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CALVERT CLIFFS
NUCLEAR POWER PLANT

March 26, 2014

U. S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: Document Control Desk

SUBJECT: Calvert Cliffs Nuclear Power Plant
Independent Spent Fuel Storage Installation; Docket No. 72-8
License Amendment Request: High Burnup NUHOMS®-32PHB Dry Shielded Canister

Pursuant to 10 CFR 72.56, the Calvert Cliffs Nuclear Power Plant, LLC hereby requests an amendment to Materials License No. SNM-2505 by incorporating the changes described below into the Technical Specifications for the Calvert Cliffs Independent Spent Fuel Storage Installation (ISFSI).

Calvert Cliffs Nuclear Power Plant, LLC (Calvert Cliffs) is requesting a change to the ISFSI Technical Specifications to allow the storage of approved Westinghouse and AREVA Combustion Engineering (CE) 14x14 fuel designs. These fuel designs and operation of the Units will sometimes result in spent fuel that is not suitable for the existing approved dry shielded canisters. Therefore, Nutech Horizontal Modular Storage (NUHOMS®)-32PHB Dry Shielded Canisters have been selected to allow storage of this fuel. These dry shielded canisters will be stored in modified horizontal storage modules. Additionally, this request also increases the amount of Uranium allowed to be stored in the ISFSI to ensure sufficient storage capacity to support continued power plant operation through the currently approved 60-year operating license period.

The environmental assessment and technical basis for this proposed change are provided in Attachment (1). Marked-up Technical Specification pages are provided in Attachment (2). Enclosures 1 through 5 contain information provided to support the technical basis described in Attachment (1).

The proposed amendment to the Calvert Cliffs ISFSI License has been reviewed by our Plant Operations Review Committee. They concluded that implementation of this license amendment will not result in an undue risk to the health and safety of the public.

In order to maintain appropriate space in the Units' spent fuel pools, we must begin loading using the NUHOMS®-32PHB Dry Shielded Canisters in 2015. Therefore, we request approval of this change by April 1, 2015.

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NMSS

There are no regulatory commitments contained in this letter.

Should you have questions regarding this matter, please contact Mr. Douglas E. Lauver at (410) 495-5219.

I declare under penalty of perjury that the foregoing is true and correct. Executed on March 26, 2014.

Very truly yours,

GHG/PSF/bjd

Attachments: (1) Evaluation of the Proposed Change

Enclosures:
1. Comparison Matrix
2. Draft USAR Chapter for NUHOMS 32 PHB DSC
3. Drawings
4. TN Calculation NUH32PHB-0600, Criticality Evaluation for NUHOMS 32PHB System
5. TN Calculation NUH32PHB-0603, USL Evaluation for NUHOMS 32PHB System

(2) Marked Up Technical Specification Pages

cc: **(Without Enclosures)**

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ATTACHMENT (1)

EVALUATION OF THE PROPOSED CHANGE

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1.0 SUMMARY DESCRIPTION

Calvert Cliffs Nuclear Power Plant, LLC (Calvert Cliffs) is requesting a change to the Independent Spent Fuel Storage Installation (ISFSI) Technical Specifications to allow the storage of approved Westinghouse and AREVA Combustion Engineering (CE) 14x14 fuel designs. These fuel designs and operation of the Units results in spent fuel that is not suitable for the existing approved dry shielded canisters. Therefore, Nutech Horizontal Modular Storage (NUHOMS®)-32PHB Dry Shielded Canisters have been selected to allow storage of this fuel. These dry shielded canisters will be stored in horizontal storage modules. Additionally, this request also increases the amount of uranium allowed to be stored in the ISFSI to ensure sufficient storage capacity to support continued power plant operation through the currently approved 60-year operating license period.

2.0 DETAILED DESCRIPTION

The Calvert Cliffs ISFSI is a Nutech Horizontal Modular Storage (NUHOMS®) dry storage system designed by Transnuclear, Inc. Calvert Cliffs has a site-specific materials license for the ISFSI. The storage system uses a reinforced concrete horizontal storage module (HSM) to store fuel that is sealed in a stainless steel dry shielded canister (DSC). Each DSC holds 24 or 32 spent fuel assemblies depending on its design. The HSM provides radiological shielding and physical protection for the DSC and has air flow passages to provide natural circulation cooling for decay heat removal. The Calvert Cliffs ISFSI is currently licensed for 120 HSMs. Ninety-six HSMs have been built. Forty-eight HSMs were loaded with NUHOMS®-24P DSCs, 24 have been loaded with NUHOMS®-32P DSCs.

A number of changes in the CE 14x14 fuel design used at Calvert Cliffs have occurred since the ISFSI was originally licensed. These include Zirlo cladding in 2002, peak pin enrichments above the current 4.5% limit for ISFSI, 6 inches top and bottom low enriched (2.6%) axial blankets, and zirconium diboride (ZrB_2) burnable absorber in 2005, and most recently the change to AREVA fuel with M5 cladding, gadolinia (Gd_2O_3) burnable absorber, and high thermal performance grids in 2011. In addition, 24-month cycle operation and the high Calvert Cliffs' capacity factors for more than the past decade have resulted in a continuing trend towards higher fuel assembly discharge burnups which need to be considered for ISFSI loading.

Additionally, this request includes increasing the amount of uranium allowed to be stored in the ISFSI to ensure sufficient capacity to support continued power plant operation through the currently approved 60-year operating license period. This requires expansion of the ISFSI total capacity from 120 HSMs to 132 HSMs on the existing site.

<u>DSC Design</u>

The NUHOMS®-32PHB DSC design is similar to the NUHOMS®-32P DSC design currently in use at Calvert Cliffs (see Enclosure 1). The NUHOMS®-32PHB DSC will accommodate up to 32 intact CE 14x14 Standard, Westinghouse value added pellet (VAP) CE 14x14, and/or AREVA CE 14x14 pressurized water reactor or equivalent spent fuel assemblies (including fuel assemblies with stainless steel replacement rods) with and without axial blankets. Fuel assemblies with missing rods are not allowed to be loaded into a NUHOMS®-32PHB DSC. The NUHOMS®-32PHB DSC is designed for a maximum heat load of 29.6 kW. These DSCs and HSMs are designed for high burnup fuel assemblies, up to 62 GWd/MTU, with a maximum fuel assembly average initial enrichment of 5 weight percent U-235.

The NUHOMS®-32PHB DSC consists of a shell assembly of the same outside dimensions as the NUHOMS®-32P DSC, which provides confinement and shielding; and an internal basket assembly (two different types) which locates and supports the fuel assemblies, transfers the heat to the cask body wall, and provides for criticality control as necessary to satisfy nuclear criticality safety requirements. The basket is a tube assembly, with aluminum and poison plates in between the tubes for heat transfer and criticality control. Except for the solid aluminum rails added to support the increased heat load, and poison plate material with increased B^{10} areal density, the NUHOMS®-32PHB DSC basket is identical to the NUHOMS®-32P DSC basket.

While the NUHOMS®-32PHB DSC design is similar to the design of the existing NUHOMS®-32P DSC, the following is a summary of the design differences which provide improved performance capabilities discussed above:

- Supports storage of all Westinghouse and AREVA variations of the CE 14x14 fuel assembly
- Increased maximum fuel assembly burnup
- Increased maximum gamma and neutron source
- Decreased maximum fuel assembly weight
- Increased maximum fuel assembly heat loads
- Time limits on vacuum drying (if nitrogen is used for blow down) and transfer
- Poison plate material includes increased B^{10} areal density
- Solid aluminum rails used to support the fuel basket

The NUHOMS®-32PHB DSC is handled, loaded, and sealed in the same manner as the NUHOMS®-32P DSC, before being transported to the ISFSI. The NUHOMS®-32PHB DSC is stored in the HSM-HB at the ISFSI. The same transfer cask is used for the NUHOMS®-32PHB, NUHOMS®-24P, and NUHOMS®-32P DSCs. When utilized with the NUHOMS®-32PHB DSC, the transfer cask may be used in a forced-cooling configuration due to the higher heat load. The forced-cooling configuration consists of a new cask lid which contains small openings around the periphery that vent out forced air that is injected at the bottom of the cask (through the ram access opening). A 0.5 inch thick spacer disc with wedge shaped protrusions is installed at the bottom of the transfer cask to facilitate air flow coming through the ram access opening to the annular space around the DSC.

See Enclosures 2 and 3 for more information.

<u>HSM Design</u>

Phases of HSMs built at the Calvert Cliffs ISFSI utilize the prefabricated high burnup horizontal storage module (HSM-HB) module design. The HSM-HB is similar to the horizontal storage module HSM-H with flat stainless steel heat shields described in the Updated Safety Analysis Report (USAR) for the standardized NUHOMS® System, Appendix P and the for NUHOMS®HD System. The HSM-HB is a free standing reinforced concrete structure designed to provide protection and radiological shielding for the 32PHB DSC. Each HSM-HB provides a self-contained modular structure for the storage of the DSC with spent fuel assemblies. A single HSM-HB is capable of storing a NUHOMS®-32PHB DSC containing 32 pressurized water reactor fuel assemblies. The HSM-HB permits heat rejection by natural convection in order to maintain acceptable temperatures.

The HSM-HBs are prefabricated and then assembled at the Calvert Cliffs ISFSI site. Each HSM-HB is placed in contact with an adjacent HSM-HB to form an array. The air inlet vents extend through the front on both sides of the front wall. The air outlet vents are provided in the roof unit. Similar to the poured in place HSMs, flat stainless steel panels are used as heat shields on the interior walls of the HSH-HB. The heat shields provide thermal protection for the HSM-HB concrete. Finally, attenuation pipes are added to the inlet vent screens to improve the shielding capabilities of the module.

While the HSM-HB module design is similar to the design of the HSM modules, the following is a summary of the design differences which provide improved heat rejection and shielding capabilities discussed above:

- Use of a thicker roof (3 feet 8 inches vs. 3 feet) provides improved shielding
- Door is inset in DSC opening, with increased thickness to provide improved shielding
- Use of slotted plates and holes in the DSC support rails to increase airflow at the bottom portion of canister
- Increased dose rates near inlet vent and inside doorway; decreased in most other locations
- Increased height of the module to increase module cavity height and to minimize air flow resistance in the module cavity
- Outlet vents repositioned from top front and back to top sides (opening shared by adjacent modules)
- Inlet vents repositioned from front bottom center to front bottom sides (opening shared by adjacent modules). Use of attenuation pipes improves inlet vent shielding

See Enclosures 2 and 3 for more information.

<u>40 Year Storage Lifetime</u>

As identified above, the design of the HSM-HB and the proposed DSC are very similar to the HSM and existing DSCs. The existing HSM and DSCs are discussed in Reference 1, and were evaluated by the Nuclear Regulatory Commission staff for ISFSI license renewal. The physical differences between the HSM and existing DSC and the HSM-HB and the proposed DSC are shown below.

The HSM-HB module design is similar to the design of the HSM modules. The HSM-HB design was reviewed against Table 3.4-1 in Attachment (1) of Reference 1. The following differences were noted:

- The HSM-HB has a thicker roof (3 feet 8 inches vs. 3 feet) but is made of the same material as the HSMs. The HSMs have been evaluated for aging management effects and an aging management program is required to manage the effects from the environment. Given the materials and service are the same, this conclusion reasonably applies to the concrete structure of the HSM-HB. The aging management program can also be applied to the new HSM-HBs when they enter an extended period of operation.
- The door is inset in DSC opening, with increased thickness but is made of the same material as the original door. The existing door has been evaluated for aging management effects and an aging management program is required to manage the effects of the environment. Given the materials and service are the same, this conclusion reasonably applies to the door of the HSM-HB. The aging management program can also be applied to the HSM-HB doors when they enter an extended period of operation.
- Slotted plates and holes in the DSC support rails are used, and are made of the same material as the original support rails. The existing support rails have been evaluated for aging management effects and an aging management program is required to manage the effects of the environment. Given the materials and service are the same, this conclusion reasonably applies to the support rails in the

HSM-HB. The aging management program can also be applied to the HSM-HB support rails when they enter an extended period of operation.

- Inlet vents use attenuation pipes attached to the inside of the bird screen which are the same material as the HSM ventilation air openings. While the attenuation pipes are included for ALARA dose reduction, their presence is not credited in the analyses for the HSM-HB, and therefore, they do not add a new intended function for the ventilation air openings. The existing ventilation air openings have been evaluated for aging management effects. That evaluation determined that there were no aging management effects that required aging management activities to address. Given the materials and service are the same, this conclusion reasonably applies to the attenuation pipes in the HSM-HB.

The NUHOMS®-32PHB DSC design is similar to the design of the NUHOMS®-32P DSC. The NUHOMS®-32PHB DSC and contained fuel designs were reviewed against Table 3.2-1 and Table 3.3-1 in Attachment (1) of Reference 1. The following differences were noted:

- The fixed neutron absorber plate material contains a higher concentration of B^{10}.
- Solid aluminum rails are used to support the fuel basket. The existing rails are also aluminum (although not solid) and were evaluated for aging management activities as part of ISFSI license renewal. That evaluation determined that there were no aging management effects that required aging management activities to address. Given the materials and service are the same, this conclusion reasonably applies to the solid rails in the NUHOMS®-32PHB DSC.
- In addition to fuel with Zircaloy-4 and Zirlo cladding, the NUHOMS®-32PHB DSCs may also contain fuel with M5 cladding. This cladding alloy show superior performance compared to Zircaloy-4 and Zirlo in the areas of waterside corrosion and hydrogen pick-up during operation. Therefore, it is expected to perform as well or better than Zircaloy-4 or Zirlo clad fuel in the inert storage environment inside the NUHOMS®-32PHB DSC.

Note that the NUHOMS®-32PHB DSC and HSM-HB have not seen the 20 years of service assumed during the license renewal review for the HSM structure and existing DSCs. Furthermore, the duration of operation of the HSM-HB modules under the proposed period of extended operation of the Calvert Cliffs ISFSI will not exceed the 40 years already approved for nearly identical components under the NUHOMS General License (Reference 2). Finally, regardless of their service life, Calvert Cliffs intends to include the HSM-HB and NUHOMS®-32PHB DSCs in the ISFSI Aging Management Program described in Reference 1. This includes placing those components into the next lead canister inspection as noted by NUREG-1927, Appendix E.

<u>Proposed Changes</u>

Proposed changes to the Calvert Cliffs ISFSI Technical Specifications needed to accommodate the above changes are described below and shown on the marked up pages in Attachment (2).

- ISFSI License SNM-2505 Section 6, Byproduct, Source, and/or Special Nuclear Material – The proposed amendment would increase the maximum allowable enrichment from 4.5 percent U-235 to 5.0 percent U-235 to allow for storage of higher enriched fuel assemblies.
- ISFSI License SNM-2505 Section 8, Maximum Amount That Licensee May Possess at Any One Time Under This License – The proposed amendment would increase this amount from the current 1,111.68 TeU to 1,558.27 TeU to allow for storage of fuel generated over the 60 year licensed lifetime of the Calvert Cliffs Units.

- ISFSI License SNM-2505 Section 16 – The proposed amendment would add acceptance standards for liquid pentrant tests of the double closure seal welds at the bottom end of the DSC for the NUHOMS®-32PHB DSC. The acceptance standards for the NUHOMS®-24P DSC and the NUHOMS®-32P DSC remain the same.

- Technical Specification 2.1, Fuel to be Stored at ISFSI – This Technical Specification ensures that the fuel assembly radiation source is below design values. To accomplish this, the Technical Specification provides limits on the neutron and gamma sources allowed in each fuel assembly. The proposed change would add a new neutron and gamma source for fuel assemblies stored in NUHOMS®-32PHB DSCs. The new neutron and gamma sources for the NUHOMS®-32PHB DSC were selected to bound fuel assemblies that reach the Technical Specification Limiting Condition for Operation 3.1.1(5) thermal limit to be loaded.

- Technical Specification 3.1.1, Fuel to be Stored at ISFSI – This Technical Specification ensures that the fuel assemblies stored in the DSCs meet the design requirements of the DSCs. This proposed amendment makes the following changes:

  - Technical Specification 3.1.1(2) – The current maximum initial enrichment limit is 4.5 weight percent U-235. The proposed amendment would add new maximum initial enrichment limits of 4.75 and 5.0 weight percent U-235 for a NUHOMS®-32PHB DSC, based on internal DSC basket design. The current maximum initial enrichment limit of 4.5 weight percent U-235 for the NUHOMS®-24P and NUHOMS®-32P DSCs remains the same.

  - Technical Specification 3.1.1(3) – The current maximum fuel assembly average burnup limit is 47,000 MWd/MTU) for the NUHOMS®-24P DSCs and 52,000 MWd/MTU for the NUHOMS®-32P DSCs. The proposed amendment would add a new maximum fuel assembly average burnup limit of 62,000 MWd/MTU for fuel stored in NUHOMS®-32PHB DSCs. The current burnup limits for the NUHOMS®-24P and NUHOMS®-32P DSCs remain the same.

  - Technical Specification 3.1.1(5) – The current maximum heat generation rate limit is 0.66 kilowatt per fuel assembly. The proposed amendment would add a new maximum heat generation rate of 0.8 kilowatt per fuel assembly for NUHOMS®-32PHB DSC basket zones 1 and 4, and a maximum heat generation rate of 1.0 kilowatt per fuel assembly for NUHOMS®-32PHB DSC basket zones 2 and 3. The current maximum heat generation rate for the NUHOMS®-24P and NUHOMS®-32P DSCs remain the same.

  - Technical Specification 3.1.1(7) – Currently, the maximum fuel assembly mass to be placed in the NUHOMS®-24P and NUHOMS®-32P DSCs, including control components, shall not exceed 1450 lb (658 kg). This proposed amendment adds a new requirement that the maximum fuel assembly mass to be placed in the NUHOMS®-32PHB DSC shall not exceed 1375 lb (625 kg) excluding control components. The current maximum fuel assembly mass limit remains the same for the NUHOMS®-24P and NUHOMS®-32P DSCs.

- Technical Specification 3.2.2.1 - The proposed amendment would add acceptance standards for liquid penetrant tests of the top shield plug closure weld, the siphon and vent port cover welds, and the top cover plate weld for the NUHOMS®-32PHB DSC. The acceptance standards for the NUHOMS®-24P and NUHOMS®-32P DSCs remain the same.

- Technical Specification 3.2.2.2 and 4.2.2.1, DSC Closure Welds – Currently, the standard helium leak rate for the top shield plug closure weld, and the siphon and vent port cover welds shall not exceed 10^{-4}atm-cc/s for the NUHOMS®-24P and NUHOMS®-32P DSCs. The proposed amendment will add a new requirement that the standard helium leak rate for the NUHOMS®-32PHB DSC top shield plug closure weld, and the siphon and vent port cover welds not exceed 10^{-7}ref-cc/s. The maximum helium leak rate for the NUHOMS®-24P and NUHOMS®-32P DSCs remains the same.

- New Technical Specification 3.3.2.1, Time Limit for Completion of NUHOMS 32 PHB Transfer Operations – The proposed amendment would establish a new Technical Specification for the time to complete the transfer of the NUHOMS®-32PHB DSC from the cask handling area to the HSM. This new Technical Specification does not apply to the NUHOMS®-24P or NUHOMS®-32P due to their lower heat load. The time limit for completion of the transfer is as follows:
  - No time limit for a DSC with a total heat load of 21.12 kW or less,
  - 72 hours for a DSC with a total heat load greater than 21.12 kW but less than or equal to 23.04 kW,
  - 48 hours for a DSC with a total heat load greater than 23.04 kW but less than or equal to 25.6 kW,
  - 20 hours for a DSC with a total heat load greater than 25.6 kW but less than or equal to 29.6 kW

- New Technical Specification 3.3.3.1, Time Limit for Completion of NUHOMS 32PHB DSC Vacuum Drying Operation - The proposed amendment would establish a new Technical Specification limiting the time to complete the NUHOMS®-32PHB DSC blowdown and vacuum drying process if nitrogen is used for blowdown. The time limit for completion of vacuum drying of a loaded NUHOMS®-32PHB DSC following blowdown with nitrogen is as follows:
  - 56 hours for a DSC with a total heat load of 23.04 kW or less,
  - 40 hours for a DSC with a total heat load greater than 23.04 kW but less than or equal to 25.6 kW,
  - 32 hours for a DSC with a total heat load greater than 25.6 kW but less than or equal to 29.6 kW

- Technical Specification 3.4.1.1, Maximum Air Temperature Rise – This Technical Specification limits the temperature rise from the HSM inlet to the outlet. This provides assurance that the fuel is being adequately air cooled while in the HSM. The current limit is a maximum 64°F temperature rise. The proposed amendment would add a new maximum allowable temperature rise for HSMs with NUHOMS 32 PHB DSCs loaded of 80°F. The Action is also changed to address the additional temperature limit and the verification of the appropriate heat load for the fuel assemblies. The maximum temperature rise limit will remain 64°F for the existing NUHOMS®-24P and NUHOMS®-32P DSCs.
- Design Feature 5.2, NUHOMS-32P Dry Shielded Canister (DSC) – The proposed amendment would add the required minimum areal density for the NUHOMS®-32PHB DSC poison plates. The NUHOMS-32PHB DSC poison plates shall have a minimum B^{10} areal density of 0.019 g/cm^2 for basket type A and 0.0270 g/cm^2 for basket type B. The minimum areal density for the NUHOMS®-32P DSC poison plates remains the same.

3.0 TECHNICAL EVALUATION

A. Revision to ISFSI License SNM-2505 Section 6

Independent Spent Fuel Storage Installation License SNM-2505 Section 6, Byproduct, Source, and/or Special Nuclear Material – The proposed amendment would increase the maximum allowable enrichment from 4.5 weight percent U-235 to 5.0 weight percent U-235 to allow for storage of higher enriched fuel assemblies as permitted by Calvert Cliffs Nuclear Power Plant Technical Specification 4.3.1.1.a. The increase in the maximum allowable enrichment limit is discussed below in Section 3.0.E.

B. Revision to ISFSI License SNM-2505 Section 8

Independent Spent Fuel Storage Installation License SNM-2505 Section 8, Maximum Amount That Licensee May Possess at Any One Time Under This License – The proposed amendment would increase the amount of uranium that may be possessed under this license from the current 1,111.68 TeU to 1,558.27 TeU. This increase reflects the change in the licensed life of the Calvert Cliffs Nuclear Power Plant Units from an initial 40 years of operation to 60 years of operation. The original amount of uranium that may be possessed under this license was based on 40 years of operation of the Calvert Cliffs Nuclear Power Plant Units. Originally, 120 HSMs were planned to accommodate these fuel assemblies. However, additional spent fuel assemblies will be generated during the additional 20 years of licensed operation. As a result of various events, a federal repository remains unavailable at the time of this amendment request. There remains uncertainty regarding when Department of Energy (DOE) will be able to take possession of the spent fuel assemblies. Given the delays in developing a permanent repository, Calvert Cliffs has utilized its existing spent fuel pools to the extent practicable and provided a separate dry fuel storage facility in order to maintain safe storage of the spent fuel assemblies until their acceptance by DOE for transportation offsite. To ensure adequate fuel storage for the remainder of the licensed operating life of the Calvert Cliffs Units, additional HSMs are being added. A total of 132 HSMs are needed. All HSMs fit on the existing ISFSI site. The 132 HSMs are composed of 48 modules containing 24 assemblies (NUHOMS®-24P DSC), and 84 modules containing 32 assemblies (NUHOMS®-32P DSCs and NUHOMS®-32PHB DSCs). The total metric tons of uranium for all fuel assemblies stored in the 132 HSMs is calculated in Table 1 as follows:

Table 1, Total Metric Tons Uranium Stored in 132 HSMs

Type of DSCs	Total Number of DSCs	Total Number of Fuel Assemblies	Design Metric Tons Uranium/Assembly	Metric Tons Uranium
NUHOMS®-24P DSCs	48	1152	0.386	444.67
NUHOMS®-32P DSCs	24*	768	0.4	307.2
NUHOMS®-32PHB DSCs	60*	1920	0.42	806.4
Total	**132**	**3840**		**1558.27**

* Additional NUHOMS®-32P DSCs may be used instead of an equal number of NUHOMS®-32PHB DSCs. This would decrease the metric tons of uranium stored.

C. Revision to ISFSI License SNM-2505 Section 16

The proposed amendment would add acceptance standards for liquid penetrant tests of the double closure seal welds at the bottom end of the NUHOMS®-32PHB DSC. The cylindrical shell and the inner bottom cover plate boundary welds are fully compliant with American Society of Mechanical Engineers (ASME) Boiler & Pressure Vessel Code, Section III, Subsection NB-5350, 1998 (with addenda up to and including 1999) edition, and are made during fabrication. Therefore, the acceptance standard proposed for the NUHOMS®-32PHB DSC is the ASME Boiler & Pressure Vessel Code, Section III, Subsection NB-5350, 1998 (with addenda up to and including 1999) edition. This is an administrative change to adopt a later version of an acceptable standard. This acceptance standard is the same as is currently used for the approved Transnuclear, Inc. Certification of Conformance (CoC)-1030 DSCs. The acceptance standards for the NUHOMS®-24P and NUHOMS®-32P DSC welds remain the same.

D. Revision to Technical Specification 2.1

The changes proposed to Technical Specification 2.1 were modeled after those previously approved in References 3 and 4. Technical Specification 2.1 is currently met for the NUHOMS®-32P DSCs by requiring that fuel assemblies selected for loading also meet certain minimum required cooling times. We are maintaining the current format for Technical Specification 2.1 to avoid altering the licensing basis of the previous NUHOMS®-24P and NUHOMS®-32P DSCs loaded at Calvert Cliffs.

Addition of Design Basis New Gamma Source-Term

Limiting Condition for Operation 3.1.1 currently limits fuel assemblies to be loaded in the ISFSI to certain enrichments, fuel assembly average burnup, heat output, and a minimum cooling time. Technical Specification 2.1 permits a fuel assembly not specifically meeting the requirements of Technical Specification 3.1.1 for maximum burnup and post-irradiation time to be stored if it meets the minimum cooling time listed in USAR Table 9.4-1 and the neutron and gamma source requirements of this specification. The proposed change would add a new gamma source for fuel assemblies stored in NUHOMS®-32PHB DSCs. An evaluation was performed using the same methods approved in Reference 4 that determined that a fuel assembly gamma source strength of 2.56 E+15 MeV/sec would bound fuel assemblies in the spent fuel pool for the cooling time required to reach a heat output of 1.0 kW. Table 2 lists the new gamma source spectrum for the NUHOMS®-32PHB DSC using the previously approved 18-group structure. This gamma source was based on a fuel assembly with an enrichment of 4.25 weight percent U-235, a fuel assembly average burnup of 42,000 MWd/MTU, a cooling time of 4.2 years and a heat output of 1.0 kW.

