72-1004

TRANSNUCLEAR
AN AREVA COMPANY

March 2, 2005
NUH03-05-66

Mr. L. Raynard Wharton
Spent Fuel Project Office, NMSS
U. S. Nuclear Regulatory Commission
11555 Rockville Pike M/S O13-D-13
Rockville, MD 20852

Subject: TN Review Comments on the Proposed Amendment No. 8 to Certificate of Compliance 1004 and Preliminary Safety Evaluation Report for the Standardized NUHOMS® System, dated February 25, 2005 (TAC No. L23653).

Reference: Proposed Amendment No. 8 to Certificate of Compliance 1004 and Preliminary Safety Evaluation Report for the Standardized NUHOMS® System, dated February 25, 2005 (TAC No. L23653).

Dear Mr. Wharton:

Enclosed herewith is a marked up copy of the reference documents which reflects TN's review comments. Please note that only those pages with comments have been included herewith.

Should you or your staff require additional information to support review of this application, please do not hesitate to contact me at 510-744-6053.

Sincerely,

UB Chopra

U. B. Chopra
Licensing Manager

Docket 72-1004

Enclosure: As stated

NMSS01

ENCLOSURE 1

PROPOSED CERTIFICATE OF COMPLIANCE

**CERTIFICATE OF COMPLIANCE
FOR SPENT FUEL STORAGE CASKS**
Supplemental Sheet

The principal component subassemblies of the DSC are the shell with integral bottom cover plate, bottom shield plug or shield plug assemblies, ram/grapple ring, top shield plug or shield plug assemblies, top cover plate, and basket assembly. The shell length is fuel-specific. The internal basket assembly for the 24P, 24PHB, and 52B DSCs is composed of guide sleeves, support rods, and spacer disks. This assembly is designed to hold 24 PWR fuel assemblies or 52 BWR assemblies.

An alternate basket assembly configuration, consisting of assemblies of stainless steel fuel compartments held in place by basket rails and a holdown ring, is designed to hold 61 BWR assemblies. The 32PT DSC basket assembly configuration is similar, consisting of welded stainless steel plates or tubes that make up a grid of fuel compartments supported by aluminum basket rails, and is designed to accommodate 32 PWR assemblies. The 24 PTH DSC basket assembly configuration consists of stainless steel tubes supported by basket rails and is designed to accommodate 24 PWR assemblies.

The basket assembly aids in the insertion of the fuel assemblies, enhances subcriticality during loading operations, and provides structural support during a hypothetical drop accident. The DSC is designed to slide from the transfer cask into the HSM and back without undue galling, scratching, gouging, or other damage to the sliding surfaces.

The HSM is a reinforced concrete unit with penetrations located at the top and bottom of the side walls for air flow, and is designed to store DSCs with up to 24.0 kW decay heat. The penetrations are protected from debris intrusions by wire mesh screens during storage operation. The DSC Support Structure, a structural steel frame with rails, is installed within the HSM. An alternate version of the HSM design, designated as HSM-H, provided with enhanced shielding and heat rejection features, is designed to store DSCs with up to 40.8 kW decay heat.

The TC is designed and fabricated as a lifting device to meet NUREG-0612 and ANSI N14.6 requirements. It is used for transfer operations within the Spent Fuel Pool Building and/or transfer operations to/from the HSM. The TC is a cylindrical vessel with a bottom end closure assembly and a bolted top cover plate. Two upper lifting trunnions are located near the top of the cask for downending/uprighting and lifting of the cask in the Spent Fuel Pool Building. The lower trunnions, located near the base of the cask, serve as the axis of rotation during downending/uprighting operations and as supports during transport to/from the Independent Spent Fuel Storage Installation (ISFSI). The 32PTH DSC is transferred in a TC with a radial liquid neutron shield.

With the exception of the TC, fuel transfer and auxiliary equipment necessary for ISFSI operations are not included as part of the Standardized NUHOMS® System referenced in this Certificate of Compliance (CoC). Such site-specific equipment may include, but is not limited to, special lifting devices, the transfer trailer, and the skid positioning system

c. Drawings

The drawings for the Standardized NUHOMS® System are contained in Appendices E, K, M, N, and P of the FSAR.

d. Basic Components

The basic components of the Standardized NUHOMS® System that are important to safety are the DSC, HSM, and TC. These components are described in Section 4.2, Table K.2-8 (Appendix K), Table M.2-18 (Appendix M), and Table P.2-17 (Appendix P) of the FSAR.

2/28/05

PRELIMINARY SAFETY EVALUATION REPORT

TRANSNUCLEAR, INC.

STANDARDIZED NUHOMS® MODULAR STORAGE SYSTEM FOR IRRADIATED NUCLEAR FUEL

DOCKET No. 72-1004

NUHOMS®-24PTH SYSTEM

AMENDMENT NO. 8

1.0 GENERAL DESCRIPTION

The TN NUHOMS®-24PTH System consists of the following components: (1) a new dual purpose Dry Shielded Canister (DSC), with three alternate configurations, -24PTH-S, -24PTH-L, and -24PTH-LC; (2) a new 24PTH basket design with two options, with and without aluminum inserts; (3) a modified version of the Horizontal Storage Module (HSM) Model 102, designated as HSM-H; (4) OS197FC Transfer Cask (TC), which is similar to the OS197/OS197H except it has a modified top lid that allows air circulation during transfer operations based on the heat load. The DSC is designed to store up to 24 intact or 12 damaged PWR fuel assemblies (B&W 15x15, WE 17x17, CE 15x15, WE 15x15, CE 14x14, and WE 14x14). The spent fuel is limited to a maximum assembly average initial enrichment of 5.0 wt %, a maximum assembly average burn up of 62,000 MWd/MTU, and a minimum cooling time of 3.0 years. The 24PTH-S and 24PTH-L DSC configurations are short and long cavity shell assemblies designed for a maximum heat load of 40.8 kW. The third DSC configuration is the 24PTH-LC, designed to accommodate the limits of the Oconee Station lifting crane. It is modified with lead shield plugs instead of steel and is designed for a maximum heat load of 24 kW.

24PTH-S-LC

up to

and balance intact

with or without control components

or equivalent assembly class.

be

inside the Standardized NUHOMS® Transfer Cask for onsite transfer.

1.1 Updated FSAR Revision

TN submitted a proposed Safety Analysis Report (SAR) for the Standardized NUHOMS Horizontal Modular Storage for Irradiated Nuclear Fuel, Revision 6 as part of the Amendment No. 8 application. On November 19, 2003, as required by 10 CFR 72.248, TN provided the biennial update of the Final Safety Analysis Report (FSAR), Revision 7. In January 2004, Amendment Nos. 5 and 6 to the Standardized NUHOMS System were issued. In March 2004 Amendment No. 7 was issued. In April 2004 TN submitted another application for an amendment to CoC No. 1004, proposed Amendment No. 9. To support the review for Amendment No. 9 the staff requested an updated FSAR reflecting approved Amendment Nos. 5, 6, and 7. TN submitted FSAR Revisions 7a and 8 to support the Amendment No. 9 review.

2.0 PRINCIPAL DESIGN CRITERIA

The objective of evaluating the principal design criteria related to the system, structures, and components (SSC) important to safety is to ensure that they comply with the relevant general criteria established in 10 CFR Part 72 (Ref. 1).

2.1 Structures, Systems, and Components Important to Safety

The SSCs important to safety are described in SAR Section P.2.3.

2.2 Design Basis for SSCs Important to Safety

The 24PTH DSC design criteria summary includes the range of spent fuel types and configurations to be stored, and design criteria for environmental conditions and natural phenomena. *with or without control components*

2.2.1 Spent Fuel Specifications

(including reconstituted) and/or damaged

The app~~licant revised the~~ allowable contents of the 24PTH DSC ~~to~~ include intact ~~B&W~~ fuel assemblies meeting the parameters specified in Table ~~1-1i~~ of Technical Specification 1.2.1, "Fuel Specifications." The specification includes a maximum burnup of ~~55~~ *62* GWd/MTU~~clad in Zircaloy (either Zircaloy-2 or Zircaloy-4) and B&W 15x15 BPRA designs as listed in Appendix J of the FSAR~~. A detailed description of the allowable fuel and storage configurations is provided in Tables P.2-1 through P.2-13 in the SAR. *1-1l and 1-1m*

The characteristics of the control components are described in SAR Table P.2-2.

2.2.2 External Conditions

Section P.2.2 of the SAR identifies the bounding site environmental conditions and natural phenomena for which the 24PTH DSC is analyzed. In cases where these did not change, no descriptions were given. External conditions are further evaluated in Sections 3 through 12 of this Safety Evaluation Report (SER).

2.3 Design Criteria for Safety Protection Systems

A summary of the design criteria for the safety protection systems of the 24PTH DSC, is presented in Section P.2.3 of the SAR. Details of the design are provided in Sections P.3 though P.11 of the SAR.

The applicant has designed the 24PTH DSC to provide storage of spent fuel for 40 years. The Standardized NUHOMS® System has been licensed by the NRC staff for 20 years of storage. The fuel cladding integrity is assured by the 24PTH DSC and basket design which limits fuel cladding temperatures and maintains a nonoxidizing environment in the cask cavity. The 24PTH DSC is designed to maintain a subcritical configuration during loading, handling, storage, and accident conditions. A combination of soluble boron in the pool, *fixed neutron absorbers,* and favorable geometry are employed. The 24PTH DSC shell and basket structure are designed, fabricated and inspected in accordance with the ASME B&PV Code, Section III, Subsection NB and NG, respectively, with a few alternative provisions (Ref. 2). However, the applicant has stated that it is their intention to follow the ASME Code requirements as closely as possible for the design

and construction of the DSC shell and the basket structure. The complete list of alternative provisions to the ASME Code and the corresponding justification for the 24PTH DSC shell and the basket structure is provided in Table P.3.1-1 and Table P.3.1-2, respectively. The staff has reviewed the alternative provisions and found that they are acceptable.

