Looking to the future PATRAM 2010

IMPACT ON THE TRANSPORTATION PACKAGE DESIGN FOR TRANSPORT FIRST & THEN INTERIM STORAGE VERSUS INTERIM STORAGE FIRST AND TRANSPORT

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ABSTRACT

In the United States of America (USA) currently because of the unavailability of the repository, all the fuel assemblies from the commercial nuclear power plants are stored on sites using dry storage systems which will be transported offsite in the future. The majority of these systems are dual purpose systems (storage and transport). However, in some countries, the fuel assemblies are stored in the interim storage facilities. In this case, the fuel assemblies needed to be transported from the nuclear power plants to the interim storage sites first and then put into storages.

The impact on the storage system design is significantly dependent on the options selected. This paper examines the important aspects of the package design affected by the options. Some of the considerations are the heat rejection capability and the radiation shielding capability of the package. In the "Storage First" option, the system is designed for the maximum possible heat load, therefore the system design is normally dominated by the heat rejection capability (limited by the maximum fuel cladding temperature). However, for the "Transport First" option, the system design is limited due to shielding considerations and thermal design is usually controlled by the maximum seal temperatures.

In addition, the crane capacities of the power plants also have a major effect on the system design. For the "Storage First" system (on-site storage), the canister can be transferred by the use of a transfer overpack (overpack to transfer the canister to the storage site) and put into storage at the Independent Spent Fuel Storage Installation (ISFSI). At the time of off-site transport, the canister can be transferred from the storage overpack to the transport overpack. In this scenario, the loaded transport overpack is not handled inside the fuel building. The fuel building crane will only need to lift the weight of the transfer overpack and canister. For the "Transport First" system, the fuel building crane needs to lift the weight of the transport overpack and canister. Normally, the onsite transfer overpack is lighter than the transport overpack, therefore for the same crane capacity; the "Storage First" system can accommodate higher capacities than the "Transport First" system.

This paper examines the important design aspects of the two systems which include thermal and shielding; in addition, design interface requirements are also addressed.

Introduction

The current trend towards extended on-site storage is likely to continue in the foreseeable future. As a matter of fact, interim storage is an essential plan for any option to be chosen later as a final location for used fuel management. Therefore, the most immediate service required for the used fuel management worldwide is to provide adequate storage for the future spent fuel inventory arising either from the continued operation of nuclear power plants or from the removal of spent fuel in preparation for plant decommissioning.

In the USA because of the unavailability of the repository, all the fuel assemblies from the commercial nuclear power plants are stored at their respective reactor sites using dry storage systems which will also be employed for off-site transport in the future. The majority of these systems are dual purpose systems (storage and transport). However, in some countries, the fuel assemblies are stored in the interim storage facilities. In this case, the fuel assemblies need to be transported from the nuclear power plants to the interim storage sites first and then put into subsequent storage.

Impact on the System Design

In the "Storage First" option, the used fuel assemblies are transferred within the premises of a nuclear power plant site from the fuel building to the ISFSI. The public access to the nuclear power plant site is generally restricted. For this option, the limits for the dose rate to the public are set at the site boundary. Due to effectiveness of the shielding, particularly for NUHOMS® designs, the dose rates at the site boundary are very low. Therefore, the design of the system for "Storage First" option is not governed by the shielding effectiveness of the packages (dose rates).

The "Storage First" systems are optimized to have the maximum number of fuel assemblies and highest burnup to satisfy the requirements of the power plants to maintain the required spent fuel pool capacity (full core off-load capacity) and to optimize the decay heat in the spent fuel pool. These conditions lead the dry storage system design toward higher heat loads. As such, the thermal design is governed by the maximum allowable fuel cladding temperature.

In contrast to the "Storage First" option, the used fuel assemblies are transported out side of a nuclear power plant in "Transport First" option. The transportation of the used fuel assemblies occur in this option using public access pathways (public highways, railroads etc.). The restrictions on the normal condition dose rate limits and consideration of hypothetical accident on the transportation "routes" limit the capacity of "Transport First" option according to shielding and criticality considerations in accordance with the requirements of 10CFR 71 regulations. The neutron and gamma source terms of a "Transport First" option design are therefore much lower than a "Storage First" option design resulting in lower heat loads. The maximum allowable fuel cladding temperatures for storage under 10CFR72 and for transport under 10CFR71 regulations are identical at 400°C (752°F). Due to restricted heat loads, the thermal design of a "Transport First" package is not governed by the maximum allowable fuel cladding temperatures. Under transport conditions, the integrity of the containment is the primary factor, which makes the operating temperature limits of other system components, such as containment seals, the governing factor in the thermal design of "Transport First" packages. The following table shows the design features of the "Storage First" vs. "Transport First" option:

Table-1 Design Features of the "Storage First" vs. "Transport First" Design Option

	"Storage First" Design	"Transport First" Design
Thermal	Highest Burnup Higher Heat Load	Highest Burnup but Lower Heat Loads due to Longer cooling times
Nuclear	Due to Effectiveness of the Shielding, Particularly for NUHOMS® Designs, the Dose Rates at the Site Boundary are Very Low	Limited by the Dose Rates Based on Shielding Effectiveness and Regulatory Requirements
Crane Capacity	Relatively Lighter Weight Transfer Cask Does Not Require the use of Higher Capacity Cranes	Heavy Weight Transport Package Requires the use of Higher Capacity Cranes

Comment [LVDD1]: Not clear what is meant here? First loading high BU-fuel or no problems for high BU-fuel? For reader to be clarified.