Table 2, Proposed Gamma Source Terms (MeV/sec) per Fuel Assembly

Emin (MeV)		Emax (MeV)	MeV/sec
0.00E+00	to	2.00E-02	1.83E+13
2.00E-02	to	3.00E-02	1.03E+13
3.00E-02	to	4.50E-02	1.80E+13
4.5E-02	to	7.00E-02	1.85E+13
7.00E-02	to	1.00E-01	1.96E+13
1.00E-01	to	1.50E-01	3.23E+13
1.50E-01	to	3.00E-01	4.67E+13
3.00E-01	to	4.50E-01	4.29E+13
4.50E-01	to	7.00E-01	1.61E+15
7.00E-01	to	1.00E+00	5.46E+14
1.00E+00	to	1.50E+00	1.88E+14
1.50E+00	to	2.00E+00	8.64E+12
2.00E+00	to	2.50E+00	8.59E+12
2.50E+00	to	3.00E+00	2.76E+11
3.00E+00	to	4.00E+00	4.34E+10
4.00E+00	to	6.00E+00	3.42E+07
6.00E+00	to	8.00E+00	5.52E+06
8.00E+00	to	1.10E+01	8.62E+05
		TOTAL	**2.56E+15**

Revision of the existing neutron source-term

Limiting Condition for Operation 3.1.1 currently limits the fuel assemblies to be loaded in the ISFSI to certain enrichments, fuel assembly average burnup, heat output, and a minimum cooling time. Technical

Specification 2.1 permits a fuel assembly not specifically meeting the requirements of Technical Specification 3.1.1 for maximum burnup and post-irradiation time to be stored if it meets the minimum cooling time listed in USAR Table 9.4-1 and the neutron and gamma source requirements of this Technical Specification. With the proposed increase in fuel assembly burnup requested in this license amendment request, the allowed neutron source term for these higher burnup fuel assemblies must also be increased to ensure that it bounds fuel assemblies at the cooling time required to reach 1.0 kW. An evaluation was performed using the same methods approved in Reference 4 that determined a fuel assembly neutron source strength of 6.66E+08 neutrons/sec would bound the fuel assemblies in the spent fuel pool for the cooling time required to reach 1.0 kW. The bounding neutron source was based on a fuel assembly with a maximum initial enrichment of 4.0 weight percent U-235, a maximum fuel assembly average discharge burnup of 58,000 MWd/MTU, a cooling time of 9.4 years and a heat output of 1.00 kW. Table 3 lists the proposed neutron source spectrum per fuel assembly for the NUHOMS®-32PHB DSC using the previously approved 44 energy group structure.

Table 3, Proposed Neutron Source Term per Fuel Assembly

Emin (MeV)	Emax (MeV)	n/sec/assy	Emin (MeV)	Emax (MeV)	n/sec/assy
1.40E+01	2.00E+01	0.00E+00	1.44E+00	1.50E+00	1.24E+07
1.20E+01	1.40E+01	1.18E+05	1.33E+00	1.44E+00	2.49E+07
			1.20E+00	1.33E+00	3.08E+07
1.00E+01	1.20E+01	7.20E+05	1.00E+00	1.20E+00	4.78E+07
8.00E+00	1.00E+01	2.44E+06	8.00E-01	1.00E+00	4.65E+07
7.50E+00	8.00E+00	1.97E+06	7.00E-01	8.00E-01	2.69E+07
7.00E+00	7.50E+00	2.64E+06	6.00E-01	7.00E-01	2.68E+07
6.50E+00	7.00E+00	3.90E+06	5.12E-01	6.00E-01	2.31E+07
6.00E+00	6.50E+00	5.83E+06	5.10E-01	5.12E-01	5.25E+05
5.50E+00	6.00E+00	8.74E+06	4.50E-01	5.10E-01	1.57E+07
5.00E+00	5.50E+00	1.18E+07	4.00E-01	4.50E-01	1.31E+07
4.50E+00	5.00E+00	1.63E+07	3.00E-01	4.00E-01	2.53E+07
4.00E+00	4.50E+00	2.13E+07	2.00E-01	3.00E-01	5.23E+03
3.50E+00	4.00E+00	3.42E+07	1.50E-01	2.00E-01	2.61E+03
3.00E+00	3.50E+00	4.24E+07	1.00E-01	1.50E-01	2.61E+03
2.50E+00	3.00E+00	5.51E+07	7.50E-02	1.00E-01	0.00E+00
2.35E+00	2.50E+00	2.08E+07	7.00E-02	7.50E-02	0.00E+00
2.15E+00	2.35E+00	2.92E+07	6.00E-02	7.00E-02	0.00E+00
2.00E+00	2.15E+00	2.32E+07	4.50E-02	6.00E-02	0.00E+00
1.80E+00	2.00E+00	3.39E+07	3.00E-02	4.50E-02	0.00E+00
1.66E+00	1.80E+00	2.62E+07	2.00E-02	3.00E-02	0.00E+00
1.57E+00	1.66E+00	1.74E+07	1.00E-02	2.00E-02	0.00E+00
1.50E+00	1.57E+00	1.45E+07	**Total**		**6.66E+08**

Additionally, dose rates for the design basis conditions were calculated for the added neutron and gamma source terms for the NUHOMS®-32PHB system using the same methods approved in Reference 4. Table 4 shows that ISFSI dose limits remain satisfied for the HSM-HBs and there are no Technical Specification changes required for a change in dose rates. Dose rates at the ISFSI site fence remain within the limits of 10 CFR 20.1301 for an individual during loading operations. The effects of both neutron and gamma radiation on the HSM–HB concrete were determined to be negligible for the NUHOMS®-32PHB DSC.

Table 4, Radiation Dose Rates

Location	HSM with NUHOMS®-32P DSC	HSM-HB with NUHOMS®-32PHB DSC	Technical Specification Limit
HSM wall or roof	13.5 mrem/hr	6.27 mrem/hr	20 mrem/hr
HSM air outlet	75.4 mrem/hr	47.1 mrem/hr	--
HSM door center	13.9 mrem/hr	0.98 mrem/hr	100 mrem/hr
HSM open door (1 ft inside)	4.66E+3 mrem/hr	1.76E+4 mrem/hr	--
HSM air inlet	61.0 mrem/hr	121 mrem/hr (w/o inserts) 73 mrem/hr (with inserts)	--
HSM (1 m from the closed door)	8.9 mrem/hr	1.01 mrem/hr	--

Of the design basis accidents listed in the USAR, those potentially impacted by the NUHOMS®-32PHB DSC neutron and gamma sources are the transfer cask drop, blockage of HSM-HB air inlets/outlets, and the forest fire event. The evaluation of the impact of the NUHOMS®-32PHB DSC neutron and gamma sources determined that accident doses for all of these events are minimal and the 10 CFR 72.106 regulatory limit continues to be met.

E. Revision to Technical Specification 3.1.1(2)

The current maximum initial fuel assembly enrichment limit is 4.5 weight percent U-235. The proposed change to Technical Specification 3.1.1(2) would add a new maximum initial fuel assembly enrichment limit of 4.75 weight percent U-235 for a NUHOMS®-32PHB DSC basket type A and 5.0 weight percent U-235 for a NUHOMS®-32PHB DSC basket type B. This change matches the enrichment allowance contained in Calvert Cliffs Nuclear Power Plant Technical Specification 4.3.1.1.a. The current maximum initial fuel assembly enrichment limit of 4.5 weight percent U-235 for the NUHOMS®-24P and NUHOMS®-32P DSCs remains the same.

A criticality analysis was performed to determine the bounding K_{eff} value for the NUHOMS®-32PHB system loaded with fuel assemblies containing uranium dioxide fuel enriched up to 5.0 weight percent U-235. Criticality is controlled by taking credit for 2,450 ppm soluble boron present in the spent fuel pool (Technical Specification 3.2.1.1) and fixed neutron absorbers present in the NUHOMS®-32PHB DSC baskets. The fixed poison inside the basket is based on an aluminum boron carbide metal matrix composite design. Credit for 90% of the absorber material (B^{10}) is assumed in the analysis. This results in conservatism in the calculated K_{eff}.

To support a demonstration of compliance with storage regulations, parametric studies were performed to maximize reactivity for the normal and off-normal storage conditions. These conditions include fuel geometry based on the arrangement of fuel assemblies (centered or inward) relative to the center of the basket, geometrical tolerances, variation in guide sleeve inner width, variation in borated water density, insert plate height, poison plate slot length, poison plate slot width, poison plate height, poison plate thickness, and temperature. Three fuel assembly types were considered, the CE 14x14 standard fuel assembly, the Westinghouse VAP 14x14 fuel assembly and the AREVA 14x14 fuel assembly. As a result of the parametric studies, the Westinghouse VAP fuel lattice is determined to be the most reactive fuel lattice and it is used in the criticality analysis with a maximum enrichment of 5.0 weight percent. Table 6.4-11 of NUH32PHB-0600 runs cases from VF=0.7 to 0.8 for both VAP and AREVA fuel at the limiting poison plate height and slot width. It demonstrates that VF=0.75 is the peak density for both fuel types, and demonstrates VAP is the more reactive lattice throughout that water density range.

A series of 102 benchmark criticality calculations were performed by Transnuclear, Inc. These calculations assumed unirradiated fuel in the criticality analysis and used the SCALE 6 computer code package. The upper subcritical limit as described in Section 4 of NUREG/CR-6361 (Reference 5) was determined using the results of these 102 benchmark calculations. The benchmark problems used to perform this verification are representative of benchmark arrays of commercial light water reactor fuels with the following characteristics: water moderation, boron neutron absorbers, unirradiated light water reactor type fuel, close reflection, and uranium oxide fuel. The 102 uranium oxide experiments were chosen to model a wide range of uranium enrichments, fuel pin pitches, fuel assembly separation, concentration of soluble boron, and control elements in order to test the code's ability to accurately calculate K_{eff}.

The minimum value of the upper subcritical limit for the NUHOMS®-32PHB system over the parameter range (in this case, the fuel assembly separation distance) is 0.9410. The limiting separation distance is determined using the inward fuel lattice position as a conservative approach. This upper subcritical limit value (0.9410) is based on a methodology bias and an administrative 5% margin on criticality. Section 6.5.2 of Reference 12 provides the basis for selecting 0.9410 as the limiting value. Enclosure 5 provides the detailed basis for the USL functions used in Table 6.5-1 of Enclosure 4, with one of the function specifically addressing rod pitch. The criticality analysis for the NUHOMS®-32PHB DSC system demonstrates that the maximum K_{eff} value is below the upper subcritical limit of 0.9410 for a variety of loading configurations under normal and off-normal conditions. The maximum K_{eff} value based on an "inward" loading of the Westinghouse VAP fuel assemblies is 0.9363 for basket type A (with a maximum enrichment of 4.75 weight percent U-235) and 0.9358 for basket type B (with a maximum enrichment of 5.0 weight percent U-235). This configuration includes the minimum fuel compartment dimension of 8.47 inch, an internal moderator (soluble boron at 2,450 ppm) density of 75%, poison plate height of 8.01 inch, and poison plate slot width of 0.75 inch with a B^{10} areal density of 0.0171 g/cm^2 for basket type A and 0.0243 g/cm^2 for basket type B. It also conservatively includes allowances for uncertainties due to fuel positioning, compartment tube dimensioning, and poison plate thickness.

The criticality analysis takes credit for only 90% of the minimum physically available B^{10} areal density in the poison plates. Therefore, the basket type A is manufactured with 0.019 g/cm^2 of B^{10} and the basket type B is manufactured with 0.027 g/cm^2 of B^{10}.

Reconstituted fuel assemblies, where the fuel pins are replaced by lower enriched fuel pins or non-fuel pins that displace the same amount of borated water, are considered intact fuel assemblies. The reactivity of the fuel assemblies with reconstituted fuel pins is bounded by those without reconstituted fuel pins because fuel pins are modeled with the highest allowable enrichment while those with the reconstituted fuel pins will contain lower enriched UO^2 or other non-fuel material.

The impact of transfer cask drop accidents on the potential for a criticality event in a NUHOMS®-32PHB DSC was also evaluated. The rod pitch of some fuel rods may be reduced to the fuel clad outside diameter during a drop accident. The upper subcritical limit as a function of the rod pitch decreases from 0.9424 to 0.9422 under these conditions. Reduced rod pitch also leads to less neutron moderation and, subsequently, K_{eff} decreases. The separation distance of fuel assemblies may increase under these conditions. The upper safety limit as the function of separation distance increases with more fuel assembly separation, but the final upper safety limit is not affected. Thus, the criticality results are not adversely affected by the transfer cask drop accident.

In summary, Enclosure 4 documents a series of criticality calculations to determine a bounding K_{eff} for the NUHOMS®-32PHB DSC for normal and accident conditions of storage for intact fuel assemblies. The results of the criticality calculation support the requested maximum enrichment of 4.75 weight percent U-235 for basket type A and 5.0 weight percent U-235 for basket type B, and demonstrate compliance with the criticality related portions of 10 CFR Part 72 for storage of fuel in the NUHOMS®-32PHB DSC.

F. Revision to Technical Specification 3.1.1(3)

Spent fuel assemblies for the NUHOMS-32P DSCs currently meet a maximum fuel assembly average burnup of not more than 52,000 MWd/MTU. An evaluation has been performed for the NUHOMS®-32PHB DSCs to determine the effect of storing fuel assemblies with a fuel assembly average burnup of 62,000 MWd/MTU.

As fuel burnup increases, cladding wall thickness may decrease due to in-reactor formation of zirconium oxide or zirconium hydride. For design basis accidents, where the structural integrity of the cladding is evaluated, Reference 6 requires that cladding stress calculations use an effective cladding thickness that is reduced by those amounts (determined via oxide thickness measurements or use of an approved code). Review of oxide measurements for Calvert Cliffs fuel determined that a maximum oxide thickness of 125 microns would be bounding for fuel assemblies with a maximum fuel assembly average burnup of 60,000 MWd/MTU. The only NUHOMS®-32PHB design basis accident where structural integrity of the fuel cladding is evaluated is the transfer cask drop event. The integrity of fuel assemblies contained within a NUHOMS®-32PHB DSC, following postulated 75g side and end drops, was analyzed using the same methods approved in Reference 4. For AREVA fuel assemblies with M5 cladding, the acceptance criteria for maximum cladding stress during a NUHOMS®-32PHB DSC side drop was 67.3 ksi, reflecting the lower yield stress of M5 cladding at 750°F. Similarly, for an AREVA fuel assembly with M5 cladding, the acceptance criteria for maximum cladding strain during a NUHOMS®-32PHB DSC end drop was 0.927%. For the end drop, the maximum principal strain for Zircaloy-4 and Zirlo cladding on Standard and VAP CE 14x14 fuel assembly cladding is the same as reported in Reference 4. The maximum principal strain for the M5 clad AREVA fuel is 0.369%. For the side drop, the maximum stress is 45.4 ksi for the Zircaloy-4 and Zirlo clad Standard and VAP CE 14x14 fuel. The maximum stress for the AREVA fuel with M5 cladding is 48.0 ksi. The results of these analyses demonstrate that stress and strain remain well below the acceptance criteria for both cladding types and confirm that cladding integrity is maintained for Standard, VAP, and AREVA fuel assemblies during these drop accidents for fuel with a maximum fuel assembly average burnup of 62,000 MWd/MTU.

In addition, Reference 6, also places specific limits on peak cladding temperatures for high burnup fuel assemblies in NUHOMS®-32PHB DSC during normal loading and storage conditions, and off-normal and accident conditions. Reference 6 peak cladding temperature acceptance criteria (in italics) and discussion of how each is met for a NUHOMS®-32PHB DSC is provided below:

1. *The maximum calculated fuel cladding temperature should not exceed 400°C (752°F) for normal conditions of storage and short-term loading operations (e.g., drying, backfilling with inert gas, and transfer of the cask to the storage pad).*

   An analysis determined the maximum fuel rod cladding temperature and the maximum basket component temperatures for NUHOMS®-32PHB DSC storage in an HSM-HB during normal, off-normal, and accident operating conditions. The results from this analysis show that the maximum fuel cladding temperature does not exceed 724°F for normal storage conditions. During short-term loading conditions, the maximum fuel cladding temperature does not exceed 733°F. Therefore, both current design basis steady-state analyses and transient analyses demonstrate that peak cladding temperatures do not exceed the more restrictive Reference 6 limit of 752°F for normal storage and short-term loading operations. Note that while this limit was previously approved in Reference 4 for short-term operations with the NUHOMS®-32P DSCs, this request seeks to extend that approval to normal storage for the NUHOMS®-32PHB DSCs. Additionally, drying time limits and soak time limits assumed in Reference 7 are administratively applied when nitrogen is used as blowdown for the NUHOMS®-32PHB DSC.

2. *During loading operations, repeated thermal cycling (repeated heatup/cooldown cycles) may occur but should be limited to less than 10 cycles, with cladding temperature variations that are less than 65℃ (117℉) each.*

   For the NUHOMS®-32PHB, Reference 7 provides a transient analysis of the blowdown with either helium or nitrogen, vacuum drying, and the helium backfill process for the NUHOMS®-32PHB DSC and demonstrates that this criteria is satisfied. Backfilling the NUHOMS®-32PHB DSC with helium after the first vacuum drying causes a one-time temperature drop, which is not considered repeated thermal cycling.

3. *For off-normal and accident conditions, the maximum cladding temperature should not exceed 570℃ (1058℉).*

   An evaluation determined the maximum fuel rod cladding temperature and the maximum basket component temperatures for NUHOMS®-32PHB DSC storage in an HSM-HB during normal, off-normal, and accident operating conditions. The evaluation shows that during the forest fire event, which is the worst scenario condition considered in the calculation, the maximum cladding temperature does not exceed 932°F during this event.

In addition to the transfer cask drop event discussed above, other USAR design basis events potentially impacted by this proposed change are the accidental pressurization event and the DSC leakage event. The accidental pressurization event considers the failure of all fuel rods within a sealed NUHOMS®-32PHB DSC. Evaluation of this event using the previously approved methods and assuming all 32 fuel assemblies in the DSC had a fuel assembly average burnup of 62,000 MWd/MTU demonstrated that the internal pressure of the DSC would remain below the design limit of 100 psig. In addition, the NUHOMS®-32PHB DSC is designed and tested to meet the leak-tight criteria defined in Interim Staff Guidance (ISG)-18 (Reference 8) and American National Standards Institute N14.5 (Reference 9), and therefore, a DSC leakage dose analysis is not required per the requirements of Reference 10.

G. Revision to Technical Specification 3.1.1(5)

The current maximum heat generation rate limit is 0.66 kW per fuel assembly for the NUHOMS®-24P and NUHOMS®-32P DSCs. The proposed amendment would add a new maximum heat generation rate of 0.8 kW per fuel assembly for NUHOMS®-32PHB DSC basket zones 1 and 4, and a maximum heat generation rate of 1.0 kW per fuel assembly for NUHOMS®-32PHB DSC basket zones 2 and 3 (see Figure 4). Zoning is used in combination with time limits on certain loading operations to accommodate the maximum total NUHOMS®-32PHB DSC heat loads up to 29.6 kW while maintaining fuel cladding and DSC component temperatures below their respective design limits. NUHOMS®-32PHB DSCs with total heat loads of 25.6 kW (limit of 0.8 kW per fuel assembly for all zones) or 23.04 kW (limit of 0.72 kW per fuel assembly for all zones) may utilize longer time limits as discussed below. Appropriate discharge cooling times have been determined for fuel assemblies to be loaded into a NUHOMS®-32PHB DSC and will be added to USAR Table 9.4.1. The current maximum heat generation rate for the NUHOMS®-24P and NUHOMS®-32P DSCs remain the same.

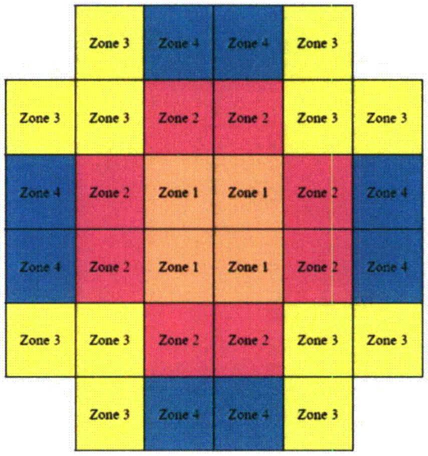


Figure 4 – NUHOMS®-32PHB DSC Maximum Heat Load Zone Configuration

H. Revision to Technical Specification 3.1.1(7)

The proposed addition of the irradiated fuel assembly weight limit of 1375 lbs is supported by the design basis calculation for the new transfer cask yoke. This new transfer cask yoke design limit applies only to the transfer of the NUHOMS®-32PHB DSCs. The remaining transfer cask and NUHOMS®-32PHB DSC calculations were performed using the existing weight limit of 1450 lbs per irradiated fuel assembly. A comparison of Westinghouse and AREVA fuel assembly weights determined that the AREVA fuel assembly is the bounding fuel assembly for this Technical Specification. The maximum weight of an AREVA fuel assembly without a control element assembly inserted is 1354 lbs (unirradiated). An irradiated fuel assembly is assumed to gain a maximum of 8.45 lbs as a result of corrosion and hydrogen absorption. Margin is also included to account for debris or other unknown issues. Control element assemblies, which are included in the existing weight limit (1450 lbs), are not included in this proposed weight limit (1375 lbs) since the length of the fuel assembly with the control element assembly inserted would physically preclude placement of the top shield plug and closure of the NUHOMS®-32PHB DSC. The structural integrity of the NUHOMS®-32PHB DSCs is evaluated at the higher weight limit of 1450 lbs. These evaluations were done for normal operations, off-normal operations, and accident conditions and the results are within the previously approved limits. The stresses imposed on the transfer cask, transfer equipment, and HSMs as a result of this change were evaluated at the higher fuel assembly weight of 1450 lbs (except the transfer cask yoke) and are within the previously approved limits. In addition, the transfer cask yoke analysis for the NUHOMS®-32PHB DSCs determined that the results are within the required structural limits. The current maximum fuel assembly weight limit for the NUHOMS®-24P DSC and the NUHOMS®-32P DSC remain the same.

I. Revision to Technical Specification 3.2.2.1

The proposed amendment would add acceptance standards for liquid penetrant tests of the top shield plug closure weld, the siphon and vent port cover welds, and the top cover plate weld for the NUHOMS®-32PHB DSC. The outer top cover plate is welded to the shell subsequent to the leak testing of the confinement boundary. The top closure confinement welds are multi-layer welds applied after fuel loading and comply with the guidance of ISG-15 and ASME Boiler & Pressure Vessel Code, Section III, Subsection NB-5350, 1998 (with addenda up to and including 1999) edition. Therefore, the acceptance standard proposed for the NUHOMS®-32PHB DSC is the ASME Boiler & Pressure Vessel Code, Section III, Subsection NB-5350, 1998 (with addenda up to and including 1999) edition. This is an administrative change to adopt a later version of an acceptable standard. This acceptance standard is the same as is currently used for the approved Transnuclear, Inc. CoC 1030 DSCs. The acceptance standard for the NUHOMS®-24P and NUHOMS®-32P DSCs remains the same.

J. Revision to Technical Specification 3.2.2.2 and 4.2.2.1

Updated Safety Analysis Report Sections 8.2.8 and 12.8.2.8 evaluate a non-mechanistic release to the environment of the gap inventory of Kr-85 fission gas from all fuel rods contained in the NUHOMS®-24P and NUHOMS®-32P DSCs, respectively. However, this event is not analyzed for the NUHOMS®-32PHB DSC. Current Nuclear Regulatory Commission guidance on radionuclides which must be considered and their release fractions are specified in Reference 10. Section IV.3 of Reference 10 also offers the option of testing closure welds to be "leak tight," as defined in Reference 9, in lieu of performing a DSC leakage dose analysis. Reference 9 defines "leak tight" as a degree of package containment that in a practical sense precludes any significant release of radioactive materials, and is achieved by demonstration of a leakage rate less than or equal to 1×10^{-7} ref·cc/sec, of air at an upstream pressure of 1 atmosphere (atm) absolute and a downstream pressure of 0.01 atm absolute or less. Leak test methods currently in use for the NUHOMS®-32P are capable of testing to this sensitivity, and a review of several NUHOMS®-32P DSC leak test results shows that all have met the above requirement. The procurement specification for the NUHOMS®-32PHB DSC requires that the boundary welds meet a leak rate sufficient to be considered "leaktight" in accordance with Reference 10. Therefore, in place of performing the non-mechanistic fission gas release for the NUHOMS®-32PHB DSC it is requested that a helium leak rate acceptance criteria of 10^{-7} ref-cc/sec be added to Technical Specifications 3.2.2.2 and 4.2.2.1 for the NUHOMS®-32PHB DSC. The proposed change would require that the standard helium leak rate for the NUHOMS®-32PHB DSC top shield plug closure weld, and the siphon and vent port cover welds be limited to 10^{-7}ref-cc/s. The current acceptance criteria would remain for the NUHOMS®-24P and NUHOMS®-32P DSCs.

K. New Technical Specification 3.3.2.1

The proposed amendment would establish a new Technical Specification for the time to complete the NUHOMS®-32PHB DSC transfer from the cask handling area to the HSM. For the NUHOMS®-32P DSC, thermal analyses performed to demonstrate that peak cladding temperatures remained below the 752°F cladding temperature limit during transfer of the NUHOMS®-32P DSC from the Auxiliary Building cask wash pit to the HSM were done using steady-state assumptions. As a result there were no time limits imposed on the transfer process for this canister design. For the NUHOMS®-32PHB DSC, thermal analyses of the transfer operation (Reference 11) impose time limits on the transfer of NUHOMS®-32PHB DSC from the Auxiliary Building cask wash pit (starting at time water is drained from the annulus) to the HSM-HB. Reference 11 establishes the maximum heat loads for NUHOMS®-32PHB DSC while it is in the transfer cask. The maximum heat load and transfer times are determined so that the maximum transfer cask component temperatures remain below the temperature evaluated for the currently approved transfer cask loaded with a NUHOMS®-32PHB DSC. Transient thermal analyses were performed to determine the maximum component temperatures of the transfer cask loaded with a NUHOMS®-32PHB DSC for the limiting heat loads and transfer times before initiation of a corrective action such as establishment of forced cooling or refilling the transfer cask/DSC annulus with water. Reference 11 also establishes a time to complete the transfer of the NUHOMS®-32PHB DSC to the HSM to ensure that the peak fuel cladding temperature remains below the temperature limit. There are no time limits associated with horizontal transfer operations once the forced air circulation is initiated. After initiation of forced cooling, if the fans are stopped for any reason, up to 8 hours are available to complete the transfer, restart the fans, or fill the transfer cask/DSC annulus with water (Reference 12). To minimize the occurrence of a malfunction of the forced cooling system, the transfer cask transporter is equipped with redundant industrial grade blowers, each of which is capable of supplying the required minimum air flow rate, as well as a redundant power supply for the blowers. For the transfer cask model, transient simulations are performed using ANSYS for the transfer cask as described in Reference 11. Table 8 summarizes the maximum temperatures for the transfer cask components and shows that the maximum component temperatures are below the allowable limits for transfer durations at the evaluated heat loads.

Table 8, NUHOMS®-32PHB Maximum Temperatures without Forced Cooling*

Heat Load	≤ 29.6 and > 25.6 kW	≤ 25.5 and > 23.04 kW	≤ 23.04 and > 21.12 kW	≤ 21.12 kW	Temperature Limit °F
Transfer Time Limit	**20 hours**	**48 hours**	**72 hours**	**No Limit**	
Component					
Fuel Cladding	728	728	705	704	752
Basket (Guide Sleeve)	709	709	686	688	--
Max. DSC Shell	407	451	456	480	620
Transfer Cask Inner Shell	313	356	365	392	--
Gamma Shield	308	351	360	387	--
Radial Neutron Shield-Bulk Avg. Temp	214	242	249	265	280
Top Neutron Shield-Bulk Avg. Temp	186	199	203	214	280
Bottom Neutron Shield-Bulk Avg. Temp	201	219	225	237	280
Transfer Cask Outer Shell	233	262	269	288	--
Transfer Cask Lid	216	240	246	263	--

* Off-normal hot transient condition: assumes an ambient temperature = 104°F and solar heat input = 127 Btu/hr-ft^2

In summary, if the transfer operations exceeds or are expected to exceed the above time limits, corrective actions such as forced cooling or refilling of the transfer cask/DSC annulus with water must be initiated. The time limit for completion of the NUHOMS®-32PHB transfer to the HSM is as follows:

- No time limit for a DSC with a total heat load of 21.12 kW or less,
- 72 hours for a DSC with a total heat load greater than 21.12 kW but less than or equal to 23.04 kW
- 48 hours for a DSC with a total heat load greater than 23.04 kW but less than or equal to 25.6 kW
- 20 hours for a DSC with a total heat load greater than 25.6 kW but less than or equal to 29.6 kW

Surveillance Requirement 4.3.2.1 is also proposed to monitor the time duration following draining of the transfer cask/DSC annulus until completion of the insertion of the NUHOMS®-32PHB DSC into the HSM.