2.4 Evaluation Findings

F2.1 The staff concludes that the principal design criteria for the 24PTH DSC are acceptable with regard to meeting the regulatory requirements of 10 CFR Part 72. This finding is reached on the basis of a review that considered the regulation itself, appropriate regulatory guides, applicable codes and standards, Interim Staff Guidance (ISG), and accepted engineering practices. A more detailed evaluation of design criteria and an assessment of the compliance with those criteria is presented in Sections 3 through 12 of the SER.

2.5 References

1. U.S. Code of Federal Regulations, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste," Title 10, Part 72.

2. American Society of Mechanical Engineers, ASME Boiler and Pressure Vessel Code, Section III, Subsection NB, NC, NF, NG and Appendices, ~~1983~~ 1998 Edition ~~with Winter 1985~~ including 2000 Addenda.

3.0 STRUCTURAL EVALUATION

This section presents the results of the structural evaluation review of the SAR amendment request for the addition of the 24PTH system to the Standardized NUHOMS® System. The NUHOMS®-24PTH System is designed to accommodate up to 24 intact (or up to 12 damaged and balance intact) PWR fuel assemblies with a maximum assembly average initial enrichment level of 5.0 wt. %, a maximum assembly average burn-up of 62 GWd/MTU, and a minimum cooling time of 3.0 years. The NUHOMS®-24PTH System is designed with three alternate system configurations; two different types of basket options; and three boron contents in the basket poison plates. The 24PTH system will be able to accommodate a maximum decay heat load of up to 40.8 kW per canister. The NUHOMS®-24PTH System consists of the 24PTH DSC basket and shell assemblies, the HSM-H and HSM Model 102, and the OS197/OS197H/OS197FC Transfer Casks. Thus, the following new or modified components are provided by the amendment request:

- A new Dry Shielded Canister (DSC) which has three alternate configurations,
- A new 24PTH DSC basket design, which can be with or without aluminum inserts and low, moderate, or high boron content in the basket poison plates,
- A modified version of the Standardized Horizontal Storage Module (HSM) Model 102 designated as HSM-H that provides enhanced shielding and heat rejection capabilities,
- An OS197/OS197H Transfer Cask (TC) with a modified top lid to allow air circulation through the TC/DSC annulus during transfer operations. The modified TC is designated as OS197FC TC.

A complete structural evaluation of the 24PTH DSC shell assembly and basket components and the HSM-H has been performed. The structural evaluation shows that the NUHOMS®-24PTH System design is compatible with the requirements of 10 CFR 72.236 for maintaining the spent fuel in a subcritical condition, providing adequate radiation shielding and confinement, having adequate heat removal capability, providing a redundant sealing of the confinement system, and providing wet or dry transfer capability. The structural review was conducted against the appropriate regulations as described in 10 CFR 72.11, 10 CFR 72.122, 10 CFR 146, and 10 CFR 72.236.

3.1 Structural Design of the NUHOMS®-24PTH System

3.1.1 Dry Shielded Canister 24PTH-DSC

The 24PTH DSC canister assembly consists of the 24PTH DSC basket and shell assembly. The 24PTH DSC shell assembly is similar to the NUHOMS® 24P DSC but the nominal DSC shell thickness is reduced to 0.5 inches from 0.625 inches thick. The thickness of the top and bottom cover plates are increased but the thickness of the top and bottom shield plugs are reduced. A test port is also added to the top cover plate to allow testing of the inner top cover plate welds and vent and siphon port cover plate welds for leakage. The 24PTH DSC shell assembly is shown on drawings NUH-24PTH-1001-SAR and NUH-24PTH-1002-SAR in Section P.1.5.

An optional

that from the confinement boundary

The 24PTH basket assembly is shown on drawings NUH-24PTH-1003-SAR and NUH-24PTH-1004-SAR in Section P.1.5. The basket assembly consists of 24 stainless steel tubes, and two types of transition rails. The transition rails provide the transition between the rectangular basket structure and the cylindrical DSC shell. There are four R90 solid aluminum rails located at 0°, 90°, 180°, and 270° and eight R45 steel transition rails located on both sides of 45°, 135°, 225°, and 315° inside the DSC cavity. Sandwiched in between the tubes are aluminum alloy 1100 plates used as heat transfer material, and neutron absorbing plates for criticality control. The tubes are welded at eight elevations along the axial length of the basket to stainless steel insert (strap) plates. The aluminum and neutron absorbing plates, which are arranged in an egg crate configuration, are separated along the basket length by the steel insert plates. The cylindrical shell and the cover plates as well as the fuel tubes and steel insert plates of the basket assembly are all fabricated from American Society of Mechanical Engineers (ASME) SA240 Type 304 stainless steel.

The 24PTH DSC shell and weldments made during fabrication that affects the confinement boundary of the DSC are fully compliant to the requirements of ASME Sect. III Subsection NB. These include the inner bottom cover plate or forging to shell welds and the circumferential and longitudinal seam welds applied to the shell. The top inner cover plate, ~~top shield plug and~~ the closure weld applied to cover plates of the vent and the siphon block defines the primary confinement boundary at the top end of the 24PTH DSC. These welds are applied using a multiple-layer technique and are liquid penetrant (PT) examined in accordance with ASME Code Case N-595-2 and Section III, NB-5000. The internal basket assembly is designed, fabricated and inspected in accordance with ASME Sect. III, Subsection NG.

or inner top forging of the top shield plug assembly and associated welds

with alternatives as listed in Table P.3.1-2 of the SAR.

During fabrication, leak tests of the 24PTH DSC shell assembly are performed in accordance with American National Standards Institute (ANSI) N14.5-1997, "Leakage Tests on Packages for Shipment of Radioactive Materials," to demonstrate that the shell assembly is leaktight. The DSC inner top closure welds, including the vent and siphon pressure boundary welds, are also leak-tested after fuel loading to demonstrate that ANSI N14.5 leaktight criteria are met following installation of the outer cover plate root pass weld.

The basis for the allowable stresses for the confinement boundary is ASME Code Section III, Division 1, Subsection NB Article NB-3200 for normal and off-normal condition loads, and Appendix F for accident condition loads.

3.1.2 HSM-H Module

The HSM-H module design is similar to the design of HSM Model 102 which is described in Chapter 1 and in the drawings included in Appendix E of the FSAR (Ref. 1). The HSM-H module design has the following improvements for better heat rejection and shielding capabilities:

- Use of a thicker roof
- Use of slotted plates and holes in the DSC support rails to increase airflow
- Increased height of the module
- Use of finned side heat shields option for high heat loads
- Use of louvered top heat shield to minimize airflow resistance

and the vent and siphon block to shell weld

in accordance

The HSM-H module assembly is shown on Drawing NUH-03-7001-SAR in Section P.1.5. The reinforced concrete for HSM-H is designed in accordance with American Concrete Institute (ACI) 349-97 and is constructed in accordance with ACI 318-95. The structural steel for HSM-H is designed and constructed with the American Institute of Steel Construction (AISC) Steel Manual and welding will be in accordance with American Welding Society (AWS) D1.1-98.

3.1.3 OS197FC Transfer Cask

The OS197FC TC is a modified version of the OS197/OS197H TC described in the FSAR and in the drawings included in Appendix E of the FSAR.

The top lid of the OS197/OS197H TC is scalloped out at 16 locations on the lid underside (See Figure P.1-5) to provide slots that provide an exit path for air circulation through the TC/DSC annulus. The required modifications to convert OS197/OS197H TC into an OS197FC TC are shown on Drawings NUH-03-8000-SAR and NUH-03-8006-SAR.

3.2 Materials

3.2.1 Materials Description

The applicant provided a general description of the materials of construction in SAR Sections P.1.2, P.3.1, and P.3.3. Additional information regarding the materials, fabrication details and testing programs can be found in SAR Section P.9.1. The staff reviewed the information presented in SAR Table P.3.1-1 and in the License Drawings to determine whether the 24PTH DSC meets the requirements of 10 CFR 72.24(c) (3) and (4), 72.122(a), (b), (h) and (l), and 72.236(g) and (h). Specifically, the staff reviewed the following material suitability areas: materials selection; brittle fracture; applicable codes and standards; weld design and specifications; and chemical and galvanic corrosion.

3.2.1.1 Structural Materials

of the 24PTH-S and 24PTH-L DSCs

Most of the structural components of the 24PTH DSC (e.g., shell, bottom plate, and top plate) are fabricated from Type 304 austenitic stainless steel. The fuel compartment tubes in the 24PTH basket are also fabricated from Type 304 stainless steel. This type of steel was selected because of its high strength, ductility, resistance to corrosion and metallurgical stability. Since there is no ductile-to-brittle transition temperature in the range of temperatures expected to be encountered for this steel, its susceptibility to brittle fracture is negligible. The top shield plug is fabricated from A 36 carbon steel. An electroless nickel coating is applied to the surface of the top shield plug. The staff concludes that the selection of these materials meet the requirements of ASME Boiler Pressure Code. Therefore, these materials are acceptable for use in the DSC.

this

The top and bottom shield plug assemblies for the 24PTH-S-LC are fabricated from Type F304 stainless steel.

3.2.1.2 Nonstructural Material

The basket assembly structure consists of a grid assembly of welded stainless steel plates or tubes that make up the fuel compartments. Each fuel compartment accommodates aluminum and/or neutron absorbing plates for criticality control. The neutron absorber plates for criticality control are either an alloy (e.g., borated aluminum), a metal matrix composite (e.g., BorAlyn, or

METAMIC) or BORAL. In accordance with Section ~~P.1.7~~, appropriate acceptance testing will be used to ensure that the neutron absorbers have the minimum specified ^{10}B loading for borated aluminum, Boral, BorAlyn, and METAMIC.

There are two transition rails that provide the transition between the fuel compartments and the DSC shell. The aluminum transition rails (R90 rails) are made of Type ~~6060~~ aluminum. The stainless steel rails (R45 rails) consist of welded Type 304 stainless steel plates with optional Type 1100 aluminum inserts between the stiffener plates.

The staff concludes that the aluminum plates used for the grid assembly are suitable for heat transfer. Further, the staff concludes that the neutron absorbers ~~(i.e., plates and rods)~~ will be adequately durable during the service life of the cask. The acceptance and qualification for the neutron absorbers are discussed in Chapter 9 of this SER.

