MAKING THE NUHOMS® -61 BT CANISTER SYSTEM TRANSPORTABLE WORLD-WIDE

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ABSTRACT

The NUHOMS® Canister based system offers utilities the option to store spent fuel in sealed canisters within concrete horizontal storage modules (HSMs). The initial design of the NUHOMS® canister for BWR fuel has a capacity for 52 fuel assemblies and is fully licensed for on-site storage under 10CFR72[1]. Over 30 NUHOMS®-52B canisters have been ordered and 8 have been successfully loaded to date. In 1999, Transnucleaire formed an international project team of engineers from its office in Paris, New York and California to provide a next generation NUHOMS® design, with the following objectives:

- Increase capacity to 61 BWR spent fuel assemblies,
- Use the existing designs of auxiliary equipment for loading spent fuel assemblies into the canister, closure operations, vacuum drying and automated welding, without modification,
- Ensure compatibility with the existing NUHOMS®-OS197 transfer cask and the HSMs, which are licensed under 10CFR72,
- Ensure that the canister can be licensed for transport in USA under 10CFR71[2] and for worldwide transport in Type B packaging, and
- Prove the feasability of transporting canister to the COGEMA La Hague reprocessing plant and identify safe methods for spent fuel unloading.

INTRODUCTION

The NUHOMS-61BT Dry Shield Canister (DSC) is a dual-purpose dry shield canister designed to provide storage of spent fuel in a standard Horizontal Storage Module (HSM). The design is based on the NUHOMS® design concept of horizontal storage, and is compatible with the current 52B DSC shell, Horizontal Storage Module (HSM), and OS-197 Transfer Cask system. The NUHOMS® 61BT DSC is licensed for storage in accordance with the requirements of 10 CFR72.

The NUHOMS®-MP197 packaging consists of the NUHOMS®-MP197 Transport Cask, which is utilized for the off-site transportation of NUHOMS®-61BT DSCs in accordance with the requirements of 10CFR71. The packaging is intended to be shipped as exclusive use.

NUHOMS® STORAGE SYSTEM

The major components of the NUHOMS®-61BT storage system including the following:

- Horizontal Storage Module

- 61BT Dry Shield Canister
- Transfer Cask
- NUHOMS® Automated Welding System
- Lifting Yokes
- Cask Transfer System
- Vacuum Drying System

The following figure shows the operating sequence of the NUHOMS®-61BTstorage system.

Operating Sequence of NUHOMS® Storage System

HORIZONTAL STORAGE MODULE (HSM)

The HSM is a robust reinforced concrete structure designed to shield and support the 61BT DSC while providing passive heat removal during storage. Ambient air enters the module through the shielded inlet vents on the side, circulates around the DSC and heat shields, and exits the HSM through the outlet vents at the top of HSM. The HSM is designed to protect the DSC from extreme environmental and geological conditions. HSMs are arranged in arrays. Each array consists of modules placed directly adjacent to one another providing a compact ISFSI foot print and reduced dose rates. An array of NUHOMS® storage modules is shown on the following figure.

Array of NUHOMS® Storage Modules

NUHOMS®-61BT DSC DESIGN FEATURES

The NUHOMS® 61BT DSC consists of 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 61BT DSC stores and transports 61 BWR fuel assemblies with or without channels.

The 61BT stainless steel basket consists of tubular fuel compartments grouped together and wrapped by over-sleeve to form 9 and 4 compartment assemblies. The compartment assemblies are connected to perimeter rail assemblies. The rail assemblies provide the circular perimeter geometry that fits the basket inside the DSC shell.

By incorporating the bundled tube and the tube-in-tube geometry features, the basket of this 61BT canister achieves good structural rigidity, while minimizing welding. The 61BT rail assemblies surrounding the basket provide a wider footprint for distributing the mechanical loads from the basket for superior structural performance under the most severe accident conditions including 30 foot drop scenarios. The most significant advantage of the wider contact surfaces achieved by the rail is the improved thermal conduction from the basket to the shell ensuring low cladding and basket temperature in the 61BT. The design features of the NUHOMS®-61BT DSC are as follows:

- Although the 61BT is a new addition to the series of canister designs for the NUHOMS® System, it incorporates many of the proven features of other Transnuclear dry fuel storage design.
- The 61BT outside diameter is the same as that of all the other NUHOMS® canisters which makes it fully compatible with the existing NUHOMS® transfer equipment.
- The 61BT incorporates the same NUHOMS® proven closure weld design that has been implemented into more than 147 loaded canisters in the US. to date.
- The 61BT basket was inspired by the basket design in our dual purpose TN-68 metal cask. A design that has been proved through fabrication and operation to be simple and efficient.