L. New Technical Specification 3.3.3.1

The proposed amendment would establish a new Technical Specification for the time to complete the NUHOMS®-32PHB DSC blowdown and vacuum drying process only if nitrogen is used for blowdown. For the NUHOMS®-32P DSC, thermal analyses were performed using steady-state assumptions to demonstrate that the peak cladding temperatures remained below the 752°F cladding temperature limit during blow down and vacuum drying. As a result there were no time limits imposed on the blowdown and vacuum drying process. For the NUHOMS®-32PHB DSC, thermal analysis of blowdown and vacuum drying (Reference 7) also demonstrates that when helium is used for blowdown, peak cladding temperatures remain well below the 752°F cladding temperature limit for normal operation, with no limitation on completion of the blowdown and vacuum drying process. However, if nitrogen is used for blowdown of the NUHOMS®-32PHB DSC, time limits on the completion of the blowdown and vacuum drying process are imposed to ensure peak cladding temperatures remain below the limit. These time limits are summarized in Table 9.

Table 9 – NUHOMS®-32PHB Vacuum Drying Time Limits*

Heat Load		**25.6 - 29.6 kW**	**23.04 - 25.6 kW**	**≤ 23.04 kW**
Vacuum Drying Time Limit (h)		32	40	56
Peak Fuel Cladding Temperature (°F)	N_2 blowdown w/time limit	711	709	718
	He blowdown w/o time limit	592	555	524

* For nitrogen blowdown only

Therefore, the time limit for completion of vacuum drying of a loaded NUHOMS®-32PHB DSC following blowdown with nitrogen is as follows:

- 56 hours for a DSC with a total heat load of 23.04 kW or less
- 40 hours for a DSC with a total heat load greater than 23.04 kW but less than or equal to 25.6 kW
- 32 hours for a DSC with a total heat load greater than 25.6 kW but less than or equal to 29.6 kW

An additional time limit on draining water from the annulus following completion of vacuum drying is also administratively imposed when nitrogen is used for blowdown, and vacuum drying exceeds a specified time, to ensure that NUHOMS®-32PHB temperatures remain within the initial conditions assumed at the start of the operation to transfer the NUHOMS®-32PHB DSC to the HSM-HB.

Surveillance Requirement 4.3.3.1 is also established to monitor the time duration following initiation of NUHOMS®-32PHB DSC blowdown using nitrogen until the initiation of helium backfill to ensure it remains within the required time limits.

M. Revision to Technical Specification 3.4.1.1

This Technical Specification limits the temperature rise from the HSM inlet to the outlets. This provides assurance that the fuel is being adequately air cooled while in the HSM. The current limit is a maximum 64°F temperature rise for HSMs or HSM-HBs loaded with NUHOMS®-24P and NUHOMS®-32P DSCs. The proposed amendment would add a new maximum allowable temperature rise from the HSM-HB inlet to the HSM-HB outlet of 80°F when loaded with NUHOMS®-32PHB DSCs. The maximum temperature rise limit will remain 64°F for the HSMs.

This Technical Specification limit is revised based on an evaluation that determined the maximum fuel rod cladding and component temperatures of NUHOMS®-32PHB DSC in the HSM-HB storage module for normal, off-normal, and accident conditions. A maximum heat load of 29.6 kW per NUHOMS®-32PHB DSC was assumed along with the appropriate thermal limits for stored fuel assemblies. The results of these analyses show an 80°F temperature rise occurs from the HSM-HB inlet to the HSM-HB outlets and demonstrate that the peak fuel cladding temperature is equal or less than 724°F for a maximum air inlet temperature of 104°F for the normal and off-normal hot conditions. In addition, for the case of the blocked vent accident in HSM-HB, the maximum peak fuel cladding temperature is less than 868°F for a maximum air inlet temperature of 104°F while maintaining an 80°F temperature rise in HSM-HB. These peak fuel cladding temperatures for normal, off-normal, and vent block storage accident conditions are below the peak fuel cladding temperature limits for the NUHOMS®-32PHB fuel assemblies that form the basis for this Technical Specification. Table 10 shows the maximum peak fuel cladding temperatures for normal, off-normal and accident storage conditions.

Table 10, Maximum Fuel Cladding Temperature

Operation Condition		**Fuel Cladding**	**Fuel Cladding Limit**	**Max. Temp Rise Limit**
		T_{max} (°F)	T_{max} (°F)	T_{air} out – T_{air} in (°F)
Normal	Cold (T_{air} = -8°F)	648	752	80
	Hot (T_{air} = 104°F)	<724	752	80
Off-Normal	Cold (T_{air} = -8°F)	648	1058	80
	Hot (T_{air} = 104°F)	724	1058	80
Accident	Blocked Vent (40 hours, T_{air} = 104°F)	867	1058	80

In addition, the evaluation assumed that the dose reduction inserts were used for inlet vents of HSM-HB. The dose reduction inlet vent inserts consist of three staggered, schedule 10, stainless steel pipes with a nominal outer diameter of 14 inches, a wall thickness of 0.25 inches, and length of 6 inches. These pipes are welded to the back side of the inlet vent bird screen and the area around the pipes remains open for air flow. The dose reduction inserts introduce a flow resistance to the air flow through the HSM-HB and will have an effect on the air temperature used for evaluation of NUHOMS®-32PHB DSC in HSM-HB. The increase of the loss coefficient due to the dose reduction inserts constitutes approximately 1.3% of the overall loss coefficient in HSM-HB. This increase is a minor change to the overall loss coefficient and is bounded by other conservatisms. Therefore, the 80°F temperature rise in HSM-HB is acceptable even with the installation of the dose reduction inserts in the inlet vents of HSM-HB design.

The ambient air flows into the HSM cavity through the inlet vents located on the bottom of the side wall and the hot air leaves the HSM through the outlet vents located at the top of the side walls towards the gap between the roof slabs of the adjacent HSMs. There is an elevation difference of 14 ft between the inlet vent and the roof of the HSM.

For the HSM-HB, the air intake is located on the front wall of the HSM-HS and the hot air leaves the HSM-HB through the outlet vents located at the top of the HSM-HB roof with a direction perpendicular to the intake airflow direction. There is an elevation difference of 18.5 ft between the inlet vent and the roof of the HSM-HB.

Due to the elevation differences and directions of inlet and outlet vents, the effect of local hot air exiting the HSM/HSM-HB vents is concentrated at the top of HSM/HSM-HB roofs and will be dispersed by any wind gust upwards such that it is unlikely to impact the air temperature at the intakes of HSM/HSM-HB. Further, the decay heat from each DSC is dissipated to the HSM/HSM-HB cavity air by convection such that the heat dissipation from the HSM/HSM-HB walls is small and its effect on local air temperature is insignificant.

It should be noted that the HSM and HSM-HBs are installed in separate rows such that the higher decay heat from HSM-HB cannot affect the performance of HSM. The thermal evaluation of the HSM-HB considers that each HSM-HB is loaded with the maximum allowable heat load such that no heat dissipation occurs through the side and back walls. This assumption bounds the effect of adjacent HSM-HBs on the evaluated HSM-HB. The same assumptions were considered for evaluation of the HSMs.

N. Revision to Design Feature 5.2

The proposed amendment would add the required minimum areal density for the NUHOMS®-32PHB DSC poison plates. The NUHOMS®-32PHB DSC poison plates shall have a minimum B^{10} areal density of 0.019 g/cm^2 for basket type A and 0.027 g/cm^2 for basket type B. The basis for the poison plate areal density is discussed in Section 3.0.E. The minimum B^{10} areal density for the NUHOMS®-32P DSC poison plates remains the same.

4.0 ENVIRONMENTAL ASSESSMENT

Calvert Cliffs Nuclear Power Plant, LLC has reviewed the environmental impact of the proposed amendment and has determined that it meets the criteria for categorical exclusion set forth in 10 CFR 51.22(c)(11). Our determination for categorical exclusion is based on the following evaluation of the proposed amendment against the standards set forth in 10 CFR 51.22(c)(11):

1. *There is no significant change in the types or significant increase in the amounts of any effluents that may be released offsite.*

   No effluents are released from the Independent Spent Fuel Storage Installation (ISFSI) during operation and the proposed changes have no impact to dry shielded canister (DSC) loading activities. Therefore, there is no significant change in the type or significant increase in the amounts of any effluents that may be released offsite from the proposed revisions to the ISFSI License.

2. *There is no significant increase in individual or cumulative occupational radiation exposure.*

   The proposed increase in the allowable enrichment results in a minor change in dose rates for some loading and transfer activities and horizontal storage module dose locations, but the analysis of the increases shows that dose rates and accumulated dose will remain below limits. Therefore, there is no significant increase in individual or cumulative occupational radiation exposure from the proposed revisions to the ISFSI License.

3. *There is no significant construction impact.*

   Seventy two horizontal storage modules (HSMs) have been filled. Ninety six HSMs and high burnup horizontal storage modules (HSM-HBs) have been constructed. Additional HSMs will be constructed to allow enough storage capacity for fuel generated through the end of the currently licensed life of the plant. The number of modules is proposed to be increased to the total 132 modules required for 60 years of power plant operation. This construction activity takes place within the previously disturbed area already evaluated in the existing license.

Therefore, there is no significant construction impact associated with the proposed revisions to the ISFSI license.

4. *There is no significant increase in the potential for or consequences from radiological accidents.*

The proposed change would allow an increased neutron and gamma source for fuel assemblies stored in Nutech Horizontal Modular Storage® (NUHOMS®)-32PHB DSCs. The accident dose for the DSC with the proposed neutron and gamma source terms meets the 10 CFR 72.106 regulatory limits. Of the events listed in the ISFSI Updated Safety Analysis Report, those potentially impacted by the use of fuel assemblies with an increased source term are the transfer cask drop, DSC leakage, accidental pressurization of the DSC, blockage of HSM air inlets/outlets, and the forest fire event. The effect of an increased neutron and gamma source term on each event was evaluated. The evaluations determined that any increases in dose are not more than minimal. Therefore, the consequences from a radiological accident are not significantly increased.

The proposed change would also allow increased heat generation limits for a fuel assembly. Evaluations have determined that the additional heat generation per fuel assembly will not affect the fuel cladding and result in any additional accident release. Therefore, the consequences from a radiological accident are not increased.

The proposed change would also allow increased fuel assembly average burnup limits for a fuel assembly. Evaluations have determined that the increased fuel assembly average burnup limit results in minimal increases in the results of the applicable accident dose analyses and the dose remains below the limit. The structural integrity of the canisters and fuel has been evaluated for normal operations, off-normal operations, and accident conditions and remains acceptable. Of the events listed in the ISFSI Updated Safety Analysis Report, those potentially impacted by the use of fuel assemblies with a higher average burnup are the transfer cask drop, DSC leakage, accidental pressurization of the DSC, blockage of HSM air inlets/outlets, and the forest fire event. The effect of a higher average fuel burnup for each event was evaluated. The evaluations determined that any increases in dose are not more than minimal. Therefore, the consequences from a radiological accident are not significantly increased.

Therefore, there is no significant increase in the potential for or consequences from radiological accidents from the proposed revisions to the ISFSI License.

5.0 PRECEDENCE

There is no identical DSC or HSM design that has been previously approved by the Nuclear Regulatory Commission. Similarities to previously approved design elements are discussed in Enclosure 1.

6.0 REFERENCES

1. Letter from G. H. Gellrich (CCNPP) to Document Control Desk (NRC), dated September 17, 2010, Site-Specific Independent Spent Fuel Storage Installation (ISFSI) License Renewal Application

2. NUH-003, Updated Final Safety Analysis Report for the Standardized NUHOMS Horizontal Modular Storage System for Irradiated Nuclear Fuel, Revision 10, Transnuclear, Inc.

3. Letter from R. J. Lewis (NRC) to G. Vanderheyden (CCNPP), dated June 10, 2005, Amendment 6 to Material License No. SNM-2505 for the Calvert Cliffs Independent Spent Fuel Storage Installation (ML051010396)

4. Letter from J. Goshen (NRC) to G. H. Gellrich (CCNPP), dated September 14, 2010, Amendment 9 to Material License No. SNM-2505 for the Calvert Cliffs Independent Spent Fuel Storage Installation
5. NUREG/CR-6361, Criticality Benchmark Guide for Light-Water-Reactor Fuel in Transportation and Storage Packages, Oak Ridge National Laboratory, March 1997
6. Spent Fuel Project Office Interim Staff Guidance 11, Cladding Considerations for the Transportation and Storage of Spent Fuel, November 2003
7. TN Calculation NUH32PHB-0408, Thermal Analysis of NUHOMS 32PHB DSC for Vacuum Drying Operations (ML12093A102)
8. Spent Fuel Project Office Interim Staff Guidance 18, The Design and Testing of Lid Welds on Austenitic Stainless Steel Canisters as the Confinement Boundary for Spent Fuel Storage, October 3, 2008
9. ANSI N14.5-1997, American National Standard for Radioactive Materials – Leakage Tests on Package for Shipment, American National Standards Institute, February 1998
10. Spent Fuel Project Office Interim Staff Guidance 5, Confinement Evaluation, May 1999
11. TN Calculation NUH32PHB-0406, Thermal Evaluation of NUHOMS 32PHB Transfer Cask for Normal, Off Normal, and Accident Conditions (Heat Loads <29.6kW) (ML12093A103)
12. Non-Proprietary TN Calculation NUH32PHB-0401, Thermal Evaluation of NUHOMS 32PHB Transfer Cask for Normal, Off Normal, and Accident Conditions with Forced Cooling (Steady State) (ML12093A107)

ENCLOSURE 1

Comparison Matrix

Differences Between the Existing and New Designs

Parameter Limits or Design Requirements	Calvert Cliffs Site Specific					General License	
	24P DSC CCNPP HSM CCNPP TC	**32P DSC CCNPP HSM CCNPP HSM-HB CCNPP TC**	**ISFSI USAR**	**32PHB DSC CCNPP HSM-HB CCNPP FC-TC**	**Calculation NUH32PHB- calc#**	**32PTH DSC (unless noted) HSM-H OS197FC TC**	**CoC 1004 NUH-003 Rev. 10 or CoC 1030 NUHOMS-HD Rev. 3**
No. of Fuel Assemblies	24	32	Table 1.2-1	32	30-7	32	NUHOMS-HD Section 2.1.1
Fuel Stored	CE 14x14 Std.	CE 14x14 Std.	Tables 3.3-3, 3.3-5, 12.3-2	CE 14x14 Std., VAP, & AREVA	0111	CE 14x14 Std.	NUHOMS-HD Sections 1.2.3, 3.9.8.2 Tables 2-1, 2-3
Cladding Material	Zircaloy-4	Zircaloy-4, Zirlo		Zircaloy-4, ZIRLO, M5	0111 0207	Zircaloy-4, ZIRLO, M5	NUHOMS-HD Table 2-3
Guide Sleeve Dimension	8.7"x 8.7"	8.5"x 8.5"	Tables 3.3-4 & 12.3-1	8.5"x 8.5"	30-7	8.7"x 8.7"	NUHOMS-HD Dwg. 10494-72-10
Guide Sleeve Spacing	10.36"	9.125"		9.125"	30-9	9.58"	
DSC Shield Plug Material/Thickness	Top: Pb 4.41" + 1.66" SS Bottom: 4.25" Pb +	Top: Pb 4" + 2.25" SS Bottom: 4.25" Bottom		Top: Pb 4" + 2.25" SS Bottom: 4.25" Bottom	30-1	As shown on the drawing	NUHOMS-HD Dwg. 10494-72-4 and -5
Spent Fuel Pool Min. Boron 10 Concentration	1800 ppm (24 Assembly Misload Only)	2450 ppm	3.3.4, 12.3.3.4	2450 ppm	0600(attached) 0603(attached)	2000 to 2400 ppm Types B, C & D	NUHOMS-HD Table 2-6
Fuel Burnup Credited for Criticality	Yes	No		No		No	NUHOMS-HD Section 2.3.4.1
Optimum Moderation Assumption	Pure Water	Borated Water		Borated Water		Borated Water	NUHOMS-HD Section 2.3.4.1
Neutron Absorber Plates – Boron 10 Content	None	Borated Aluminum Alloy or MMC 10 mg/cm^2		Borated Aluminum MMC 19 mg/cm2 10B Type A 27 mg/cm^2 10B Type B		Boral or Borated Aluminum Alloy or MMC 7-50 10B mg/cm^2	NUHOMS-HD Section 2.1.1
Effective Multiplication Factor (K_{eff})	<0.95 (normal) <0.98 (off-normal)	<0.95		<0.95		< 0.95	NUHOMS-HD Section 2.3.4.1
Fuel Assembly Uranium Mass	0.386 MTU (Nominal)	0.41 MTU (Maximum)	Table 1.2-1 Table 3.1-1	0.420 MTU (Maximum)	0502 0503(ML12093A106) 0505	0.476 MTU (Maximum)	NUHOMS-HD Table 2-3

ENCLOSURE 1

Comparison Matrix

Parameter Limits or Design Requirements	Calvert Cliffs Site Specific					General License	
	24P DSC CCNPP HSM CCNPP TC	32P DSC CCNPP HSM CCNPP HSM-HB CCNPP TC	ISFSI USAR	32PHB DSC CCNPP HSM-HB CCNPP FC-TC	Calculation NUH32PHB- calc#	32PTH DSC (unless noted) HSM-H OS197FC TC	CoC 1004 NUH-003 Rev. 10 or CoC 1030 NUHOMS-HD Rev. 3
U-235 Maximum Enrichment Limit	4.5%	4.5%	Table 1.2-1 Table 3.1-1 Table 9.4-1	4.75% Type A 5.0% Type B	0111 0600(attached) 0603(attached)	5.0% Types B, C & D	NUHOMS-HD Table 2-6
Fuel Assembly Average Burnup Limit (GWd/MTU)	47	52	Table 1.2-1 Table 9.4-1	60 Westinghouse 62 AREVA	0111	60	NUHOMS-HD Section 2.1.1
Gamma Source (MeV/sec/assembly)	1.53E+15	1.61E+15	Table 3.1-1	2.56E+15	0502 0503(ML12093A106) 0505	6.91E+15	NUHOMS-HD Table 5-10
Neutron Source (n/s/assembly)	2.23E+08	4.175E+08	Table 3.1-1	6.66E+08	0502 0503(ML12093A106) 0505	1.095E+09	NUHOMS-HD Table 5-13
Fuel Assembly Weight (lbs)	1300/1450(1)	1450	Table 3.1-1, 12.8.1.1.3	1375(1)	0201(ML12173A186) 0204 0205	1585 (based on AREVA Mk BW 17x17)	NUHOMS-HD Sections 2.1.1, A.3.2, 3.9.1.2.3.B.2 Table 2-1
Active Fuel Length (in)	136.7	136.7	Tables 3.1-1, 3.3-3	136.7	0502 0503(ML12093A106) 0600(attached)	137 (CE 14x14)	NUHOMS-HD Section 4.7
Loaded Dry DSC Weight (kips)	69.4	91.0	3.4.1, Table 12.3-3	92.4	0201(ML12173A186)	108.8	NUHOMS-HD Table 1-1
Total Heat Source	Max 15.84 kW (0.66 kW/assy)	Max 21.12 kW (0.66 kW/assy)	Table 3.1-1, Table 9.4-1	Max 29.6 kW (max 12 @ 0.8 kW/assy & 20 @ 1.0 kW/assy; see Fig. 8 for zoning)	0401(ML12093A107) 0402(ML12093A104) 0403(ML12173A182) 0408(ML12093A102) 0410	32PTH Max 33.8 kW for CE 14x14 w/ zoning per p. 4-19	NUHOMS-HD Table 2-1. Section 4.3.1.3
DSC Shell Design Pressure	50 psig	100 psig	Table 3.6-3	100 psig	0404	120 psig	NUHOMS-HD Sections 3.5.4, 3.9.1, 4.1, 4.4.5

Parameter Limits or Design Requirements	Calvert Cliffs Site Specific: 24P DSC CCNPP HSM CCNPP TC	32P DSC CCNPP HSM CCNPP HSM-HB CCNPP TC	ISFSI USAR	32PHB DSC CCNPP HSM-HB CCNPP FC-TC	Calculation NUH32PHB- calc#	General License: 32PTH DSC (unless noted) HSM-H OS197FC TC	CoC 1004 NUH-003 Rev. 10 or CoC 1030 NUHOMS-HD Rev. 3
Vacuum Drying Time Limit	No limit (steady-state analysis)	No limit (steady-state analysis)	N/A	No limit for He blow down. 32h - 56h for N2 blow down depending on DSC heat load.	0408(ML12093A102)	No limit for 32PTH – He blowdown only; 31h for 24kW 32PT and 17h – 22h for N2 blowdown 24PTH – no limit for He blowdown	NUHOMS-HD Section 4.5.1 NUH-003 Sections M.4.7.1, P.4.7.2
Time Limit on Completion of Transfer to HSM or Initiation of 450 cfm Forced Air Cooling (time from draining of annulus)	No limit	No limit	N/A	20h – 72h depending on DSC heat load if above 21.12kW. No limit below 21.12 kW	0401(ML12093A107) 0402(ML12093A104) 0406(ML12093A103)	24PTH DSC in OS197FC 25h at 31.2kW 9.5h at 40.8kW	NUH-003 P. 4.5.3, P.4.5.5.1, TS 1.2.18
Peak Fuel Cladding Temperature – Loading 1058°F limit for 24P 752°F limit for 32P/PHB	739°F	742°F w/ N2 S.S. 536°F w/ He S.S.		29.6 kW: 711°F at 32h w/ N2, 592°F w/ He S.S. 25.6 kW: 709°F at 40h w/ N2, 555°F w/ He S.S. 23.04 kW: 718°F at 56h w/ N2, 524°F w/ He S.S.	0408(ML12093A102)	734°F	NUHOMS-HD Table 4-8

Comparison Matrix

Parameter Limits or Design Requirements	Calvert Cliffs Site Specific					General License	
	24P DSC CCNPP HSM CCNPP TC	**32P DSC CCNPP HSM CCNPP HSM-HB CCNPP TC**	**ISFSI USAR**	**32PHB DSC CCNPP HSM-HB CCNPP FC-TC**	**Calculation NUH32PHB- calc#**	**32PTH DSC (unless noted) HSM-H OS197FC TC**	**CoC 1004 NUH-003 Rev. 10 or CoC 1030 NUHOMS-HD Rev. 3**
Peak Fuel Cladding Temperature – Transfer 1058°F limit for 24P 752°F limit for 32P/PHB	739°F	742°F at 103°F Steady-State		29.6kW: <728°F at 20h at 104°F w/o FC 25.6kW: 728°F at 48h at 104°F w/o FC 23.04kW: 705°F at 72h at 104°F w/o FC 21.12kW: 704°F at 104°F w/o FC (no time limit)	0403(ML12173A182) 0406(ML12093A103)	32PTH 727°F at 115°F	NUHOMS-HD Table 4-1
Peak Fuel Cladding Temperature – Storage 635°F limit for 24P & 32P 752°F limit for 32PHB	618°F at 103°F	HSM - 620°F at 103°F HSM-HB - 631°F at 103°F	8.1.3.2, Formerly in Table 8.1-13, 12.3.3.7	29.6 kW Bounding < 724°F at 104°F (DSC surface temp based on 31.2kW 61BTH in HSM-H at 117°F)	0403(ML12173A182) 0410	32PTH 684°F at 115°F	NUHOMS-HD Table 4-2
Peak Fuel Cladding Temperature – Accident 1058°F limit for off-normal and accident	732°F at 103°F	HSM - 838°F at 103°F HSM-HB - 741°F at 103°F	8.2.7, 12.3.3.7, 12.8.2.7 (48h blocked vent)	29.6kW Bounding 867°F w/ 40h Blocked Vent 932°F for Fire	0402(ML12093A104) 0403(ML12173A182) 0406(ML12093A103) 0409	32PTH 1036°F Fire 823°F 34h blocked vent	NUHOMS-HD Tables 4-5 & 4-6
Storage Location	HSM or HSM-HB	HSM or HSM-HB	1.3.1.2	HSM-HB only	0208 0410 0503(ML12093A106) 0505	HSM-H	NUHOMS-HD Chapter 1
HSM Maximum Air Temperature Rise T/S 3.4.1.1 64°F max	51°F at 103°F (HSM)	64°F at 103°F (HSM)	Formerly in Table 8.1-13 for 24P	80°F (HSM-HB)	0403(ML12173A182) 0410	For 32PTH 77°F for 34.8kW 68°F for 32kW 58°F for 26kW	NUHOMS-HD Tables 4-21, 4-22, 4-23

Comparison Matrix

Parameter Limits or Design Requirements	Calvert Cliffs Site Specific					General License	
	24P DSC CCNPP HSM CCNPP TC	**32P DSC CCNPP HSM CCNPP HSM-HB CCNPP TC**	**ISFSI USAR**	**32PHB DSC CCNPP HSM-HB CCNPP FC-TC**	**Calculation NUH32PHB- calc#**	**32PTH DSC (unless noted) HSM-H OS197FC TC**	**CoC 1004 NUH-003 Rev. 10 or CoC 1030 NUHOMS-HD Rev. 3**
HSM Dimensions	HSM 19' L 8' 8" W 18' H	HSM 19' L 8' 8" W 18' H HSM-HB 20' 8" L 9' 8" W 18' 6" H		HSM-HB 20' 8" L 9' 8" W 18' 6" H	0208	HSM-H 20' 8" L 9' 8" W 18' 6" H	NUHOMS-HD Table 1-1
HSM Dose Rate Wall or Roof 20 mrem/hr T/S limit	12.5	HSM - 13.5 HSM-HB – 5.4	1.3.1.2, Tables 7.3-1 and 12.7-1	6.27	0503(ML12093A106) (*based on 43% reduction in gamma component from 0503 Table 12-2)	15.8	NUHOMS-HD Table 5-21
HSM Dose Rate Air Outlet 100 mrem/hr design goal	82	HSM - 75.4 HSM-HB – 48.1		47.1		170 (max)	
HSM Dose Rate Door Center 100 mrem/hr T/S limit	10	HSM - 13.9 HSM-HB – 0.6		0.98		1.6	
HSM Dose Rate Open Doorway (1foot inside)	3240	HSM – 4659 HSM-HB - 3874		1.76E+4		Not given	
HSM Dose Rate Air Inlet 100 mrem/hr design goal	73	HSM - 61.0 HSM-HB – 88.9		121 (73 w/ pipes*)		752 (max)	
HSM Dose Rate 1m from Door	6	HSM - 8.9 HSM-HB – 0.7		1.01		Not given	
Centerline DSC Shield Plug (Flooded DSC)	80	180	1.3.1.2, Tables 7.3-1 and 12.7-1	244	0502	N/A	Not calculated in the same configurations or locations NUHOMS-HD Table 5.3 and 5.4
DSC Cover Plate (Dry DSC) Center	141	206		695		N/A	
DSC Cover Plate (Dry DSC) Edge (Wet Gap)	142	226		631		N/A	
DSC Cover Plate (Dry DSC) Edge (Dry Gap)	260	350		785		N/A	
Transfer Cask Side 200 mrem/hr design goal 24P/32P 250 mrem/hr design goal 32PHB	141	164		217		509	