3.2.1.3 Welds

The DSC cylindrical shell is assembled using full penetration longitudinal welded joints and circumferential welded joints at the junction between the inner bottom plate and the shell. These welds are performed in accordance with ASME Code Section III, Subsection NB-4000 and Section IX. The top outer and inner cover plates are joined to the shell by partial penetration groove welds. The applicant has taken an alternative to the ASME Code, Section III, with respect to the design of this closure. All top and bottom end closures welds are multiple-layer welds.

The DSC materials of construction (e.g., stainless steel, carbon steel, etc.) are readily weldable using common available welding techniques. The use of an experienced fabricator will ensure that the process chosen for fabrication will yield a durable canister. The DSC welds were well-characterized on the License Drawings, and the standard welding symbols and notations in accordance with AWS Standard A2.4, "Standard Symbols for Welding, Brazing, and Nondestructive Examination." The sealing procedures and acceptance tests for welds are discussed in Chapter 8 and 9 of this SER, respectively.

The staff concludes that the welded joints of the DSC meets the requirements of the ASME Code. Although the DSC closure welds are partial penetration welds, this configuration will perform its intended structural and confinement functions.

3.2.1.4 Bolting Materials

The DSC is an all-welded canister.

3.2.1.5 Coatings

No zinc, zinc compounds, or zinc-based coatings are used on the carbon steel top shield plug of the DSC. The shield plug will be coated with an electroless nickel-phosphorous coating, which has been reviewed by the staff against American Society for Testing and Materials (ASTM) specifications and found acceptable. The coating will protect the steel from excessive oxidation of the surface.

DSC shell assembly, (2) a three-dimensional top-end model with the top shield plug assembly, and (3) a three-dimensional bottom-end model. The axisymmetric model is shown in Figure P.3.6-4. The three-dimensional top and bottom end models are shown in Figure P.3.6-5. The axisymmetric model is a complete model of the 24PTH-S-LC-DSC shell assembly which includes top and bottom shield plug assemblies, covers plates, and the cylindrical shell. The model is used to analyze axisymmetric loads such as vertical dead weight, top/bottom end drop loads, and internal/external pressure loads. The three-dimensional top and bottom end models are half-symmetric (i.e., 180° representations) and are used to analyze non-axisymmetric loads such as thermal loads, side drop loads, and grapple pull/push loads.

3.3.2.2 24PTH Basket Assembly

The structural analysis of the 24PTH basket assembly is performed by using a combination of hand calculations and three-dimensional LS-DYNA finite element models. The LS-DYNA finite element model of the 24PTH basket assembly is shown in Figure P.3.6-6. The model is a 24-inch long section of the basket assembly. This span corresponds to the 24-inch periodicity of the steel insert plates, and twice (12") the periodicity of the stiffener plates in the R45 transition rails. The steel insert plates, steel insert plates-to-tube welds, and a full thickness R45 transition rail stiffener plate is modeled at Z=0.0". The model is extended half way to the next insert plate/weld location to Z=+12.0" and Z= -12.0". Half-thickness R45 stiffeners are included at ends of the model (e.g., Z=±12.0"). The model includes a segment of the DSC shell which is modeled with shell elements. The model allows thermal expansion and applies symmetry boundary conditions at the ends.

3.3.2.3 HSM-H Modules

The NUHOMS® modular storage system has the flexibility of arranging HSM-H modules in arrays of single or double module rows. The structural analysis is performed on a single module of HSM-H, which provides a conservative estimate of the response of the HSM-H structural components for any array configuration. A three-dimensional ANSYS finite element model of the HSM-H, including all the concrete components, as shown in Figure P.3.7-11 is developed for the stress analysis. Included in the model is the steel support structure (e.g., rail and cross members) and a simplified beam model of the 24PTH DSC, as shown in Figure P.3.7-12. The ANSYS eight-node brick element is used to model the concrete structure. The 24PTH DSC and the support structure are modeled using the beam elements with the mass of the 24PTH DSC lumped at the nodes. Linear elastic analyses are performed to determine internal forces and moments. The strength method of ACI 349 is used for the design of the HSM-H reinforced concrete structural components.

3.3.2.4 OS197FC TC

The OS197FC TC is the same as the OS197/OS197H TC with the exception of the cask top lid, which is modified to provide vents around the perimeter of the lid. To address the effects of the lid vent cutouts on the lid stresses, two separate finite element models of a 1/32 (e.g., 11.25°) segment of the lid, one with cutouts and one without the cutouts, are constructed using ANSYS. The two model configurations are shown in Figure P.3.6-11. For purposes of the thermal stress analysis, the TC is evaluated for the boding temperature distributions resulting from transfer of a 24PTH DSC with heat loads of 40.8 kW with air circulation and 31.2 kW steady state by a three-dimensional ANSYS model of the TC as shown in Figure P.3.6-15.

bounding

inside the HSM-H. The stresses are combined with the deadweight and pressure load stresses and shown in Table P.3.7-10 and Table P.3.7-11 for the seismic evaluation of the -24PTH DSC shell assembly. Seismic loads on the 24PTH basket are enveloped by the 2.0g loads used for the on-site handling evaluation. Thus, specific evaluation for seismic loads is not necessary for the 24PTH basket assembly.

An equivalent static analysis of the HSM-H is performed using the ANSYS finite element model and seismic accelerations of 0.37g horizontally (both longitudinal and transverse directions) and 0.2g vertically. These amplified accelerations are determined based on the frequency analysis of the HSM-H module. The responses for each orthogonal direction are combined using the square root of the sum of the squares (SRSS) method. The seismic analysis results are incorporated in the loading combinations C4C and C4S for the concrete and support steel structure components, respectively, in Table P.3.7-16 and Table P.3.7-17. The applicant performed hand calculations to show the HSM-H module will not overturn or slide during the seismic event.

The effect of a seismic event occurring when a loaded DSC is resting inside the TC has been addressed previously in Section 8.2.3 of the FSAR. Because the weight of the -24PTH DSC is similar to the DSC weight used in Section 8.2.3, it is concluded that the TC/trailer with the -24PTH DSC will not be overturned due to seismic loading.

3.4.2.3 Flood

The design basis flooding load is specified as a 50-foot static head of water and a maximum flow velocity of 15 feet per second. Because the HSM-H is open to the atmosphere, static differential pressure due to flooding is not a design load. The maximum drag force acting on the HSM-H due to a 15-fps flood water velocity is calculated based on drag coefficient for a flat plate to be 8.07 kips/ft. Based on hand calculations, the application shows that the HSM-H will not overturn or slide by the flood water drag force. A minimum of two HSM-H modules adjacent to each other are required to prevent overturning. The external pressure due to the postulated 50-foot flood height is calculated to be 21.7 psi. The DSC shell stresses for the postulated flood condition are determined by using the ANSYS analytical models. The 21.7 psig external pressure is applied to the model as a uniform pressure on the outer surfaces of the top cover plate, DSC shell and the bottom cover plate. The resulting stresses are shown to be considerable less than the Service Level C allowable stresses. The DSC allowable external pressure is calculated to be 45 psi using the formula presented in NB-3133.3. Since the allowable pressure is more than two times the maximum pressure of 21.7 psi, the DSC shell will not buckle under the postulated 50-foot flood height.

3.4.2.4 Accidental TC Drop and Loss of Neutron Shield

A drop accident for the TC is unlikely but drop scenarios are developed and discussed in the application. The range of drop scenarios selected for evaluation are: (1) a horizontal side drop from a height of 80 inches (e.g., 75g horizontal drop) and (2) a vertical end drop of a maximum 60g impact load. An oblique corner drop is not specifically evaluated assuming the side drop and end drop cases will envelop the corner drop. An analysis has been performed in Section 8.2.5.2 of the FSAR to evaluate the OS197 and OS197H TCs for postulated horizontal and vertical drop accidents with a static equivalent deceleration of 75g. The analysis was based on

3.4.2.5 Blockages of HSM-H Air Inlet and Outlet Openings

This accident conservatively postulates the complete blockage of the HSM-H ventilation air inlet and outlet openings on the HSM-H side walls. The structural consequences due to the weight of the debris blocking the vent openings are negligible and are bounded by postulated HSM-H loads such as the tornado winds or earthquake. The thermal effects of this accident for the HSM-H and the 24PTH DSC are presented in Section P.4. The temperatures determined in Section P.4 are used in the structural evaluation of 24PTH DSC.

The thermal test results conducted by the applicant have shown that the HSM-H concrete component temperature will exceed the ACI 349, A4.2 temperature limits. The applicant has assumed a 10% reduction of strength based on short term (i.e., approximately 40 hours) elevated temperature as defined in ACI 349, Section 9.3. However, in order to ensure that concrete capacity will not be adversely affected by the elevated temperatures, a condition has been placed in the CoC to require tests be performed to verify no ~~signs of concrete deteriorations~~ and that the concrete compressive strength is greater than that assumed in the structural analysis of the HSM-H concrete components.

3.4.2.6 DSC Leakage and Accident Pressurization of DSC

The 24PTH DSC is leak tested to demonstrate it meets the leakage criteria of ANSI N14.5 and the DSC has been evaluated for internal pressures, which would bound the maximum accident pressures calculated in Section P.4.6. However, the applicant has stated that the analysis of the bounding internal pressure (i.e., 125 psig) for the DSC shell assembly will require both the outer and inner top lids acting together to minimize the primary stresses in the inner lid. The analysis results have shown that the DSC pressure boundary will not be breached by meeting the allowable stress criteria for normal, off-normal and accident conditions. Therefore, the 24PTH-DSC is acceptable for the postulated accident condition.

3.4.3 Load Combinations

Normal condition loads are presumed to exist during accident and/or extreme environment events. Thus, the stress intensities at various critical locations for the applicable normal operating condition loads are combined with the stress intensities experienced by the component during a postulated accident or extreme environment event.

