NUHOMS® 32PT
A High-Capacity Transportable NUHOMS® PWR System

B. Grubb, J. Bondre, M. Manrique, J. Boshoven, and W. Ingles
Transnuclear West Inc., Fremont California

ABSTRACT
The standard NUHOMS® PWR system, licensed under Certificate of Compliance (CoC) 72-1004 and 71-9255, provides for storage and transportation of 24 PWR spent fuel assemblies in a sealed canister within a concrete horizontal storage module. Over 210 NUHOMS® 24P canisters have been ordered and 98 have been successfully loaded to date. The NUHOMS® 32PT is the next generation system designed for both storage and transport of PWR spent fuel assemblies. The NUHOMS® 32PT system major design features are:

- Capacity for storage and transport of 32 PWR spent fuel assemblies with or without control components,
- Increased fuel assembly heat load and enrichments with a maximum heat load of 24 kW per canister and 1.2 kW per assembly,
- Use of the same on-site transfer cask and HSMs as the existing system (CoC 72-1004),
- Utilizes the existing designs of the auxiliary equipment for loading spent fuel assemblies into the canister, closure operations, vacuum drying and automated welding, without modification,
- On-the-hook weight of 100 tons for plants with 100-ton crane capacity,
- On-the-hook weight of 125 tons for plants with 125-ton crane capacity, and
- Leak tight canister per the criteria of ANSI N14.5-1997.

This paper describes the design of the NUHOMS® 32PT system. The NUHOMS® 32PT system consists of a new canister, existing NUHOMS® on-site transfer casks, and existing concrete storage modules. The NUHOMS® 32PT canister consists of shell and basket subassemblies. The canister shell design is similar to the existing NUHOMS® 24P canister designs. The basket is a tube/plate type design based on the experience gained from other similar Transnuclear basket designs.

INTRODUCTION
NUHOMS® storage systems have been in operation for more than 15 years. Over 140 PWR and BWR systems have been successfully loaded with spent fuel. The requirements of the commercial nuclear power industry have evolved during this period of operation. It has become clear that provision must be made for the storage of spent fuel with increased initial enrichments and increased burnups. Additionally, the economics of fuel storage have demonstrated the need to store more fuel assemblies in a single canisterized system while still maintaining the flexibility to operate as much as possible within existing power plant space limitations and crane capacities. Transnuclear has designed and is currently in the process of amending its existing storage (72-1004 [1]) and transportation (71-9255 [2]) licenses to include the NUHOMS® 32PT high capacity storage/transport dry shielded canister to meet future industry needs. The NUHOMS® 32PT design takes advantage of lessons learned from various previous Transnuclear designs including the TN-24, TN-32 and TN-68 along with the NUHOMS® 24P. The canister is designed to meet the requirements of

10CFR71 [3] and 10CFR72 [4]. This canister design is operationally compatible with currently licensed NUHOMS® system storage and transport equipment.

DESIGN DESCRIPTION

The NUHOMS®32PT canister is a dual-purpose dry shielded canister designed to store and transport 32 PWR spent fuel with or without BPRAs in accordance with 10CFR71 and 10CFR72 requirements. There are four design configurations for the NUHOMS® 32PT DSC, two 100-ton configurations, one long and one short canister; and two 125-ton configurations, one long and one short canister. The main differences between the 100-ton and 125-ton configuration basket designs are the thicknesses of shield plugs. The long 100-ton configuration is designated the 32PT-L100 and the short 100-ton configuration is designated the 32PT-S100. Likewise the long 125-ton configuration is designated the 32PT-L125 and the short 125-ton configuration the 32PT-S125. The basket layout for these two configurations is identical except for the length of the components. The 32PT-L100 and 32PT-L125 are also designed to store 32 intact standard PWR fuel assemblies with or without BPRAs. The NUHOMS® 32PT DSC design includes three alternate heat zone loading configurations with a maximum decay heat of 1.2kW per assembly and a maximum decay heat load of 24 kW per DSC.

Design Features

The NUHOMS® 32PT canister is shown in Figure 1. The 32PT canister consists of a stainless steel cylindrical shell, top and bottom shield plugs, inner and outer bottom cover plates, inner and outer top cover plates, and the internal basket assembly.

