THE FIRST HANFORD DRY CASK STORAGE PROJECT FOR VITRIFIED MATERIAL

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ABSTRACT

Highly radioactive items (total curie inventory in excess of 8.3 million curies) fabricated in the mid-1980s became a challenge for management in the 1990s. Under terms of an agreement with the Federal Republic of Germany (FRG), the United States Department of Energy (DOE) had thirty radioactive isotopic sealed heat sources fabricated at the Pacific Northwest National Laboratory. The sealed sources were to be used by the German Geologic Repository Program to simulate spent nuclear fuel in performance assessment testing at their repository site near Asse, Germany. After fabrication was completed in 1986, the sources were stored in a hot cell designed for process development and demonstration at the fabrication facility at Hanford. By 1995, the German government determined that they would not be able to take delivery of the sources. Thus presented with the challenge of the disposition of the sources, the DOE negotiated a settlement agreement. Under terms of the DOE/FRG Agreement, the German government provided funds to cover the DOE costs as well four casks designed to hold the sources during their planned transport to Germany and five casks designed to hold the sources during interim storage prior to their emplacement in the repository at Asse. The challenge was to modify the casks to utilize metallic seals that would meet a storage requirement to maintain a seal for 40 years for a cask loaded with the radioactive sources. The modified cask also had to meet the requirements for on-site transport to the new storage site and, ultimately, from the storage site. Results of the safety analyses for both cask designs, cask transport to the new storage facility, and placement on the storage pad will be discussed.

INTRODUCTION

Highly radioactive items (total curie inventory in excess of eight million curies) fabricated in the mid-1980s became a challenge for management in the mid-1990s. Under terms of an agreement with the Federal Republic of Germany, the United States Department of Energy (DOE) had thirty radioactive isotopic sealed heat sources fabricated at the Pacific Northwest National Laboratory. Two additional instrumented sources were fabricated as well as two sources generated during process pilot runs for a total of 34 sources for disposition. The thirty requested sealed sources were to be used by the German Geologic Repository Program to simulate spent nuclear fuel in performance assessment testing at their repository site near Asse, Germany. The sources were fabricated by pouring vitrified glass, spiked with Cs-137 and Sr-90 from the Hanford B-Plant, into Type 304 stainless steel canisters and seal welding them. The canisters were electropolished to decontaminate them prior to storage while awaiting shipment to Germany. Each canister weighs approximately 250 kg. Estimates of the average exposure rate at the canister surface ranged from 112,000 to 310,000 R/hr and the average decay heat ranged from 1330 to 2285 Watts per canister in 1989 (1).

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The first Hanford dry cask storage project for vitrified material responded to the challenge to properly store 34 highly radioactive sources (total radioactive source term in excess of eight million curies) fabricated in the mid-1980s. The project selected a remote location in the Central Waste Complex, high on the Hanford Plateau, more than 10 miles from the Columbia River and more than 30 miles from the city of Richland. The sealed sources are contained in eight heavily shielded, sealed, dry storage casks. The casks are designed to protect the public health and safety and the environment from the millions of curies of radiation stored in them.

The structure of the dry storage facility has a very simple design (Figure 1) and a design life of 40 years. Durable metal casks designed to meet Type B radioactive material packaging requirements provide protection, containment, and radiation shielding for the radioactive heat sources. A concrete pad was poured to provide a stable surface for storing the casks. The casks were painted with two coats of a weather-resistant epoxy paint to protect them from degradation by the environment. A metal cover, similar to a hay shed, was erected over the casks to further protect them from the weather. A locked chain-link fence around the storage structure limits access to the pad and reduces the accumulation of combustibles (tumbleweeds) around the casks. The facility provides reliable passive storage with low surveillance and maintenance costs.

Figure 1 Dry Cask Storage Facility showing concrete pad, CASTOR casks, and metal weather shelter