3.4.3.1 DSC Load combinations

It is assumed that only one postulated accident event occurs at any given time. The DSC load combination is summarized in Table P.2-14 for the 24PTH DSC. Because the postulated cask drop accidents are by far the most critical, the load combinations for these events envelop all other accident event combinations. (See Table P.3.7-12 and Table P.3.7-13.)

3.4.3.2 TC Load Combinations

Table P.3.7-15 is a summary of OS197/OS197H/OS197FC TC stresses. The table incorporates the thermal stress analysis results for the TCs loaded with a 24PTH DSC. The stress results summarized in Table P.3.7-15 use the stresses due to mechanical loads for OS 197H as

F3.5 The NUHOMS®-24PTH System is evaluated and tested to demonstrate that the system has adequate heat removal capacity without active cooling system. Thermal evaluations are discussed in Section 4 of this SER

F.3.6 The SAR describes the materials that are used for structures, systems, and components (SSCs) important to safety and the suitability of those materials for their intended functions in sufficient detail to facilitate evaluation of their effectiveness.

F.3.7 The design of the DSC and the selection of materials adequately protects the spent fuel cladding against degradation that might otherwise lead to gross rupture.

F.3.8 The DSC employs noncombustible materials which will help maintain safety control functions.

F.3.9 The materials that comprise the DSC will maintain their mechanical properties during all conditions of operation.

F.3.10 The DSC employs materials that are compatible with wet and dry spent fuel loading and unloading operations and facilities. These materials are not expected to degrade over time, or react with one another, during any conditions of storage.

F3.11 The staff concludes that the structural design of the NUHOMS®-24PTH System is in compliance with 10 CFR Part 72 and that the applicable design and acceptance criteria have been satisfied. The structural evaluation provides reasonable assurance that the NUHOMS®-24PTH System will enable safe storage of spent fuel. This finding is based on a review that considered the regulations, appropriate regulatory guides, applicable industry codes and standards, accepted practice and confirmatory analysis.

3.6 Reference

1. Transnuclear, Inc., Final Safety Analysis Report (FSAR) for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel, Revision ~~6~~ 8, ~~October 2001~~ June 2004, USNRC Docket Number 72-1004.

4.0 THERMAL EVALUATION

The applicant is seeking approval of the use of the NUHOMS®-24PTH System for the storage of spent fuel. Five heat loading configurations and six basket types are proposed for the dry shielded canister (DSC). The proposed maximum heat load per DSC is 40.8 kW depending on the load configuration. There are also heat load limits per assembly. The applicant completed thermal analyses for the three bounding system configurations.

The new horizontal storage module (HSM-H), is a concrete structure that houses the DSC in a horizontal attitude for long-term storage, has been designed for the storage of spent fuel with high heat loads. The structure incorporates several thermal design variations to the original HSM design.

The objective of the thermal review is to ensure that the temperatures of the cask storage system components will remain within the allowable values for normal, off-normal and accident conditions. This objective includes confirmation that the temperatures of the fuel cladding will be maintained throughout the transfer and storage periods to protect the cladding against degradation which could lead to gross rupture. This review also confirms that the thermal designs of the DSC, TC and the HSM-H have been evaluated using acceptable analytical methods.

4.1 Spent Fuel

The NUHOMS®-24PTH System is designed to store up to 24 intact and/or reconstituted B&W 15x15, WE 17x17, CE 15x15, WE 15x15, CE 14x14, and WE 14x14 class fuel assemblies.

For the PWR fuel assemblies, the allowable temperature limits are based on Interim Staff Guidance -11 (ISG-11), "Cladding Considerations for the Transportation and Storage of Spent Fuel," Revision 3, (November 2003). For normal conditions (long-term) of storage and short-term fuel loading and storage operations (which includes drying, backfilling with inert gas, and transfer of the cask to the storage pad), the temperature limit of the fuel cladding is maintained below 400°C. This is done to ensure that circumferential hydrides in the cladding will not dissolve and go into solutions during fuel loading operations, and that re-precipitation of radial hydrides do not occur in the cladding during storage. (See ISG-11, Rev. 3 for a discussion on hydride reorientation.) The applicant established a temperature limit of 570°C (1058°F) for off-normal and hypothetical accident conditions for Zircaloy-4 fuel cladding. Fuel with burnup greater than 62 GWd/MTU is unacceptable for storage in the 24 PTH DSC system. ~~Fuel cladding types are limited to Zircaloy. Zirconium based alloys (i.e., M5, Optin, ZIRLO, etc.) are unacceptable for storage in the 24 PTH DSC system at this time.~~

It should be noted that due to the paucity of irradiated data on the mechanical properties and fracture toughness properties for zirconium alloys, future needs to transport this spent fuel would need to demonstrate compliance with the requirements of 10 CFR Part 71. The NRC is currently re-evaluating the position stated in ISG-11, Rev. 3, with respect to the storage and transport of all claddings types for low and high burnup fuel.

- Offsets in the structural steel insert plates to eliminate hot spots.

- Use of aluminum and steel transition rails with aluminum inserts to transfer heat from the basket interior regions to the DSC shell.

The DSC is cooled by buoyancy driven air flow through openings at the base of the HSM-H, which allows ambient air to be drawn into the module to cool the DSC. Heated air exits through vents in the top of the shield block, creating a stack effect.

The DSC cavity is backfilled with helium gas to aid removal of heat from the fuel assemblies and maintain an inert atmosphere.

A metal heat shield is placed around a major portion of the DSC to shield the HSM-H concrete surfaces above and to the side of the DSC from thermal radiation effects.

The staff verified that all methods of heat transfer internal and external to the system are passive. The SAR drawings and summary of material properties provide sufficient detail for the staff to perform an in-depth evaluation of the thermal performance of the system.

4.3 Thermal Load Specifications

SAR Section P.4.1 discusses the thermal loads. Three configurations with bounding heat loads are analyzed for steady state and transient cases for normal, off-normal and accident conditions. The staff reviewed these configurations and has reasonable assurance that the cases are bounding.

4.3.1 Storage and Transfer Conditions

The following tables provide the temperature and insolation conditions that the applicant applied in the thermal analyses.

Table 4-1
Ambient Temperatures

Condition	Temperature (°F)	24 Hour Average (°F)
Normal	0 to 104	
Off-Normal	-40 to 117	105
Accident	-40 to 117	

Table 4-2
Solar Insolation (BTU/hr-in^2)

HSM-H Surface	24 Hour Average Insolation
Roof	0.8537

Front	0.2134

The minimum storage conditions assume no solar insolation. Maximum and minimum daily temperatures are included in TS Section 4.4.3 as siting parameters that must be evaluated by the storage system user.

4.3.2 Accident Analyses

4.3.2.1 Blocked Vents

The complete blockage of the HSM-H ventilation inlet and outlet openings model is described in SAR Sections P.4.4.5 and P.4.8.4. The HSM-H and the DSC are evaluated for the ambient temperatures and insolation values outlined in Tables 4-1 and 4-2 above for accident conditions.

4.3.2.2 Transfer Cask Loss of Neutron Shield and Sunshade

The loss of water neutron shield in the annular region of the transfer cask, no fan convection, and a loss of the required sunshade during transfer operations at the extreme off-normal ambient temperature condition of 117°F (47.3°C) is postulated. This accident starts at steady state temperature conditions. The applicant developed a new model to evaluate the thermal performance of the TC. The model is described in SAR Section P.4.5. The staff reviewed this model and accepted it for the TC thermal analyses.

4.3.2.3 Fire

The third accident condition postulated by the applicant is a fire (SAR Section P.4.5.5.3) that occurs during transfer of the DSC to the HSM-H.

A 15-minute fire with an average flame temperature of 1475°F(800°C) is postulated to be caused by the spillage and ignition of 300 gallons of combustible transporter fuel. The assumed 15-minute duration for the transient evaluation is based on a calculated fire duration for this amount of fuel. The staff finds that this is a reasonable assumption.

Following the fire, the transfer cask is subjected to the prevailing maximum off-normal ambient conditions and a loss of the water neutron shield from the transfer cask is postulated. The analysis is continued to determine peak temperatures of cask components. The applicant states that the results of the fire accident analysis are bounded by the loss of neutron shield accident condition described above. Based on its review, the staff concludes that the thermal loads for the fire accident are acceptable and that the loss of neutron shield accident does bound this accident.

4.3.2.4 Cask Heatup During Loading

The applicant's description of the effects of loading and unloading conditions on the system is provided in SAR Section P.4.7. Three bounding loading conditions were evaluated by the applicant, including heat up of the DSC prior to blowdown, an analysis of heatup of the DSC during vacuum drying, and a steady state analysis of the canister after helium backfill. The applicant also analyzed the unloading condition of a reflood of the DSC.

For heatup of water in the DSC prior to blowdown, the DSC is evaluated for an initial DSC temperature of 215°F. DSC heat loads up to 40.8 kW were analyzed. The heatup analyses neglected radiation within the DSC.

For heatup of the DSC during vacuum drying, the DSC has been drained of water and filled with helium or air. The air and helium calculations used a three dimensional finite element model of the canister. The applicant completed both steady-state and transient analyses. An initial DSC shell temperature of 215°F and a maximum allowable DSC heat load of 40.8 kW were assumed for the analyses.

The applicant also analyzed the effect of reflooding on the DSC during unloading operations. Limits placed on the flow rate of water into the DSC during this evolution will minimize thermal shock and prevent pressurization of the DSC above 20 psig.

The staff reviewed the analysis approach and found it acceptable.

4.4 Model Specification

4.4.1 Configuration

The applicant developed thermal models of the module and the DSC using the ANSYS finite element code. These models are described in SAR Sections P.4.4 and P.4.6, respectively.

4.4.1.1 HSM-H Model

The HSM-H model represents the entire module and DSC shell. The analysis for the HSM-H is performed for a loaded DSC located in the interior of a multiple cask array with a DSC present in two adjacent modules. The DSC internals are not modeled. Instead, a uniform heat flux is applied to the shell surface. The HSM-H top and front surfaces are exposed to prevailing ambient conditions, and the side and back surfaces are modeled as adiabatic to simulate adjacent casks.