The NUHOMS® 32PT canister incorporates an innovative basket design that consists of a welded grid assembly of slotted crisscrossed welded stainless steel plates or tubes that make up 32 fuel compartments. Each compartment is sufficiently large to accommodate poison inserts and/or aluminum heat transfer plates and a PWR fuel assembly. The space between the inside of the canister shell and the fuel compartment grid assembly is bridged by "transition rails". These transition rails are made from stainless steel welded plates or aluminum sections connected to the fuel compartment grid structure. The fuel compartment plates transfer the spent fuel loads to the canister shell, via the transition rails. The transition rails distribute the mechanical loads from the fuel compartment grid to the canister shell, and also provide a thermal conduction path for heat transfer from the basket to the shell, which makes it efficient in rejecting heat from the spent fuel assemblies. The fuel assemblies are supported by the stainless steel fuel compartments that extend through the entire canister cavity. Geometric spacing and borated aluminum poison sheets in the basket maintain criticality control. Depending on fuel requirements, neutron poison rod assemblies may also be used for this purpose to maximize the flexibility of the design and minimize the overall cost of the basket.

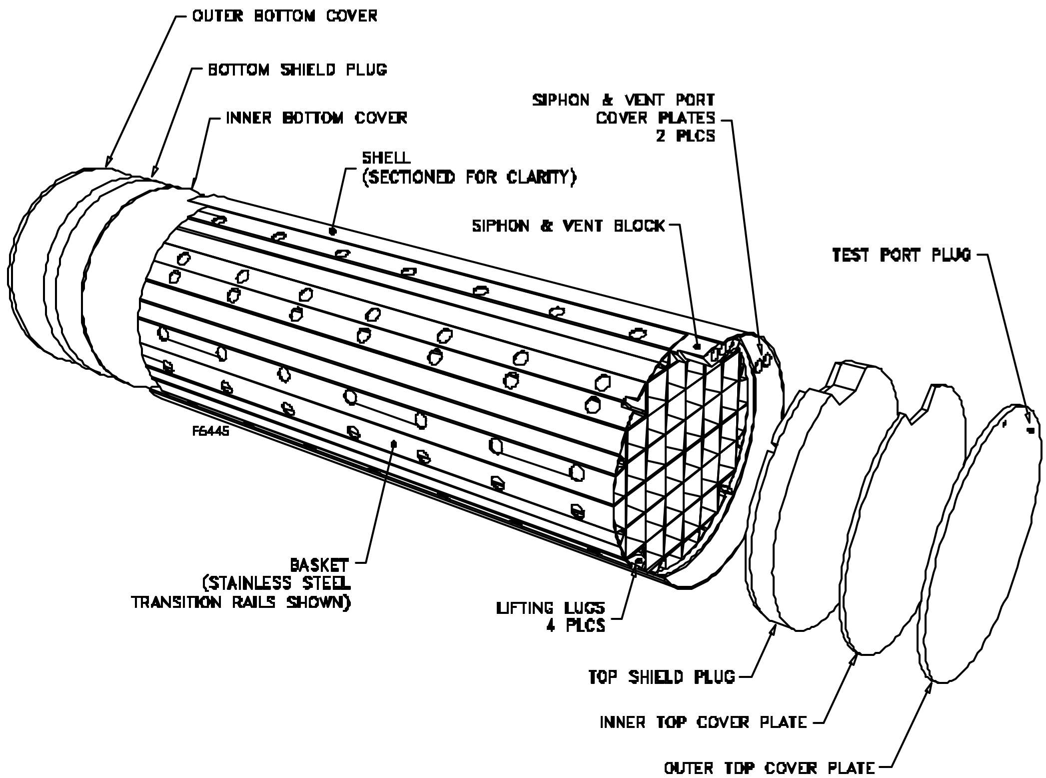

Figure 1 NUHOMSâ 32PT DSC

(shown with steel transition rails option)

Although the 32PT 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 designs. For example, the 32PT canister outside diameter is the same as all the other NUHOMS® canisters, which makes it fully compatible with the existing NUHOMS® System transfer equipment. Additionally, the 32PT canister incorporates the same NUHOMS® proven closure weld design that has been successfully implemented into more than 140 loaded canisters in the U.S. to date.

