# NUHOMS® - MP197 Transport Cask

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## ABSTRACT

The NUHOMS®-MP197 cask is an optimized transport design which can be loaded in the spent fuel pool (wet loading) or loaded the canister from the NUHOMS concrete modules at the ISFSI site. With impact limiters attached, the package can be transported within the states or world-wide.

The NUHOMS®-MP197 packaging can be used to transport either BWR or PWR canisters.

The NUHOMS®-MP197 cask is designed to the ASME B&PV Code [1] and meets the requirements of Section III, Division 3[2] for Transport Packaging. The cask with impact limiters has undergone drop testing to verify the calculated g loadings during the 9m 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.

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

- 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[3],
- Ensure that the cask can be licensed for transport in USA under 10CFR71[4] and for worldwide transport in Type B packaging, and
- Prove the feasibility of transporting canister to the COGEMA La Hague reprocessing plant and identify safe methods for spent fuel unloading.

These limitations and considerations are included in the NUHOMS®-MP197 packaging design. In addition, the design requirements specified in IAEA[5] (IAEA TS-R-1, 1996) for the transport package are also included in the NUHOMS®-MP197 packaging evaluation to ensure that NUHOMS® canister system can be transported world-wide.

## INTRODUCTION

The NUHOMS®-MP197 cask provides containment, shielding, criticality control, and passive heat removal, independent of any other facility structures or components. The cask also maintains structural integrity of the fuel during transport condition.

This cask can be used for the transfer of spent fuel in an independent spent fuel storage installation (ISFSI) at a power reactor site or with impact limiters installed transported off-site.

The criticality control features of the NUHOMS®-MP197 cask is designed to maintain the neutron multiplication factor k-effective less than the upper subcritical limit equal to 0.95 minus benchmarking bias and modeling bias under all conditions.

During dry transport of the spent fuel, no active systems are required for the removal and dissipation of the decay heat from the fuel. The NUHOMS®-MP197 cask is designed to transfer the decay heat from the fuel to the basket, from the basket to the canister, cask body and ultimately to the surrounding air by radiation and natural convection.

## NUHOMS® MP197 TRANSPORT PACKAGE (with BWR Canister)

The NUHOMS®-MP197 packaging will be used to transport 61 intact standard Boiling Water Reactor (BWR) fuel assemblies with or without fuel channels, contained in a single NUHOMS®-61BT DSC.

### The NUHOMS®-MP197 Packaging consists of the following components:

- A NUHOMS®-61BT Dry Shielded Canister (DSC) consisting of a cylindrical shell, top and bottom shield plugs, inner and outer bottom closure plates, and inner and outer top cover plates. After loading, the DSC is vacuum dried and back-filled with an inert gas.

- A fuel basket assembly, located inside the DSC, which locates and supports the fuel assemblies, transfers heat to the DSC wall, and provides neutron absorption to satisfy nuclear criticality requirements. A basket hold down ring is installed on top of the basket, after fuel loading, to prevent axial motion of the basket within the canister.

- A NUHOMS®-MP197 transport cask consisting of a containment boundary, structural shell, gamma shielding material, and solid neutron shield. The containment boundary consists of 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, are 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 to the bottom limiter. Each impact limiter is held in place by twelve (12) attachment bolts.

**NUHOMS®-61BT DSC DESIGN FEATURES**

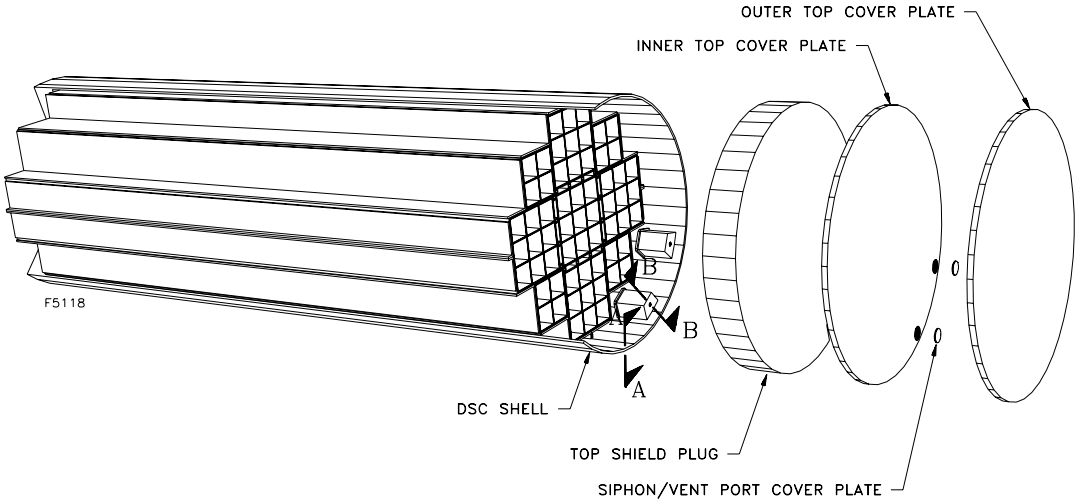
The NUHOMS® 61BT DSC consists of stainless steel cylindrical shell, top and bottom shield plugs, inner and outer bottom closure plates, inner and outer top cover plates, and the internal basket. The 61BT DSC stores and transports 61 BWR fuel assemblies with or without channels.