4.4.1.2 DSC Basket Section/Fuel Assembly Model

The model is described in SAR Section P.4.6. The applicant developed a detailed full length one half cross section three dimensional model of the DSC basket assembly and fuel cross sections. The outer surface of the DSC is set to a specified temperature distribution determined from the HSM-H model. Each fuel region within the DSC is modeled as a solid with an effective thermal conductivity (described in SAR Section P.4.8).

4.4.1.3 DSC in Transfer Cask Model

This model is described in SAR Section P.4.5. The DSC thermal model is a full length one half cross section three dimensional model that includes the shell, top and bottom (but no internal structures). Computer codes are used to predict the DSC shell and TC temperatures. The maximum DSC shell temperatures are extracted from this model and used in the DSC basket analysis. Several TC alternatives are described in SAR Section P.4.5.

4.4.2 Material Properties

The material properties used in the thermal analysis of the storage cask system are listed in SAR Section P.4.2. The applicant provided a summary of the material compositions and thermal properties for all components used in the system. The material properties given reflect the accepted values of the thermal properties of the materials specified for the construction of the storage system. All material properties provided were within the operating temperature ranges of the storage system components. For homogenized materials such as the fuel assemblies, the applicant described the source from which the effective thermal properties were derived in SAR Section P.4.8.

4.4.3 Boundary Conditions

Boundary conditions were applied to the models described above to analyze the behavior of the systems under normal, off-normal, and accident conditions. The applicant analyzed the shell model of the DSC in the transfer cask and in the HSM-H to obtain maximum shell temperatures for the DSC under all conditions. The maximum shell temperatures were then used in the DSC basket/fuel assembly model to determine a maximum fuel cladding temperature for each set of conditions. Ambient temperature and insolation values were tabulated for all analyzed conditions (see Tables 4-1 and 4-2 above).

4.4.3.1 Accident Conditions - Blocked Vent

For the postulated blocked vent accident conditions (see SAR Section P.4.4.5), the finite element HSM-H model was modified to a transient model, and the inlet and outlet vents were blocked. No convection is considered in the HSM-H cavity, only air thermal conductivity is credited. The boundary conditions include the DSC off-normal condition temperature distribution before the postulated accident, the extreme off-normal ambient temperature of 117°F and maximum insolation.

4.4.3.2 Accident Conditions- Loss of Neutron Shield and Sunshade for Transfer Cask

The applicant completed transfer cask accident analyses for all bounding conditions using the model described in SAR Section P.4.5. The staff reviewed the analysis approaches and accepted them for this application.

4.4.3.3 Accident Conditions-Fire

The postulated fire accident conditions and the model of the DSC in the transfer cask are described in SAR Section P.4.6. The boundary conditions for the fire accident are described in Section 4.3.2.3 above. The boundary conditions include the DSC and transfer cask off-normal condition temperature distribution before the postulated fire and the maximum off-normal ambient conditions after the fire.

4.4.3.4 Cask Heatup Analysis

The cask heatup analysis is described in SAR Section P.4.7. Analysis details are provided in Section 4.3.2.4 above.

4.5 Thermal Analysis

4.5.1 Temperature Calculations

4.5.1.1 Storage Conditions

The system has been analyzed to determine the temperature distribution under long-term storage conditions that envelop normal, off-normal, and accident conditions. The DSC basket is considered to be loaded at design-basis maximum heat loads with PWR assemblies. The HSM-Hs are considered to be arranged in an ISFSI array and subjected to design-basis ambient conditions with insolation. The maximum predicted and allowable temperatures of the components important to safety are discussed in SAR Sections P.4.4 and P.4.6. Low temperature conditions were also considered. The calculated clad temperatures for fuel assemblies are listed in SAR Tables P.4-14, P.4-20 and P.4-25, for normal, off-normal, and accident conditions, respectively. The applicant's analysis of the fuel cladding temperatures for the maximum heat load of 40.8 kW (which bounds other heat loads) showed that the fuel cladding temperatures remain below their respective acceptable temperature limits. Table 4-3 below summarizes the maximum temperatures of key components in the cask for various environmental conditions.

Table 4-3
Maximum Temperatures (°F) of Key Components With 40.8 kW Heat Load

HSM-H Component	Normal Storage	Transfer ~~(off-normal)~~	Blocked Vent Accident
Concrete	220	N/A	431
Top heat shield	202	N/A	375
Side heat shield	193	N/A	517
DSC shell	439	445	631
Fuel cladding	708	711	881

4.5.1.2 Accident Conditions- Blocked Vents

The blocked vent accident analysis is presented in SAR Section P.4.6.7.1. The analysis predicted the component and cladding temperatures for a 38.5 hour blockage. Results are presented in SAR Table P.4-5 (components) and Table P.4-25 (cladding).

The maximum concrete temperature reported was above the limit specified by the applicant. The applicant committed to testing the concrete used to fabricate the HSM-H. The testing will be conducted at an elevated temperature to demonstrate that the concrete will perform satisfactorily. The results for this accident analysis are summarized in Table 4-3 above. Based on this analysis, the staff finds reasonable assurance that the fuel cladding integrity and the confinement boundary will not be compromised during the blocked vent transient.

4.5.1.3 Accident Conditions- Loss of Neutron Shield and Sunshade for Transfer Cask

The applicant analyzed an accident involving loss of water from the annular neutron shield

The staff reviewed the applicant's calculations and determined that the applicant used appropriate methods and cover gas temperatures for the analyses. The highest predicted pressure was 97.2 psig at a cavity gas temperature of 653°F for the accident condition, which is below the DSC thermal criteria pressure of 120 psig.

Based on review of the applicant's pressure analyses, the staff found reasonable assurance that the internal cask pressures remain below the cask design pressure for normal, off-normal, and accident conditions.

4.5.2.2 Pressure During Unloading of Cask

Pressurization of the DSC is discussed in SAR Section P.4.7.3. Because the DSC is vented during reflood, a rapid pressure build-up is not a concern. The procedure for reflood assures that the flow rate of water into the relatively hot DSC is controlled to avoid exceeding the 20 psig design pressure for this condition.

4.5.2.3 Pressure During Loading of Cask

The applicant has technical specifications and procedures to ensure that the cask pressure remains below design limits.

4.5.3 Confirmatory Analyses

4.5.3.1 Analysis of DSC

The NRC staff and Pacific Northwest National Laboratory (PNNL) personnel completed confirmatory analyses of the performance of the DSC for a heat load of 40.8 kW. The staff used the ANSYS finite element code while PNNL used the COBRA-SFS finite difference thermal-hydraulics code (the COBRA-SFS code has been validated against data gathered from spent fuel assemblies stored at the Idaho National Engineering and Environmental Laboratory). The COBRA-SFS code utilized detailed fuel assembly models, while the ANSYS model used effective conductivity to predict maximum fuel cladding temperatures for different heat loads. The staff model conservatively ignored convection and radiation in the DSC. The results from these analyses were similar. Additionally, they were similar to the applicant's results. All three of the analyses used the same DSC surface temperature distribution boundary conditions, which are based on the HSM-H analysis. Therefore, the validity of the DSC analyses depends on the accuracy of the HSM-H analysis.

4.5.3.2 Analysis of HSM-H

The applicant's HSM-H analysis was described previously in Section 4.4.1.1 of this SER. The analysis utilizes the ANSYS finite element code with several stack effect calculations to characterize aspects of the flow thru the module (see SAR Section P.4.4.3). The staff expressed some concern about the accuracy of similar calculations in previous applications. The applicant responded by conducting a confirmatory analysis using a different modeling approach, FLUENT (a robust computational fluid dynamics (CFD) program), to predict the DSC surface and HSM-H temperatures, and the air flow patterns. The CFD results (SAR Table P.4-40) were similar to the ANSYS results for the DSC shell and cask base concrete temperatures.

However, the CFD results for the roof concrete, top heat shield, and side heat shield were higher than the ANSYS results (the side heat shield temperature prediction was 44°F higher). The applicant stated that the side heat shield temperature difference is directly related to a modeling simplification (that is, the exclusion of the side heat shield fins). The staff agrees that the simplification could be a significant cause for the difference. However, the simplification could have an effect on the flow patterns in the cask cavity, which could also adversely affect the temperature distribution in the cavity and on the DSC surface.

To address staff concerns and validate the analysis approach, the applicant conducted a series of tests on a full scale mockup of the HSM-H and DSC shell. These tests demonstrated that the methodology used to evaluate the thermal performance of the HSM-H conservatively overestimated the DSC surface temperatures, but underestimated the temperatures of significant portions of the concrete and heat shields.

The applicant evaluated these issues and modified the model to better predict component temperatures. In addition, the applicant recommended a limit on geometry changes to ensure that the final methodology could accurately predict the thermal characteristics of a modified HSM-H.

The staff reviewed the applicant's test protocols and results, and the modified HSM-H analysis. The staff found reasonable assurance that the final predictions provided conservative temperatures for the DSC shell and acceptable temperatures for the concrete and heat shields.

4.5.4 Conclusion

The staff accepts the applicant's thermal analyses for transfer and storage of fuel as stated in SAR Section P.4.

4.5 Evaluation Findings

F4.1 The staff finds that the thermal SSCs important to safety are described in sufficient detail in Sections P.1 and P.4 of the SAR to enable an evaluation of their effectiveness. Based on the applicant's analyses, there is reasonable assurance that the system is designed with a heat removal capability consistent with its importance to safety. The staff also finds that there is reasonable assurance that analyses of the systems demonstrate that the applicable design and acceptance criteria have been satisfied for the storage of the authorized fuel assemblies.

F4.2 The staff has reasonable assurance that the temperatures of the cask SSCs important to safety will remain within the predicted operating temperature ranges and that cask pressures under normal and accident conditions were determined correctly.

F4.3 The staff has reasonable assurance that the system provides adequate heat removal capacity without active cooling systems.

F4.4 The staff has reasonable assurance that the spent fuel cladding will be protected against degradation that leads to gross ruptures by maintaining the clad temperature below maximum allowable limits and by providing an inert environment in the cask cavity.