The NUHOMS® 32PT canister is designed to maintain the fuel cladding temperature below allowable limits during storage, short-term accident conditions, short-term off-normal and accident conditions and fuel transfer operations. The criticality control features of the NUHOMS® 32PT canister are 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.

Confinement within the NUHOMS® 32PT canister is provided for intact fuel and BPRAs. The intact fuel is confined first within the fuel cladding that is protected from degradation by an inert helium atmosphere. The second confinement barrier is the canister shell and multiple barriers formed by the inner and outer top and bottom cover plates. For BPRAs the canister itself is sufficient to confine both failed and intact

BPRAs. The canister shell and inner and outer cover plates are fabricated and inspected to ASME Code requirements and leak tested in accordance with ANSI N14.5-1997 to a "leak tight" condition.

The NUHOMS® 32PT canister (basket and shell) is fabricated primarily from high quality stainless steel. All of the canister shell materials are ASME code materials and are used consistent with Code approved applications. 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 32PT canister are expected to demonstrate minimal corrosion during a 50-year exposure. The 32PT canister internals are enveloped in a dry helium inerted environment and are designed for all postulated environmental conditions.

Payload

A key feature of the NUHOMS® 32PT system is that it can be handled by existing facility cranes and handling equipment with 100 Ton or greater capacity. A large variety of PWR fuel assembly types are considered in the design. These types include several assembly designs from Babcock & Wilcox, Combustion Engineering, Westinghouse, and Advanced Nuclear Fuels, as shown in Table 1. The basic fuel related parameters are presented in Table 2.

Table 1 Fuel Assembly Types Allowed in the NUHOMS® 32PT System

Fuel Assembly Type
B&W 15x15 Mark B
CE 14x14 Standard/Generic
CE 14x14 Fort Calhoun
CE 14x14 Palisades
CE 16x16 System 80(1)
Exxon/ANF 14x14 Westinghouse
Exxon/ANF 15x15 CE
Exxon/ANF 15x15 Westinghouse
Westinghouse 14x14 OFA
Westinghouse 14x14 Std/ZCA
Westinghouse 14x14 Std/ZCB
Westinghouse 15x15 Std/ZC
Westinghouse 15x15 OFA
Westinghouse 17x17 Vantage 5
Westinghouse 17x17 Standard

(1) For criticality analysis only. The 32PT maximum cavity length (based on carbon steel shield plugs) is currently 175.6". A design modification to incorporate thinner lead plugs will be required in the future to accommodate this fuel type.

Table 2 Basic Fuel Related Parameters

Parameter	Value
Maximum Number of PWR Assemblies	32 Assemblies
Maximum Initial Enrichment	5 wt% U-235
Maximum Burnup	45,000 MWd/MTU
Maximum Assembly Decay Heat	1.2 kW
Maximum DSC Decay Heat	24 kW

Qualification of the fuel that can be loaded into the DSC is dependent on initial enrichment, burnup, and cooling time along with the associated peak clad temperature limit. Individual evaluations are performed for various assembly decay heats with and without control components to establish the qualification requirements. Table 3 presents an example qualification table for fuel assemblies with decay heats of 1.2 kW per assembly and without control components.

Table 3 Example PWR Fuel Qualification Table for 1.2 kW per Assembly Fuel for the NUHOMS® 32PT DSC

(Minimum required years of cooling time after reactor core discharge)

BU (GWd/ MTU)	Initial Enrichment wt % U-235															
	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0
10	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
15	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
20	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
25		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
28			5	5	5	5	5	5	5	5	5	5	5	5	5	5
30				5	5	5	5	5	5	5	5	5	5	5	5	5
32				5	5	5	5	5	5	5	5	5	5	5	5	5
34					5	5	5	5	5	5	5	5	5	5	5	5
36					5	5	5	5	5	5	5	5	5	5	5	5
38						5	5	5	5	5	5	5	5	5	5	5
39						5	5	5	5	5	5	5	5	5	5	5
40		Not Analyzed					5	5	5	5	5	5	5	5	5	5
41							6	5	5	5	5	5	5	5	5	5
42							6	6	6	6	5	5	5	5	5	5
43							6	6	6	6	6	6	6	6	5	5
44								6	6	6	6	6	6	6	6	6
45								6	6	6	6	6	6	6	6	6

- Use burnup and enrichment to lookup minimum cooling time in years. Licensee is responsible for ensuring that uncertainties in fuel enrichment and burnup are correctly accounted for during fuel qualification.
- Round burnup UP to next higher entry, round enrichments DOWN to next lower entry.