- Payload
  - 61 BWR fuel assemblies (with or without channels)

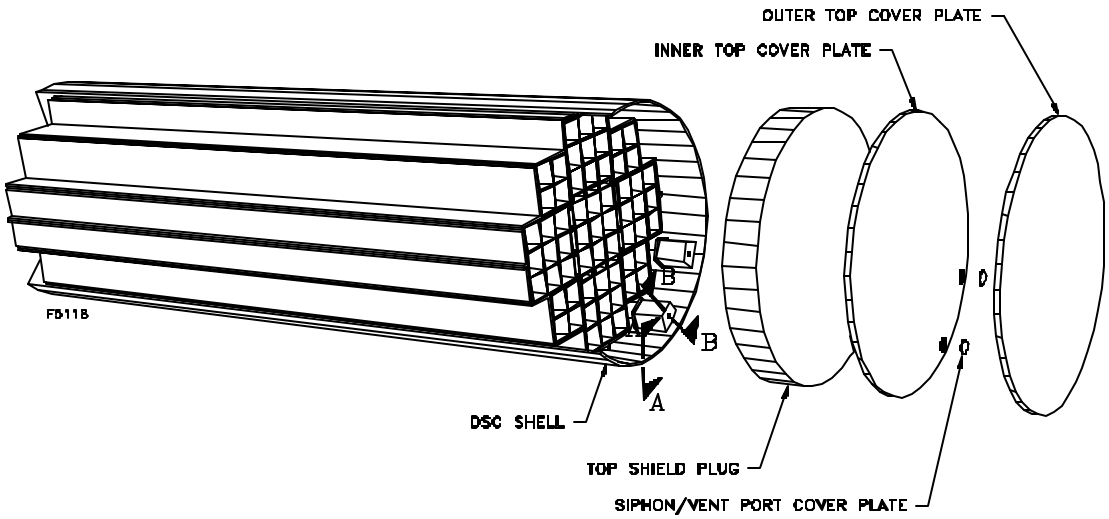
- 19.8 kW decay heat (Storage)
- 15.9 kW decay heat (Transport)
- 4.4 U-235 initial enrichment
- 45,000 MWD/MTU Burnup
- 5 year minimum cooling

- **Enveloping Dimensions of 61BT DSC**
  - Outer diameter 67.25 in
  - Outer length 196 in
  - Cavity length 177 in
  - Empty weight 37,900 lb
  - Loaded weight 81,700 lb
  - Maximum "on-hook" weight 200,000 lb

- **Construction**
  - Welded stainless steel shell
  - Stainless steel basket
  - Nickel coated carbon steel shield plugs
  - Enriched Boron Aluminum Alloy or Boron Carbide/Aluminum Metal Matrix Composite or Boral as neutron poison material

The NUHOMS® 61BT DSC (basket and shell) is fabricated primarily from high quality stainless steel. The shell materials are resistant to corrosion and are not susceptible to other galvanic reactions. Studies under severe marine environments have demonstrated that the shell materials used in the 61BT DSC will experience minimal corrosion during a 50-year exposure. During storage the 61BT DSC internals are filled with dry helium and are designed for all postulated environmental conditions.

The NUHOMS® 61BT DSC is shown on the following figure.