Comparison Matrix

Parameter	Calvert Cliffs Site Specific					General License	
Parameter Limits or Design Requirements	**24P DSC CCNPP HSM CCNPP TC**	**32P DSC CCNPP HSM CCNPP HSM-HB CCNPP TC**	**ISFSI USAR**	**32PHB DSC CCNPP HSM-HB CCNPP FC-TC**	**Calculation NUH32PHB- calc#**	**32PTH DSC (unless noted) HSM-H OS197FC TC**	**CoC 1004 NUH-003 Rev. 10 or CoC 1030 NUHOMS-HD Rev. 3**
Transfer Cask Top 200 mrem/hr design goal 24P/32P 250 mrem/hr design goal 32PHB	7	12.8		26		33.3	
DSC Dimensions as required to fit in Transfer Cask	Length 172.93" OD 67.25"	Length 172.93" OD 67.25"	Table 3.3-5	Length 172.93" OD 67.25"		Length 185.75" OD 69.75	NUHOMS-HD Sect 1.5.2
Transfer Cask Dimensions	Cavity Diameter = 68" Cavity Length = 173.5" Payload = 95,000 lbs. Max	Cavity Diameter = 68" Cavity Length = 173.5" Payload = 95,000 lbs. Max	Table 3.3-4, 12.3-3	Cavity Diameter = 68" Cavity Length = 173.5" Payload = 95,000 lbs. Max		Cavity Diameter = 70.5" Cavity Length = 186.6" Payload = 108,800 lbs. Max	Section 3.1.1.3, 3.9.2.1.1
Transfer Cask Max Weight (lbs/tons)	199,944 / 100.0 (Wet)	218,106 / 109.1 (Wet)		216,985 / 108.5	0201(ML12173A186)	114.5 tons (Dry) 121 tons (Wet)	Section 3.1.1.3, 3.9.2.1.1
Transfer Cask Lift Yoke Capacity (tons)	109.25	109.25	4.7.3.4	109.25	N/A	N/A	N/A
Fuel Building Crane Capacity (tons)	125	125		125	N/A	>100	Table 1.2-4, NUH-003
Ambient Temperature	-3 to 103 °F	-3 to 103 °F	Table 1.2-1	-8 to 104 °F	0403(ML12173A182)	-21 to 115 °F	HD Section 2.2.9.4, 4.31
Solar Heat Load (Btu/hr-ft2)	127 max 82 avg	127 max 82 avg	Table 1.2-1	127 max 82 avg	0401(ML12093A107) 0402(ML12093A104) 0403(ML12173A182) 0408(ML12093A102) 0410	Variable	
Snow/Ice Loads	110 psf	110 psf	3.2.4	110 psf	0208	110 psf	NUH-003, P.2.2.5.2.1.B
Loss of Air Outlet Shielding	Not applicable Dry Site	Not applicable Dry Site	8.2.1, 12.8.2.1	Not applicable Dry Site	N/A	N/A	N/A
Tornado Winds Max wind velocity: 360 mph Max wind pressure: 397 psf (TC) 304 psf (HSM)	360 mph (290 mph rotational, 70 translational)	360 mph (290 mph rotational, 70 translational)	3.2.1, 8.2.2 12.8.2.2, Table 3.6-3	360 mph (290 mph rotational, 70 translational)	0208(HSM-HB) 0214(TC)	360 mph	NUHOMS-HD NUH-003 8.2.2, Table P.2-18,
Tornado Pressure	3 psi / 2 psi/sec	3 psi / 2 psi/sec		3 psi / 2 psi/sec		3 psi	

Comparison Matrix

Parameter Limits or Design Requirements	Calvert Cliffs Site Specific					General License	
	24P DSC CCNPP HSM CCNPP TC	**32P DSC CCNPP HSM CCNPP HSM-HB CCNPP TC**	**ISFSI USAR**	**32PHB DSC CCNPP HSM-HB CCNPP FC-TC**	**Calculation NUH32PHB- calc#**	**32PTH DSC (unless noted) HSM-H OS197FC TC**	**CoC 1004 NUH-003 Rev. 10 or CoC 1030 NUHOMS-HD Rev. 3**
Tornado Missiles	Automobile - 3,967 lb 8" diam shell - 276 lb 1" solid sphere	Automobile - 3,967 lb 8" diam shell - 276 lb 1" solid sphere		Utility pole, Armor Piercing Shell, 12" OD Steel Pipe, 4000 lb auto		Utility pole, Armor Piercing Shell, 12" OD Steel Pipe – No penetration, some scabbing 4000 lb auto – 0.34" slide & no overturning	P.2.2.5.2.3, P.3.7.1, P.11.2.3
Seismic Criteria	0.15g horizontal 0.10g vertical 7% critical damping	0.15g horizontal 0.10g vertical 7% critical damping	2.6.2.3, 3.2.3, 8.2.3, 12.8.2.3, Table 3.6-3	0.3g horizontal 0.2g vertical 7% critical damping	0208	0.3g horizontal 0.2g vertical	Table P.2-18, P.2.2.5.2.3, P.3.7.2
Flooding	Not applicable Dry Site	Not applicable Dry Site	3.2.2, 8.2.4, 12.8.2.4, Table 3.6-3	Not applicable Dry Site	N/A	50' static head 15 fps flow	Table P.2-18 P.3.7.3
Cask Drop Height 75g vertical end drop 75g horizontal side drop 25g corner drop with slapdown (corresponds to 80" drop height) Structural damping: 10%	80 inches	80 inches	8.2.5, 12.8.2.5, Table 3.6-3	80 inches	0111 0203 0207	80 inches	3.7.3.7 TC Impact Analysis 11.3.1 Cask Drop
Cask Drop Dose (due to loss of neutron shield)	776 mrem at 15 feet in 8h	1164 mrem at 15 feet in 8h		1218 mrem at 15 feet in 8h	0502	2390 mrem at 1 meter in 8h	NUHOMS-HD Table 5-23
Lightning	No impact	No impact	8.2.6, 12.8.2.6	No impact		No impact	NUHOMS-HD Section 11.3.7 NUH-003 Section P.3.7.5
Blocked Vent Restoration Time	24 hours	12 hours	8.2.7, 12.8.2.7	16 hours	0403(ML12173A182) 0410	34 hours	NUHOMS-HD Section 4.4.5 TS 5.2.5
Blocked Vent Recovery Dose < 5 Rem	584 mrem in 8h	488 mrem in 8h		968 mrem in 8h	0503(ML12093A106)	2856 mrem in 8h	NUHOMS-HD Table 5-21
Blocked Vent HSM Temperature < 395°F	391°F w/48hr blocked vent	387°F w/36 hr blocked vent		416°F w/36 hr blocked vent 426°F w/40 hr blocked vent	0410	377°F	NUHOMS-HD Table 4-6

ENCLOSURE 1

Comparison Matrix

Parameter Limits or Design Requirements	Calvert Cliffs Site Specific: 24P DSC CCNPP HSM CCNPP TC	32P DSC CCNPP HSM CCNPP HSM-HB CCNPP TC	ISFSI USAR	32PHB DSC CCNPP HSM-HB CCNPP FC-TC	Calculation NUH32PHB- calc#	General License: 32PTH DSC (unless noted) HSM-H OS197FC TC	CoC 1004 NUH-003 Rev. 10 or CoC 1030 NUHOMS-HD Rev. 3
Confinement/DSC Leakage	17.8 mrem skin 0.11 mrem WB	109.6 mrem skin 0.65 mrem WB	8.2.8, 12.8.2.8	N/A Leaktight	N/A	N/A Leaktight	N/A
Accidental Pressurization (psig)	49.9	<99.4 (83.6)	8.2.9, 12.8.2.9	91.4	0404	91.0	NUHOMS-HD Table 4-10
Forest Fire Accident (1 hr fire 65' from HSM)	4.5" spallation 21 mrem/hr	6" spallation 60.4 mrem/hr	8.2.10, 12.8.2.10, Table 3.6-3	9" spallation 59.3 mrem/hr	0409 0503(ML12093A106)	N/A	N/A
LNG Spill/Explosion Probability <10-7 /yr	Overpressure <1psi – No Impact	Overpressure <1psi – No Impact	8.2.11, 12.8.2.11	Overpressure <1psi – No Impact	N/A	N/A	N/A
Flammable Liquid Fire	200 gal. diesel, 190"OD pool, 15 min	200 gal. diesel, 190"OD pool, 15 min	8.2.13, 12.8.2.13	200 gal. diesel, 190"OD pool, 15 min	0402(ML12093A104) 0403(ML12173A182)	300 gal diesel, 200" OD pool, 15 min	NUHOMS-HD Section 4.4.1.1
Aircraft Hazards Assessment	5.8E-8/yr for 55,448 ft2 ISFSI		2.2.1	No change same ISFSI footprint	N/A	Qualitative discussion only	2.2

(1) A Technical Specification Amendment was issued for 24P for a maximum weight of 1450 lbs including allowance for control components. This was decreased for 32PHB by eliminating control component allowance to compensate for increased basket weight.

ENCLOSURE 2

Draft USAR Chapter for NUHOMS 32PHB DSC

13.0 NUHOMS-32PHB DRY SHIELDED CANISTER

An evaluation of the Nutech Horizontal Modular Storage / Nuclear Horizontal Modular Storage (NUHOMS)-32PHB Dry Shielded Canister (DSC) used in the NUHOMS dry storage system is presented in this chapter. Chapter 1 is revised to include information for the NUHOMS-24P, NUHOMS-32P, and NUHOMS-32PHB DSCs. Chapters 2 through 11 primarily apply to the NUHOMS-24P DSC, whereas USAR Sections 12.2 through 12.11 provide the same information as it applies to the NUHOMS-32P DSC and USAR Sections 13.2 through 13.11 provide similar information as it applies to the NUHOMS-32PHB DSC.

General references (i.e., calculations) are identified throughout the body of this chapter, and are listed in USAR Section 13.13. General references are intended to provide background information or additional detail that the reader may refer to in order to learn more about a particular topic presented in this document, but are not considered part of the Calvert Cliffs Nuclear Power Plant (CCNPP) Independent Spent Fuel Storage Installation (ISFSI) Updated Safety Analysis Report (USAR). A referenced document shall be considered to be a part of the USAR only if it is clearly annotated as being "incorporated by reference" in Chapter 13 of this report. Documents that are incorporated by reference are subject to the same administrative controls and regulatory requirements as the USAR.

13.1 INTRODUCTION AND GENERAL DESCRIPTION OF INSTALLATION

The introduction and general description of the NUHOMS-32PHB DSC and the horizontal storage module - high burnup model (HSM-HB) is integrated into Chapter 1.

The NUHOMS-32PHB DSCs is designed to safely store 32 spent nuclear fuel assemblies with a maximum initial enrichment of 5.0 weight percent of U-235 and a maximum assembly average burnup of 62,000 MWD/MTU for AREVA fuel and 60,000 MWD/MTU for the Standard and Value Added Pellet (VAP) fuels (Reference 13.2, Table 4-2). The fuel-loaded HSM-HB are designed to handle heat loads up to 29.6 kW per canister with exterior dose rates at or below 100 mR/hr at the shield door and 20 mR/hr on the exterior sides and roof of the HSM-HB (Reference 13.2, Section 12 p.61). The HSM-HBs were prefabricated off site and assembled at the CCNPP ISFSI site whereas the original CCNPP HSMs were poured in place.

The DSC basket assembly provides a stainless steel guide sleeve for each fuel assembly. Structural support for the guide sleeves and fuel assemblies in the lateral and longitudinal direction is provided by a series of basket plates and rails. The DSC shell supports the fuel assembly along its entire length. The NUHOMS-32P and NUHOMS-32PHB DSCs are very similar in design. The major difference between the two DSCs is the type of rails used to support the DSC fuel basket. Solid aluminum rails are used to support the NUHOMS-32PHB DSC fuel basket, whereas the NUHOMS-32P DSC has stainless steel and aluminum transition rails but most of the periphery space between the DSC shell and the fuel basket is open space. Also, the NUHOMS-32PHB DSCs has a fuel basket design with poison plates that have a minimum B^{10} areal density of 0.019 g/cm^2 and 0.027 g/cm^2 for Type A and B baskets, respectively, while the NUHOMS-32P DSC has a fuel basket design with poison plates that have a minimum B^{10}areal density of 0.0100 g/cm^2 (Reference 13.33, Table 6.4-12).

13.2 SITE CHARACTERISTICS

The CCNPP ISFSI site characteristics are discussed in Chapter 2. The evaluation presented in Chapter 2 encompasses discussion of the NUHOMS-32PHB DSC and the associated modular constructed HSM-HB as part of the NUHOMS System used at CCNPP.

13.3 PRINCIPAL DESIGN CRITERIA

13.3.1 PURPOSE OF THE CALVERT CLIFFS INDEPENDENT SPENT FUEL STORAGE INSTALLATION

Information contained in USAR Section 3.1 is applicable to the NUHOMS-32PHB DSC and the HSM-HB.

13.3.2 STRUCTURAL AND MECHANICAL SAFETY CRITERIA

Compared to the existing NUHOMS-24P DSC, the main difference in the principal design parameters for the NUHOMS-32PHB DSC, as in the case for the NUHOMS-32P DSC, consists of an increase in canister weight, radiological source, and decay heat due to the addition of eight more fuel assemblies, higher burnup fuel, and modifications to the DSC basket assembly. The NUHOMS-32P and NUHOMS-32PHB DSCs are very similar in design. The major differences between the two DSCs are the solid aluminum rails used to support the NUHOMS-32PHB DSC fuel basket, and the higher minimum B10 areal density of the NUHOMS-32PHB DSC poison plates (Reference 13.3).

The NUHOMS-32PHB DSC is handled, loaded, and sealed in the same manner as the NUHOMS-24P and NUHOMS-32P DSCs before being transported to the ISFSI. The transport to the ISFSI is done utilizing the self-propelled modular transporter which is shared between various Constellation Energy Nuclear Group, LLC stations and ISFSIs. At the ISFSI, due to high burnup fuel characteristics, the NUHOMS-32PHB DSC is stored in a modular constructed HSM-HB and will not be placed into one the original poured in place HSMs. The environmental conditions and natural phenomena for a NUHOMS-32PHB DSC are the same as those described in USAR Section 3.2.

13.3.2.1 Tornado Wind and Tornado-Generated Missile Loadings

The principal tornado wind and tornado-generated missile loading criteria are not dependent on the type of DSC or HSM employed and, therefore, are the same for the NUHOMS-32PHB, NUHOMS-32P and NUHOMS-24P DSCs and the original poured in place HSMs and the HSM-HBs. The tornado wind and tornado-generated missile loading criteria are described in USAR Section 3.2.1. They are based on Reference 13.45, which applies to the NUHOMS-24P DSC, but are applicable to the NUHOMS-32PHB DSC as well.

Evaluation of the NUHOMS-32PHB DSC for tornado wind and tornado generated missiles is presented in USAR Section 13.8.2.2.

13.3.2.1.1 Applicable Design Parameters

Applicable design parameters for the design basis tornado wind intensities are the same for the modular constructed HSM-HB and the original poured in place HSM (Reference 13.10, Section 7 and Table 7-2).

13.3.2.1.2 Determination of Forces on Structures

Tornado wind and missile loads were calculated using the method described in Reference 13.10, Section 7.1 and Table 7-2.

13.3.2.1.3 Ability of Structures to Perform

The analyses of the HSM-HB and transfer cask for tornado effects are contained in Reference 13.10, Section 7.1 and USAR Section 8.2.2.

The possibility of blocking the ventilation air openings by a foreign object during a tornado event is considered. The effects of ventilation opening blockage are presented in USAR Section 13.8.2.7.

13.3.2.1.4 Tornado Missiles

The effects of tornado missiles defined by Regulatory Guide (RG) 1.76, for the transfer cask, were evaluated and reported in USAR Section 8.2.2.

The determination of impact forces created by design basis tornado (Reference 13.10, Section 7.1 or Table 7-2) generated missiles for the HSM-HB is based on the criteria provided by NUREG-0800, Section 3.5.1.4, III.4. Accordingly, eight types of missiles are postulated:

1. The utility wooden pole, 13.5 inch diameter, 35 feet long missile weighing 1500 lbs at a horizontal velocity of 294 fps.

2. The armor piercing artillery shell 8 inch diameter, weighing 276 lbs at a horizontal velocity of 185 fps.

3. The steel pipe missile 12 inch diameter, Schedule 40, 30 foot long weighing 1500 lbs at a horizontal velocity of 205 fps.

4. The massive automobile missile weighing 4000 lbs at a horizontal velocity of 195 fps traveling through the air not more than 25 feet above the ground and having contact area of 20 square feet.

5. Wood plank missiles traveling end on, 200 lbs, traveling at 440 fps.

6. Steel Pipe 3 inch diameter, Schedule 40, weighing 115 lbs, traveling at 268 fps.

7. Steel Pipe 6 inch diameter, Schedule 40, 285 lbs, traveling at 230 fps.

8. Steel rod, 1 inch diameter, 3 feet long weighing 8 lbs traveling at 317 fps.

For the overall effects of a design basis tornado (DBT) missile impact, overturning and sliding of the HSM-HB, the force due to the deformable massive missile impact is applied to the structure at the most adverse location. Conservation of momentum is assumed to demonstrate that sliding and/or tipping of the module will not result in an unacceptable condition for the module. The coefficient of restitution is assumed to be zero and the missile energy is transferred to the module to be dissipated as sliding friction, or an increase in potential energy due to raising the center of gravity. The force is evenly distributed over the impact area. The magnitude of the impact force for design of the local reinforcing is calculated in accordance with Bechtel Topical Report "Design of Structures for Missile Impact".

For the local damage analysis of the HSM-HB for DBT missiles, three governing missiles are used for the evaluation of concrete penetration, spalling, scabbing and perforation thickness. The modified National Defense Research Committee (NDRC) empirical formula is used for this evaluation as recommended in NUREG-0800, Section 3.5.3. The results of these evaluations are reported in USAR Section 13.8.2.2.

13.3.2.2 Water Level (Flood) Design

As stated in USAR Section 3.2.2, the CCNPP ISFSI is not subject to flooding.

13.3.2.3 Seismic Design

Evaluation for the use of the NUHOMS-32PHB DSCs for seismic loading is presented in USAR Section 13.8.2.3.

The seismic design criteria for the modular constructed HSM-HB are consistent with the criteria for original poured in place HSM, with the exception that the RG 1.60 response spectra is anchored to a maximum ground acceleration of 0.30g (instead of 0.25g) for the horizontal components and 0.20g (instead of 0.17g) for the vertical component (Reference 13.10, Table 7-2). The results of the frequency analysis of the HSM-HB structure (which includes a simplified model of the DSC) yield a lowest frequency of 23.2 Hz in the transverse direction and 28.4 Hz in the longitudinal direction (Reference 13.10, Table 7-9). The first significant Y (vertical) direction mode has a frequency of 53.49 Hz and is in the rigid range. The corresponding spectral acceleration is 0.20g (Reference 13.10, Table 7-9). Thus, based on the RG 1.60 response spectra amplifications, the corresponding seismic accelerations used for the design of the HSM-

HB are 0.37g and 0.33g in the transverse and longitudinal directions respectively and 0.20g in the vertical direction. The corresponding accelerations applicable to the DSC are 0.41g and 0.36g in the transverse and longitudinal directions, respectively, and 0.20g in the vertical direction (Reference 13.10, Section 7.5). The seismic analysis of the HSM-HB and NUHOMS-32PHB DSC are further discussed in USAR Section 13.8.2.3

13.3.2.4 Snow and Ice Loadings

The snow and ice load analysis methodology and results for a transfer cask loaded with a NUHOMS-32PHB or NUHOMS-24P DSCs are the same, and are described in USAR Section 3.2.4.

The snow and ice load analysis methodology for the modular constructed HSM-HB and the original poured in place HSM is the same, and is described in USAR Section 3.2.4. The results for the modular constructed HSM-HB snow and is loading analysis are provided in Reference 13.10, Section 7.1 Live Loads).

13.3.2.5 Combined Load Criteria

13.3.2.5.1 HSM-HB

The CCNPP site-specific load combinations matrix and design criteria for the modular constructed HSM-HB storing the NUHOMS-32PHB DSC is presented in Section 7.3 of Reference 13.10 (Table 7-6) and in USAR Table 13.3-7.

Structural evaluation of the modular constructed HSM-HB for the NUHOMS-32PHB DSC is presented in USAR Section 13.8.2.12.

13.3.2.5.2 NUHOMS-32PHB DSC

The CCNPP site-specific load combinations for the NUHOMS-32PHB DSC are presented in USAR Table 13.3-6.

Structural evaluation of the NUHOMS-32PHB DSC basket assembly is presented in USAR Section 13.8.

13.3.2.5.3 Transfer Cask in the Forced-Cooling Configuration

The transport to the ISFSI is done utilizing the self-propelled modular transporter which is shared between various Constellation Energy Nuclear Group, LLC stations and ISFSIs. At the ISFSI, due to high burnup fuel characteristics, the NUHOMS-32PHB DSC is stored in a modular constructed HSM-HB and will not be placed into one the original poured in place HSMs. When utilized with the NUHOMS-32PHB DSC, the transfer cask is in the forced-cooling configuration for heat loads greater than Table 7-1 of Reference 13.26, Section 7.

In the forced-cooling configuration, the transfer cask utilizes a top lid with vents around the perimeter. The added vents permit passage of cooling airflow that is circulated through the ram access opening at the bottom of the cask. To provide distribution of the blower airflow to the transfer cask/DSC annulus region, ten wedge shaped half inch thick steel plates are attached to the inside bottom plate of the transfer cask to form radial channels emanating from the ram access opening to the transfer cask/DSC annulus (Reference 13.3). The air circulation system is sized to provide a minimum capacity of 450 cfm (Reference 13.20). The airflow circulates through the annulus between the transfer cask and the DSC, and exits through the top lid vents. Two industrial grade motor driven redundant blowers with associated ductwork are connected to the transfer cask ram cover plate opening. This provides a reliable source of external air circulation for the in the transfer cask (USAR Chapter 1 figures are provided to show the spacers for forced cooling, force air cooling modifications and the transfer cask ram connection).

The analysis in USAR Section 3.2 for the transfer cask in the non-forced-cooling configuration is applicable for the transfer cask is in the forced-cooling configuration, unless stated otherwise in USAR Chapter 13.

The CCNPP site-specific load combinations and allowable stress criteria for the transfer cask are the same as those presented in USAR Section 3.2.5.3 and a more detailed the bounding load combination for NUHOMS-32PHB DSC is given in Table 5-1 of Reference 13.6.

Structural evaluation of the transfer cask for the NUHOMS-32PHB DSC is presented in USAR Section 13.8.

13.3.2.5.4 System Transfer Equipment

The system transfer equipment for the NUHOMS-32PHB DSC consists of the self-propelled modular transporter, the transfer cask support skid and the hydraulic ram used with self-propelled modular transporter. This equipment is non-safety-related and is designed, fabricated, and operated in accordance with applicable industry codes and standards. USAR Chapter 4 provides a discussion of the design loads, codes, and standards for the system transfer equipment. Reference 13.41 qualifies the SPMT for the turn-over loads. Since the resisting moment of the SPMT is greater than the overturning wind loads, the SPMT is qualified.

The self-propelled modular transporter is used to transport a fuel-loaded NUHOMS-32PHB DSC from the Auxiliary Building to the ISFSI. The ram system and transfer cask support skid for this vehicle are different than the original transport system utilized for NUHOMS-24P DSC and NUHOMS-32P DSC.

The transfer cask utilized is the same as for the NUHOMS-24P DSC and NUHOMS-32P DSC, but it is configured in the forced-cooling configuration.

13.3.2.6 Weld Requirements

The NUHOMS-32PHB DSC shell assembly welded joint details are the same as for the NUHOMS-32P DSC shell assembly and are presented in Section 12.3.2.6. (References 13.6, Section 12.0 App. B and 13.39).

The NUHOMS-32PHB DSC basket structure welded joint details are shown in Reference 13.3, Section 9, Appendix sketches. Full penetration welds in the DSC basket assembly are examined by progressive penetrant test examination in accordance with the requirements of paragraph NG-5231 of the American Society of Mechanical Engineers (ASME) Code Section III, Subsection NG (References 13.38 and ASME Section V nondestructive examination).

Hot transfer condition temperatures for NUHOMS-32P DSC are bounding for NUHOMS-32PHB DSC. Thus thermal stress evaluation for transfer condition is not performed in Reference 13.6. See Figure 3 in Reference 13.6 for temperature distribution plots.

The individual load case stress results for the NUHOMS-32PHB DSC components are obtained by directly using results of NUHOMS-32P components except for the storage condition thermal stress results.

For thermal stress calculation lead material is assumed to be bilinear-plastic material thermal properties with 1% tangent modulus. The elastic-plastic strain hardening is used to model the confinement state of the lead after thermal expansion.

The NUHOMS-32PHB DSC is identical to NUHOMS-32P DSC, the only major difference being NUHOMS-32PHB basket has solid aluminum rails compared to stainless steel rails in the NUHOMS-32P basket. The other change is the lifting fixture of NUHOMS-32PHB which replaces the lifting blocks welded to inner bottom plate for NUHOMS-32P DSC with lifting lugs welded at the support ring at the top. These lifting lugs are evaluated in Reference 13.15.

The NUHOMS-32PHB canister evaluation criteria are based on the rules of the ASME Code Section III. Per Reference 13.2, all components of the NUHOMS-32PHB DSC are evaluated per Subsection NB of the Code. For welds of non-pressure-retaining parts, criteria are guided by the Code rules for component supports. The component and weld qualification criteria are documented in Reference 13.2. The DSC welds are evaluated in Reference 13.6, Section 12, Appendix B.

Results provided in Reference 13.6 are based on the results provided in the NUHOMS-32P DSC structural analysis. Table 4-3 of Reference 13.6 provides a comparison of loading condition between the NUHOMS-32P and the NUHOMS-32PHB DSC.

13.3.3 SAFETY PROTECTION SYSTEMS

13.3.3.1 General

USAR Section 3.3 discusses the CCNPP ISFSI design for the safe and secure long-term containment and storage of spent fuel. The NUHOMS-32PHB DSC is designed for storage of spent nuclear fuel as described in USAR Section 3.3.1 and in the following subsections.

13.3.3.2 Protection by Multiple Confinement Barriers and Systems

The NUHOMS-32PHB DSC provides confinement of the spent fuel similar to the NUHOMS-24P DSC and the NUHOMS-32P DSC. Sealing of the NUHOMS-32PHB DSC is leak tested in accordance with American National Standards Institute (ANSI) N14.5 after loading and sealing the canister, as described in USAR Section 3.3.2. Thus, the NUHOMS-32PHB DSCs are considered to be leak-tight per ANSI N14.5-1997.

Containment of radioactive material associated with spent fuel assemblies is provided by fuel cladding, the DSC stainless steel shell and double seal welded primary and secondary closures. As described in USAR Section 3.3.2, there are no credible events that will breach a DSC to provide a possible leakage path to the environment.

13.3.3.3 Protection by Equipment and Instrumentation Selection

The discussion in USAR Section 3.3.3 is applicable to the NUHOMS-32PHB DSC.