- Fuel with a burnup less than 10 GWd/MTU is acceptable for storage after 5-years cooling
- Example: An assembly with an initial enrichment of 3.75 wt. % U-235 and a burnup of 41.5 GWd/MTU is acceptable for storage after a six-year cooling time as defined by 3.7 wt. % U-235 (rounding down) and 42 GWd/MTU (rounding up) on the qualification table.

Operational Considerations

The system design is based on the patented concept of horizontal storage, and is compatible with the current NUHOMS® canister shell, HSM, and OS-197, OS-197H Transfer Cask (TC) system and the MP-187 Transport Cask. The major operations considered for the design of the NUHOMS® 32PT canister are:

- Fabrication leak testing,
- Loading the canister into the TC,
- Filling the canister and TC with water,
- Placing the TC/canister with water in the fuel pool,
- Loading spent fuel into the canister,
- Moving the loaded TC to the decontamination area,
- Welding the canister inner top cover plate to the canister shell,
- Draining and drying the canister,
- Welding the canister outer top cover plate to the canister shell, and leak testing the inner top cover plate and vent and siphon port covers for leak tightness,
- Loading the loaded TC/canister on the transfer trailer,
- Transferring the loaded TC/canister/Trailer to the ISFSI,
- Inserting the canister into the Horizontal Storage Module (HSM) from the TC,
- Storage of the canister in the HSM, and
- Retrieving the canister from the HSM.
- Transporting the canister in a transport cask

The simplicity of the NUHOMS® 32PT system basic operational steps is shown in Figure 2. It should be noted that the system operation provides for complete transfer of the canisterized fuel with no critical lifts performed outside the fuel building. These operational steps have proven to be very efficient and effective in transferring spent fuel to storage. No significant operational problems have occurred during over 140 transfers.

Retrieval of the NUHOMS® 32PT DSC from the horizontal storage module for transport is performed following the same process as loading. The canister is compatible with the NUHOMS® MP-187 Transport Cask. The transport package is loaded onto a rail car or truck for transport to the final storage location.