5.0 SHIELDING EVALUATION

5.1 Shielding Design Description

The applicant performed a computer shielding analysis to evaluate the shielding effectiveness of the new NUHOMS®-24PTH ~~System~~ for incorporation into the Standardized NUHOMS® -24P System. The NUHOMS® 24PTH System is a modular canister based spent fuel storage and transfer system that incorporates a new dual purpose Dry Shielded Canister (DSC) with three alternate configurations, a new 24PTH DSC basket design with two alternate options and three varying boron poison plate configurations, and a modified version of the Standardized Horizontal Storage Module (HSM) Model 102, HSM-H. The staff evaluated the proposed addition of these configurations based on information provided in the proposed SAR and the responses to the Request for Additional Information (RAI) questions against the regulatory requirements of 10 CFR Part 72.

The NUHOMS®-24PTH System is designed to store up to 24 intact PWR assemblies or up to 12 damaged and 12 intact PWR assemblies. The 24PTH-L and 24PTH-S-LC DSCs are also designed to store up to 24 intact standard PWR fuel assemblies with or without control components (CC), such as burnable poison rod assemblies (BPRAs), Control Rod Assemblies (CRAs), Thimble Plug Assemblies (TPAs), Axial Power Shaping Rod Assemblies (APSRAs), Orifice Rod Assemblies (ORAs), and Neutron Source Assemblies (NSAs). The 24PTH-S DSC does not store any CCs. Due to the additional gamma source from the CCs, the 24PTH-L bounds the 24PTH-S DSC for shielding purposes.

Dose rates for the 24PTH-L DSC are calculated within both a HSM-Model 102 and a HSM-H. Because the HSM-Model 102 provides less shielding than the HSM-H, and the dose rates bound this scenario, no estimates are made for the ~~24PTH-S and 24PTH-L~~ DSCs contained in a HSM-H.

The transfer cask (TC) designs are essentially identical with the exception of the top lid. For the shielding analysis of the 24PTH-S and -L DSCs, the OS197FC TC bounds the OS197/OS197H TC.

The licensee makes a special point that while the B&W, CE, and Westinghouse fuel designs are specifically listed as authorized contents for the 24PTH DSC designs other future fuel types may be used provided that an analysis is performed to demonstrate that the limiting features bound the replacement fuel. Any additional fuel designs would need to be formally amended to this analysis.

5.2 Radiation Source Definition

The effect on dose rates of the various configurations of the NUHOMS®-24PTH System were performed for the authorized contents. The bounding fuel assembly was shown by the analysis to be the B&W 15x15 assembly for shielding purposes since it has the highest initial heavy metal loading and ^{59}Co content of the hardware regions as compared to the 14x14, other 15x15, and 17x17 fuel assemblies. The neutron source term is assumed to come from the spontaneous fission of ^{244}Cm since it represents more than 85% of the total neutron source, and for high burnups with short (<5 year) cooling times ^{244}Cm accounts for more than 94% of the total neutron source for all cases.

Dose rates are also provided for the 24PTH-S-LC within the HSM Model 102.

5.3 Shielding Model

The calculation of dose equivalent rates of the NUHOMS®-24PTH System were performed for the authorized contents under the various configurations listed in the amendment using MCNP4C2 code package with the ENDF/B-VI cross-section data. Sources were developed for all fuel regions using the source term data the licensee developed. As noted in TN's RAI response, dated July 6, 2004, there is no data currently available for fuels with burnups greater than 47 GWd/MTU and up to 62 GWd/MTU. However, the expected uncertainty in the neutron source is provided as ± 11% based on measured data comparisons for ^{244}Cm to SAS2H predictions using the 44-group ENDF/BV data for burnups up to 46,460 MWd/MTU. For the gamma source term, the uncertainty is ± 5% for the gamma source and resulting dose rates and the basis. Based on these uncertainties, the neutron and gamma source terms are similar to those for fuels with burnups less than 45 GWd/MTU and appears to be conservative when compared to the actual measured values.

5.4 Shielding Analysis

The licensee calculated the dose rates at the surface and the areas surrounding the HSM-H, OS197FC TC, and the Standardized TC for both normal and hypothetical accident scenarios. MCNP4C2 was used to analyze the thick shields and account for streaming through both the HSM-H air vents and the cask/DSC annulus. Surface dose rates were not explicitly calculated for the HSM-Model 102 and were determined by scaling the results. For the modeled cases, bounding loading conditions were utilized in the calculations.

5.5 Evaluation Finding

F5.1 The staff confirmed the applicant's conclusion by reviewing the submitted calculations. Additionally, an independent review was conducted by generating source terms for the B&W 15x15 fuel using SAS2H from the SCALE 4.4a suite of computer codes. The staff's analysis was consistent with the applicant's conclusions. Based on the confirmatory review of the SAR and the licensee's RAI responses, the staff has reasonable assurance that the NUHOMS®-24PTH System as specified will meet the shielding requirements of 10 CFR Part 72.

6.0 CRITICALITY EVALUATION

6.1 Criticality Design

The staff performed a criticality safety review of the proposed amendment to incorporate the new NUHOMS®-24PTH System into the Standardized NUHOMS®-24P System. The NUHOMS®-24PTH System is a modular canister based spent fuel storage and transfer system that incorporates a new dual purpose Dry Shielded Canister (DSC) with three alternate configurations, a new 24PTH DSC basket design with two alternate options and three varying boron poison plate configurations, a modified version of the Standardized Horizontal Storage Module (HSM) Model 102, HSM-H. The staff evaluated the proposed addition of these configurations based on information provided in the SAR amendment against the regulatory requirements of 10 CFR Part 72.

6.2 Fuel Specification

The NUHOMS®-24PTH System is designed to store up to 24 intact PWR assemblies or up to 12 damaged and 12 intact PWR assemblies. The fuel is limited to a maximum initial enrichment of 5.0 wt%. Criticality safety is ensured by fixed neutron absorbers in the basket, soluble boron in the pool and favorable basket geometry. No burnup credit is taken for spent fuel. The DSC basket uses borated aluminum, aluminum/B_4C metal matrix composite or Boral as its fixed neutron poison material.

6.3 Criticality Analysis

TN performed a comprehensive analysis to determine the most reactive contents allowed in the 24PTH DSC. The -24PTH-S is the most reactive design of the three canister types (-24PTH-S, -24PTH-L, and -24PTH-S-LC), since it contains the shortest "egg crate" section length. The "egg crate" is formed by the aluminum/borated aluminum plates surrounding each fuel compartment tube. The other two canister designs are bounded by the -24PTH-S since the amount of neutron poison per unit length is minimized.

The 24PTH DSC basket can be configured either with aluminum inserts in R45 transition rails (Type 1) or without the aluminum inserts (Type 2). Additionally, there are three varying levels of boron content in the basket poison plates, Type A for low B10, Type B for moderate B10, and Type C for high B10 content. These provide six different basket types, designated as Types 1A, 1B, 1C, 2A, 2B, and 2C.

6.4 Computer Programs

Analyses were performed by the licensee to encompass credible fuel configurations, including normal and hypothetical accident conditions to ensure that $k_{eff} + 2\sigma \leq 0.95$ was met for all analyzed configurations. The fuel may contain various enrichments of ^{235}U (up to a maximum of 5.0 wt%) as specified by fuel type in the CoC and is considered fresh (i.e., no burnup credit is taken) for all criticality calculations to maximize the potential reactivity of the fuel. The licensee used the SCALE 4.4 criticality sequence computer code package using the 44GROUPNDF5 cross-section library for fissile and shielding media in their calculations.

7.0 CONFINEMENT EVALUATION

The confinement review ensures that radiological releases to the environment will be within the limits established by the regulations and that the spent fuel cladding and fuel assemblies will be sufficiently protected during storage against degradation that might otherwise lead to gross ruptures. The staff reviewed the information provided in the SAR to determine whether the NUHOMS®-24PTH DSC System fulfills the following acceptance criteria:

- The design must adequately protect the spent fuel cladding against degradation that might otherwise lead to gross ruptures during storage, or the fuel must be confined through other means such that fuel degradation during storage will not pose operational safety problems with respect to removal of the fuel from storage. [10 CFR 72.122(h)(1)]

- The cask design must provide redundant sealing of the confinement boundary. [10 CFR 72.236(e)]

- Storage confinement systems must allow continuous monitoring, such that the licensee will be able to determine when to take corrective action to maintain safe storage condition. [10 CFR 72.122(h)(4)]

- The design must provide instrumentation and controls to monitor systems that are important to safety over anticipated ranges for normal and off-normal operations. In addition, the applicant must identify those control systems that must remain operational under accident conditions. [10 CFR 72.122(i)]

- SSCs important to safety must be designed to withstand the effects of credible accidents and severe natural phenomena without impairing their capability to perform safety functions. [10 CFR 72.122(b)]

7.1 Confinement Design Characteristics

The staff reviewed the applicant's confinement analyses in SAR Section P.7 and the license drawings in SAR Section P.1. The applicant clearly identified the confinement boundary. The confinement boundary includes the stainless steel shell, bottom baseplate, top closure (including the vent and drain port), and the associated welds. There are no bolted closures or mechanical seals in the primary confinement boundary. The DSC is designed, fabricated, and tested in accordance with the applicable requirements of the ASME Code, Section III, Subsection NB, to the maximum extent practicable. Alternatives to the ASME Code, with respect to the confinement boundary, are identified in SAR Table ~~P.3.3-1~~ P.3.1-1. The ~~inner top cover plate~~ vent/siphon block has two penetrations for the vent and siphon ports which are closed with welded cover plates. The outer top ~~and bottom~~ cover plates provide redundant sealing of the confinement system. The system is designed and tested to be leaktight as defined by ANSI N14.5-1997. The outer top cover plate has ~~a~~ an optional single penetration to leak test the closure welds. This is closed with a welded cover plate after testing to complete the redundant sealing of the confinement boundary. The welds forming the confinement boundary are described in detail in SAR Sections P.3.1.2.1 and P.7.1.3. The design, testing, inspection, and examination of the welds forming the confinement boundary are described in detail in SAR Section P.7.1.3.

