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AREVA/TRANSNUCLEAR'S NUHOMS® MP197 TRANSPORTATION PACKAGE WITH HIGHER BURNUP AND HIGHER HEAT LOAD CANISTERS AS A PAYLOAD

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ABSTRACT

The AREVA/Transnuclear, Inc. (TN) licensed NUHOMS® MP197 Transportation Package is licensed for transportation of used fuel assemblies (SFAs) under U.S. Nuclear Regulatory Commission (NRC) requirements of 10CFR Part 71, Certificate of Compliance (CoC) No. 9302. The MP197 Transportation Package includes the NUHOMS® -61BT Canister as a payload with maximum heat load of 15.86 kW. The NUHOMS® -61BT Canister is currently licensed for storage under the requirements of 10CFR Part 72 with a maximum heat load of 18.3 kW. As burnups of the discharged SFAs from nuclear reactors are increasing, decay heats from these SFAs are also increasing. The dry storage systems currently been procured by the utilities have high burnup, high heat load SFAs. Design enhancements are made to the 61BT canister to increase the heat load for storage under the requirements of 10CFR Part 72 to 31.2 kW with high burnup (up to 62 GWD/MTU) and high heat load SFAs. TN has submitted an amendment application to the NRC for approval to store these high heat load, high burnup SFAs in the 61BT Canisters in the Standardized NUHOMS® CoC 1004. The design enhancements include the use of aluminum basket transition rails instead of stainless steel for improved heat transfer.

The heat loads are expected to be high at the time of transportation of these SFAs. If the transportation package is not licensed for high heat loads, then there will be significantly longer cooling times required before these SFAs can be transported. To address this need, TN is planning to submit an amendment application for the MP197 Transportation Package CoC 9302 to increase the heat load up to 31 kW. Design enhancements made to the MP197 cask are the use of improved neutron shield resin material, use of heat transfer fins on the surface of the cask, and use of improved heat transfer material for the impact limiters. TN is also utilizing appropriate placement of SFAs in the 61BT canister basket locations to allow higher total heat loads.

INTRODUCTION

AREVA/Transnuclear, Inc. (TN) NUHOMS® MP197 Transportation Package is licensed for transportation of used fuel assemblies (SFAs) under the U.S. Nuclear Regulatory Commission (NRC) requirements of 10CFR Part 71, Certificate of Compliance (CoC) No. 9302. The MP197 Transportation Package currently includes the NUHOMS®-61BT canister as a payload with a maximum heat load of 15.86 kW. The NUHOMS®-61BT canister is currently licensed for storage under the requirements of 10CFR Part 72 with a maximum heat load of 18.3 kW. As burnups of the discharged SFAs from nuclear reactors are increasing, decay heats from these SFAs are also increasing. The dry storage systems currently being procured by the utilities have high burnup, high heat load SFAs. Design enhancements are made to the 61BT canister to increase the heat load for storage under the requirements of 10CFR Part 72 to 31.2 kW with high burnup (up to 62 GWD/MTU) and high heat load SFAs. TN has submitted an amendment application to the NRC for approval to store this high heat load, high burnup SFAs in the 61BT canisters in the Standardized NUHOMS® CoC 1004. The design enhancements include the use of aluminum basket transition rails instead of stainless steel for improved heat transfer.

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61BT CANISTER ENHANCEMENTS (UP TO 31.2 KW HEAT LOAD)

The 61BT canister is designed to store 61 BWR fuel assemblies of more than 20 different fuel types. Design enhancements are made to basket transition rails to improve thermal performance up to 31.2 kW. This model of 61BT canister is called 61BTH canister. Pictorial representation of the 61BTH canister is shown in Figure 1.