TECHNICAL BASIS FOR CASK QUALIFICATION

The approach to qualify the German casks for transport was not to accept *a priori* the analytical results in the GNS Safety Analysis, but to perform the analyses required to evaluate whether the cask design would meet the performance criteria used to determine package acceptability for use on the Hanford Site. Results of the engineering analyses were then compared to the results in the GNS Safety Analysis as a confirmation of the results. The Hanford analyses used the engineering design data provided by GNS. The casks were designed and fabricated by GNS to be a certified Type B(U) packaging and comply with the requirements of the International Atomic Energy Agency (IAEA) for transport of the respective payloads. The Hanford Safety Analysis Report for Packaging (SARP) provided the analyses and evaluations necessary to demonstrate that the casks, with the canister payload, met the intent of the Type B packaging regulations set forth in 10CFR71 and therefore met the onsite transportation safety requirements of WHC-CM-2-14, *Hazardous Material Packaging and Shipping*. Subsequently, the SARPs were amended to include analyses and evaluation of the cask design necessary to demonstrate the acceptability of the loaded casks for storage for 20 years and for transport after storage. Provision has also been made for extending the storage period. An innovative approach had been developed to analyze and evaluate the Helicoflex metallic seals used as the primary containment boundary seal in the Interim Storage Cask (ISC), which is being used for the onsite transport and storage of spent fuel from the Fast Flux Test Facility (FFTF).

Qualification Issues

The primary qualification issue was to demonstrate that the loaded package could maintain the required seal for 20 years and still be certifiable for on-site transport after storage. The CASTOR GSF cask design (Figure 2) incorporated a Helicoflex metallic seal as the primary containment boundary seal, i.e., the inner seal on the primary lid, as well as the secondary containment boundary seal, i.e., the inner seal on the secondary lid (2). However, the GNS-12 cask (Figure 3) was originally designed for transport and utilized elastomeric seals for both the primary and secondary containment boundary seals (3). Use of elastomeric seals is common practice for spent fuel transport casks and has been utilized in spent fuel transport cask designs licensed by the Nuclear Regulatory Commission (NRC) under 10CFR71. Degradation of the seal and its ability to continue to provide the required level of containment has not been an issue with transportation casks because of the relatively short time that a seal must be maintained on a loaded cask and the seal durability during that time. However, when the period of use of the seal is 20 years with the possibility of extending for another 20 years, degradation of the elastomer does become an issue.

Figure 2 Illustration of CASTOR cask showing general appearance and cast in cooling fins.

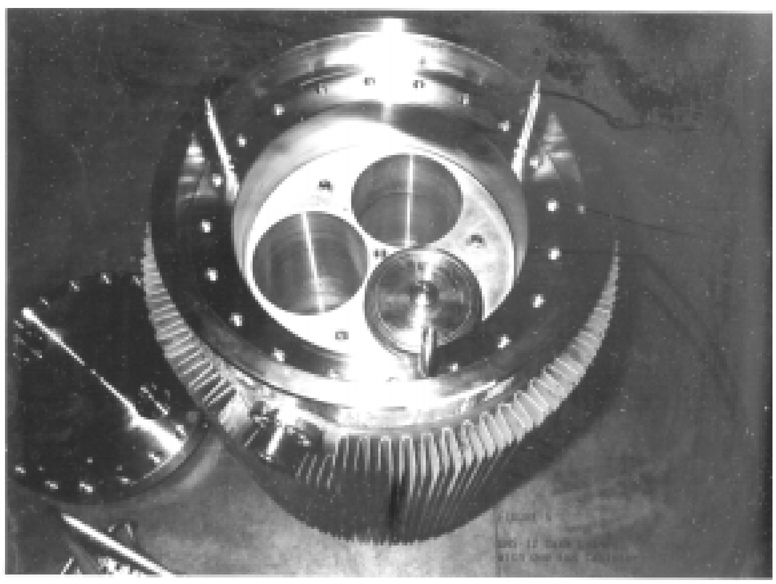

Figure 3 Illustration of GNS-12 cask showing cask interior, canister basket, one dummy canister, welded cooling fins, and cask lid on floor.

<u>Issue Solution</u>

The solution to qualify the GNS-12 cask for 20-year storage and transport after storage was obvious, use a metallic seal as the primary containment boundary seal. How to do it was not was not so obvious. The design of the groove for the elastomeric seal had a pinched profile that would retain the O-ring, but would not accommodate nor retain the metallic seal. German ingenuity and engineering excellence rose to the occasion with an elegantly simple solution. The profile of the inner primary seal groove in the cask lid could be modified to accommodate the Helicoflex metallic seal and the small plastic clips that would hold the seal in place until the cask lid could be placed in position and sealed. The original inner seal groove in the primary lid was widened and a rectangular cut was made in the side of the widened groove on the side toward the longitudinal axis of the cask to hold the small plastic retainer clips (Figure 4).