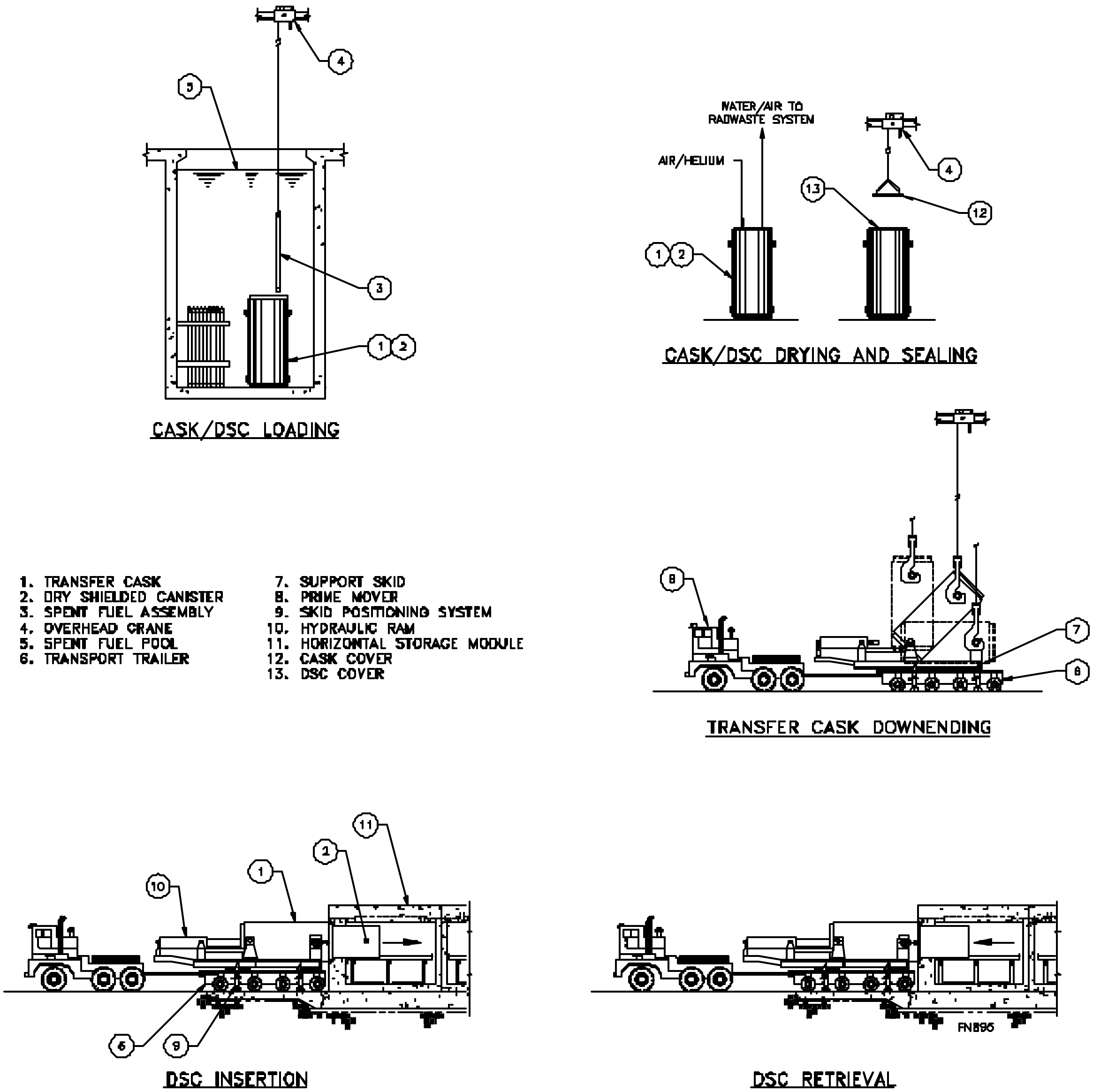

Figure 2 Basic Operational Steps For Horizontal Storage and Transport

LICENSING

Transnuclear has submitted a license amendment application to the NRC to add the NUHOMS® 32PT canister to our 72-1004 Certificate of Compliance. The amendment was submitted in June 2001 and is currently under review by the NRC. A similar license amendment application is currently being developed to our 71-9255 Certificate of Compliance to add the NUHOMS® 32PT DSC as a payload for the MP187 Transport Cask. The first use of the NUHOMS® 32PT system will be at the Point Beach Nuclear Plant.

CONCLUSION

The NUHOMS® 32PT canister design provides a versatile, cost effective solution to the commercial nuclear power industry to store spent fuel with increased initial enrichments and decay heats, and provides the basis for storage of fuel with increased burnups in the future. Additionally, the NUHOMS® 32PT canister design provides for proven operational simplicity and flexibility for effective and efficient use at essentially all commercial power plants. Transnuclear has designed and is currently in the process of amending its existing storage (72-1002 [1]) and transportation (71-9255 [2]) Certificates of Compliance to allow use of the NUHOMS® 32PT DSC for storage and transport of spent fuel.

Transnuclear West Inc., a wholly owned subsidiary of Transnuclear Inc. with headquarters in Hawthorne, New York, is a member of Cogema's international Transnuclear Group of companies founded by Transnucleaire, SA of Paris, France. The company, which was incorporated in the United States in 1965, and its subsidiaries supply engineering products and services for the transport and storage of radioactive materials.

REFERENCES

1. TN West, "Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," NUH-003, Revision 5, August 2000, USNRC Docket Number 72-1004.
2. TN West, "Safety Analysis Report for the NUHOMS® MP187 Multi-Purpose Cask, "NUH-05-151, Revision 10, September 1998, USNRC Docket Number 71-9255.
3. Title 10, Code of Federal Regulations, Part 71, "Packaging and Transportation of Radioactive
4. Title 10, Code of Federal Regulations, Part 72, "Licensing Requirements for the Storage of Spent Fuel in an Independent Spent Fuel Storage Installation."