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 9m 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.

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




NUHOMS® 61BT DSC

## NUHOMS® MP197 TRANSPORT CASK DESIGN FUTURES

The cask is fabricated primarily of stainless steel. Non-stainless steel members include the cast lead shielding between the containment boundary inner shell and the structural shell, the o-ring seals, the borated polyester resin neutron shield material and the carbon steel closure bolts. Socket headed cap screws (bolts) are used to secure the top closure lid to the cask body and the RAM access closure plate to the bottom of the cask. The body of the cask consists of 1.25 inches (32mm), 68 inch (1727mm) inside diameter stainless steel inner (containment) shell and a 2.5-inch (63.5mm) thick, 82.00 inch (2083mm) outside diameter stainless steel structural shell which sandwich the 3.25 inch (83mm) thick cast lead shielding material.

The overall external dimensions of the cask are 208.00 inches (5283mm) long and 91.5 inches (2324mm) outer diameter. The weight of the cask body (excluding the lid and lid bolts, which weighs approximately 5,610 pounds) is approximately 143,000 pounds (64,864 kg), including 9,960 pounds of neutron shield material and roughly 60,000 pounds of cast lead.

## DESIGN/FABRICATION CODES

The NUHOMS®-MP197 cask is designed to satisfy the requirements of 10CFR 71 for the transport of radioactive materials.

The NUHOMS®-MP197 cask is designed and fabricated in accordance with the ASME Boiler and Pressure Vessel Code.

The cask confinement boundary is designed, fabricated and inspected in accordance with the ASME Code Subsection NB to the maximum practical extent. The basket is designed, fabricated and inspected in accordance with ASME Code Subsection NG to the maximum practical extent.

## WEIGHTS

Specific weights are provided in the table below.

| Component | Nominal Weight (lbs. x 1000) |
|---|---|
| **Cask Weight w/o Impact Limiters and Attachments** | **148.84 (67,513 kg)** |
| Canister | 22.47 |
| Basket | 22.92 |
| Impact Limiters w/Attachment bolts and Thermal Shield | 27.87 |
| **Total Package Weight (Empty)** | **222.10 (100,743kg)** |
| Fuel Assemblies | 43.0 |
| | |
| **Total Package Weight (Loaded)** | **265.1 (120,248 kg)** |

## DYNAMIC DROP TESTS

A series of dynamic tests have been performed on one-third scale models of the NUHOMS®-MP197 impact limiters. The tests were performed to evaluate the effect of the 9 m free drop hypothetical accident defined in 10 CFR 71.73(c)(1). The unyielding drop surface consisted of a two inch thick steel plate secured to the surface of a concrete pad. The test model was a solid steel 1/3 scale mockup of the cask body with impact limiter. The steel body was designed to scale the weight and the center of gravity of the package. The test results will be used to verify the analyses performed for the NUHOMS®-MP197 cask and basket. The objectives of the NUHOMS®-MP197 impact limiter test program were to:

- Demonstrate that the inertia *g* values and forces used in the analyses presented are conservative.
- Demonstrate that the extents of crush depths are acceptable, i.e., limiters do not bottom out and trunnions would not impact target.
- Demonstrate the adequacy of the impact limiter enclosure.
- Demonstrate adequacy of attachment design.