TN's "Storage First" System Design

TN has developed used fuel dry storage system with the highest decay heat capacities and the highest shielding performance of any cask system in the USA. TN adapted our European cask designs to meet US NRC requirements to develop the most advanced high decay heat basket designs in the industry today. The new generation systems are the only high heat load systems that have received approval from the NRC. TN's 40.8 kW is already approved and has been loaded with record heat loads with remarkably low occupational exposure.

The NUHOMS® System consists of the following components:

1 A Dry Shielded Canister (DSC) that provides confinement, an inert environment, structural support, and criticality control for fuel assemblies. The DSC shell is a welded stainless steel confinement boundary that includes thick shield plugs at either end to maintain occupational exposures ALARA.

2 The Transfer Cask (TC) provides shielding and protection from potential hazards during the DSC closure operations and transfer to the Horizontal Storage Module (HSM).

3 A HSM that provides used fuel decay heat removal, physical and radiological protection for the DSC. The HSM consists primarily of thick concrete walls, a steel support structure for the DSC, and a thick concrete door. Each HSM includes provisions for thermal monitoring instrumentation.

4 At the time of transportation, DSC is removed from the HSM into transport cask for transportation (e.g. 32PTH DSC stored on site in HSM-H, 32PTH will be transferred from HSM-H into MP197HB transportation cask for transport)

Tables 2 and 3 show the effects on the heat loads and crane capacities on the "Storage First" vs. "Transport First" design. The effect on the radiation source terms for the storage and transportation designs is also related to the differences in the heat loads between these designs as shown in Table 2. For these DSCs, the radiation source terms for storage are between 10% to 20% higher, compared to the radiation source terms for transportation.

Table-2 Effect on Heat Loads

	Heat Loads for Storage	Heat Loads for Transport
NUHOMS®- 24PTH	40.8 kW	26.0 kW
NUHOMS®- 32PTH	34.8 kW	26.0 kW
NUHOMS®- 32PTH1	40.8 kW	26.0 kW
NUHOMS®- 37PTH	30.0 kW	22.0 kW
NUHOMS®- 61BTH	31.2 kW	24.0 kW
NUHOMS®- 69BTH	35.0 kW	32.0 kW

Table-3 Effect due to Crane Capacities

	Storage	Transport
	Weight (DSC + Transfer Cask)	Weight (DSC + Transport Cask) Without Impact Limiters
NUHOMS®- 24PTH	211 kips	263 kips
NUHOMS®- 32PTH	229 Kips	274 kips
NUHOMS®- 32PTH1	241 Kips	276 kips
NUHOMS®- 37PTH	241 kips	274 kips
NUHOMS®- 61BTH	221 kips	274 kips
NUHOMS®- 69BTH	235 kips	269 kips