The HSM-HBs are built with the ability to accommodate a temperature monitoring system whereas the current poured in place HSMs are not equipped with a temperature monitoring system. The temperature monitoring system is not important to safety instrumentation and the loss of the system will not impact the safety function of the HSM-HBs to provide passive cooling to the DSCs. The air inlet and outlet vents of the HSM-HB may be visually inspected for obstructions during any interruption of the operability of the HSM-HB temperature monitoring system.

13.3.3.4 Nuclear Criticality Safety

The NUHOMS-32PHB DSC internals are designed to provide nuclear criticality safety during all phases of dry cask storage operations and storage, including wet loading operations and postulated accident conditions. The CCNPP site-specific NUHOMS-32PHB DSC design satisfies the requirements of 10 Code of Federal Regulations (CFR) 72.124 for normal, off-normal, and accident conditions.

13.3.3.4.1 Control Methods for Prevention of Criticality

Criticality control is provided during the transfer cask fuel loading, DSC drying and sealing (wet conditions), and the transfer and storage phases (dry conditions). Control methods for the prevention of criticality under wet conditions consist of the physical properties of the fuel, fixed neutron absorbers in the NUHOMS-32PHB DSC basket, 2,450 ppm (Reference 13.33) soluble boron in the spent fuel pool water, and CCCNPP's administrative controls for fuel identification, verification, and handling.

Rigorous measures are taken to exclude the possibility of introducing moderator into the DSC cavity during the dry operations of transfer and storage. Prior to these operations, the DSC is vacuum dried, backfilled with helium, double seal welded, and helium leak tested to assure weld integrity. Therefore, under normal operating conditions there is no possibility of a criticality incident. Since the transfer cask in the forced-cooling configuration and the HSM-HB are designed to provide adequate drop and/or missile protection for the DSC, there is no credible accident scenario which would result in the possibility of the introduction of a moderator into the DSC; nor is there a credible accident scenario which would prohibit the canister from being opened and re-flooded.

13.3.3.4.2 Design Parameters for Criticality Model

The design basis criticality analysis uses design parameters for Westinghouse/CE design 14x14 VAP fuel assemblies and AREVA 14x14 fuel lattices containing UO_2 enriched up to 5.0 wt% U^{235} with geometry and fuel characteristics as shown in Table 3.3-3 (Reference 13.33, Section 6.1). The nominal dimensions of the NUHOMS-32PHB DSC are provided in USAR Table 13.3-1. A summary of the design parameters for the criticality analysis is presented in USAR Table 13.3-2.

13.3.3.4.3 Criticality Analysis Methods

Effective neutron multiplication factors, k_{eff}, are calculated using the CSAS5 of the SCALE-6 package of codes, and the 44 Group ENDF-V cross-section library. The CSAS5 control module allows simplified data input to the functional modules BONAMI-S, NITAWL-S, and KENO V.a. These modules process the required cross-sections and calculate the k_{eff} of the system. BONAMI-S performs resonance self-shielding calculations for nuclides that have Bondarenko data associated with their cross sections. NITAWL-S applies a Nordheim resonance self-shielding correction to nuclides having resonance parameters. Finally, KENO V.a calculates the k_{eff} of a three-dimensional system. A sufficiently large number of neutron histories are run so that the standard deviation is below 0.0010 for all calculations.

The final k_{eff} that is calculated represents the maximum value of the effective multiplication factor with a 95% probability at a 95% confidence level (95/95). The "worst case" k_{eff} values from the CSAS5 output are adjusted for uncertainty, such that:

$$k_{eff} = k_{keno} + 2\sigma_{keno}$$

A series of 102 benchmark criticality calculations are documented in Reference 13.34, Section 3.2. These calculations assume unirradiated fuel in the criticality analysis and use the SCALE-6 computer code package. The upper subcriticality limit (USL), as described in Section 4 of NUREG/CR-6361, is determined using the results of these 102 benchmark calculations (Reference 13.34, Section 3.2). The benchmark problems used to perform this verification are representative of benchmark arrays of commercial light water reactor fuels with the following characteristics:

- water moderation
- boron neutron absorbers
- unirradiated light water reactor type fuel (no fission products or "burnup credit")
- near room temperature (vs. reactor operating temperature)
- close reflection
- uranium oxide fuel

The 102 uranium oxide experiments are chosen to model a wide range of uranium enrichments, fuel pin pitches, assembly separation, water/fuel ratio, concentration of soluble boron and control elements in order to test the codes ability to accurately calculate k_{eff}. The minimum value of the USL from Reference 13.34, Table 2 over the parameter range (in this case, the assembly separation distance) is 0.9410 (0.9410 is shown in Reference 13.33, Table 6.5-2 Section 6.1). This USL value (0.9410) is based on a methodology bias and an administrative 5% margin on criticality. That is, k_{eff} < USL, ensures that k_{eff} is less than 0.95 (with 95% probability and 95% confidence) when bias and uncertainty are taken into account.

For the criticality analyses, the criticality limits are shown in the following equation:

$$k_{eff} = (k_{keno} + 2\sigma_{keno}) \leq 0.9410$$

(Reference 13.33, Table 6.5-2 Section 6.1)

13.3.3.4.4 Normal Conditions

The calculated normal condition, "worst-case," reactivity (maximum k_{eff}) of a fully loaded NUHOMS-32PHB DSC is 0.9363 for a Type A basket and 0.9358 for a Type B basket (Reference 13.33, Table 6.4-12). This is below the USL (0.9410), thus confirming that the "worst case" k_{eff} is $\leq$ 0.9410. It conservatively includes allowances for uncertainties due to fuel positioning, basket rail modeling, compartment tube dimensions, poison plate thickness, and optimum moderator density. The "worst case" configuration includes the following:

- no credit for burnable absorbers in the fuel rods (e.g., erbia, etc.),
- fuel is unirradiated,
- the maximum uniform enrichment, 5.0 wt% U^{235}, for all 32 fuel assemblies,
- an "inward" loading of all the 32 CE 14x14 fuel assemblies (i.e., all fuel assemblies are shifted toward the center of the DSC),
- credit for 90% of the of the absorber material (B^{10}) in the fixed neutron absorbers in the NUHOMS-32PHB DSC basket assembly,
- a minimum compartment tube dimension of 8.47 inches,
- an internal moderator (soluble boron at 2,450 ppm Reference 13.33, Table 6.4-12) density of 0.75 (Reference 13.33, Table 6.4-11).
- an external (to the DSC and internal to the transfer cask) moderator (pure water) density of 100% (Reference 13.33, Table 6.3-1).

13.3.3.4.5 Off-Normal Conditions

Three postulated off-normal conditions are analyzed:

- Cask Drop Accidents,
- B^{10} Absorber Plates at Minimum Thickness, and
- Optimum Moderator Density.

These analyses confirm that the off-normal conditions will not result in a DSC storage array with a reactivity higher than the USL of 0.9410 (Reference 13.33, p.26 Section 6.4.3).

Cask Drop Accidents

The criticality analysis for the cask drop accidents demonstrates that the most reactive configuration is the triple contingency accident involving fuel damage, optimum pitch (due to grid deformation), and optimum moderator density. For the borated water moderated system, the maximum k_{eff} is 0.9363 for a Type A basket and 0.9358 for a Type B basket, which is also below the USL (0.9410).

B^{10} Poison Plate Thickness Variation

The criticality analysis for sensitivity to B^{10} absorber plate thickness demonstrates that there is enough conservatism in the plate loadings of 19.0 and 27.0 mg B^{10}/cm^2 for Type A and B baskets, respectively, to offset changes in reactivity due to a reduction in thickness. Credit is taken for 90% of the B^{10} loading in the analysis. For the "worst case," with a Type B basket loading of 24.3 mg/cm^2, a thickness of 0.0791 inches, a maximum enrichment of 5.0%, and optimum moderator density, the k_{eff}, is calculated to be 0.9358 (Reference 13.33, Table 6.4-12). For the "worst case," with a Type A basket B^{10} loading of 17.1 mg/cm^2, a thickness of 0.0791 inches, a maximum enrichment of 4.75%, and optimum moderator density, the k_{eff} is calculated to be 0.9363 (Reference 13.33, Table 6.4-13).

USAR Section 13.3.3.4.7 has a detailed discussion on poison plate acceptance testing.

Optimum Moderation

Since all reported reactivities include an allowance for optimum moderator density, and all reported reactivities are less than the USL, a criticality event due to moderator density alone is not credible. Therefore subcriticality is assured, even in the event that a flooded DSC remains out of the pool long enough for boiling to occur.

13.3.3.4.6 Criticality Analysis Method Verification

The analysis method which ensures a subcriticality margin of greater than 5% under all normal conditions uses the CSAS5, of the SCALE-6 package of codes, and the 44 Group ENDF-V cross-section library.

A series of 102 benchmark criticality calculations are documented in Reference 13.34. These calculations assume unirradiated fuel in the criticality analysis and use the SCALE-6 computer code package to demonstrate its applicability and to establish methods bias and variability.

13.3.3.4.7 B^{10} Poison Plate Testing

Description

The poison plates consist of wrought aluminum containing boron, which is isotopically enriched to approximately 95 wt% B^{10}. Because of the negligibly low solubility of boron in solid aluminum, the boron appears entirely as discrete second phase particles of AlB_2 in the aluminum matrix. The effect on the properties of the matrix aluminum alloy are those typically associated with a uniform fine (1-10 micron) dispersion of an inert equiaxed second phase.

The nominal plate thickness is 0.125 inches.

The design minimum B^{10} areal density is 19.0 mg B^{10}/cm^2 for a Type A basket and 27.0 mg B^{10}/cm^2 for a Type B basket (Reference 13.33, Table 6.4-14).

Functional Requirements of Poison Plates

The poison plates serve as a neutron absorber for criticality control and as a heat conduction path. The NUHOMS-32PHB DSC safety analysis does not rely upon their mechanical strength. The radiation and temperature environment in the DSC is not severe enough to damage the aluminum matrix that retains the boron-containing particles. To assure performance of the plates' important-to-safety functions, the critical variables that need to be verified are thermal conductivity and B^{10} areal density.

Borated Aluminum Test Coupon and Lot Definitions

Test coupons will be taken so that there is at least one coupon contiguous with each plate. These coupons will be used for neutron transmission and thermal conductivity testing.

A lot is defined as all the plates produced from a single cast ingot, or all the plates produced from a single heat.

Thermal Conductivity Testing of Poison Plates

The poison plate material is qualification-tested to verify that the thermal conductivity equals or exceeds the design requirements.

Testing may be by American Society for Testing and Materials (ASTM) E1225, ASTM E1461, or equivalent method.

B^{10} Areal Density Testing of Poison Plates

The testing program for the NUHOMS-32PHB DSC poison plates meet the requirements of NUREG/CR-5661.

The effective B^{10} content is verified by neutron transmission testing of the coupons. The transmission through the coupons is compared with transmission through calibrated standards. The neutron transmission testing measurements are taken using a collimated neutron beam. The neutron transmission test procedure includes provisions to vary the selected measurement location along the coupon length.

The acceptance criterion for neutron transmission testing is that the B^{10} areal density, minus 3σ based on the number of neutrons counted for that measurement, must be greater than or equal to the minimum value of 19.0 and 27.0 mg B^{10}/cm^2 for Type A and B baskets, respectively.

Macroscopic uniformity of B^{10} distribution is verified by neutron radioscopy/radiography of the coupons. The acceptance criterion is that there is uniform luminance across the coupon. This inspection shall cover the entire coupon. If a coupon fails this test, the associated plate is rejected.

In addition, a statistical analysis of the neutron transmission results for all plates in a lot is performed. This analysis shall demonstrate, using a one-sided tolerance limit factor for a normal distribution with at least 95% probability, the areal density is greater than or equal to the specified minimum value of 19.0 and 27.0 mg B^{10}/cm^2 for Type A and B baskets, respectively, with 95% confidence level.

13.3.3.5 Radiological Protection

The discussion presented in USAR Section 3.3.5 is not affected by the addition of the NUHOMS-32PHB DSC and the HSM-HB to the NUHOMS System. However, the maximum contact dose on the exterior surface of the transfer cask containing a fuel-loaded NUHOMS-32PHB DSC has been increased to 250 mrem/hr from 200 mrem/hr for a transfer cask loaded with a fuel-loaded NUHOMS-24P or NUHOMS-32P DSC. See USAR Section 13.7 for additional discussion on radiation protection design considerations for the NUHOMS-32PHB DSC and the HSM-HB.

13.3.3.6 Fire and Explosions Protection

The discussion presented in USAR Section 3.3.6 is applicable to the NUHOMS-32PHB DSC and the HSM-HB. The effects of a forest fire around the facility are discussed in USAR Section 13.8.2.10.

13.3.3.7 Materials Handling and Storage

The evaluation presented in USAR Section 3.3.7 is applicable to the NUHOMS-32PHB DSC and the HSM-HB, with the exception of peak cladding temperatures which are higher than those of the NUHOMS-32P DSC. For long-term storage, the HSM-HB passive ventilation maintains the maximum normal operating fuel clad temperature at 724°F or less (assuming a 104°F ambient temperature) as documented in Reference 13.23, Table 6-1. During short-term conditions, such as DSC draining and drying, transfer of the DSC to/from the HSM-HB, the maximum fuel cladding temperature is 728°F as documented in References 13.23 and 13.28, which remains below the limit of 752°F. For off-normal and accident temperature conditions (Reference 13.23), the fuel cladding temperature maximum value is 932°F (Reference 13.23, Table 6-

1 only for an accident with high burnup), which is significantly less than the maximum allowable value of 1,058°F.

As documented in Reference 13.28, Section 4.1, backfilling the DSC with helium gas causes a one time temperature drop, which is not considered as a repeated thermal cycling. Re-evacuation of the DSC under a helium atmosphere does not reduce the pressure sufficiently to decrease the thermal conductivity of helium. Therefore, re-evacuation and re-pressurizing the DSC under a helium atmosphere proceeds on a descending curve to the minimum steady state temperatures, and does not include any thermal cycling. It is concluded that the limit of 65°C (117°F) considered for thermal cycling during loading operations is satisfied for the NUHOMS-32PHB DSC system.

13.3.3.8 Industrial and Chemical Safety

The discussion presented in USAR Section 3.3.8 is applicable to the NUHOMS-32PHB DSC and the HSM-HB.

13.3.4 CLASSIFICATION OF STRUCTURES, COMPONENTS, AND SYSTEMS

The discussion presented in USAR Section 3.4 is applicable to the NUHOMS-32PHB DSC and the HSM-HB.

13.3.5 DECOMMISSIONING CONSIDERATIONS

The discussion presented in USAR Section 3.5 is applicable to the NUHOMS-32PHB DSC and the HSM-HB.

13.3.6 SUMMARY OF DESIGN CRITERIA

USAR Tables 13.3-3 to 13.3-5 provide a summary of the design criteria information for the normal, off-normal, and accident conditions, respectively for the HSM-HB, NUHOMS-32PHB DSC and the transfer cask.

TABLE 13.3-1
NUHOMS-32PHB DRY SHIELDED CANISTER DIMENSIONS

GEOMETRY DESCRIPTION	NOMINAL DIMENSIONS (inches)
Guide Sleeve Inside Dimension	8.50
Guide Sleeve Thickness	0.1874
Center to Center Spacing	9.125
Stainless Steel Strip Thickness	0.25
Aluminum + Poison Plate Thickness	0.25 (0.245)
Basket Assembly Length	158.0 max.
DSC Shell Outside Diameter	67.25
DSC Shell Inside Diameter	66.0
DSC Shell Length (with grapple ring)	176.50
DSC Shell Thickness	0.625
Top Shield Plug Thickness	6.25
Top Cover Plate Thickness	1.25
DSC Lead Shielding Thickness	
• Top Shield Plug	4.0 min.
• Bottom Shield Plug	4.25 min.
Vent / Siphon Port Tube Inside Diameter	1.05

TABLE 13.3-2
DESIGN PARAMETERS FOR CRITICALITY ANALYSIS OF THE NUHOMS-32PHB DSC

PARAMETERS	DESIGN VALUE
FUEL ASSEMBLIES	
Number/Type	32/CE design 14x14
Rod Array	14x14
Number of Fuel Rods	176
Number of Control Rod Guide Tubes	5
Number of Instrument Tubes	1 (1 of the 5 guide tubes)
Rod Pitch (inches)	0.580
Burnup Credit	Not Applicable for the NUHOMS-32PHB DSC
FISSILE CONTENT	
wt% U^{235} (Standard)	4.5 max.
wt% U^{235} (VAP)	5.0 max.
wt% U^{235} (AREVA)	5.0 max.
FUEL PELLETS	
Density (Standard, Theoretical)	96.0% max
Density (VAP, Theoretical)	96.5% max
Density (AREVA, Theoretical)	96.0% max
Diameter (inches, Standard)	0.3765[a]
Diameter (inches, VAP)	0.3810
Diameter (inches, AREVA)	0.3805
FUEL ROD CLADDING	
Material	AREVA (M5)
Thickness (inches, Standard)	0.028[a]
Thickness (inches, VAP)	0.026
Thickness (inches, AREVA)	0.0315
Outside Diameter (inches, Standard)	0.440
Outside Diameter (inches, VAP)	0.440
Outside Diameter (inches, AREVA)	0.440
CONTROL ROD GUIDE TUBES	
Material	Zircaloy-4
Thickness (inches)	0.040
Outside Diameter (inches)	1.115
INSTRUMENT TUBE	
Material	Zircaloy-4
Thickness (inches)	0.040
Outside Diameter (inches)	1.115
DSC COMPARTMENTS	
Material	Stainless Steel
Thickness (inches)	0.1874
Inside Diameter (inches)	8.5
DSC POISON PLATES	
Number	150
Material	B4C MMC

TABLE 13.3-2
DESIGN PARAMETERS FOR CRITICALITY ANALYSIS OF THE NUHOMS-32PHB DSC

PARAMETERS		DESIGN VALUE
Density (g/cm^3)		2.52
Thickness (inches)		0.0791
B^{10} Areal density (mg/cm^2)		24.3
DSC FILL MATERIAL		
Material	(wet)	Borated Water (2,450 ppm min.)
Moderator Density	(wet)	0.01% to 100%
Material	(dry)	helium
Moderator Density	(dry)	1.785E-04 g/cm^3 /atm
DSC SHELL		
Material		Stainless Steel
Thickness (inches)		0.625
Outside Diameter (inches)		67.25
CASK		
Material		Stainless Steel/Lead
Thickness (inches)		6.25[(b)]
Outside Diameter (inches)		80.5[(b)]

(a) The fuel pellet outside diameter and clad thickness varied slightly for Fuel Batches A, B, and C in Units 1 and 2. These variances do not affect the results of the design basis analysis.

(b) Exclusive of the cask neutron shield.

TABLE 13.3-3
NUHOMS-32PHB DSC SUMMARY OF DESIGN CRITERIA FOR NORMAL OPERATING CONDITIONS

COMPONENT	DESIGN LOAD TYPE	REFERENCE	DESIGN PARAMETERS	APPLICABLE CODE
HSM-HB	Dead Load	13.10, 13.2	Dead weight including loaded DSC	ANSI 57.9-1984 ACI 349-85 and ACI 349R-85
	Load Combination	USAR Table 13.3-7	Load combination methodology	ANSI 57.9-1984 Sec 6.17.1.1
	Design Basis Operating Temperature	13.23, Table 4-9 Note 3	DSC with spent fuel rejecting 29.6 kW decay heat. Ambient air temperature range -8°F to 104°F	ANSI 57.9-1984
	Normal Handling Loads	13.2	Hydraulic ram load: 23,750 lb	ANSI 57.9-1984
	Snow and Ice Loads	USAR Section 3.2.4	Design load: 200 psf (included in live load)	ANSI 57.9-1984
	Live Loads	13.10	Design load: 200 psf	ANSI 57.9-1984
	Shielding	USAR Section 4.2.3.1 13.31	Contact dose rate on HSM-HB exterior surface ≤ 20 mrem/hr. HSM-HB door ≤ 100 mrem/hr.	ANSI 57.9-1984
DSC	Dead Loads	13.3	Weight of loaded DSC: 92,402 lb nominal, 95,000 lb enveloping	ANSI 57.9-1992
	Design Basis Internal Pressure Load	13.24	DSC internal pressure 15.0 psig	ANSI 57.9-1992
	Structural Design	13.6	Service Level A and B	ASME B&PV Code Sec III, Div 1, NB, Class 1
	Design Basis Operating Temperature Loads	13.23, Table 4-9 note 3	DSC decay heat 29.6 kW. Ambient air temperature -8°F to 104°F	ANSI 57.9-1992
	Operational Handling	13.2, Section 7.1.1	Hydraulic ram load: 23,750 lb	ANSI 57.9-1992
	Criticality	13.2, Section 3	K_{eff} less than 0.95	ANSI 57.9-1992

TABLE 13.3-3

NUHOMS-32PHB DSC SUMMARY OF DESIGN CRITERIA FOR NORMAL OPERATING CONDITIONS

COMPONENT	DESIGN LOAD TYPE	REFERENCE	DESIGN PARAMETERS	APPLICABLE CODE
DSC Support Assembly	Dead Loads		Loaded DSC + self weight: 95,900 lb	ANSI 57.9-1992 AISC Code
	Operational Handling	USAR Section 13.8.1	DSC reaction load with hydraulic ram load: 23,750 lb	ANSI 57.9-1992
Transfer Cask	Normal Operating Condition	13.2	Service Level A and B	ASME B&PV Code Sec III, Div 1, Class 2, NC-3200
Structure:				
Shell, Rings, etc.	Dead Loads	13.13	a) Vertical orientation, self weight + loaded DSC + water in cavity: 220,000 lb enveloping	ANSI 57.9-1984
			b) Horizontal orientation, self weight + loaded DSC on transfer skid: 215,000 lb enveloping	ANSI 57.9-1984
	Snow and Ice Loads	USAR Section 3.2.4	External surface temperature of cask will preclude buildup of snow and ice loads when in use: 110 psf	10 CFR 72.122
	Design Basis Operating Temperature Loads (Forced-cooling Configuration)	13.23, Table 4-9 note 3 13.26	Loaded DSC rejecting 29.6 kW decay heat. Ambient air temperature range -8°F to 104°F	ANSI 57.9-1984
	Shielding	USAR Section 13.7.1.2, 13.2	Contact dose rate ≤ 250 mrem/hr.	ANSI 57.9-1984

TABLE 13.3-3
NUHOMS-32PHB DSC SUMMARY OF DESIGN CRITERIA FOR NORMAL OPERATING CONDITIONS

COMPONENT	DESIGN LOAD TYPE	REFERENCE	DESIGN PARAMETERS	APPLICABLE CODE
Transfer Cask Upper Trunnions	Operational Handling	13.2, 13.8	a) Upper lifting trunnions while in Auxiliary Building: i) Stress must be less than yield stress for 6 times critical load of 126,500 lb/trunnion nominal (13.8) 13.2, Table 9-10	ANSI N14.6-1978
		13.2	ii) Stress must be less than ultimate stress for 10 times critical load	
		USAR Table 3.2-4	b) Upper lifting trunnions for on-site transfer: i) Dead Load +/- 1g vertically ii) Dead Load +/- 1g axially iii) Dead Load +/- 1g laterally iv) Dead Load (+/- 1/2g vertically +/- 1/2g axially + 1/2g laterally)	ASME B&PV Code Sec III, Div 1, Class 2, NC-3200
Lower Trunnions	Operational Handling	13.3	Lower support trunnions weight of loaded cask during downloading and transit to HSM-HB	ASME B&PV Code Sec III, Div 1, Class 2, NC-3200
Shell	Operational Handling	13.2	Hydraulic ram load due to friction of extracting loaded DSC: 23,750 lb	ANSI 57.9-1984
Bolts	Normal Operation	13.2, Table 9-11	Service levels A, B,C and D Avg stress less than 2 $S_{m \text{ for } A,B,C}$ Max stress less than 3 $S_{m \text{ for } A,B,C}$	ASME B&PV Code Section III, Div 1, Class 2, NC-3200

ACI American Concrete Institute
AISC American Institute of Steel Construction
B&PV Boiler and Pressure Vessel

(ASME B&PV Code-1983, with Addenda up to 1985 for HSM-HB and Transfer Cask)
(ASME B&PV Code-1998, with Addenda up to 1999 for DSC)

TABLE 13.3-4
NUHOMS-32PHB DSC SUMMARY OF DESIGN PARAMETERS FOR OFF-NORMAL OPERATING CONDITIONS

COMPONENT	DESIGN LOAD TYPE	REFERENCE	DESIGN PARAMETERS	APPLICABLE CODE
HSM-HB	Off-Normal Temperature	13.2, Table 8-10	-8°F and 104°F ambient temperature	ANSI 57.9-1984
	Jammed Condition Handling	USAR Section 13.8.1.2.1	Hydraulic ram load equal to 95,000 lb	ANSI 57.9-1984
	Load Combination	USAR Table 13.3-7	Load combination methodology	ANSI 57.9-1984 Sec 6.17.1.1
DSC	Off-normal Temperature	13.2, Table 8-10	-8°F and 104°F ambient temperature	ANSI 57.9-1992
	Off-normal Pressure	13.2, Table 8-9	DSC internal pressure 20 psig	ANSI 57.9-1992
	Blowdown Pressure	13.2, Table 8-9	DSC internal pressure: 20 psig CA07315 NUH32PHB-0217 Section 5.1	10 CFR 72.122(b)
	Jammed Condition Handling	USAR Section 13.8.1.2.1	Hydraulic ram load equal to 95,000 lb	ANSI 57.9-1992
	Structural Design Off-Normal Conditions	13.2, Table 8-2	Service Level C	ASME B&PV Code Sec III, Div 1, NB, Class 1
DSC Support	Jammed Handling Condition	USAR Section 13.8.1.2.1	Hydraulic ram load: 95,000 lb	ANSI 57.9-1992
	Load Combination	13.6, Table 5-1	Load combination methodology	ANSI 57.9-1992
Transfer Cask	Off-normal Temperature		-8°F and 104°F ambient temperature	ANSI 57.9-1992
	Jammed Condition Handling	USAR Section 13.8.1.2.1	Hydraulic ram load: 95,000 lb	ANSI 57.9-1992
	Structural Design Off-Normal Conditions	13.2, Table 9-10	Service Level C	ASME B&PV Code Sec III, Div 1, Class 2, NC-3200
	Bolts, Off-Normal Conditions	13.2, Table 9-11	Service Level C Avg stress less than 2 S_m Max stress less than 3 S_m	ASME B&PV Code Sec III, Div 1 Class 2, NC-3200

TABLE 13.3-5
NUHOMS-32PHB DSC SUMMARY OF DESIGN CRITERIA FOR ACCIDENT CONDITIONS

COMPONENT	DESIGN LOAD TYPE	REFERENCE	DESIGN PARAMETERS	APPLICABLE CODE
HSM-HB	Design Basis Tornado	USAR Section 3.2.1	Max velocity 360 mph Max wind pressure 304 psf	RG 1.76 ANSI 58.1 1982
	Load Combination	USAR Table 13.3-7	Load Combination Methodology	ANSI 57.9-1984 Sec 6.17.1.1
	Design Basis Tornado Missiles	13.10, Section 5.7 Table 10-1	Types: Automobile, 4,000 lb @ 195 fps 12 inch diameter steel pipe 1500 lb @205 fps	NUREG-0800 Sec 3.5.1.4
	Flood	USAR Section 2.4.2	Dry Site	
	Seismic	USAR Section 13.3.2.3	Horizontal ground acceleration 0.30g (both directions) Vertical ground acceleration 0.20g 7% critical damping	NRC RGs 1.60 and 1.61
	Accident Condition Temperature	USAR Section 13.8.2.7 13.10, Figure 7-3	HSM-HB vents (inlet/outlet) blocked for 36 hrs or less. HSM-HB inside surface temperature: 408°F (Figure 7-3)	ANSI 57.9-1984
	Fire	USAR Section 13.8.2.10	1 hour forest fire 130 feet from HSM-HB	CA07326 NUH32PHB-0409 Table 4-1
	Explosions	USAR Section 8.2.11	Probability of liquefied natural gas spill affecting HSM-HB $< 10^{-7}$	NUREG-0800 Section 2.2.3
DSC	Accident Drop	USAR Section 13.8.2.5	Equivalent static deceleration: 75g vertical end drop 75g horizontal side drop 25g corner drop with slap down (corresponds to an 80 inch drop height) Structural damping during drop: 10%	RG 1.61
	Flood	13.10	Maximum water height: 50 feet	10 CFR 72.122(b)

