A New Type B Cask Design for Transporting Californium-252

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A project to design, certify, and build a new Department of Energy (DOE) Type B container for transporting greater than 5 mg of ^{252}Cf is more than halfway to completion. This project was necessitated by the fact that the existing Oak Ridge National Laboratory (ORNL) Type B containers were designed and built many years ago and thus do not have the records and supporting data that current regulations require. Once the new cask is available, it will replace the existing Type B containers. The cask design is driven by the unique properties of ^{252}Cf, which is a very intense spontaneous fission neutron source and necessitates a large amount of neutron shielding. The cask is designed to contain up to 60 mg of ^{252}Cf in the form of californium oxide or californium oxysulfate, in pellet, wire, or sintered material forms that are sealed inside small special-form capsules. The new cask will be capable of all modes of transport (land, sea, and air).

The conceptual design was developed at ORNL with design specifications developed from a customer survey. User concerns such as flexibility in loading/unloading capabilities and other operational issues were incorporated into the design specifications. An in-house study on neutron shielding materials was also performed to allow selection of the best material available for this purpose. Several neutron shielding materials were evaluated, including hafnium hydride, boron carbide, water-extended polyester, zirconium hydride, and NS-4-FR (a solid, borated, hydrogenous synthetic polymer with neutron absorption capabilities similar to those of borated water). The selection was made on the basis of shielding analyses, fabrication tests, structural and thermal properties, and economic feasibility. The material chosen was NS-4-FR.

The specifications were completed, and the bid package was prepared and submitted to potential bidders in May 1996. Bids were received from several companies in the late summer of 1996. The ORNL team, composed of technical and purchasing personnel and using rigorous selection criteria, chose NAC, International, as the subcontractor for the project. In January 1997, NAC started work on developing the conceptual design and performing the analyses. The original design concept was for a tungsten alloy gamma shield surrounded by two concentric shells of NS-4-FR neutron shield material. A visit to Nuclear Regulatory Commission (NRC) regulators in November 1997 to present the conceptual design for their comments resulted in a design modification when the question of potential straight-line cracking in the NS-4-FR neutron shield material arose. NAC's modified design includes offset, wedge-like segments of the neutron shield material. The new geometry eliminates concerns about straight-line cracking but increases the weight of the packaging and makes the fabrication more complex.

NAC has now completed the cask design and performed the analyses (shielding, structural, thermal, etc.) necessary to certify the cask. The cask plus the associated equipment is collectively called the NAC Californium Transport System (CTS) and consists of the cask, impact limiter, and transport skid, which is designed to mate with and provide tie-downs to a dedicated trailer. The NAC CTS cask body is a right circular cylinder with a truncated cone-shaped top and bottom. Concentric layers of neutron and gamma shielding surround the basket that holds the special-form capsules in a small cavity in the center of the cask. A tungsten alloy gamma shield is centered around the cask cavity that holds the capsule basket, and this shield is then surrounded by the neutron shield material. The NS-4-FR neutron shield material is contained in inner, middle, and outer layers of cells, which are arranged radially and axially outward from the gamma shield. The structural shells of the cask body are composed of 304L stainless steel; these include the

cask outer shell, interior walls, gussets and support plates for the cask cavity, and interior cell walls that contain the shielding materials.

The cask alone, which is ~173 cm tall and 157.5 cm wide, weighs 7000 kg (15,433 lb). When assembled in the impact limiter (which consists of upper and lower sections), it is ~259 cm tall and 244 cm wide and weighs 11,970 kg (26,390 lb). The weight of the total assembled CTS (including cask, contents, impact limiter, and transport skid) is ~12,383 kg (27,300 lb). The cask, which has top-to-bottom symmetry, can be loaded and unloaded from the top or the bottom, in a spent fuel or reactor pool underwater or dry in a hot cell by using either grapple fixtures or pneumatic systems.

The Safety Analysis Report for Packaging (SARP) was presented to DOE regulators in late March of 1999. The questions raised by the DOE regulators are currently being evaluated by NAC and ORNL. After DOE approves the SARP and issues a Certificate of Compliance (CoC) for the cask design, NRC will start its evaluation. Fabrication will not begin until all certifications (DOE and NRC CoCs, as well as an International Atomic Energy Agency Certificate of Competent Authority for international transport) have been obtained. This project is extremely challenging due to the complexity of the design and the certification and fabrication processes. The certification process is complicated by the necessity to obtain CoCs from two different regulatory agencies.