The redundant closure of the DSCs satisfy the requirements of 10 CFR 72.236(e) for redundant sealing of confinement systems.

The applicant's proposed procedures for drying and evacuating the cask interior during loading operations were reviewed by the staff to ensure that the design is acceptable for the pressures and temperatures that may be experienced during storage. The staff finds that this design, if fabricated and tested in accordance with the SAR requirements, will maintain the confinement boundary. Maintaining a stable vacuum pressure of 3 mm Hg for 30 minutes during vacuum drying provides reasonable assurance that the moisture content in the 24PTH DSCs will be acceptably low during its service life. The 24PTH DSC is designed to be leaktight and is tested to a leak rate of 1×10^{-7} atm cm^3/sec, as defined in ANSI N14.5-1997. This testing confirms that the amount of helium lost from the 24PTH DSC over the approved storage period is negligible. Thus, an adequate amount of helium will remain in the canister to maintain an inert atmosphere and to support the heat transfer during the storage period.

For normal storage conditions, the 24PTH DSC provides multiple confinement barriers for spent fuel assemblies to assure that the confinement system will reasonably maintain confinement of radioactive material. The canisters are backfilled with an inert gas (helium) to protect against cladding degradation. SAR Section P.3 indicates that all confinement boundary components are maintained within their code-allowable stress limits during normal storage conditions.

Welding and weld examinations are evaluated in Section P.3.2.1.3 of this SER and include the following; multiple surface and volumetric examinations, pneumatic pressure testing, and leakage rate testing on the finished shell and the inner cover plate at the fabricator; leakage rate testing of the closure welds (inner top cover plate and vent and siphon port cover plates) after loading the spent fuel; and multiple surface and dye penetrant examinations on the redundant confinement boundary.

The applicant described the canister inspection and test acceptance criteria in SAR Section P.9. The closure weld examination and acceptance criteria are included in Technical Specifications (TS) 1.2.4.a and 1.2.5 and have not changed from previously approved specifications in Amendment No. 7. The staff finds that this is acceptable provided that all NDE personnel, both at the fabricator facility and at the loading site, are qualified in accordance with applicable standards and codes such as SNT-TC-1A. This is a requirement of ASME Section V, Article 1, Paragraph T-140.

The staff verified the applicant's analysis in SAR Section P.3.4 and analyzed any possible chemical and galvanic reactions in Section P.3.2.1.7 of this SER and concluded that in this dry, inert environment, the DSC components are not expected to react with one another or with the cover gas. Further, oxidation, or corrosion, of the fuel and the DSC internal components will effectively be eliminated during storage and loading of the DSC.

The all-welded construction of the 24PTH DSCs with the redundant closure, extensive inspection and testing, ensures that no release of radioactive material for normal storage and on-site transfer will occur.

8.0 OPERATING PROCEDURES

The review of the technical bases for the operating procedures is to ensure that the applicant's SAR presents acceptable operating sequences, guidance, and generic procedures for key operations. The procedures for the 24PTH DSC, as described in Section P.8.1 of the SAR are very similar to those previously approved by the staff for the Standardized NUHOMS® System (Ref. 1).

8.1 Cask Loading

Detailed loading procedures must be developed by each user.

The loading procedures described in the SAR include appropriate preparation and inspection provisions to be accomplished before cask loading. These include cleaning and decontaminating the transfer cask and other equipment as necessary, and performing an inspection of the 24PTH DSC to identify any damage that may have occurred since receipt inspection.

8.1.1 Fuel Specifications

The procedures described in SAR Section P.8.1.2 provide for fuel handling operations to be performed in accordance with the general licensee's 10 CFR Part 50 license and requires independent, dual verification, of each fuel assembly loaded into the 24PTH DSC. It outlines appropriate procedural and administrative controls to preclude a cask misloading.

8.1.2 ALARA

The ALARA practices utilized during operations are discussed in Section 10.4 of this SER and are found to be acceptable.

8.1.3 Draining, Drying, Filling and Pressurization

SAR Section P.8.1.3 describes draining, drying, filling and pressurization procedures for the 24PTH DSC. These procedures provide reasonable assurance that an acceptable level of moisture remains in the cask and the fuel is stored in an inert atmosphere. The procedures for helium backfill pressure (TS 1.2.3a) are the same as those previously approved by the staff for the Standardized NUHOMS® System. The procedures for DCS cavity boron concentration during filling (TS1.2.15c) and DCS vacuum drying time (TS1.2.17c) are specific to the 24PTH design. Sealing operations for dye penetrant testing of the closure welds are performed in accordance with TS 1.2.5.

8.1.4 Welding and Sealing

Welding and sealing operations of the 24PTH DSC are similar to that previously approved by the staff for other DSCs used with the Standardized NUHOMS® System. The procedures include monitoring for hydrogen during welding operations. ~~Unlike previous DSCs approved for use with the Standardized NUHOMS® System,~~ As discussed in Section 7.0 of this SER, leak checks performed by TS 1.2.4a for the 24PTH DSC demonstrate that the

inner top cover plate is "leak tight" as defined by ANSI N14.5 - 1997 (Ref. 2). Sealing operations invoke TS 1.2.5 for dye penetrant testing of the closure welds.

8.2 Cask Handling and Storage Operations

All handling and transportation events applicable to moving the DSC to the storage location are the same as those previously reviewed by the staff for the Standardized NUHOMS® System and are bounded by Section P.11 of the SAR. Monitoring operations include daily surveillance of the HSM or HSM-H air inlets and outlets in accordance with TS 1.3.1, and temperature performance is monitored on a daily basis in accordance with TS 1.3.2. Occupational and public exposure estimates are evaluated in Section P.10 of the SAR. Each cask user will need to develop detailed cask handling and storage procedures that incorporate ALARA objectives of their site-specific radiation protection program.

8.3 Cask Unloading

Detailed unloading procedures must be developed by each user.

Section P.8 provides the same unloading procedures as those previously approved by the staff for use with the Standardized NUHOMS® System. The procedures provide a caution on reflooding the DSC to ensure that the cask vent pressure does not exceed 20 psig to prevent damage to the cask.

Section P.8 provides a discussion of ALARA practices that should be implemented during unloading operations; however, detailed procedures incorporating provisions to mitigate the possibility of fuel crud particulate dispersal and fission gas release must be developed by each user.

8.4 Evaluation Findings

F8.1 The 24PTH DSC is compatible with wet loading and unloading. General procedure descriptions for these operations are summarized in Section P.8 of the applicant's SAR. Detailed procedures will need to be developed and evaluated on a site-specific basis.

F8.2 The welded cover plates of the cask allow ready retrieval of the spent fuel for further processing or disposal as required.

F8.3 The DSC geometry and general operating procedures facilitate decontamination. Only routine decontamination will be necessary after the cask is removed from the spent fuel pool.

F8.4 No significant radioactive waste is generated during operations associated with the independent spent fuel storage installation (ISFSI). Contaminated water from the spent fuel pool will be governed by the 10 CFR Part 50 license.

F8.5 No significant radioactive effluents are produced during storage. Any radioactive effluents generated during the cask loading will be governed by the 10 CFR Part 50 license.

9.0 ACCEPTANCE TEST AND MAINTENANCE PROGRAMS

9.1 Acceptance Tests

All materials and components will be procured with certification and supporting documentation to assure compliance with procurement specifications and receipt inspected for visual and dimensional traceability.

9.1.1 Visual and Nondestructive Examination Inspections

The DSC confinement boundary is fabricated and inspected in accordance with ASME Code Section III, Subsection NB. Alternatives to the ASME Code are identified in Chapter 3 of the SAR and include: (1) partial penetration welds of the top outer and inner cover plates of the containment shell joints (Note- this alternative does not apply to other shell confinement welds, i.e., the longitudinal and circumferential welds applied to the DSC shell, and the inner bottom plate cover plate-to-shell weld, which comply with ASME Code, Section III, Subsection NB-4243 and NB-5230, and (2) root and final layer surface liquid penetrant examination of the top outer and inner cover plates of the containment shell welds. The staff reviewed these alternatives, and the corresponding justifications, and found them to be acceptable.

The nondestructive examination (NDE) of weldments is well characterized in the License Drawings and discussed in Sections P.3.1.2.1 and P.9.1.2 of the SAR. Standard NDE symbols and/or notations are used in accordance with AWS 2.4, "Standard Symbols for Welding, Brazing, and Nondestructive Examination." Fabrication inspection include visual (VT), liquid penetrant (PT), ultrasonic, (UT), and radiographic (RT) examinations, as applicable.

9.1.2 Leakage Testing

The 24PTH DSC is designed to be leaktight and is tested to a leak rate of 1×10^{-7} atm cm^3/sec, as defined in ANSI N14.5-1997. The confinement boundary testing includes; leakage rate testing on the finished shell and the inner cover plate at the fabricator; leakage rate testing of the closure welds (inner top cover plate and vent and siphon port cover plates) after loading the spent fuel. The staff finds that this is acceptable provided that all personnel performing leak rate testing, both at the fabricator and at the loading site, are qualified in accordance with applicable standards and codes such as SNT-TC-1A.

9.1.3 Neutron Absorber Tests

There are four neutron absorbers (also called poisons) used in the 24PTH DSC basket. They are Boral, borated aluminum, BorAlyn, and Metamic. BorAlyn and Metamic are considered as metal Matrix Composites (MMCs).

9.1.4 Qualification Tests

The applicant submitted procedures for qualifying a Metal Matrix Composite for types of processing changes, major and minor processing changes.

Major processing changes, such a billet formation by processes other than hot vacuum pressing or CIP/vacuum sintering, or direct rolling of the billet shall be subject to testing. Testing shall include exposure of the absorber to a radiation field to assess the effects of radiolysis, exposure of the absorber material to the full range of service temperatures, and immersion of the fabricated absorber in pool water to simulate the cask environment during loading. Other examples of major processing changes are discussed in Section P.9.1.7.2.2 of the SAR.

Minor process changes that do not have an adverse effect on the particle bonding, microstructure or uniformity of the B_4C particle distribution may be accepted by engineering review. Section P.9.1.7.2.2 discusses these changes.