TABLE 13.3-5
NUHOMS-32PHB DSC SUMMARY OF DESIGN CRITERIA FOR ACCIDENT CONDITIONS

COMPONENT	DESIGN LOAD TYPE	REFERENCE	DESIGN PARAMETERS	APPLICABLE CODE
	Seismic	USAR Section 13.8.2.3.2	Horizontal acceleration: 1.5g Vertical acceleration: 1.0g 3% critical damping	NRC RGs 1.60 and 1.61
	Accident Internal Pressure (HSM-HB vents blocked)	USAR Section 13.8.2.7 13.6, Table 5-4	DSC internal pressure: 100 psig based on 100% fuel clad rupture and fill gas release, and ambient air temp. = 104°F. DSC shell temperature: 595°F Blocked vent time = 36 hrs	10 CFR 72.122(b)
	Accident Conditions	13.2, Section 8	Service Level D	ASME B&PV Code Sec III, Div 1, NB, Class 1
	Reflood Pressure	USAR Section 13.8.2	DSC internal pressure: 75.0 psig	10 CFR 72.122(i)
DSC Support Assembly	Seismic	USAR Section 13.8.2.3.2 13.10, Section 5.9	DSC reaction loads: Horizontal acceleration: 0.43g Vertical acceleration: 0.20g 7% critical damping	NRC RGs 1.60 and 1.61
	Load Combination	USAR Table 13.8-4	Load combination methodology	ANSI 57.9-1984 Sec 6.17.3.2.1
Transfer Cask	Design Basis Tornado	13.10, Section 7.1	Max wind velocity: 360 mph Max wind pressure: 344 psf	NRC RG 1.76, ANSI 58.1-1982
	Design Basis Tornado Missiles	13.10, Table 7-2	Automobile, 4000 lb at 195fps steel rod, 8 lbs at 317fps	NUREG-0800 Sec 3.5.1.4
	Flood	13.2	Cask use to be restricted by administrative controls	10 CFR 72.122
	Seismic	USAR Section 13.2.3, 13.2, Section 9.2.4	Horizontal ground acceleration: 0.15g (both directions) Vertical acceleration: 0.10g 3% critical damping	NRC RGs 1.60 and 1.61

TABLE 13.3-5
NUHOMS-32PHB DSC SUMMARY OF DESIGN CRITERIA FOR ACCIDENT CONDITIONS

COMPONENT	DESIGN LOAD TYPE	REFERENCE	DESIGN PARAMETERS	APPLICABLE CODE
	Accident Drop	USAR Section 13.8.2.5	Equivalent static deceleration: 75g vertical end drop 75g horizontal side drop 25g corner drop with slapdown (corresponds to an 80 inch drop height)	10 CFR 72.122(b)
		13.14	Structural damping during drop 10%	RG 1.61
	Bolts, Accident Drop	13.13	Service Level D	ASME B&PV Code Sec III, Div 1, Class 2, NC-3200
	Structural Design, Accident	13.14	Service Level D	ASME B&PV Code Sec III, Div 1, Class 2, NC-3200
	Internal Pressure	--	Not applicable because DSC provides pressure boundary	10 CFR 72.122(b)

TABLE 13.3-6
SUMMARY OF NUHOMS-32PHB DSC SHELL LOAD COMBINATIONS

Load Combinations Case		***Normal Operating Conditions***							***Off-Normal Conditions***						***Emergency Conditions/ Accident Conditions***						
		1	*2*	*3*	*4*	*5*	*6*	*7*	*1*	*2*	*3*	*4*	*5*	*6*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Dead Weight	Vertical, DSC Empty	X																			
	Vertical, DSC w/ and w/o Water		X																		
	Horizontal, DSC w/Fuel			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Thermal	Inside HSM: 70°F (ambient)				X										X						
	Inside Cask: 70°F (ambient)		X	X		X	X		X									X		X	
	Inside HSM: 104°F (ambient)										X		X			X					
	Inside Cask: 104°F (ambient)									X		X		X							
	Inside Cask: Accident																X		X		
	Inside HSM: Accident (vent block)																				X
Internal Pressure	Normal Pressure			X					X						X	X				X	
	Off-Normal/Blowdown				X		X			X	X	X	X	X							
	Accident																		X		X
External Pressure	Hydrostatic		X																		
Handling Loads	Normal			X	X																
	Off-normal								X	X	X										
Transfer Loads	Normal					X	X						X	X							
	Accident (Drop)																	X		X	
Seismic															X						
ASME Code Service Level		A	A	A	A	A	A	A	B	B	B	B	B	B	C	C	D	D	D	D	D

(References 13.2, Table 7.2 and 13.6, Table 5.1)
Notes:

1. For normal and off-normal load combinations, the DSC shall not be allowed to deform to an extent that would prevent retrieval of the spent fuel. Also, both end plug assemblies shall maintain their ability to provide shielding for personnel during DSC handling operations.

TABLE 13.3-6
SUMMARY OF NUHOMS-32PHB DSC SHELL LOAD COMBINATIONS

Load Combinations Case		*Normal Operating Conditions*			*Off-Normal Conditions*		*Emergency Conditions/ Accident Conditions*		
		1	*2(2)*	*3(3)*	*1*	*2*	*1*	*2*	*3*
Dead Weight	Vertical	*X*							
	Horizontal		*X*	*X*	*X*	*X*	*X*	*X*	*X*
Thermal	Inside HSM: 70°F (ambient)		*X*						
	Inside Cask: 70°F (ambient)			*X*					
	Inside HSM: 104°F (ambient)				*X*				
	Inside Cask: 104°F (ambient)	*X*				*X*			
	Inside HSM: Accident (vent block)							*X*	
Transfer Loads	Normal			*X*		*X*			
	Accident *(1)*								*X*
Seismic							*X*		
ASME Code Service Level		*A*	*A*	*A*	*B*	*B*	*C*	*D*	*D*

Notes:

(1) Side Drop orientations of 0°, 45°, 60°, and 180°, and End Drop should be considered for accident transfer load analysis.

(2) This load case is bounded by Off-Normal Condition load case 1.

(3) This load case is bounded by Off-Normal Condition load case 2.

TABLE 13.3-7
HSM-HB CONCRETE LOAD COMBINATION METHODOLOGY

Case No.	Identifier	Load Combination
C1C	COMB1C	U > 1.4*DW+1.7*LLRO(1)
C2C	COMB2C	U > 1.05*DW+1.275*(LL(2)+TN+WW)
C3C	COMB3C	U > 1.05*DW+1.275*(LLRA(3)+TN)
C4C	COMB4C	U > DW+LL(2)+TN+EQ
C5C	COMB5C	U > DW+LL(2)+TN+WT
C6C	COMB6C	U > DW+LL(2)+TN+FL
C7C	COMB7C	U > DW+LL(2)+MAX(TO and TA)

(1) LLRO = Sum of live load cases 1 and 2 described in Section 7.2.
(2) LL = Live load case 1 described in Section 7.2.
(3) LLRA = Sum of live load cases 1 and envelop of (3 and 4) described in Section 7.2.

13.4 INSTALLATION DESIGN

The discussion presented in Chapter 4 is applicable to the NUHOMS-32PHB DSC and the HSM-HB. Chapter 4 describes the installation design associated with the CCNPP ISFSI and related systems. The narrative describes the installation design unique to the CCNPP ISFSI systems, such as the storage structures, auxiliary systems, decontamination systems, transfer cask repair and maintenance, and the fuel handling operation systems. The CCNPP ISFSI is a self-contained, passive storage facility, which requires no auxiliary systems other than the HSM-HB temperature monitoring system.

When transporting a NUHOMS-32PHB DSC, the transfer cask is in the forced-cooling configuration. In the forced-cooling configuration, the transfer cask utilizes a top lid with vents around the perimeter. To provide distribution of the blower airflow to the transfer cask/DSC annulus region, wedge shaped steel plates are attached to the inside bottom plate of the transfer cask to form radial channels emanating from the ram access opening to the transfer cask/DSC annulus. The airflow circulates through the annulus between the cask and the DSC, and exits through the top lid vents. Two industrial grade motor driven redundant blowers with associated ductwork are connected to the transfer cask ram cover plate opening. This provides a reliable source of external air circulation for the transfer cask.

13.5 OPERATION SYSTEMS

The discussion presented in Chapter 5 is applicable to the CCNPP ISFSI facility addition of the NUHOMS-32PHB DSC, the HSM-HBs, the self-propelled modular transporter, the hydraulic ram and transfer cask support skid used with the self-propelled modular transporter and the transfer cask in the forced-cooling configuration. Chapter 5 describes the operation of the CCNPP ISFSI. The narrative describes operations unique to the CCNPP ISFSI systems, such as draining, drying, and closure of the DSC and the use of the self-propelled modular transporter. Although some operational details are provided, the description is not intended to limit or restrict operation of the facility. Operational procedures may be revised according to the requirements of the plant, provided that the limiting conditions of operation are not exceeded.

13.6 SITE GENERATED WASTE CONFINEMENT AND MANAGEMENT

The discussion presented in Chapter 6 is applicable to the CCNPP ISFSI facility addition of the NUHOMS-32PHB DSC, the HSM-HBs, the self-propelled modular transporter, the hydraulic ram and transfer cask support skid used with the self-propelled modular transporter and the transfer cask in the forced-cooling configuration. Chapter 6 describes the on-site waste sources, off-gas treatment and ventilation, liquid waste treatment and retention, solid wastes and radiological impact of normal operations of the CCNPP ISFSI.

13.7 RADIATION PROTECTION

This section contains the radiation protection discussion as it relates to the NUHOMS-32PHB DSC and the HSM-HB. The outline and content of this section is based on Chapter 7. The NUHOMS-32PHB DSC and the HSM-HB provides enhanced shielding which helps to compensate for the higher source term of spent fuel elements compared to the NUHOMS-24P and NUHOMS-32P DSCs. Dose rates for the NUHOMS-32PHB DSC within the HSM-HB and the transfer cask are presented in Table 13.7-1. The CCNPP site-specific ISFSI facility design meets the requirements of 10 CFR 72.104 and 10 CFR 72.106 for normal, off-normal, and accident conditions (References 13.30, 13.31 and 13.32).

The principal system, subsystem and components of the CCNPP ISFSI for a NUHOMS-32PHB DSC are listed in Table 1.3-2. Tables 1.2-3, 13.3-1, and 13.3-2 lists the capacity, dimensions, and design parameters for the NUHOMS-32PHB DSC.

The differences between the NUHOMS-32PHB DSC and the NUHOMS-32P DSC that affect shielding and radiation protection are:

- increasing the maximum fuel assembly neutron source term from 4.175E+08 n/sec/assy to 6.664E+08 n/sec/assy (Reference 12.47),
- increasing the maximum fuel assembly gamma source term from 1.61E+15 MeV/sec/assy to 2.56E+15 MeV/sec/assy,
- full-length solid aluminum rail inserts between the DSC stainless steel cylindrical shell and the outside guide sleeves, and
- a redesign of the top shield plug (including vent and siphon ports).

The differences between the HSM-HB and the HSM that affect shielding and radiation protection are:

- Use of a 3-foot 8-inch thick roof on HSM-HB versus 3-foot thick roof on the HSM,
- HSM-HB door is inset in the doorway, with increased thickness,
- Outlet vents repositioned from top front and back of module to top sides (opening shared by adjacent modules),
- Inlet vents repositioned from front bottom center to front bottom sides (opening shared by adjacent modules), and
- Optional inlet vent attenuation pipes improves shielding (pipes are not credited for normal, off-normal or accident conditions).

The radiation protection and shielding aspects of the NUHOMS-32PHB DSC and the HSM-HB, and the effects of these differences, are addressed in detail below.

13.7.1 ENSURING THAT THE OCCUPATIONAL RADIATION EXPOSURES ARE AS LOW AS REASONABLY ACHIEVABLE

13.7.1.1 Policy Considerations

The discussion in USAR Section 7.1.1 is applicable to NUHOMS-32PHB DSC and the HSM-HB.

13.7.1.2 Design Considerations – NUHOMS-32PHB DSC

Like the NUHOMS-32P DSC discussed in USAR Section 12.7, the NUHOMS-32PHB DSC can store 32 spent fuel assemblies (all CE 14x14 fuel of the Standard, Westinghouse VAP, and AREVA designs used at CCNPP have been considered). The maximum heat source of the spent fuel assemblies for the NUHOMS-32PHB DSC is increased to 1.0 kW (maximum of 29.6 kW per canister when zone loaded with 0.8 kW fuel assemblies), compared to 0.66 kW per fuel assembly for the NUHOMS-24P DSC and the NUHOMS-32P DSC. This means that the fuel assemblies for the NUHOMS-32PHB DSC may spend less time cooling in the spent fuel pool before being transported to the ISFSI. Thus, the maximum radiation source in the NUHOMS-32PHB DSC may be at a higher level than the NUHOMS-24P or NUHOMS-32P DSCs. The design considerations which ensure that occupational exposures for the CCNPP ISFSI utilizing the NUHOMS-24P DSC and the original poured in place HSMs are as low as reasonably achievable are discussed in USAR Section 7.1.2. The following paragraphs, which are numbered to correspond with USAR Section 7.1.2, discuss differences in the NUHOMS-24P and/or NUHOMS-32P DSCs, and the NUHOMS-32PHB DSC designs, which affect the shielding design considerations.

1-3. These items are the same as in USAR Section 7.1.2.

4. The contact dose goal for a transfer cask with a NUHOMS-32PHB DSC is 250 mrem/hr (Reference 13.2).

5-7. These items are the same as in USAR Section 7.1.2.

8. USAR Section 7.1.2 states that the cavity of the NUHOMS-24P DSC will be submerged in the spent fuel pool for about 12 hours and, on removal from the pool, will contain borated water from the spent fuel pool for less than 50 hours. Because of the larger number of fuel assemblies (32 opposed to 24) to be stored in the NUHOMS-32PHB DSC, it is expected that the DSC will be submerged in the pool for a longer period of time than the NUHOMS-24P DSC, but similar to the NUHOMS-32P DSC. This additional submersion time does not affect the performance of the austenitic stainless steel as discussed in USAR Section 7.1.2. The NUHOMS-32PHB DSC also contains aluminum plates (borated and un-borated). There is a substantial body of industry experience with exposure of aluminum to borated and unborated water and its performance is not affected by the pool conditions. Due to the use of solid aluminum rails at the basket periphery, the surface area of exposed metal is less than in the NUHOMS-32P DSC.

9-13. These items are the same as in USAR Section 7.1.2.

9-14. The discussion in USAR Section 7.1.2 is unchanged, with the exception that the NUHOMS-32PHB DSC is loaded into the transfer cask in the forced-cooling configuration for DSC heat loads exceeding 21.12 kW.

15. This item is the same as in USAR Section 7.1.2.

13.7.1.3 Operational Considerations

The discussion in USAR Section 7.1.3 is applicable to the NUHOMS-32PHB DSC and the HSM-HB.

13.7.2 RADIATION SOURCES – NUHOMS-32PHB

13.7.2.1 Characterization of Sources

The radiological source terms were calculated using SAS2H/ORIGEN-S codes of the SCALE package for the range of initial enrichments and burnups given in Table 9.4-4. The source terms were calculated with cooling times for each fuel assembly corresponding to maximum heat output of 0.8 kW and 1.0 kW.

The fuel assembly with the largest gamma source terms at a heat load of 1.0 kW for both the HSM-HB and the transfer cask in the forced-cooling configuration was found to be VAP fuel with 4.25 weight percent initial enrichment, 42,000 MWD/MTU burnup, cooled for 4.2 years.

The fuel assembly with the largest gamma source terms at a heat load of 0.8 kW for both the HSM-HB and the transfer cask in the forced-cooling configuration was found to be VAP fuel with 4.27 weight percent initial enrichment, 36,000 MWD/MTU burnup, cooled for 4.4 years.

The fuel assembly with the largest neutron source terms for both the HSM-HB and the transfer cask in the forced-cooling configuration was found to be AREVA fuel with 4.0 weight percent initial enrichment, 58,000 MWD/MTU burnup, cooled for 9.4 years to reach 1.0 kW and 16.4 years to reach 0.8 kW.

The neutron and gamma energy spectra for these fuel assemblies are given in Tables 13.7-2, 13.7-3 and 13.7-4.

The source modeling methodology is similar to the one used for the NUHOMS-32P DSC. For the NUHOMS-32PHB DSC bounding gamma source terms, MCNP models were created to determine response functions for the modular constructed HSM-HB, as well as for the transfer cask in the forced-cooling configuration. Note that the purpose of analysis with MCNP was to determine a response function for identifying bounding gamma source terms and not to determine the actual dose rates reported later in this section. The gamma energy spectrum for analyzed fuel assemblies was multiplied by the response function to obtain the dose rates. The burnup and enrichment case which yielded the highest gamma dose rate were selected as the bounding gamma source terms.

Fuel assemblies meeting the requirements of Table 9.4-4 may be loaded into a NUHOMS-32PHB DSC and stored in the modular constructed HSM-HBs as long as the total heat load in the DSC is equal to or less than 29.6 kW (i.e. 12 fuel assemblies at 0.8 kw and 20 fuel assemblies at 1.0 kw).

This NUHOMS-32PHB DSC sources bound all fuel assemblies that have an initial U^{235} enrichment less than or equal to 5.0%, burnup less than or equal to 62,000 MWD/MTU, and a thermal output less than or equal to 1.0 kW or less than or equal to 0.8 kW.

13.7.2.2 Airborne Radioactive Material Sources

The discussion in USAR Section 7.2.2 is applicable to the NUHOMS-32PHB DSC and the HSM-HB.

13.7.3 RADIATION PROTECTION DESIGN FEATURES – NUHOMS-32PHB DSC

13.7.3.1 Installation Design Features

The discussion referred to in USAR Section 7.3.1 is applicable to the NUHOMS-32PHB DSC, with the exception that the modular constructed HSM-HBs are used for storage instead of the concrete poured in place HSMs. Figure 1.2-1 is the layout and arrangement drawing for CCNPP ISFSI storage array with HSM-HB units. Radiation sources are contained within DSCs which are stored in concrete HSM-HBs. The radioactive sources for this ISFSI installation are described in USAR Section 13.7.2.

13.7.3.2 Shielding

The shielding analyses for the NUHOMS-32PHB DSC are similar in form and methodology to the design basis analyses for the NUHOMS-24P DSC and the NUHOMS-32P DSC, with the exception that the basket of the NUHOMS-32PHB DSC is modeled explicitly and only the fuel is homogenized in the four axial fuel regions used previously for the NUHOMS-24P and NUHOMS-32P DSC (upper end fitting, plenum, active fuel, and bottom end fitting). The methodology and model are described in detail in References 13.30 and 13.31.

The results of the shielding analyses for the NUHOMS-32-PHB DSC with the HSM-HB and the transfer cask in the forced-cooling configuration are presented in Table 13.7-1.

13.7.3.3 Ventilation

The discussion in USAR Section 7.3.3 is generally applicable to the NUHOMS-32PHB DSC. The only differences are that the outlet vents are repositioned from their prior location on the top front and back of the HSM to the top sides of the HSM-HB (opening shared by adjacent modules).

Similarly, the inlet vents are repositioned from their prior location on the front bottom center of the HSM to the front bottom sides of the HSM-HB (opening shared by adjacent modules). In addition, the HSM-HB inlet vent may optionally utilize an alternative bird screen design with attenuation pipes attached to the inside of the bird screen (pipes are not credited for normal, off-normal or accident conditions). The attenuation pipes consist of three 14" Schedule 10 stainless steel pipes stacked in a triangular formation. The pipes have no significant impact on air flow, but reduce maximum gamma dose rates at the inlet vent by 43% (Reference 13.31, Section 12, Appendix D).

13.7.3.4 Area Radiation and Airborne Radioactivity Monitoring Instrumentation

The discussion in USAR Section 7.3.4 is applicable to the NUHOMS-32PHB DSC.

13.7.4 ESTIMATED ON-SITE COLLECTIVE DOSE ASSESSMENT

13.7.4.1 Operational Exposure

The discussion of USAR Section 7.4.1 is applicable to the NUHOMS-32PHB DSC, the HSM-HB and the transfer cask in the forced-cooling configuration.

13.7.4.2 Storage Term Exposure

The discussion of USAR Section 7.4.2 is applicable to the NUHOMS-32PHB DSC, the HSM-HB and the transfer cask in the forced-cooling configuration.

13.7.5 HEALTH PHYSICS PROGRAM

The discussion in USAR Section 7.5 is applicable to the NUHOMS-32PHB DSC, the HSM-HB and the transfer cask in the forced-cooling configuration.

13.7.6 ESTIMATED OFF-SITE COLLECTIVE DOSE ASSESSMENT

13.7.6.1 Effluent and Environmental Monitoring Program

The discussion in USAR Section 7.6.1 is applicable to the NUHOMS-32PHB DSC and the HSM-HB.

13.7.6.2 Analysis of Multiple Contribution

The discussion in USAR Section 7.6.2 is applicable to the NUHOMS-32PHB DSC and the HSM-HB.

13.7.6.3 Estimated Dose Equivalents

The discussion in USAR Section 7.6.3 is applicable to the NUHOMS-32PHB DSC and the HSM-HB.

13.7.6.4 Liquid Release

The discussion in USAR Section 7.6.4 is applicable to the NUHOMS-32PHB DSC and the HSM-HB.

TABLE 13.7-1
NUHOMS-32PHB DSC SHIELDING ANALYSIS RESULTS - MAXIMUM DOSE RATES
(mrem/hr)

LOCATION	NEUTRON[c]	GAMMA[c] (PRI + SEC)	TOTAL[c]
NUHOMS-32PHB DSC in HSM-HB[d]			
1. HSM-HB Wall or Roof	1.34	4.93	6.27
2. HSM-HB Air Outlet	11.9	35.2	47.1
3. Center of Door	0.38	0.60	0.98
4. Doorway (Maximum, 1 ft. into opening)	1.27×10^3	1.64×10^4	1.76×10^4
5. Air Inlet Vent	10.3	110[f]	121[f]
6. 1 m from HSM-HB Door (closed)	0.38	0.63	1.01
NUHOMS-32PHB DSC in Cask			
1. Centerline DSC Shield Plug (Flooded DSC)[a]	2	242	244
2. DSC Cover Plate (Dry DSC)			
2.1 Center	549	150	695
2.2A Edge[b] (Wet Gap)	317	314	631
2.2B Edge[b] (Dry Gap)	378	407	785
3. Transfer Cask[e]			
3.1 Side	138	112	217
3.2 Top	12	14	26
3.3 Bottom	100	108	208[g]

(a) The DSC/cask annular gap is filled with water. All but the top 8" of the DSC inner cavity is filled with water.
(b) Nominal at top edge of cover plate. The total dose rate is approximately a factor of 3.8 times higher above the wet annulus and a factor of 5.4 times higher above the dry annulus.
(c) From References 13.30 and 13.31.
(d) The modular constructed HSM-HB.
(e) The transfer cask in the forced-cooling configuration with ram port open.
(f) With optional attenuation pipes installed in the inlet vent, the gamma dose rate is reduced by 43% (Reference 13.31, Appendix D), resulting in a total dose rate of 73 mrem/hr.
(g) Maximum dose rates with the ram port off are 13.7 times larger than the average values reported. The maximum dose rate with the ram port installed is 170 mrem/hr (Reference 13.30, Tables 7-20 and 8-1).

TABLE 13.7-2
Neutron Source Terms (Neutron/Sec)
(BOUNDING FOR NUHOMS-32PHB DSC IN THE HSM-HB[(a)] and THE TRANSFER CASK[(b)])

Group Number	Upper Energy (MeV)	1000 Watt Neutrons/Sec	800 Watt Neutrons/Sec	Adjusted 800 Watt[(c)] Neutrons/Sec
1	2.00E+01	0.000E+00	0.000E+00	0.000E+00
2	1.40E+01	1.175E+05	9.004E+04	9.463E+04
3	1.20E+01	7.200E+05	5.518E+05	5.800E+05
4	1.00E+01	2.440E+06	1.870E+06	1.965E+06
5	8.00E+00	1.973E+06	1.512E+06	1.589E+06
6	7.50E+00	2.636E+06	2.020E+06	2.123E+06
7	7.00E+00	3.901E+06	2.990E+06	3.143E+06
8	6.50E+00	5.829E+06	4.467E+06	4.695E+06
9	6.00E+00	8.736E+06	6.695E+06	7.037E+06
10	5.50E+00	1.175E+07	9.004E+06	9.463E+06
11	5.00E+00	1.627E+07	1.247E+07	1.311E+07
12	4.50E+00	2.125E+07	1.631E+07	1.714E+07
13	4.00E+00	3.424E+07	2.630E+07	2.764E+07
14	3.50E+00	4.236E+07	3.264E+07	3.431E+07
15	3.00E+00	5.511E+07	4.251E+07	4.468E+07
16	2.50E+00	2.084E+07	1.606E+07	1.688E+07
17	2.35E+00	2.917E+07	2.247E+07	2.362E+07
18	2.15E+00	2.319E+07	1.786E+07	1.877E+07
19	2.00E+00	3.385E+07	2.604E+07	2.737E+07
20	1.80E+00	2.616E+07	2.011E+07	2.114E+07
21	1.66E+00	1.741E+07	1.337E+07	1.405E+07
22	1.57E+00	1.452E+07	1.116E+07	1.173E+07
23	1.50E+00	1.241E+07	9.529E+06	1.002E+07
24	1.44E+00	2.486E+07	1.909E+07	2.006E+07
25	1.33E+00	3.075E+07	2.359E+07	2.479E+07
26	1.20E+00	4.783E+07	3.669E+07	3.856E+07
27	1.00E+00	4.654E+07	3.568E+07	3.750E+07
28	8.00E-01	2.687E+07	2.060E+07	2.165E+07
29	7.00E-01	2.684E+07	2.057E+07	2.162E+07
30	6.00E-01	2.309E+07	1.770E+07	1.860E+07
31	5.12E-01	5.247E+05	4.022E+05	4.227E+05
32	5.10E-01	1.574E+07	1.206E+07	1.268E+07
33	4.50E-01	1.311E+07	1.005E+07	1.056E+07
34	4.00E-01	2.533E+07	1.941E+07	2.040E+07
35	3.00E-01	5.225E+03	4.716E+03	4.957E+03
36	2.00E-01	2.613E+03	2.358E+03	2.478E+03
37	1.50E-01	2.613E+03	2.358E+03	2.478E+03
38	1.00E-01	0.000E+00	0.000E+00	0.000E+00
39	7.50E-02	0.000E+00	0.000E+00	0.000E+00
40	7.00E-02	0.000E+00	0.000E+00	0.000E+00
41	6.00E-02	0.000E+00	0.000E+00	0.000E+00
42	4.50E-02	0.000E+00	0.000E+00	0.000E+00

Group Number	Upper Energy (MeV)	1000 Watt Neutrons/Sec	800 Watt Neutrons/Sec	Adjusted 800 Watt[c] Neutrons/Sec
43	3.00E-02	0.000E+00	0.000E+00	0.000E+00
44	2.00E-02	0.000E+00	0.000E+00	0.000E+00
total		6.664E+08	5.119E+08	5.380E+08

(a) The modular constructed HSM-HB.
(b) Transfer cask in the forced-cooling configuration.
(c) The neutron sources for the 0.8 kW are conservatively scaled up to bound the standard fuel.