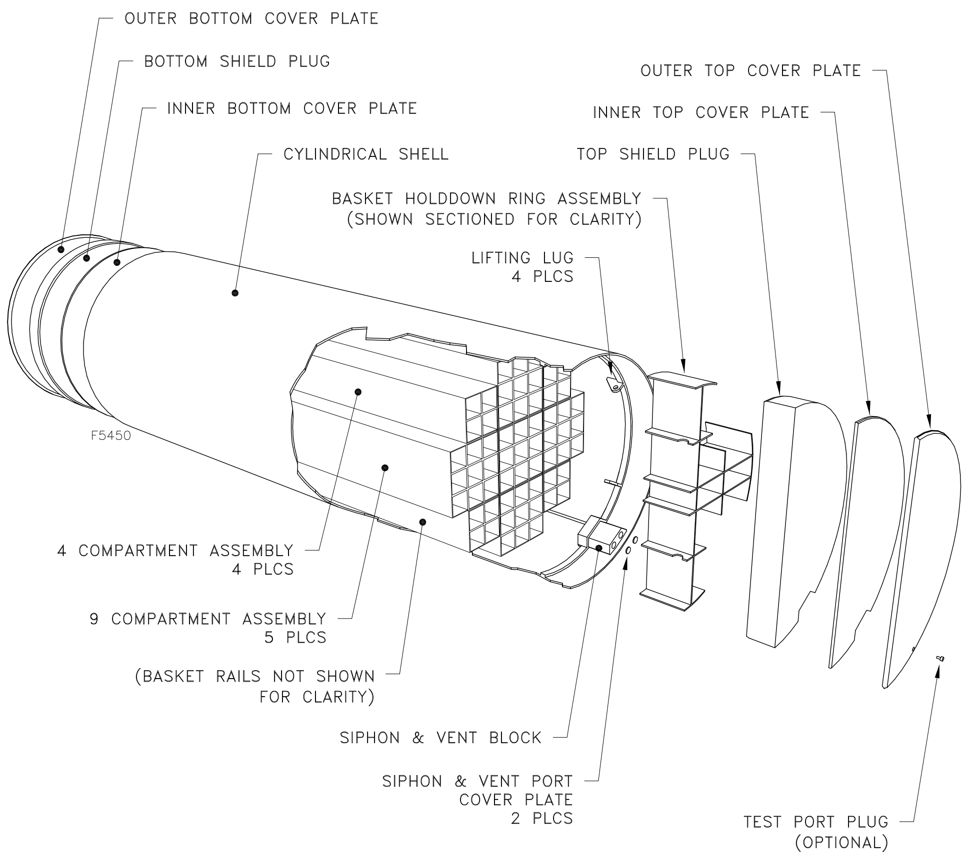

Figure 1. 61BTH canister

The 61BTH canister consists of a stainless steel cylindrical shell, top and bottom shield plugs, inner and outer bottom closure plates, inner and outer top cover plates, and the internal basket. The basket assembly consists of a top grid, stainless steel fuel compartment tubes. The basket structure is connected to the aluminum rails, which provide the transition between the basket geometry and the circular perimeter that fits the basket inside the canister shell. The transition rails also increase the area of thermal conduction from the basket to the shell. Appropriate SFAs placement (zoning) is utilized to allow up to 31.2 kW heat load.

MP197 HD PACKAGE

The thickness of neutron and gamma shielding materials are optimized for total weight of the package and radiation source term corresponding to the higher burnup (62 GWD/MTU) used fuel assemblies. This enhanced version of MP197 package is called MP197 high density (HD) package.

The NUHOMS® MP197 transport cask consists of a containment boundary, structural shell, gamma and neutron shields. The containment boundary consists of cylindrical inner shell, bottom end plate with ram access penetration, top closure flange, top closure lid with closure bolts, drain port closures and bolts, double o-ring seals for each penetration. Set of removable upper and lower trunnions, bolted to the outer shell provide support for handling and lifting of the cask.

Impact limiters consisting of balsa and redwood, encased in stainless shells, are attached to each end of the cask during shipment. Each impact limiter is attached to the cask top (front) and bottom (rear) by 12 bolts. The impact limiters are provided with fusible plugs that are designed to melt during the fire accident, thereby relieving excessive internal pressure. A thermal shield is provided between the bottom impact limiter and the cask to minimize heat transfer to the bottom impact limiter.

Pictorial representation of the NUHOMS® MP197 cask is shown in Figure 2.

Figure 2. NUHOMS® MP197 Transport cask

Enhancements are made to this MP197 package to improve thermal performance and also provide superior shielding capabilities. Design features of the existing AREVA/Transnuclear, Inc. transportation packages are utilized such as radial fins, thermal shields, and neutron shield resin material to improve thermal and shielding performance.

- Inner diameter of cask is increased from 68” to 70.5” to accommodate canister types with larger outer diameter
- Radial fins are added at the outer surface of the neutron shield shell
- A small thickness of wooden impact limiters, which is in contact with cask body in both radial and axial directions is replaced by foam
- Thickness of gamma shield (lead) is optimized to 3.25”
- Thickness of neutron shield is increased to 6.25”
- Thickness of shield shell is increased to 0.375”
- A thermal shield is added to the cask top

The outside dimensions of MP197 package are as follows: 97.75” outer diameter (OD) without heat transfer fins, 103.75” OD with heat transfer fins. The total length of the cask without impact limiters is 208”.

Similar to MP197 package, MP197HD is designed for exclusive use by rail, truck or marine transport.

This NUHOMS® MP197HD package is analyzed for all the transportation loads to demonstrate that it satisfies all the requirements of 10CFR Part 71. A summary of thermal and shielding analyses are presented below.

MP197HD thermal model accounts for convection, radiation and insolation at cask outer surface, conduction in solids, conduction and radiation within cask-canister shell helium gaps. The fins are modeled with an effective heat transfer coefficient, which is applied over the neutron shield outer surface to simulate the heat dissipation. MP197HD thermal model includes conservative radial and axial gaps.

Maximum MP197HB component and fuel cladding temperatures in comparison to limits for 31 kW heat load are listed in Table 1.

Table 1 MP197HD Maximum Component Temperatures

Component	Maximum Temperature, °F	Temperature Limit, °F
Fuel cladding	716	752
DSC shell	438	-
Sleeve	357	
Gamma shield	349	621
Neutron shield resin	299	325
Wood	199	230

Thermal analysis results show that all material maximum temperature limits are satisfied.

A shielding analysis was performed to determine the dose rates around the MP197HD Cask. The bounding dose rates for a 31 kW heat load 61BTH canister are calculated to be less than 8.0 mrem/hour at 2 meters from the edge of impact limiter. These dose rates are below the 10CFR71 limit of 10 mrem/hour.

The shielding analysis methodology consists of calculating the bounding neutron and gamma source terms for a combination of burnup, enrichment and cooling time. These source terms, are subsequently used in the detailed three dimensional shielding models to determine the dose rates.

The shielding analysis methods – both the source term calculation methods and the dose rate calculation methods are identical to those previously employed by TN in licensing applications. These methods are benchmarked against actual measured data from various cask loading campaigns and have consistently predicted dose rates that are at least a factor of 2 greater than measured dose rates.

CONCLUSIONS

NUHOMS® MP197HD cask accommodates used fuel assemblies with total decay heat up to 31 kW. This new thermally efficient cask/canister design will provide AREVA/TN customer with significant savings on SFAs pool time and transportation/transfer expenses.