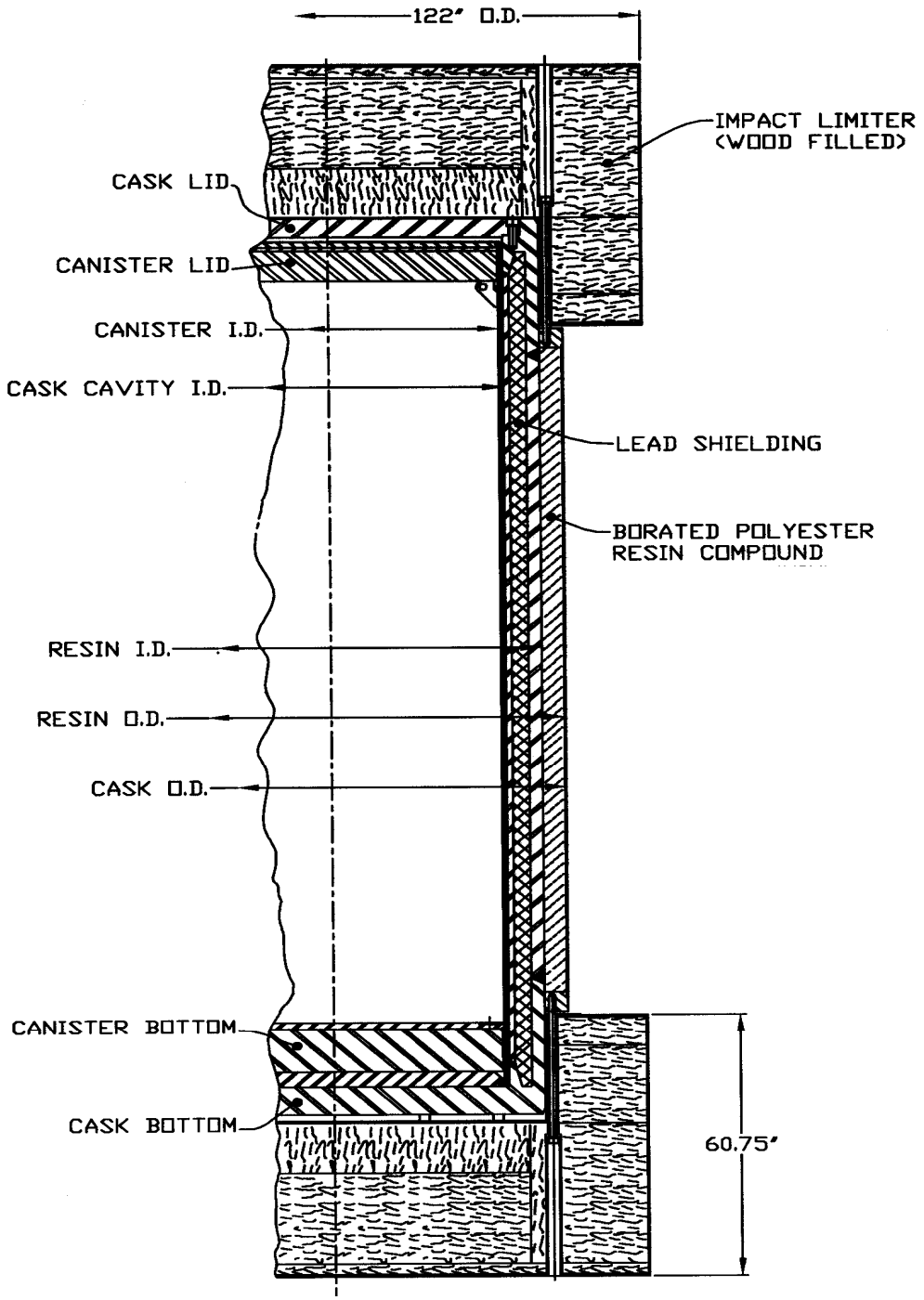
- Evaluate the effects of low temperature (-20° F or -28.9° C) on the crush strength and dynamic performance of the impact limiters.
- Evaluate the effects (puncture depth and shell damage) of a 40 inch (1.07m) drop onto a six inch diameter puncture bar on a previously crushed impact limiter, as per 10 CFR 71.73(c)(3).

Four 1/3 scale impact limiters that were constructed for the drop testing. The various drop test orientations were performed in the following sequence.

| Test Number | Drop Orientation | Drop Height | Impact Limiter Number | Location of Impact Limiter | Comments |
|---|---|---|---|---|---|
| 1 | 0° Side Drop | 30 feet | 1 | Top | |
| | | | 2 | Bottom | |
| 2 | 20° Slap Down | 30 feet | 3 | Top ($2^{nd}$ Impact) | Limiter #1 was removed and replaced with limiter #3, entire test article rotates 180°. |
| | | | 2 | Bottom ($1^{st}$ Impact) | |
| 3 | 90° End Drop | 30 feet | 3 | Top | Limiter #2 was removed and replaced with limiter #4. Limiter #4 chilled at –20° F for 48 hours before installed to the test body. |
| | | | 4 | Bottom (Impact End) | |
| 4 | 90° End Drop | 40 inches | 3 | Top | Drop onto scaled 6 inch diameter puncture bar. |
| | | | 4 | Bottom (Puncture End) | |

The four drop tests were performed without any unusual observations. The impact limiters contained the wood during the drop tests, and none of the attachment bolts failed. The predicted performance of the impact limiters in terms of decelerations and crush depths agrees well with the measured data.

The NUHOMS® -MP197 cask is shown on the following figure.



## SUMMARY

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. Transnuclear received the NRC approval of transport Safety Analysis Report (NUHOMS®-MP197 packaging with 61BT canister) in July 11, 2002. The transport SAR for NUHOMS®-MP197 packaging (with 32T canister) will be submitted to NRC in 2005.

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

- Diameter of impact limiters limited to 122 inches (3099mm) and overall length of the packaging limited to less than 287 inches (7290mm).
- Trunnions with double shoulders for handling at La Hague reprocessing plant.
- Diameter of transport cask lid limited to 74.68 inches (1897mm) 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® canister system can be transported world-wide.

## REFERENCES


1. ASME Boiler & Pressure Vessel Code, Section III, Division 1,Subsections NB, NG, and NF.

2. ASME Boiler & Pressure Vessel Code, Section III, Division 3,Subsections WB.

3. Title 10, Code of Federal Regulations, Part 72, “Licensing Requirements for the Storage of Spent Fuel in an Independent Spent Fuel Storage Installation.”

4. Title 10, Code of Federal Regulations, Part 71, “Packaging and Transportation of Radioactive Materials.”

5. Safety Series N$^{o}$6 International Atomic Energy Agency (IAEA) “Regulations for Safe Transport of Radioactive Materials”.