The staff concluded that the testing for major and minor processing changes will ensure the acceptability and durability of the resulting neutron absorber product over the licensed service life.

9.1.5 Acceptance Testing

Sample coupons from plates are evaluated using chemical analysis and/or neutron attenuation techniques to verify presence, proper distribution, and minimum ^{10}B content as described in Section P.9.1.7 of the SAR. The minimum allowable ^{10}B content are provided in Table P.9-1 of the SAR. Any panel with a ^{10}B loading less than the minimum allowed will be rejected, if the acceptance criteria described in SAR P.9.1.7.2.1 are not met.
The staff's acceptance of the neutron absorber test described above is based, in part, on the fact that the criticality analyses assumed only 75% of the minimum required ^{10}B content of the Boral and 90% of the minimum required ^{10}B content of the borated aluminum, BorAlyn, and Metamic.

Installation of the neutron absorber plates on the fuel basket shall be performed in accordance with written and approved procedures. Quality control procedures shall be in place to ensure that the basket tube walls contain neutron absorber plates (i.e., Boral, borated aluminum, BorAlyn, or Metamic) as specified in the SAR Section P.1.5 drawings.

The staff concludes that the acceptance tests are adequate for verifying the presence, proper distribution, and minimum ^{10}B content in the absorber.

9.1.6 Visual Examination

The applicant has also committed to performing dimensional measurements (e.g., plate thickness) and visual examination of the material for evidence of defects such as cracks, porosity, blisters, or foreign inclusions.

9.2 Reference

1. ANSI N14.5-1997, "American National Standard for Radioactive Materials - Leakage Tests on Packages for Shipment."

10.0 RADIATION PROTECTION REVIEW

The staff reviewed the radiation protection design features of the NUHOMS®-24PTH system, which will be used with the HSM-H to ensure that the cask will meet the regulatory dose requirements of 10 CFR Part 20, 10 CFR 72.104(a), 10 CFR 72.106(b), 10 CFR 72.212(b), and 10 CFR 72.236(d). This amendment was also reviewed to determine whether the cask fulfills the acceptance criteria listed in Chapter 10 of NUREG-1536, Standard Review Plan for Dry Cask Storage Systems. The staff's conclusions are based on information provided in the proposed Amendment No. 8 SAR.

10.1 Radiation Protection Design Criteria and Design Features

The radiological protection design criteria are the limits and requirements of 10 CFR Part 20, 10 CFR 72.104, and 10 CFR 72.106. As required by 10 CFR Part 20 and 10 CFR 72.212, each general licensee is responsible for demonstrating site-specific compliance with these requirements. The TS also establish dose limits for the TC and HSM that are based on calculated dose rate values, which are used to determine occupational and off-site exposures.

The staff evaluated the radiation protection design features and design criteria for the NUHOMS®-24PTH system and found them acceptable. The SAR analysis provides reasonable assurance that use of the system can meet the regulatory requirements in 10 CFR Part 20, 10 CFR 72.104(a), and 10 CFR 72.106(b). Other sections of the SER discuss staff's evaluations of the shielding features, confinement systems, and operating procedures.

10.2 Occupational Exposures

Table P.10-1 of the SAR amendment shows the estimated number of personnel, the estimated time, the estimated dose rates, the tasks involved, and the estimated dose to load one design basis -24PTH-L DSC in a HSM-H. The loading operations are identical for the -24PTH-S and -24PTH-S LC DSC. The estimated occupational doses are based on estimations from the direct radiation calculations in SAR Section P.5.4 and on operational experience. The dose estimates indicate that the total occupational dose in loading a single canister with design basis fuel into the HSM is approximately 4.4 person-rem for the -24PTH-L canister and bounds the expected dose for the -24PTH-S and -24PTH-S-LC canisters. The applicant indicated that the general licensees may choose to modify the sequence of operations, and will also use ALARA practices to mitigate occupational exposure.

10.3 Public Exposures Normal and Off-Normal Conditions

SAR Section P.10.2 presents the calculated direct off-site radiation dose rates at various distances ranging from 6.1 to 600 meters from each face of a sample cask array configuration loaded with 24 design basis fuel assemblies for Configuration 2 (see Tables P.10-2 and -3) for the -24PTH-L DSC within a HSM-H and the -24PTH-S-LC DSC within a HSM-Model 102, respectively, for both front and back cask array configurations. The included tables in Section P.10 specify distances at which the regulatory design limit of 25 mrem/yr can be achieved and indicate that arrays loaded with design basis fuel and placed in the two HSM designs are below regulatory limits at approximately 400 meters for most arrays, depending on the specific configuration. This assumes 100% occupancy for 365 days.

11.0 ACCIDENT ANALYSIS EVALUATION

11.1 Dose Limits for Off-Normal Events

SAR Section P.11.1.4 examines the dose consequences for the identified off-normal events. The 24PTH DSC is tested leaktight in accordance with ANSI N14.5 and there will be no breach of the confinement boundary due to off normal conditions. The ~~direct~~ off-normal radiation conditions are the same as normal conditions analyzed in Chapter P.5 and P.10 of the SAR amendment.

The staff reviewed the consequences of postulated off-normal events with respect to 10 CFR 72.104(a) dose limits, and found them acceptable. The radiation consequences from off-normal events are the same as for normal conditions of operation. The staff has reasonable assurance that the dose to any individual beyond the controlled area will not exceed the limits in 10 CFR 72.104(a) during off-normal conditions (anticipated occurrences). Sections 5, 7, and 10 of this SER further evaluate the radiological doses applicable to off-normal events.

11.2 Dose Limits for Design-Basis Accidents and Natural Phenomena Events

Section 11.2 of the SAR amendment examines the dose consequences for the identified design-basis accidents and natural phenomena events. The 24PTH DSC is tested leaktight in accordance with ANSI N14.5 and there will be no breach of the confinement boundary due to accident conditions.

The staff reviewed the design-basis accident analyses with respect to 10 CFR 72.106(b) dose limits and found them acceptable. The staff has reasonable assurance that the dose to any individual at or beyond the controlled area boundary of 100 meters will not exceed the limits in 10 CFR 72.106(b). Chapters 5, 7, and 10 of the SER further evaluate the estimated radiological doses during accident conditions.

Table 12-1

Standardized NUHOMS® Horizontal Modular Storage System Technical Specifications for use with the NUHOMS®-24PTH System

1.1 General Requirements and Conditions

- 1.1.1 Regulatory Requirements for a General License
- 1.1.2 Operating Procedures
- 1.1.3 Quality Assurance
- 1.1.4 Heavy Loads Requirements
- 1.1.5 Training Module
- 1.1.6 Pre-Operational Testing and Training Exercise
- 1.1.7 Special Requirements for First System in Place
- 1.1.8 Surveillance Requirements Applicability
- 1.1.9 Supplemental Shielding
- 1.1.10 HSM-H Storage Configuration

1.2 Technical Specifications, Functional and Operating Limits

- 1.2.1 Fuel Specifications
- 1.2.2 DSC Vacuum Pressure During Drying
- 1.2.3 24P and 52B DSC Helium Backfill Pressure
- 1.2.3a 61BT, 32PT, 24 PHB and 24PTH DSC Helium Backfill Pressure
- 1.2.4 24P and 52B DSC Helium Leak Rate of Inner Seal Weld
- 1.2.4a 61BT, 32PT, 24PHB and 24PTH DSC Helium Leak Rate of Inner Seal Weld
- 1.2.5 DSC Dye Penetrant Test of Closure Welds
- 1.2.6 Deleted
- 1.2.7 HSM Dose Rates with a Loaded 24P, 52B or 61BT DSC
- 1.2.7a HSM Dose Rates with a Loaded 32PT DSC Only
- 1.2.7b HSM Dose Rates with a Loaded 24PHB DSC Only
- 1.2.7c HSM-H Dose Rates with a Loaded 24PTH-S or 24PTH-L DSC Only
- 1.2.7d HSM or HSM-H Dose Rates with a ~~Loaded 24PTH-S or 24PTH-L DSC Only~~
- 1.2.8 HSM Maximum Air Exit Temperature
- 1.2.8a HSM-H Maximum Air Exit Temperature with a Loaded 24PTH-S or 24PTH-L DSC Only
- 1.2.9 Transfer Cask Alignment with HSM
- 1.2.10 DSC Handling Height Outside the Spent Fuel Pool Building
- 1.2.11 Transfer Cask Dose Rates with a Loaded 24P, 52B, 61BT, or 32 PT DSC
- 1.2.11aTransfer Cask Dose Rates with a Loaded 24PHB DSC
- 1.2.11bTransfer Cask Dose Rates with a Loaded 24PTH-S or 24PTH-L DSC
- 1.2.11cTransfer Cask Dose Rates with a Loaded 24PTH-S-LC DSC
- 1.2.12 Maximum DSC Removable Surface Contamination
- 1.2.13 TC/DSC Lifting Heights as a Function of Low Temperature and Location
- 1.2.14 TC/DSC Transfer Operations at High Ambient Temperatures
- 1.2.15 Boron Concentration in the DSC Cavity Water for the 24P Design Only
- 1.2.15a Boron Concentration in the DSC Cavity Water for the 32PT Design Only
- 1.2.15b Boron Concentration in the DSC Cavity Water for the 24PHB Design Only
- 1.2.15c Boron Concentration in the DSC Cavity Water for the 24PTH Design Only

1.2.16 Provision of TC Seismic Restraint Inside the Spent Fuel Pool Building as a Function of Horizontal Acceleration and Loaded Cask Weight
1.2.17 61BT DSC Vacuum Drying Duration Limit
1.2.17a 32PT DSC Vacuum Drying Duration Limit
1.2.17b 24PHB DSC Vacuum Drying Duration Limit
1.2.17c 24PTH DSC Vacuum Drying Duration Limit
1.2.18 Time Limit for Completion of 24PTH DSC Operation

1.3 Surveillance and Monitoring

1.3.1 Visual Inspection of HSM or HSM-H Air Inlets and Outlets (Front Wall and Roof Birdscreen)
1.3.2 HSM or HSM-H Thermal Performance