TABLE 13.7-3
Gamma Source Terms for 1.0 kW
(BOUNDING FOR NUHOMS-32PHB DSC IN THE HSM-HB[a] and THE TRANSFER CASK[b])

Group Number	Upper Energy (MeV)	Active Fuel	Bottom End Fitting	Plenum	Top End Fitting	Total	
		Gamma/sec	Gamma/sec	Gamma/sec	Gamma/sec	Gamma/sec	MeV/sec
1	2.00E-02	1.8309E+15	1.1975E+12	2.6007E+11	5.9645E+11	1.8329E+15	1.8329E+13
2	3.00E-02	4.0336E+14	5.0116E+12	1.4867E+11	4.9134E+12	4.1343E+14	1.0336E+13
3	4.50E-02	4.7812E+14	9.5228E+11	4.5905E+10	8.8477E+11	4.8000E+14	1.8001E+13
4	7.00E-02	3.2245E+14	9.0541E+10	2.3267E+10	3.2518E+10	3.2260E+14	1.8549E+13
5	1.00E-01	2.3072E+14	4.3150E+10	1.1047E+10	1.5604E+10	2.3079E+14	1.9618E+13
6	1.50E-01	2.5838E+14	4.1052E+10	5.7417E+09	2.7865E+10	2.5846E+14	3.2307E+13
7	3.00E-01	2.0693E+14	3.0845E+11	8.0501E+09	3.0519E+11	2.0755E+14	4.6699E+13
8	4.50E-01	1.1069E+14	1.8091E+12	4.0435E+10	1.8085E+12	1.1434E+14	4.2879E+13
9	7.00E-01	2.7885E+15	2.3256E+12	5.1568E+10	2.3255E+12	2.7932E+15	1.6061E+15
10	1.00E+00	6.4182E+14	1.1389E+11	1.4123E+11	1.5876E+10	6.4209E+14	5.4578E+14
11	1.50E+00	1.1430E+14	2.4863E+13	8.8480E+12	2.2137E+12	1.5023E+14	1.8779E+14
12	2.00E+00	4.9356E+12	1.9702E+04	8.7286E+03	5.2170E+03	4.9356E+12	8.6373E+12
13	2.50E+00	3.8170E+12	1.3123E+08	4.6700E+07	1.1684E+07	3.8172E+12	8.5888E+12
14	3.00E+00	1.0030E+11	2.0348E+05	7.2413E+04	1.8117E+04	1.0030E+11	2.7584E+11
15	4.00E+00	1.2406E+10	1.5404E-09	1.7135E-13	2.1771E-12	1.2406E+10	4.3420E+10
16	6.00E+00	6.8458E+06	0.0000E+00	0.0000E+00	0.0000E+00	6.8458E+06	3.4229E+07
17	8.00E+00	7.8837E+05	0.0000E+00	0.0000E+00	0.0000E+00	7.8837E+05	5.5186E+06
18	1.10E+01	9.0680E+04	0.0000E+00	0.0000E+00	0.0000E+00	9.0680E+04	8.6146E+05
total		7.3950E+15	3.6756E+13	9.5840E+12	1.3139E+13	7.4545E+15	2.5640E+15

For more information see 13.1
[a] The modular constructed HSM-HB.
[b] Transfer cask in the forced-cooling configuration.

TABLE 13.7-4
Gamma Source Terms for 0.8 kW
(BOUNDING FOR NUHOMS-32PHB DSC IN THE HSM-HB[a] and THE TRANSFER CASK[b])

Group Number	Upper Energy (MeV)	Active Fuel Gamma/sec	Bottom End Fitting Gamma/sec	Plenum Gamma/sec	Top End Fitting Gamma/sec	Total Gamma/sec	Total MeV/sec
1	2.00E-02	1.5125E+15	9.7577E+11	2.1445E+11	4.7483E+11	1.5142E+15	1.5142E+13
2	3.00E-02	3.3255E+14	3.9578E+12	1.1892E+11	3.8756E+12	3.4051E+14	8.5125E+12
3	4.50E-02	3.9444E+14	7.7666E+11	3.7880E+10	7.2024E+11	3.9597E+14	1.4849E+13
4	7.00E-02	2.6589E+14	7.4854E+10	1.9376E+10	2.6379E+10	2.6601E+14	1.5295E+13
5	1.00E-01	1.8874E+14	3.5761E+10	9.2020E+09	1.2748E+10	1.8879E+14	1.6048E+13
6	1.50E-01	2.0785E+14	3.3716E+10	4.7739E+09	2.2699E+10	2.0791E+14	2.5988E+13
7	3.00E-01	1.6860E+14	2.5111E+11	6.5768E+09	2.4838E+11	1.6911E+14	3.8049E+13
8	4.50E-01	8.9579E+13	1.4724E+12	3.2917E+10	1.4719E+12	9.2556E+13	3.4708E+13
9	7.00E-01	2.2569E+15	1.8929E+12	4.1972E+10	1.8927E+12	2.2607E+15	1.2999E+15
10	1.00E+00	4.6266E+14	8.4611E+10	1.0470E+11	1.1775E+10	4.6286E+14	3.9344E+14
11	1.50E+00	8.6705E+13	2.0769E+13	7.3749E+12	1.8475E+12	1.1670E+14	1.4587E+14
12	2.00E+00	3.7017E+12	8.5923E+03	4.0391E+03	1.9076E+03	3.7017E+12	6.4779E+12
13	2.50E+00	2.9071E+12	1.0962E+08	3.8925E+07	9.7514E+06	2.9073E+12	6.5413E+12
14	3.00E+00	7.1891E+10	1.6998E+05	6.0357E+04	1.5120E+04	7.1891E+10	1.9770E+11
15	4.00E+00	8.8689E+09	5.2264E-10	1.0373E-13	1.3202E-12	8.8689E+09	3.1041E+10
16	6.00E+00	3.4765E+06	0.0000E+00	0.0000E+00	0.0000E+00	3.4765E+06	1.7382E+07
17	8.00E+00	4.0028E+05	0.0000E+00	0.0000E+00	0.0000E+00	4.0028E+05	2.8020E+06
18	1.10E+01	4.6037E+04	0.0000E+00	0.0000E+00	0.0000E+00	4.6037E+04	4.3736E+05
total		5.9732E+15	3.0325E+13	7.9657E+12	1.0605E+13	6.0220E+15	2.0210E+15

[a] The modular constructed HSM-HB.
[b] Transfer cask in the forced-cooling configuration.

13.8 ACCIDENT ANALYSIS – NUHOMS-32PHB DSC

Analyses of all design events for the NUHOMS-32P DSC have been reanalyzed for the NUHOMS-32PHB DSC. The results are reported in this section in the same format as in Section 12.8. The analytical assumptions, methodology, and computer codes used to generate the results in this section are identical to those used in Section 12.8 unless otherwise noted in the text.

13.8.1 NORMAL AND OFF-NORMAL OPERATIONS

This section includes the evaluation of the normal and off-normal events for the NUHOMS-32PHB DSC.

13.8.1.1 Normal Operation Structural Analysis

The normal operating loads for the NUHOMS-32PHB DSC important-to-safety components are shown in Table 7-1 of 13.2. A comprehensive structural analysis of the NUHOMS-32PHB DSC was performed and documented in Reference 13.6.

13.8.1.1.1 Normal Operation Structural Analysis

The loads applicable to the normal operation structural analysis are calculated as described in detail in USAR Section 8.1.1.1, with the following exceptions:

A. Dead Weight Loads
No exceptions

B. Design Basis Internal Pressure Loads

– 15 psig (Normal), 20 psig (Off-normal), 100 psig (Accident) The assumed fuel rod average burnup needs to be increased to 60 GWD/MTU (Standard and VAP fuels) and 62 GWD/MTU (AREVA fuel).

C. Design Basis Thermal Loads

–Ambient temperature -8°F 10 104°F The long-term average temperature assumed fuel rod average burnup needs to be increased to 60 GWD/MTU (Standard and VAP fuels) and 62 GWD/MTU (AREVA fuel).

D. Operational Handling Loads

The sealed NUHOMS-32PHB DSC weighs 92,402 lb, which is more than analyzed in NUHOMS-32P DSC Topical Report (80,000 lb) (Reference 13.3, Table 1). Also, the hydraulic ram load (95,000 lb) for the hydraulic ram used with the self-propelled modular transporter (SPMT) is equal to that analyzed in the NUHOMS-24P Topical Report (80,000 lb) (Reference 13.2, Table 8-11).

E. Design Basis Live Loads
A live load of 200 lbf/ft^2 envelopes the NUHOMS-32PHB DSC analysis (Reference 13.2, Section 7.2, and 13.10, Section 7.1).

13.8.1.1.2 NUHOMS-32PHB DSC Analysis

Stresses were evaluated in the DSC due to:

A. Dead Weight Loads

B. Design Basis Normal Operating Internal Pressure Loads
C. Normal Operating Thermal Loads
D. Normal Operation Handling Loads

The NUHOMS-32PHB DSC is analyzed using analytical methods comparable to those described for the NUHOMS-32P DSC in USAR Section 12.8. The ANSYS analytical model used for the analysis of dead weight, pressure, thermal, and handling loads is similar to that used in the evaluation of the NUHOMS-32P. The ANSYS analysis model is described in Reference 13.6. Stresses due to normal operating pressures are based on a bounding internal pressure of 15 psig (Table 4-3), applied as a uniform load to the inner boundary of the analytical model. Also considered was the external hydrostatic pressure loading on the DSC shell, when the annulus between the DSC shell and the transfer cask, in the forced-cooling configuration, is filled with water. Circumferential shell temperature variations are analyzed using the ANSYS three-dimensional solid shell model. The NUHOMS-32PHB DSC stresses remain within ASME code allowable stresses (Reference 13.6).

13.8.1.1.3 NUHOMS-32PHB DSC Internal Basket Analysis

The DSC basket analysis was performed for:

A. Dead Weight Loads
B. Thermal Loads

The fuel assembly weight of 1,375 lbs (Reference 13.2, Table 4-2) and 158 inches length (Reference 13.2, Table 4-2) are used in the analysis. The basket temperature is taken as 650°F uniform. The peripheral rail temperature is taken as 500°F uniform (Reference 13.7).

The three-dimensional finite element analysis ANSYS model used in the evaluation is described in Reference 13.7. The analysis model consists of a 10.28 inches slice of the NUHOMS-32PHB DSC basket, rails, and canister using "SHELL 43" elements, with appropriate boundary conditions applied at the cut faces of the model. The fuel assembly and aluminum plates are not included in the analysis model. The fuel assembly weight is applied as pressure on the basket plates. The weight of the aluminum plates is accounted for by increasing the density of stainless steel tubes. The aluminum plate stiffness is conservatively neglected in the analysis. The fusion welds connecting the fuels compartment guide sleeves and the bolts connecting the rails are modeled by three-dimensional PIPE16 elements. Gap elements (CONTACT 52) are used to simulate the interface between the basket rails and inner side of canister as well as between outer side of canister and inside of transfer cask.

The results of the analysis show that the stresses in the DSC are within the allowable stress limits (Reference 13.6).

13.8.1.1.4 NUHOMS-32PHB DSC Support Assembly Analysis

The DSC support assembly inside a modular constructed HSM-HB, for the NUHOMS-32PHB DSC, was evaluated for the loads listed below. The allowable stresses are taken at a bounding temperature of 300°F for all conditions, including normal operation (Reference 13.10).

A. Dead Weight Loads
B. Normal Operational Handling Loads
C. Thermal Loads

The calculated stresses were small and meet all code allowables. (Reference 13.10, Section E4.1).

13.8.1.1.5 Modular Constructed HSM-HB Analysis

The HSM-HB arrangement used for the NUHOMS-32PHB DSC analysis is that of two, 1x12, back-to-back arrays and one array of 1x12 HSM-HBs. The following loads are considered in the structural analysis for normal operation loads for the modular constructed HSM-HBs.

A. Modular Constructed HSM-HB Dead and Live Loads

The HSM-HB dead and live loads were evaluated using the ANSYS methodology as discussed in Reference 13.10 for the NUHOMS-32PHB DSC.

B. Concrete Creep and Shrinkage Loads

Loads due to creep and shrinkage of the concrete are determined by the same methodology described in Section 8.1.1.5.B of NUH-002 Rev. 1A July 1989..

C. Modular Constructed HSM-HB Thermal Loads

The HSM-HB thermal loads, temperature-dependent material properties, analysis approach, and analysis results are documented in Reference 13.44.

Conservatively, a maximum heat load of 29.6 kW per DSC is used for all conditions, including normal operation (Reference 13.44 and 13.23).

D. Radiation Effect on Modular Constructed HSM-HB Concrete

The effects of radiation on the original poured in place HSM concrete were determined to be negligible for the NUHOMS-24P DSC in Section 8.1.1.5.D of NUH-002 Rev. 1A July 1989. The 50-year neutron fluence at the heat shield for a NUHOMS-32P DSC was determined to be 2.7E14 n/cm^2 (Reference 12.30). The maximum NUHOMS-32PHB DSC neutron source is 60% higher than that of the NUHOMS-32P DSC, which would correspondingly increase this fluence to 4.3E14 n/cm^2. The neutron fluence from the NUHOMS-32PHB DSC remains below the threshold for neutron induced degradation of concrete cited in NHU-002.

Similarly, the maximum gamma flux at the bottom of the roof heat shield for the NUHOMS-32P DSC was determined to be 1.3E9 MeV/cm^{2}s (Reference 12.30). The maximum NUHOMS-32PHB DSC gamma source is also 60% higher than that of the NUHOMS-32P DSC, which would correspondingly increase this flux to 2.1E9 MeV/cm^{2}s. This flux remains over an order of magnitude below that cited in NUH-002 as causing a negligible temperature rise in concrete per ANS/ANSI 6.4-1977. Therefore, the effect of gamma radiation on the modular constructed HSM-HB concrete also remains negligible for the NUHOMS 32PHB DSC.

E. Modular Constructed HSM-HB Design Analysis

Structural evaluation of the modular constructed HSM-HB concrete structure, DSC support structure, heat shield and miscellaneous components for the effects of the increased weight and thermal load of the NUHOMS-32PHB DSC are documented in Reference 13.10.

The effects of the weight increase are addressed by analysis of the affected components.

The thermal load evaluation of the modular constructed HSM-HB concrete structure is performed with the ANSYS computer program using a representative 2-D analytical model of the HSM-HB.

The results of the evaluation confirm that the normal operation moment and shear in the modular constructed HSM-HB concrete structure are less than the ultimate moment and shear capacity, as shown in Table 13.8-5.

13.8.1.1.6 Modular Constructed HSM-HB Door Analysis

The shield door is free to grow in the radial direction when subjected to thermal loads. Therefore, there will be no stresses in the door due to thermal growth. The dead weight, tornado wind, differential pressure, and flood loads cause insignificant stresses in the door compared to stresses due to missile impact load. Therefore, the door is evaluated only for the missile impact load. The computed maximum ductility ratio for the door is less than 1 (compared to the allowable ductility of 20) (Reference 13.10, Section 10.2.5 Part A).

For the door anchorage, the controlling load is tornado generated differential pressure drop load. The maximum tensile force per bolt (there are four bolts that attach the door assembly to the front concrete wall of the HSM-HB is 4.5 kips. This is less than the allowable load per bolt of 44.3 kips (Reference 13.10, Section C6.2). The concrete pull-out strength is conservatively estimated as 24 kips which is greater than the ultimate capacity of the four bolts, thus satisfying the ductility requirements of the ACI Code (Reference Page P.3.7-25 of the Standardized NUHOMS UFSAR).

13.8.1.1.7 Heat Shield Analysis

Each panel has a stainless steel 12 gauge sheet which is 0.1054 inch thick. Both panels of the heat shield are suspended from the roof by 15 rods of ½ inch diameter ASTM A193, Grade B7 in three rows. These rods are bolted in the stainless steel sheets.

The top heat shield has 2 panels and the side heat shield has 4 panels (Reference 13.10, Section B3.3).

For thermal protection of the HSM-HB concrete, stainless steel heat shields with anodized aluminum backing plates and fins are installed on the sidewalls of the base unit. Heat shields with stainless steel mounting bars and aluminum louvers are also installed under the roof. The heat shields guide cooling airflow through the HSM-HB. Flat stainless steel heat shields on the side walls of the base unit and under the roof are also allowed (References Page P.3.1-5 of the Standardized NUHOMS UFSAR and 13.10).

The top heat shield (louvers) consists of two panels. The natural lateral frequency of a typical rod is conservatively estimated to be 9.0 Hz. The combined axial and bending stress in the hanger rods is 24.0 ksi. The allowable axial and bending stress is 84.3 ksi.

The side heat shields consist of three panels. Each panel is suspended from the roof by two threaded rods, and supported laterally and longitudinally by four rods. The maximum axial plus bending stress in the lateral and longitudinal support rods is 83.7 ksi. The allowable axial and bending stress is 84.3 ksi. The maximum temperature used in the stress analysis of the heat shields is 270°F (Reference 13.10, App. B B3.1).

The alternate top heat shield consists of two panels made of stainless steel plate. The panels are suspended from the roof by fifteen ½ inch diameter rods threaded into concrete embedments. The combined axial and bending stress in the rods is 59.5 ksi. The allowable stress is 70.2 ksi.

The alternate side heat shield configuration may consist of four panels made from aluminum or stainless steel. The panels are supported off the base unit side wall by thirty four rod stand-offs threaded into concrete embedments. For the aluminum heat shield configuration, the maximum axial and bending stress in the rods is about 1 ksi and 53.7 ksi, respectively. For the stainless steel heat shield configuration, the maximum axial and bending stress in the rods is about 1.4 ksi and 79.3 ksi, respectively. The axial and bending stress allowable for the rods is 67.9 ksi and 112.3 ksi, respectively (Reference Page P.3.7-25 of the Standardized NUHOMS UFSAR and 13.10, App. B B5.2).

13.8.1.1.8 HSM-HB Seismic Restraint for DSC

The seismic retainer consists of a tube steel embedment located within the bottom center of the round access opening of the HSM-HB, and a tube steel retainer assembly that drops into the embedment cavity after the NUHOMS-32PHB DSC transfer is complete. The drop-in retainer extends approximately 4 inches above the rail to provide axial restraint of the NUHOMS-32PHB DSC. The maximum seismically induced shear load in the retainer is 61 kips. The maximum shear stress in the retainer is 15.25 ksi. The allowable shear stress is 17.8 ksi (Reference Page P.3.7-25 of the Standardized NUHOMS UFSAR). Details of the analysis of the CCNPP DSC seismic restraint is provided in Reference 13.10, Section C6.4 Table C 4-1.

13.8.1.1.9 Transfer Cask Forced-cooling Configuration Analysis

The transfer cask in the forced-cooling configuration was re-evaluated (Reference 13.26) for the normal operation loads identified in USAR Section 8.1.1.9, with the following differences:

A. Transfer Cask Dead Weight Loads

The analysis methodology is the same as in USAR Section 8.1.1.9, but additional weight was considered due to increased mass of the NUHOMS-32PHB DSC payload and the supporting equipment. Associated analysis is presented in References 13.3 and 13.13.

B. Transfer Cask Normal Handling Loads

The analysis methodology is the same as in USAR Section 8.1.1.9, but the transfer handling stresses are calculated for cask loading and unloading into a modular constructed HSM-HB. Associated analysis is presented in References 13.8 and 13.2, Table 8-11.

C. Transfer Cask Normal Operation Thermal Loads

The analysis methodology is the same as in USAR Section 8.1.1.9, but the thermal loads are calculated assuming 29.6 kW decay heat power.

Additionally, heat removal due to forced cooling is incorporated into the analysis and is further described in References 13.22 and 13.26, Section 4.4.

A bounding design temperature of 570°F is used for both normal and off-normal operating conditions (Reference 13.26).

The resulting maximum dead weight, thermal, and handling stresses in the transfer cask and its components are within the allowable stress limits.

13.8.1.2 Off-Normal Load Structural Analysis

The off-normal loads for the NUHOMS-32PHB DSC are identified in USAR Section 8.1.2. A detailed analysis is provided in References 13.6 and 13.10.

13.8.1.2.1 Jammed NUHOMS-32PHB DSC During Transfer with Self-Propelled Modular Transporter

This off-normal condition results from the DSC becoming jammed in the transfer cask, in the forced-cooling configuration, or the modular constructed HSM-HB during the transfer operation.

A. Postulated Cause of Jammed DSC

If the transfer cask is not accurately aligned with the HSM-HB, the DSC might become bound or jammed during the transfer operation. The maximum tolerable misalignment for the DSC insertion operation into the modular constructed HSM-HB is +/- 1/16" inches as discussed in the TN Operational Manual.

B. Detection of Jammed DSC

When DSC jamming occurs, the hydraulic pressure in the ram will increase. When the hydraulic pressure corresponds to a force on the DSC of 80,000 lbf, the DSC will be presumed to be jammed (Reference 13.2, Table 8-11). The normal pushing and pulling forces will be limited to 23,750 lbf with a ram system design capability of up to 95,000 lbf (Reference 13.2, Table 8-11).

C. Analysis of Effects and Consequences

The analyses of the NUHOMS-32PHB DSC under the assumed jamming and binding conditions are documented in the TN Operational Manual.

The stresses on the NUHOMS-32PHB DSC body have been analyzed for a maximum ram force of 95,000 lbf (Reference 13.10, Table 4-3). The calculated stresses were significantly less than the ASME code allowable stress criteria. Therefore, plastic deformation of the NUHOMS-32PHB DSC body will not occur and there is no potential for rupture.

Since the maximum NUHOMS-32PHB DSC stresses applied to a jammed NUHOMS-32PHB DSC generated from the maximum ram force is within the design basis limits of the DSC, there are no dose (airborne release) consequences associated with the postulated jammed NUHOMS-32PHB DSC during HSM-HB loading.

D. Corrective Actions

Two courses of corrective action are open to the system operators. The operator may choose to apply a ram force of up to 95,000 lbf to the DSC without risk of damage to the DSC or other system components, as discussed in the TN Operational Manual.

The courses of action open to the system operators to correct a jammed NUHOMS-32PHB DSC are described in USAR Section 8.1.2.1.D.

13.8.1.2.2 Off-Normal Thermal Loads Analysis

Structural analyses of the ISFSI components for off-normal thermal loads are discussed below using the temperature extremes of -8°F and 104°F (Reference 13.44).

A. HSM-HB Off-Normal Thermal Analysis

The methodology used for the off-normal thermal loads structural analysis of the HSM-HB concrete structure storing the loaded NUHOMS-32PHB DSC is the same as for the normal thermal loads structural analysis of the structure described in USAR Section 13.8.1.1.5.C. The DSC support assembly is designed with slotted holes as described in Section 9 of Reference 13.10; and therefore, the increase in temperature has no effect on the DSC support structure.

B. DSC Off-Normal Thermal Analysis

Off-normal thermal loads structural analysis of the NUHOMS-32PHB DSC shell assembly and the DSC fuel basket assembly for the DSC inside the HSM-HB are performed using the same methodology as for the normal thermal loads structural analyses of these components.

As discussed in USAR Section 13.8.1.1.9, the off-normal thermal loads for the transfer cask are identical to the normal thermal loads. Therefore, the off-normal thermal loads for the DSC inside the transfer cask are identical to the normal thermal loads for the DSC inside the transfer cask, and are not considered further.

C. Transfer Cask Off-Normal Thermal Analysis

As previously stated, the off-normal thermal loads for the transfer cask are identical to the normal thermal loads. Therefore, the off-normal thermal loads for the transfer cask are not considered further.

13.8.1.3 Thermal Hydraulic Analyses

The following evaluations have been performed for the CCNPP ISFSI:

A. Thermal Analysis of the modular constructed HSM-HB
B. Thermal Analysis of the NUHOMS-32PHB DSC in the HSM-HB
C. Thermal Analysis of the NUHOMS-32PHB DSC in the Transfer Cask (forced-cooling configuration)

The analytical models of the HSM-HB, the NUHOMS-32PHB DSC, and the transfer cask in the forced-cooling configuration are described in References 13.44 (HSM-HB), 13.23 (DSC in the HSM-HB), and 13.23 (DSC in the transfer cask).

The method described in Reference 13.27 is used for calculating the effective thermal conductivity of the spent fuel assemblies.

The HSM-HB and CCNPP-FC TC and NUHOMS-32PHB DSC are based on 3D models (Reference 13.42).

The HSM-HB and CCNPP-FC TC were evaluated to determine the DSC shell temperatures. These temperatures were used on the NUHOMS-32PHB DSC model to determine the fuel cladding temperature. The same approach was used to evaluate the 32P and 32P+ designs.

The primary portion of the thermal evaluation of the NUHOMS-32PHB DSC design uses a methodology that differs from the thermal analysis methodology utilized for the NUHOMS-24P DSC. The NUHOMS-32PHB DSC thermal methodology has three major new features:

- Solution Method – ANSYS finite element
- Model Geometry – 3D
- Treatment of Effective Transverse Thermal Conductivity of Fuel – A detailed finite element model of the spent fuel according to method of the TRW Spent Nuclear Fuel Effective Conductivity Report (Reference 13.27)

The new methodology has been compared in detail with the methodology used for the thermal analysis of the Transnuclear NUHOMS-32PT DSC design which was used in Amendment 8 and Amendment 10 to CoC 1004 and were approved by the NRC. The use of the NUHOMS-32PT DSC methodology is appropriate for the CCNPP ISFSI with the NUHOMS-32PHB DSC.

The radial effective thermal conductivity for helium backfill conditions is determined by creating a two-dimensional finite element ANSYS model of the fuel assembly centered within a basket compartment. The outer surfaces, representing the fuel compartment walls, are held at a constant temperature, and decay heat is applied to the fuel pellets within the model. A maximum fuel assembly temperature is then determined. From the heat load, maximum fuel temperature, and outer surface temperature, the effective fuel conductivity can be determined via an equation given in Reference 13.27, Section 8.1.

The axial effective conductivity (K_{axl}) is determined directly from the geometry and conductivities of the fuel components.

Mass-weighted averages are used in the determination of the effective density (ρ_{eff}) and specific heat values ($C_{p,eff}$).

The effective properties of the fuel are shown in Reference 13.27.

The thermal analyses are performed with the following ambient air temperatures:

A. Normal Conditions

The ambient temperature range for the NUHOMS-32PHB DSC, thermal analysis is -8°F to 104°F. Detailed analysis is discussed in Reference 13.23.

B. Off-Normal Condition

The ambient temperature range for the NUHOMS-32PHB DSC, thermal analysis is -8°F to 104°F. A solar heat flux of 127 Btu/hr-ft^2 is included in the analysis, as discussed in Reference 13.23.

C. Accident Condition

An extreme summer condition with an ambient temperature of 104°F was considered in Reference 13.23, Table 6-2. In addition, the HSM-HB vents are assumed to be completely blocked for a period of 40 hours (Reference 13.23, Table 6-2). A solar heat flux of 127 Btu/hr-ft^2 is conservatively included to maximize the HSM-HB concrete temperatures.

