) in length. It is configured with an outer body of Type 304 stainless steel and an inner gamma shielding liner of depleted uranium contained by inner and outer shells of stainless steel. This configuration was chosen to maximize the waste loading of DHLW while minimizing the external dose rates and staying within the legal weight truck limit. The SRP DHLW and WVDP high level waste forms do not require additional neutron shielding. The cask components are designed to serve one or more of three functions: energy absorption, radiation shielding, and containment of the waste form. Those components that provide physical waste containment are referred to as primary containment boundaries. To minimize the radiation dose to the facility operating personnel, the DHLW shipping cask transportation system is designed such that remote handling techniques can be used for all normal operations.

The 7.5- to 10-cm (3- to 4-inch) thick stainless steel walls of the cask body are designed to ensure the structural integrity of the cask and to provide some radiation shielding. The cask body, in conjunction with the outer closure and double elastomer O-ring seals, forms a primary containment boundary. During impacts on the bottom of the cask, a ring impact limiter acts as an energy absorber. Although the impact limiter is an integral part of the cask body, it is not a primary containment boundary component. A second notched-ring metal impact limiter provides the primary protection to the closure area. During impacts on the side of the cask, two aluminum honeycomb limiters provide protection to the containment boundary.

Depleted uranium in the form of removable shielding liner provides radiation shielding. It is restrained from axial movement by a segmented shear ring bolted to the top rim of the shielding liner. The shear ring extends into a circumferential groove machined in the inside wall of the cask body. The cask design allows this liner to be removed and replaced by different liners having other inside diameters. This feature allows the transport of larger or smaller sized waste forms having different shielding requirements than the DWPF waste, such as the WVDP waste, research reactor fuel and RH-TRU waste.

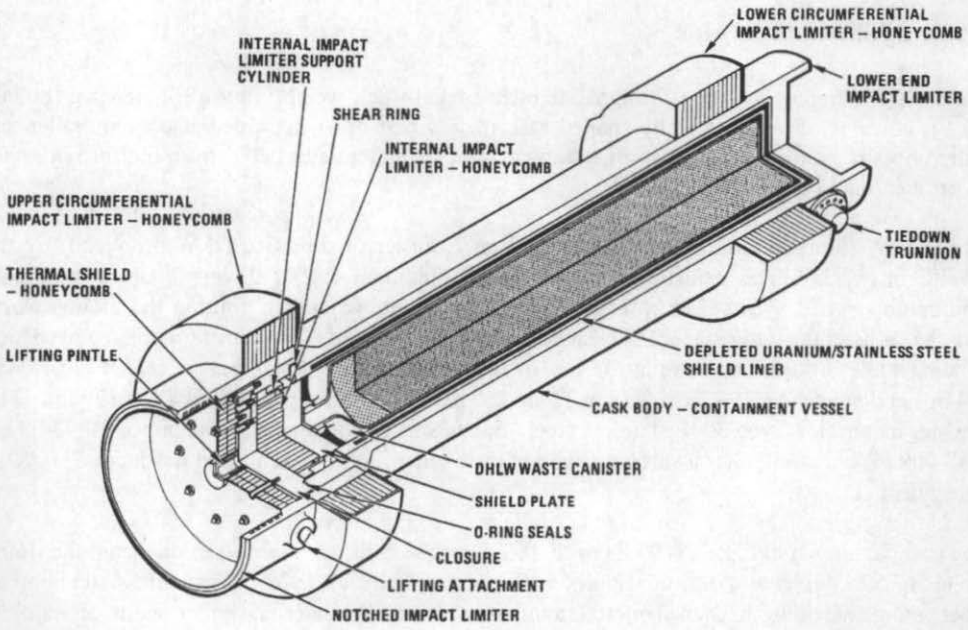

Fig. 1. DHLW truck cask uses standard materials

The closure assembly, which is part of the primary containment boundary, consists of a stainless steel plate that includes a double O-ring seal, a leak test port, and a gas sample port and is secured to the cask body by 24 Inconel 718 bolts. An internal aluminum honey-comb impact limiter assembly is bolted to the inner face of the closure. A plate distributes the load between the waste canister and impact limiter to limit the load transmitted to the closure and closure bolts during a 9-m (30-ft.) free drop onto an unyielding surface. Both the closure plate and the internal impact limiter have radiation shielding functions.

The function of the thermal barrier is to protect the elastomeric seal gaskets, the cavity gas sample port, and the seal leakage rate test port built into the closure from excessive temperatures during the hypothetical accident condition thermal event. The thermal barrier is bolted to the outside face of the closure. It consists of two thicknesses of stainless steel honeycomb contained between and bonded to stainless steel sheets. This nonstructural component must remain attached throughout the 9-m (30-ft.) drop and the 1-m (40-in.) puncture hypothetical accident sequence. The damage expected during those accident events will not substantially reduce its effectiveness in protecting the seals.

The trunnions are designed to safely support the DHLW shipping cask during handling and transport. They are also designed to deform or fail during the hypothetical accident conditions in a manner that will not breach or endanger the containment boundary.

TECHNICAL REGULATORY ISSUE

As mentioned in the introduction, the NRC is considering a rule change to 10 CFR Part 71.63b that would add glassified high-level waste as a waste form that is exempted from the separate inner container requirements when the authorized contents contains more than 0.74 TBq (20 ci) of Pu. DOE submitted a petition to the NRC to amend Sec. 71.63 to add a provision that would specifically remove canisters containing plutonium-bearing vitrified waste from the packaging requirement for double containment. DOE's main arguments were that the canistered vitrified waste provided a comparable level of protection to reactor fuel elements, that the plutonium concentration in the vitrified waste will be lower than that in spent nuclear fuel, and that the vitrified waste is in an essentially nonrespirable form. The NRC has responded by publishing a proposed amendment to Sec. 71.63 for public review and comment. This section requires special provisions when shipping plutonium in excess of 0.74 TBq (20 ci) per package. The provisions require a double containment system except when plutonium is in solid form in reactor fuel elements, metal or metal alloys. The NRC agrees with the petitioner that canisters containing vitrified HLW are in an essentially nonrespirable form and should not be included in the double containment requirement. The NRC is also proposing that the canister and waste form meet the specific waste package design criteria in 10 CFR Part 60. This provides the NRC reasonable assurance that the process the DOE uses to prepare and package the HLW is acceptable. As this paper is being written, the NRC is in the process of responding to the few public comments it received. The proposed rule change would allow a more cost effective means of transporting this waste with no significant impact to public health and safety.

CONCLUSION

The DHLW cask has been designed to efficiently transport defense high-level waste as a single containment cask. It is likely that the proposed rule change to allow shipment with a single containment cask will be approved. The cask also has the flexibility to transport other types of waste such as the commercial high-level waste at WVDP due to its replaceable shield liner.