NUHOMS® 61BT DSC

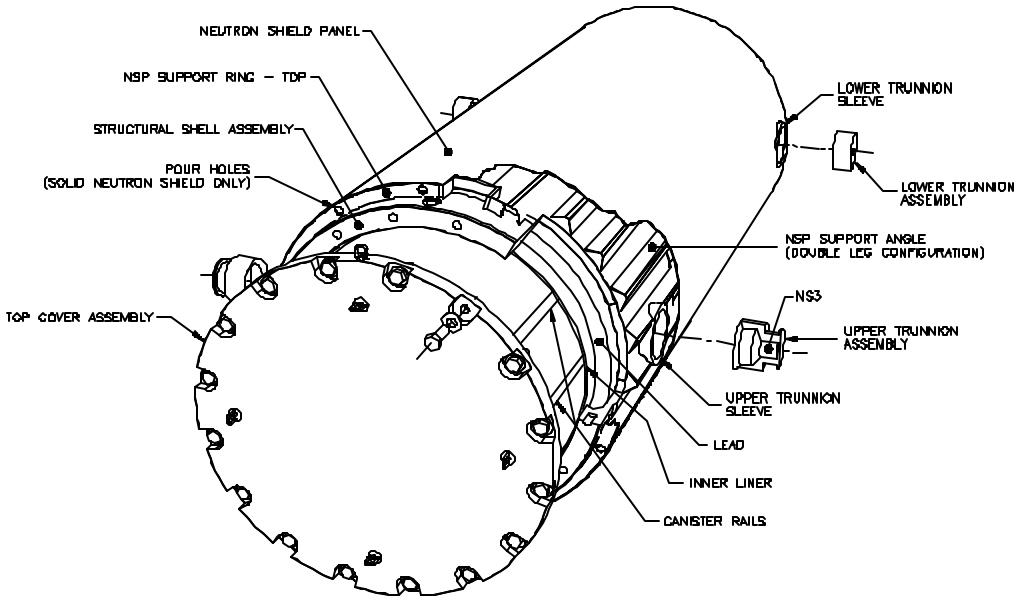
NUHOMS® -OS 197 TRANSFER CASK

The NUHOMS®-OS197 transfer cask is used for the fuel transfer operation inside the fuel/reactor building and for transferring the loaded 61BT DSC to the storage modules at the ISFSI.

Basic cask features are as follows:

- The maximum loaded weight (on the hook) of the cask is 100 tons.
- The cask is capable of rotation, from the vertical to the horizontal position on the support skid
- The NUHOMS® transfer cask inner and outer structural shells are made entirely out of stainless steel. The exterior shell has a highly polished surface finish to facilitate decontamination.
- The cask is capable of rejecting up to 24 kw decay heat load to the atmosphere assuming the most severe ambient conditions postulated to occur during normal, off-normal and accident conditions.
- Horizontal transfer of the canister in and out of the module precludes the need for critical heavy lifting or upending at the ISFSI.
- Retrieval and off-site shipment of the canister without future reliance on plant facilities.
- The transfer equipment is third generation equipment, which was designed, built, and tested using our industry leading fuel storage experience.

The NUHOMS® OS197 Transfer Cask is shown on the following figure.



The NUHOMS®-OS197 transfer cask

NUHOMS® MP197 TRANSPORT SYSTEM

The NUHOMS®-MP197 packaging will be used to transport 61 intact standard BWR fuel assemblies with or without fuel channels, contained in a single NUHOMS®-61BT DSC. The NUHOMS®-MP197 packaging is designed for a maximum heat load of 15.9 kW or 260 W/assembly.

The NUHOMS®-MP197 packaging consists of the following components:

- A NUHOMS®-61BT DSC as discussed previously.
- A NUHOMS®-MP197 transport cask consisting of a containment boundary, structural shell, gamma shielding material, and solid neutron shield. The containment boundary has a cylindrical shell, bottom end (closure) plate with a ram access penetration, top end forging ring, bottom and top cover plates (lids) with associated seals and bolts, and vent and drain port closure bolts and seals. The transport cask cavity also contains an inert gas atmosphere.
- Sets of removable upper and lower trunnions, bolted to the outer shell of the cask that provide support, lifting, and rotation capability for the NUHOMS®-MP197 cask.
- Impact limiters consisting of balsa and redwood, encased in stainless steel shells, attached to each end of the NUHOMS®-MP197 cask during shipment. A thermal shield is provided between the bottom impact limiter and the cask to minimize heat transfer during fire accident to the bottom limiter. Each impact limiter is held in place by twelve (12) attachment bolts.

The NUHOMS®-MP197 cask is designed to the ASME B&PV[3] Code and meets the requirements of Section III, Division 3[4] for Transport Packagings. The NUHOMS®-MP197 cask with impact

limiters has recently undergone drop testing to verify the calculated g loadings during the 30 foot drops. The test showed good correlation with analytical results and demonstrate that the impact limiters stay in place and protect the package and fuel during the hypothetical accidents.

DESIGN CONSIDERATIONS DUE TO EUROPEAN CONSTRAINTS (TRANSPORT AND UNLOADING AT COGEMA LA HAGUE REPROCESSING PLANT)

The following considerations are taken into account for designing the NUHOMS® MP197 packaging.