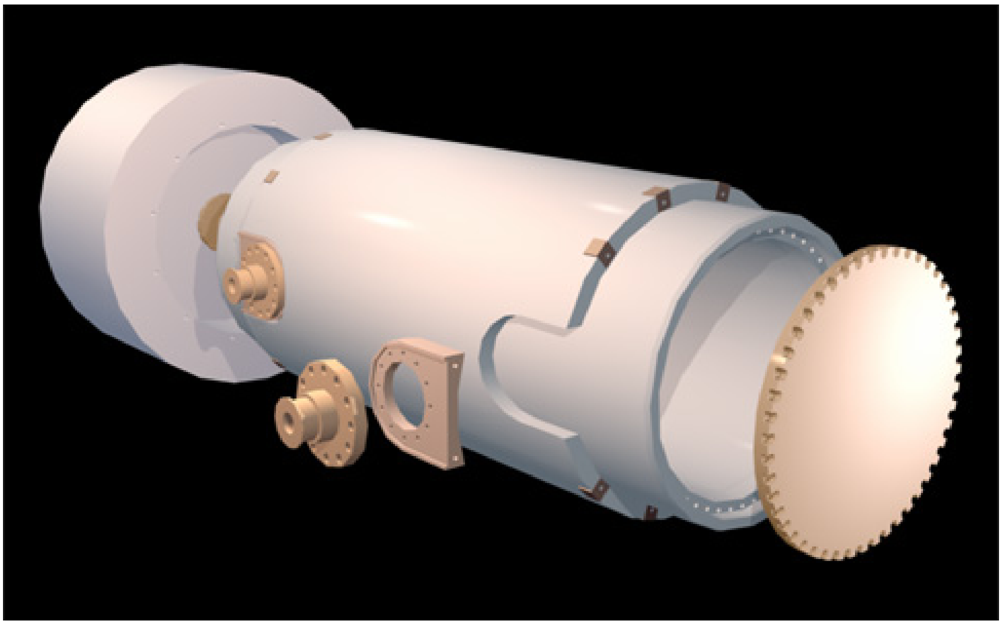
TN's "Transport First" System Design

For the "Transport First" system design, the DSC is loaded into the transport cask directly and then transported to an off-site interim storage facility where it is stored. TN Inc and TN International are in the process of obtaining a license for the MP197HB transport package and the TN NOVA storage system. The MP197HB transport package is being licensed in the US for transport and will be validated in Europe for transport. The TN NOVA storage system (TN NOVA storage overpack and NUHOMS®- 69BTH DSC) will be licensed in Europe for storage.

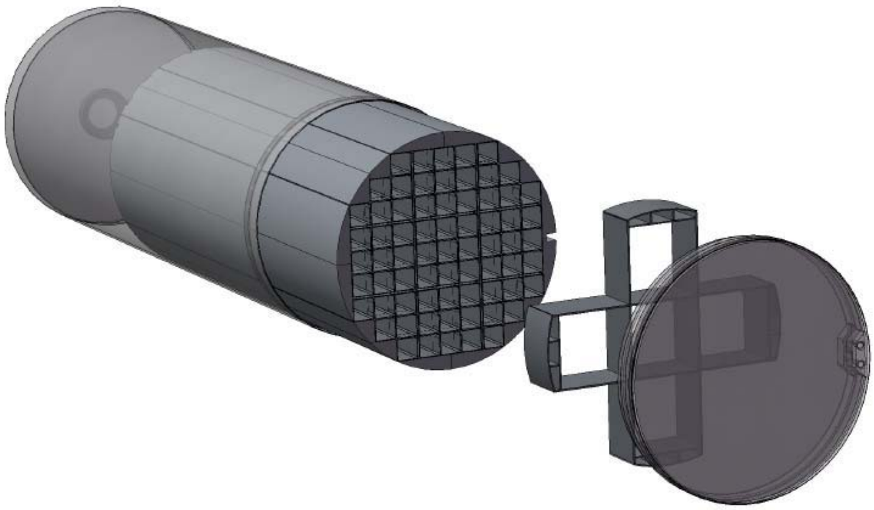
The MP197HB transport cask will be placed in the spent fuel pool with the NUHOMS®69BTH DSC for loading the BWR fuel and transport the 69BTH DSC to the storage site. At the storage site, the 69BTH DSC is transferred from the MP197HB transport cask to the TN NOVA storage overpack in a horizontal position. Once the transfer is complete, the TN NOVA overpack is uprighted in a vertical position for storage. The TN NOVA overpack is equivalent in terms of function and operational sequence of the NUHOMS® storage module (NUHOMS® HSM) used in the USA.

This “Transport First” then storage System consists of the following components:

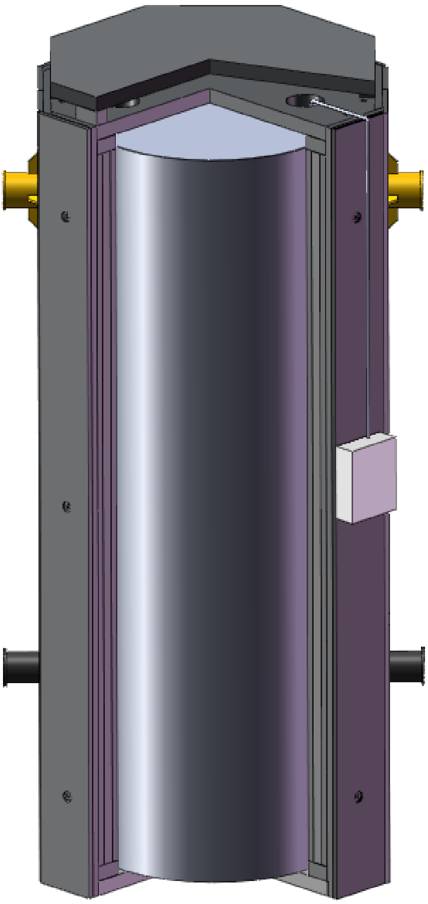
1. MP197HB transport cask, placed in the spent fuel pool with 69BTH DSC during loading operation. Contains the 69BTH DSC and Impact limiters during transport operations.



2. NUHOMS®-69BTH DSC contains the basket with 69 BWR fuel assemblies.



3. TN NOVA storage system used to store the NUHOMS®-69BTH DSC in the vertical position.



Conclusion

TN has developed products which satisfy both options. TN dry used fuel canisters licensed for "Storage First" option include two standard diameters. Cavity versatility is essential to handle several basket designs and also varies the weight to accommodate the site crane capacities. For the "Transport First" option, TN also developed a transport cask which can transport any of the dual purpose canisters. Both of these options provide TN with significant flexibility to meet future needs in the USA and in International market place.