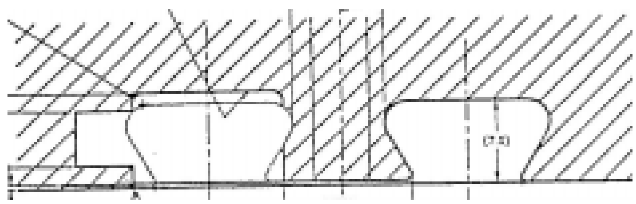

Figure 4 Schematic illustrating modification of GNS-12 primary lid seal groove. Note square cut inside groove to hold seal retainer clips.

Hanford sent an inspection team to the GNS plant in Germany to witness the leak testing of every cask following complete refurbishment and modification. The casks had been stored for several years. The CASTOR casks had been outside; the GNS-12s in their Open All Closed Transport Container System. GNS completely refurbished the casks, made the groove design modification, inspected, and leak tested all the casks. All casks met or exceeded the $1x10^{-8}$ atm-cm/s requirement in the DOE/FRG Agreement. The inspection team also reviewed original engineering data, fabrication reports and quality assurance records. The casks were wrapped, crated, placed on a ship and shipped to the Port of Tacoma, Washington. They were then transported by truck to the Hanford Site.

CASK LOADING AND LEAK CHECK

The casks were loaded in the Hanford Site 300 Area, closed, sealed and leak checked one at a time. The sequence and location of operations, described in the Environmental Assessment (4) was developed using As Low As Reasonably Achievable (ALARA) principles to minimize the dose to the workers. The entire cask loading process was done remotely in two connected shielded hot cells. The overhead cranes in the hot cells did not have the capacity to lift the casks. Temporary rails were laid from the cask handling area, which was serviced by a 30-ton bridge crane, into the airlock. The cask was placed on a wheeled dolly on the rails and moved into position in the airlock. The shield door was closed and another shield door from the air lock to the hot cell containing the sealed sources was opened. The sources had been stored dry but the rack was water-cooled. The sources were individually lifted from their storage rack and the identification number was verified from the loading plan. They were visually inspected for damage, smear samples were taken and evaluated, and the information recorded for quality control records to accompany the casks to storage. Prior to storage, the sources had been decontaminated by electropolishing in the hot cell. On removal from storage, the surface appearance of the stainless steel canisters showed heat tinting. The colors ranged from silver gray to straw color to dark blue, consistent with the temperatures anticipated during storage. The smear samples indicated surface contamination had remained low during more than nine years of storage.

Still suspended from the crane, the source was moved into the airlock and placed into the prepared cask. Placement into the cask was videotaped as part of the record of handling (non-) events and to verify its location in the cask. After loading, the primary cask lid was put in place and the bolts remotely inserted and tightened. The storage cell door was closed and the door to the cask handling area opened. The cask was moved out of the airlock on the dolly, a radiation survey completed, and the lid bolts were torqued to the specified tightness. The cask was moved from the cask handling area into the truck lock for the final leak check prior to loading on the transport trailer. All casks passed the leak check.

CASK PLACEMENT AND STORAGE AT DRY STORAGE FACILITY

The CASTOR casks were transported individually on a transport trailer by truck. The two GNS-12 casks were transported together in an Open All Closed Transport Container System with a ventilation and engineered cask securement system by truck. About an hour after leaving the 300 Area, the casks arrived at the dry storage facility location in the Central Waste Complex in the 200 West Area. A 40-ton mobile crane was used to transfer the individual casks to their respective storage location on the concrete pad.

CONCLUSION

Transport and placement of 34 sealed isotopic heat sources were uneventful but represent the completion of an important task, i.e., the removal of a significant amount of the Hanford curie inventory from a location not designed for storage near the Columbia River, the city of Richland, a middle school and a high school, and a university branch campus to a facility designed for safe, passive storage in a remote but secure location on the Hanford Site.

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REFERENCES

1. L. K. Holton, Jr., and J. E. Surma, *Processing SummaryReport: Fabrication of Cesium and Strontium Heat and Radiation Sources*, PNL=6790/UC-510, Pacific Northwest Laboratory, Richland, Washington (February 1989).

2. E. P. Clements, *Safety Analysis Report for Packaging (Onsite) for the GNS-12 Packaging*, HNF-SD-TP-SARP-022, Fluor Daniel Hanford, Richland, Washington (1997).
3. M. E. Burnside, *Safety Analysis Report for Packaging (Onsite) for the CASTOR GSF Cask*, HNF-SD-TP-SARP-021, Fluor Daniel Hanford, Richland, Washington (1997).
4. DOE/EA-1211, *Relocation and Storage of Isotopic Heat Sources*, Hanford Site, U. S. Department of Energy, Richland, Washington (June 1997).