- Diameter of impact limiters limited to 122 inches and overall length of the packaging limited to less than 287 inches.
- Trunnions with double shoulders for handling at La Hague reprocessing plant.
- Diameter of transport cask lid limited to 74.68 inches in order to ensure acceptance of the cask at the COGEMA La Hague facility.
- Cask lid handling interface compatible with La Hague lid handling system.
- Design packaging weight is limited to less than 131 metric tons for crane capacity.
- Design of a transport skid compatible with european transport system.

These limitations and considerations are included in the NUHOMS®-MP197 packaging design. In addition, the design requirements specified in IAEA for the transport package are also included in the NUHOMS®-MP197 packaging evaluation to ensure that NUHOMS®-61BT canister system can be transported world-wide.

STATUS OF THE NUHOMS®-61BT LICENSE

- **Storage**

The design and license application work has been completed on the NUHOMS®-61BT. An amendment request was submitted to the USNRC on July 15, 2000 to add the transportable NUHOMS®-61BT DSC to the current NUHOMS® C of C 72-1004. The NRC accepted the amendment for review on August 22, 2000. The status of the NRC schedule for review as follows:

NUHOMS®-61BT Storage Licensing Milestones			
Milestones	Target Dates	Actual Dates	Comments
TN Application Received	7/15/00	7/15/00	Complete
NRC Acceptance Review, Issue Schedule	8/25/00	8/25/00	Complete
NRC Generated 1st RAI	12/8/00	12/8/00	Complete
TN Responds 1st RAI	1/22/01	1/22/01	Complete
NRC Issue Preliminary SER/CoC	3/31/01	4/16/01	Complete
NRC Final SER/CoC			Expected September 2001

The first use of the NUHOMS®-61BT system will be at Oyster Creek Nuclear Plant.

- **Transport**

The transport SAR was submitted on May 2, 2001 and the NRC schedule for review included the following milestones:

NUHOMS®-MP197 Transport Licensing Milestones			
Milestones	Target Dates	Actual Dates	Comments
TN Application Received	5/2/01	5/2/01	Complete
NRC Acceptance Review, Issue Schedule	6/30/01	6/30/01	Complete
NRC Generated 1st RAI	10/29/01	-	-
RAI Meeting Schedule, if Needed	11/12/01	-	-
TN Responds 1st RAI	1/30/02	-	-
NRC Issue SER/CoC	5/17/02	-	-

Transnucleaire has jointly studied with Transnuclear Inc. the 61BT and MP197 design with the ultimate objective obtaining a package approved for transporting BWR fuel to the COGEMA La Hague reprocessing plant.

SUMMARY

The NUHOMS®-61BT system design is based on patented concept of horizontal storage, and is compatible with the current NUHOMS®-52 DSC shell, Horizontal Storage Module and OS-197 transfer cask system. The advantages of the NUHOMS®-61BT are listed as follows:

- 147 NUHOMS® canisters have been loaded to date in the US. The NUHOMS®- system is a proven reliable solution to dry fuel storage.
- NUHOMS® transfer casks and equipment are available on a lease basis, reducing overall life cycle costs to the utility.
- The NUHOMS® Horizontal Storage Module is the most seismically stable system for the storage of spent nuclear fuel in the United States.
- A NUHOMS® ISFSI will meet the most stringent site dose limits without the need for supplementary shielding.

The NUHOMS®-61BT DSC can be retrieved from the NUHOMS® horizontal storage module into MP-197 Transport Cask. The MP-197 is an optimized design which can be used to load the DSC from the HSM or load the DSC in the spent fuel pool and with impact limiter installed and transported off-site. The MP-197 packaging also designed to meet the IAEA requirements to transport fuel world-wide and can be handled and unloaded in the COGEMA La-Hague reprocessing plant.

REFERENCES

1. Title 10, Code of Federal Regulations, Part 72, “Licensing Requirements for the Storage of Spent Fuel in an Independent Spent Fuel Storage Installation.”
2. Title 10, Code of Federal Regulations, Part 71, “Packaging and Transportation of Radioactive

3. ASME Boiler & Pressure Vessel Code, Section III, Division 1, Subsections NB and NG
4. ASME Boiler & Pressure Vessel Code, Section III, Division 3, Subsection WB.