After initiation of forced cooling of the transfer cask, if malfunction of that system were to occur, up to 8 hours are available to complete the transfer, restart the fans, or fill the transfer cask/DSC annulus with water (Reference 13.21). To minimize the occurrence of malfunction of the forced cooling system, the self-propelled modular transporter is equipped with redundant industrial grade blowers, each of which is capable of supplying the required minimum air flow rate, as well as a redundant power supply for the blowers.

13.8.1.3.1 Thermal Analysis of the Modular Constructed HSM-HB

The modular constructed HSM-HB thermal analyses are performed for the ambient air temperatures defined in USAR Section 13.8.1.3.

The decay heat load is transferred from the DSC to the HSM-HB air space by convection and then is removed from the HSM-HB by natural convection air flow. Heat is also radiated from the DSC surface to the heat shield and HSM-HB walls where the natural convection air flow removes the heat. The solar heat flux is applied to the HSM-HB roof and front wall. Heat transfer from the outer surface of the HSM-HB roof and front wall is by natural convection and radiation to the ambient air. Heat transfer from the HSM-HB concrete foundation slab is by conduction to the soil below.

Maximum temperatures on the DSC outer surfaces and the concrete inner and outer surfaces are calculated for the normal, off-normal winter, and off-normal summer ambient conditions, and the postulated accident conditions with blocked HSM-HB vents (References 13.44 and 13.23).

13.8.1.3.2 Thermal Analysis of the DSC in the HSM-HB

The DSC and fuel assembly heat transfer analysis with the DSC inside the HSM was performed for the ambient air temperatures defined in USAR Section 13.8.1.3. The analytical model is described in Reference 13.44. The cases of interest are those that maximize fuel cladding temperature (summer ambient conditions) as described in Reference 13.23. Reference 13.7 evaluates the impact of aluminum/poison material plates in the DSC basket assembly on the maximum component temperatures. In the analysis, an effective conductivity is determined for the aluminum/poison plates and is substituted for that of the all-aluminum interior basket plates in the model from Reference 13.23, Section 5.2. The modified model is run for normal, off-normal, and blocked vent conditions. The analysis shows that the modified plates have a negligible impact on maximum component temperatures. The temperatures from these cases are used to derive the DSC internal pressures in Reference 13.24.

The maximum allowable fuel cladding temperature for long-term storage is 400°C which is greater than 335°C value discussed in USAR Section 8.1.3.2.

The acceptable peak fuel clad temperature limit for accident conditions for ISFSI storage is 1058°F (570°C) (Reference 13.23). This limit is based on the empirical work presented in ISG-11. The peak fuel clad temperature limit (short-term) of 570°C (1,058°F) is specified in the off-normal DSC thermal calculation (Reference 13.23).

13.8.1.3.3 Thermal Analysis of the DSC in the Transfer Cask (Forced-Cooling Configuration)

The thermal analyses for the cases with the DSC inside the transfer cask are performed for the ambient air temperatures defined in USAR Section 13.8.1.3. The analyses are conducted using the model described in Reference 13.23, Section 6.0.

In the models presented in Reference 13.22, Section 3.1, the gap size between the inner shell of the transfer cask and the outer shell of the DSC is assumed uniform in all directions. A sensitivity analysis was performed of gap symmetry between the DSC and transfer cask. In addition, the sensitivity of maximum temperatures to axial gap size was investigated. For the asymmetries and gap sizes investigated, there is little impact on the maximum component temperatures.

References 13.7 and 13.23 evaluate the impact of aluminum/poison material plates in the basket on the maximum component temperatures. In the analysis, an effective conductivity is determined for the aluminum/poison plates and is substituted for that of the all-aluminum interior basket plates in the models from Reference 13.23. The analysis shows that the modified plates have a negligible impact on maximum component temperatures.

Use of NS-3 for the transfer cask neutron shield is discussed in USAR Section 8.1.3.3.

13.8.2 ACCIDENTS

This section addresses design events of the third and fourth types as defined by ANSI/American Nuclear Society 57.9-1984, and other credible accidents consistent with 10 CFR Part 72 which could impact the safe operation of the CCNPP ISFSI. The postulated events identified in USAR Section 12.8.2 and Section 7.1 of Reference 13.10 and addressed for the CCNPP ISFSI are:

A. Loss of Air Outlet Shielding
B. Tornado Winds/Tornado Missile
C. Earthquake
D. Flood
E. Transfer Cask Drop
F. Lighting
G. Blockage of Air Inlets and Outlets
H. DSC Leakage
I. Accidental Pressurization of DSC

In addition, two additional CCNPP site-specific accidents have been identified and addressed. These are:

A. Forest Fire
B. Liquified Natural Gas Plant or Pipeline Spill or Explosion

In the following sections, each accident condition is evaluated for applicability to the CCNPP ISFSI with respect to the NUHOMS-32PHB DSC and the HSM-HB. For each applicable condition the accident cause, structural, thermal, radiological consequences, and recovery measures required to mitigate the accident are discussed. Where appropriate, resulting accident condition stresses were combined with those of normal operating loads in accordance with the load combination definitions of USAR Section 13.3.2.5. Load combination results for the HSM-HB, NUHOMS-32PHB DSC, and transfer cask in the forced-cooling configuration are discussed in USAR Section 13.8.2.12.

Reflood pressure is included as an ASME Service Level D activity but is not identified as an accident.

13.8.2.1 Loss of Air Outlet Shielding

"Loss of Air Outlet Shielding," is evaluated for the CCNPP NUHOMS-24P DSC in Section 8.2.1 of the ISFSI USAR. This accident was considered not credible for the current CCNPP HSMs because the air outlet shielding is designed to remain in place and withstand all design events including the effects of tornado missiles. Section P.11.2.1.1 of NUH-003 Revision 9 indicates that this accident is also not credible for the general license HSM-H design, which is structurally identical to the HSM-HB to be used at the CCNPP ISFSI. Furthermore, Reference 13.10, Section 12.3 demonstrates that the HSM-HB air outlet vent concrete covers are also designed to remain in place and withstand all design events including the effects of tornado missiles. Therefore, the conclusion that the Loss of Air Outlet Shielding accident is not credible remains valid for the HSM-HB.

13.8.2.2 Tornado Winds/Tornado Missile

The structural reanalysis of the HSM–HB concrete structure, DSC supports, and miscellaneous structural steel components of the HSM-HB storing the NUHOMS-32PHB DSC confirm the structural integrity of the HSM-HB under all normal operations, off-normal operations, and accident conditions, including Tornado Wind/Missile (Reference 13.10).

In addition, a Tornado Wind/Missile overturning analysis for the transfer cask is presented in USAR Section 8.2.2 for the 24P DSC and USAR Section 12.8.2.2 for the 32P DSC. The overturning analysis for the original cask/skid/trailer conservatively assumed that the missile impacts the uppermost part of the transfer cask. The maximum angle of rotation of the current cask/skid/trailer arrangement at impact was calculated as 1.9°, based on the conservation of angular momentum. Tip-over (i.e., instability of the cask/skid/trailer) occurs when the center of gravity of the transfer cask is directly above the point of rotation, which is 35.2° from vertical. The maximum calculated rotation of 1.9° due to missile impact is approximately 5% of that necessary to cause overturning. Analyses performed for the NUHOMS-32PHB DSC and the forced cooling transfer cask confirm that this conclusion continues to apply for transport of those SSCs using the original skid/trailer (Reference 13.16). For transport of these SSCs, as well as the NUHOMS-24P and NUHOMS-32P DSCs and the transfer cask in its original configuration, using the new transfer cask support skid (TCSS) and self-propelled modular transporter (SPMT), Reference 13.41 demonstrates that similar overturning margin exists for tornado wind/missile loading.

13.8.2.3 Earthquake

13.8.2.3.1 Cause of Accident

As specified in USAR Section 3.2.3, a Design Basis Earthquake with peak ground acceleration values of 0.15g horizontal and 0.10g vertical is postulated to occur at the CCNPP ISFSI.

13.8.2.3.2 Accident Analysis

A. NUHOMS-32PHB DSC Seismic Analysis

1. DSC Seismic Analysis

Inside the HSM-HB the combined earthquake load of 0.41g transverse, 0.36g axial, and 0.25g vertical is applied to the finite element model depicting the horizontal orientation of the DSC in storage. In addition to the seismic loads, 1.0g vertical acceleration is added to account for the self-weight effects (Reference 13.2, Table 7-1).

A three-dimensional finite element model of the basket, rails, and the DSC canister was constructed by using the ANSYS computer program. Since the seismic loading is non-symmetric, a 360° model is used. Details of the analysis model and boundary conditions used are described in Reference 13.7. The finite element model used in the seismic analysis is shown in Section 5.1 of Reference 13.7.

A nonlinear stress analysis is conducted for computing the elastic stresses in basket and canister shell models using ANSYS computer program. The nonlinearity of analysis results from the gap elements used in the analysis model. Details of the analysis are documented in Reference 13.7, Figure 47 and Figure 48 for the DSC canister and Reference 13.7, Figure 63 for the DSC basket assembly.

The resulting maximum stresses in the DSC canister and in the DSC basket assembly remain within the specified ASME code allowable stress criteria.

2. DSC Seismic Stability Analysis

An evaluation for the potential of the NUHOMS-32PHB DSC to lift-off from the DSC support assembly rail during a seismic event is documented in Reference 13.10, Section 5.9. The seismic loadings applied to the DSC that would cause instability are based on conservative rigid range seismic acceleration inputs to the HSM-HB of 0.43g horizontal in both transverse and longitudinal directions, and 0.20g vertical (Reference 13.10, Section 7.5). The stability analysis is based on showing that the overturning moment of the DSC on the HSM-HB support structure is smaller than the restoring force moment due to gravity. The non-rigid body modes of the DSC do not contribute to overturning so that the use of the rigid body accelerations is appropriate.

The resultant horizontal acceleration used to calculate the overturning moment is 0.43g. The vertical acceleration used to calculate the minimum restoring force is gravity less the vertical acceleration. The restoring moment is determined greater than the overturning moment (Reference 13.10, Section 5.9). Therefore, the DSC canister is stable during a seismic accident.

B. Modular Constructed HSM-HB Seismic Analysis

1. HSM-HB Seismic Stress Analysis

The resulting forces and moments in the HSM are found to be within the ultimate capacity (Reference 13.10, Section 5.1 and 5.2).

2. HSM-HB Seismic Stability Evaluation

An analysis was performed to show that a single free-standing HSM-HB with an end shield wall (in an array of two or more loaded modules) will not overturn due to seismic loads. Conservatively, only the overturning about the long axis (i.e. the short direction of the module) is considered. Three cases with and without DSC loaded inside the HSM module were reviewed. In all cases the stabilizing moment is greater than the overturning moment and the HSM-HB will not overturn during a seismic event.

Reference 13.10, Section 5.1

C. DSC Support Assembly Seismic Analysis

An evaluation was performed for the DSC resting on the support rails inside the HSM-HB which includes the stability of the DSC against lifting off from one of the rails during a seismic event and potential sliding off of the DSC from the support rails. Conservatively, this evaluation was performed only for a DSC with minimum weight.

Because the stabilizing moment is greater than the overturning moment the DSC will not uplift from the support structure rails inside the HSM-HB.

Reference 13.10, Section 5.9, and Reference 13.2, Section 6.3 and Section 8.4.4.

D. Transfer Cask Seismic Analysis

Seismic stresses for the transfer cask with a NUHOMS-32PHB DSC are determined by conservatively scaling the seismic analysis results of the transfer cask - NUHOMS-32P DSC assembly to account for the increased payload of the NUHOMS-32PHB DSC (Reference 13.13, Section 5.1.4).

Seismic stability of the transfer cask is not a function of the DSC weight; and therefore, remains unaffected by the use of the NUHOMS-32PHB DSC.

13.8.2.3.3 Accident Dose Consequences

Major components of the CCNPP ISFSI have been designed and evaluated to withstand the forces generated by the Design Basis Earthquake. Hence, there are no dose consequences.

13.8.2.4 Flood

As discussed in USAR Section 3.2.2, flood loads are not applicable to the CCNPP ISFSI.

13.8.2.5 Transfer Cask Drop

This section addresses the structural integrity of the transfer cask in the forced-cooling configuration, the NUHOMS-32PHB DSC, and its internals under a postulated transfer cask accident condition. The transfer trailer is not used for the transfer of the NUHOMS-32PHB DSC, only the self-propelled modular transporter with its associated transfer cask support skid is used to transfer the NUHOMS-32PHB DSC into a HSM-HB.

13.8.2.5.1 Cause of Accident

As discussed in Section 9.2.6 of Reference 13.2, an end drop event is considered to be credible. It is postulated that the transfer cask with the DSC inside will be subjected to an end, side, or oblique drop with a maximum height of 80 inches onto a thick concrete slab. A drop of greater than 80 inches is not considered because (a) transfer inside the Auxiliary Building will be performed using a single-failure-proof crane and (b) the self-propelled modular transporter and haul road are designed such that the transfer cask cannot be raised greater than 80 inches from the ground (Reference 13.11).

A failure of the self-propelled modular transporter will cause the braking system to fail-safe, that is "lock tight." The self-propelled modular transporter has emergency stop switches at easy access locations on all four sides of the transporter.

13.8.2.5.2 Accident Analysis

The drop height (80 inches), drop orientations, the properties of the target concrete surface, and the methodology used for the evaluation of the transfer with the NUHOMS-32PHB DSC as payload are described in Section 4 of Reference 13.11.

The design basis cask drop decelerations are specified in Table 13.3-5.

NUHOMS-32PHB DSC

Three accidental drop orientations are postulated for analysis.

A. Top end vertical drop
B. Horizontal side drop
C. Corner Drop

A. Top End Vertical Drop

A 360° three-dimensional finite element model of the basket, rails, and the NUHOMS-32PHB DSC was constructed with the ANSYS computer program. Gap elements are used to simulate the interface between the basket rails and inner side of the canister. Details of the analysis model and boundary conditions used are described in Reference 13.12.

Two loadings are applied to the top end drop case:

1. 75g drop load only.
2. 75g drop load with accident pressure (100 psig).

The weight of the basket and fuel assemblies is idealized as an equivalent pressure load against the inner cover plate of the top shield plug. The effect of the combined basket and fuel weight at a maximum 75g acceleration is simulated by equivalent pressure. The effect of the self-weight of the NUHOMS-32PHB DSC shell assembly at 75g is also applied to the analysis model.

The maximum stress intensity for the "75g drop only" load case is located in the top cover plate side casing (Reference 13.14, Table 18) and Section 8.3.2. Since these maximum stress intensities are due to the moments at the junction of the respective plates and casings which resist the bending of the flat plates, these are classified as Q stresses in accordance with Note (2) of Table NG 3217-1 of the ASME Code (Reference 13.6, Table 7-6 and 13.14, Table 18) and are ignored for accident condition evaluation.

B. Horizontal Side Drop

DSC impact is applied to cask model based upon a DSC weight of 96 kips. The DSC structure impact is not explicitly modeled but simulated as a profiled contact pressure load.

In case of side drop accident simulation the load is imposed as a pressure load distributed uniformly in axial direction over the effective length of inner shell and as the cosine shaped function in circumferential direction over the ±45° angle span.

In the case of top end drop the contact pressure load is defined as distributed uniformly over the contact area of DSC top end area with cask body (Reference 13.14, Section 6.5.4).

C. Corner Drop

Because the corner drop is only postulated for the DSC while it is within the Transfer Cask, the corner drop stresses for the DSC are bounded by the vertical and horizontal drops, and therefore no separate analysis is required for corner drop.

Summary of Results

The maximum membrane plus bending stress enveloping all the cask drop scenarios evaluated above are below the Level D allowable stresses for the NUHOMS-32PHB DSC during a cask drop accident (Reference 13.14, Section 5 and USAR Section 8.3.2).

NUHOMS-32PHB DSC Basket Assembly

A. Horizontal Side Drop

The basket and canister are analyzed for two modes of side drops. Firstly, the cask is assumed to drop away from the transfer support rails. Under this condition, 0°, 45°, and 60° orientation of side drops are evaluated to bound the possible maximum stress cases. Secondly, the side drop occurs on transfer cask support rails at 180° orientation. The load resulting from the fuel assembly weight, for 1g and 75g accelerations, is applied as equivalent pressure on the plates. At 0° and 180° orientations, the pressure acts only on the horizontal plates while at other orientations, it is divided in components to act on both horizontal and vertical plates of the basket.

A nonlinear static stress analysis of the DSC basket structural assembly is conducted for computing the stresses for the 0°, 45°, 60°, and 180° drop orientations. A three-dimensional ANSYS model was used for this evaluation. The maximum load of 75g was applied in each analysis. Details of the analysis are described in Reference 13.12, Section 5.4.

B. Vertical End Drop

During an end drop, the fuel assemblies and fuel compartments are forced against the bottom of the canister/cask. For any vertical or near vertical loading, the fuel assemblies react directly against the bottom or top end of the canister/cask and not through the basket structure as in lateral loading. It is only the dead weight of the basket that causes axial compressive stress during an end drop. Axial compressive stresses are conservatively computed by assuming that all load acts on the fuel compartment guide sleeves during an end drop.

<u>Summary of Results</u>

The enveloping maximum membrane plus bending stresses in the basket assembly structural components are below the ASME Code Level D allowable stresses for the NUHOMS-32PHB DSC basket assembly during a transfer cask drop accident.

<u>Transfer Cask Forced-Cooling Configuration</u>

The evaluation of the transfer cask drop accident with a NUHOMS-32PHB DSC is based on the results of the drop evaluation for the NUHOMS-32P DSC using the ANSYS computer model. The maximum stress intensities for individual components of the transfer cask are obtained by scaling to reflect the increased weight of the loaded NUHOMS-32PHB DSC, and are compared to Level D elastic allowable limits.

No evaluation is required for the corner drop since the stresses are bounded by the vertical drop stresses (Reference 13.2, Section 9.2.6 P.49).

A. Top and Bottom End Vertical Drops and Horizontal Side Drop

The lowest side drop frequency for canister is 84.3 Hz, basket is 129.8 Hz and fuel assembly is 70.6 Hz. The lowest end drop frequency for canister is 116.2 Hz and the basket is 662.4 Hz. The DLF (Dynamic Load Factors) for NUHOMS-32PHB canister for end and side drop are 1.20 and 1.28, respectively. The DLF for NUHOMS-32PHB DSC basket for end and side drop are 1.00 and 1.05, respectively.

Conservatively, the overall DLF for the NUHOMS-32PHB basket and canister for end drop and side drop are taken to be 1.20 and 1.28, respectively. The DLF for the fuel assembly for side drop is 1.42 (Reference 13.12, Section 7).

Summary of Results

The enveloping maximum membrane plus bending stresses are below allowable ASME Code Level D limits for the dropped transfer cask accident.

13.8.2.5.3 Accident Dose Consequences

Dose calculations for the transfer cask drop accident with a NUHOMS-32PHB DSC use the same methodology and model as the calculations for the NUHOMS-24P DSC, and continue to assume that the neutron shielding is lost. The doses for the NUHOMS-32PHB DSC, with the increased neutron source term, are 3521 mrem/hr on contact, and 152.2 mrem/hr at 15 feet (Reference 13.30, Tables 13-2 and 13-4). The contact dose rate remains below the limit of 5 rem/hr for this accident. The recovery dose to an on-site worker, at an average distance of 15 feet, increases from 1164 mrem for a NUHOMS-32P DSC to 1218 mrem during the 8 hour time required to mitigate the accident. The recovery dose remains below the limit of 5 rem at the site boundary since the total dose at 15 feet is much less than 5 rem.

13.8.2.6 Lightning

The modular constructed HSM-HBs are equipped with a lightning protection system. Thus, the lightning evaluation presented in USAR Section 8.2.6 for a poured in place HSMs is applicable for the modular constructed HSM-HBs and the NUHOMS-32PHB DSC System.

13.8.2.7 Blockage of Air Inlets and Outlets

This accident is postulated to consist of the complete and total blockage of all HSM-HB air inlets and outlets for a period of 36 hours.

13.8.2.7.1 Cause of Accident

See USAR Section 8.2.7.1.

13.8.2.7.2 Accident Analysis

The stresses caused by the additional weight of debris blocking the air inlets and outlets are bounded by the structural consequences of other accidents described in this section (i.e., tornado and earthquake analyses). The thermal consequences of this accident result from heating of the DSC and HSM-HB due to the loss of natural convection cooling.

The thermal analyses to determine the temperature rise for the HSM-HB and DSC components due to blocked vents are performed using the ANSYS finite element methodology (Reference 13.44 and 13.23, Section 5.1.2). The design basis pressure is considered in the DSC accident pressure evaluation presented in USAR Section 13.8.2.9.

The thermally induced stresses for the HSM for the blocked vent case are calculated using an ANSYS finite element model. The same methodology was used for evaluation of the 61BTH DSC in the HSM-H under a TN general license approved by the NRC. A maximum decay heat of 31.2 kW was considered for the 31BTH as opposed to 29.6 kW for the 32PHB. The thermally induced stresses for the DSC during accident conditions are addressed in Reference 13.23.

13.8.2.7.3 Accident Dose Consequences

To assure that the HSM concrete design temperature is not exceeded, the HSM vents are required to be inspected at 24 hour intervals (see Technical Specifications Surveillance Requirement 4.4.1.2) to verify that they are open, and to clear any blockage found within 12 hours of discovery. Title 10 CFR 72.106 establishes an accident dose limit of 5 rem at the site boundary. There is no radiological release from this accident. Direct doses from blockage of air inlets and outlets for the current HSM design is highest for the NUHOMS-24P DSC design, which has a dose rate of 73 mrem/hr at the air inlet vent. Doses to an on-site worker performing a recovery action are 584 mrem (73 mrem/hr x 8 hr) during an estimated 8 hour debris removal period. The highest vent dose rate for the NUHOMS-32PHB DSC stored in the HSM-HB is 121 mrem/hr at the front inlet (13.31, Table 8-1), not including credit for additional gamma shielding provided by the alternate bird screen design. This would increase the on-site worker 8-hour debris removal dose to 968 mrem (121 mrem/hr x 8 hr).

13.8.2.8 Dry Shielded Canister Leakage

CCNPP ISFSI USAR Sections 8.2.8 and 12.8.2.8 evaluate a non-mechanistic release to the environment of the gap inventory of Kr-85 fission gas from all fuel contained in the NUHOMS-24P and NUHOMS-32P DSCs, respectively. Current NRC guidance on analysis methodology for this accident is specified in Interim Staff Guidance 5 Revision 1, "Confinement Evaluation." Section IV.3 of ISG-5, Revision 1 also offers the option of testing closure welds to be "leak tight", as defined in "American National Standard for Leakage Tests on Packages for Shipment of Radioactive Materials," ANSI N14.5-1997, in lieu of performing a DSC leakage dose analysis. ANSI N14.5-1997 defines "leak tight" as a degree of package containment that in a practical sense precludes any significant release of radioactive materials, and is achieved by demonstration of a leakage rate less than or equal to $1x10^{-7}$ ref•cc/s, of air at an upstream pressure of 1 atmosphere (atm) absolute (abs) and a downstream pressure of 0.01 atm abs or less. Technical Specification LCO 3.2.2.2 and SR 4.2.2.1 implements the requirements to ensure the NUHOMS-32PHB DSC closure welds will be leak tight. Furthermore, stress analyses of the NUHOMS-32PHB DSC demonstrate that the pressure boundary is not breached by any design basis event since it meets the applicable stress limits for normal, off-normal and postulated accident conditions. Therefore, the DSC leakage analysis is not required and was not performed for the NUHOMS-32PHB DSC.

13.8.2.9 Accidental Pressurization of Dry Shielded Canister

This accident addresses the consequences of accidental pressurization of the NUHOMS-32PHB DSC.

13.8.2.9.1 Cause of Accident

See USAR Section 8.2.9.1.

13.8.2.9.2 Accident Analysis

The maximum NUHOMS-32PHB DSC pressurization is calculated assuming that 100% of the fuel rods in a DSC rupture and release the fission and fuel rod fill gasses to the DSC cavity. The fuel rod fission gas release fraction is assumed to be 30% and the fuel rod fill gas release fraction is assumed to be 100%. The maximum fuel rod fill gas pressure is assumed to be 1400 psia (Reference 13.9) and is used to calculate the quantity of fill gas released from fuel rods to the DSC cavity during fuel rod rupture conditions. The internal DSC pressure is calculated at the maximum ambient temperature of 104°F (Reference 13.2, Table 8-10) and a solar heat flux of 127.0 Btu/hr-ft^2.

The limiting accident for DSC pressurization is the fire accident as discussed in Reference 13.24 Table 7-1.

The maximum 32PHB DSC internal pressures calculated for normal, off-normal and accident conditions are summarized in Table 7-1.

Table 7-1 Maximum Internal Pressures during Transfer and Storage

Operating Condition	Bounding Case	N_{total} (lbmole)	$T_{gas\ avg}$ (°F)	Pressure (atm)	Pressure (psia)	Pressure (psig)	Pressure Limit (psig)
During Normal Transfer and Storage	Normal Transfer @104 °F, 29.6 kW	0.313	516	1.63	24.0	9.3	15
During Off-Normal	Off-Normal	0.388	516	2.02	29.7	15.0	20

Transfer and Storage	Transfer @104 °F, 29.6 kW						
During Accident Transfer and Storage	Fire Accident Transfer @ 29.6 kW	1.134	732	7.22	106.1	91.4	100

The analysis of accidental pressurization of the DSC includes the effect of fuel burnup on internal fuel rod pressure by using the volume of fission gas generated in the fuel rod at the maximum burnup of 62,000 MWD/MTU. The results of the analysis show that the maximum DSC accident pressures are within the allowable design bases limits.

13.8.2.9.3 Accident Dose Calculations

Since the maximum NUHOMS-32PHB DSC accident pressure is within the design basis limits, there are no dose consequences.

13.8.2.10 Forest Fire

This postulated event involves a forest fire occurring in the woods adjacent to the CCNPP ISFSI.

13.8.2.10.1 Cause of Accident

See USAR Section 8.2.10.1.

13.8.2.10.2 Accident Analysis

The ISFSI USAR Sections 8.2.10 and 12.8.2.10 postulates a forest fire occurring in the woods adjacent to the CCNPP ISFSI. The initial parameters used in those sections remain unchanged for the NUHOMS-32PHB DSC in the HSM-HB. The damage to the HSM-HB wall, based on the wall temperature gradient resulting from the fire (depth at which temperatures remain below 350°F) will be limited to a thickness of 9 inches (Reference 13.40). Fuel cladding temperature limits will be maintained within the fuel cladding short-term temperature limit, and the NUHOMS-32PHB DSC internal pressure limit (100 psig) will not be exceeded. The effect of the surface cracking and spalling will be minimal with respect to the load capacity of the HSM-HB walls, but will reduce the effective shielding thickness and increase dose rates outside of the HSM-HB. The HSM storing fuel-loaded NUHOMS-24P and/or NUHOMS-32P DSCs surface dose rate increase associated with forest fire induced spalling of the HSM wall was based on a 12 inch reduction in concrete thickness producing a factor of 20 increase in dose rate at the HSM surface. For the NUHOMS-32PHB DSC, a 9 inch reduction in concrete depth would translate to surface dose rates increasing by a factor of 9.5 using the same rule. The original design goal for the CCNPP ISFSI was that the spalling not increase dose rates to a level beyond which repair actions could be performed by conventional methods (1 rem/hr at 1m). For the NUHOMS-32PHB DSC, forest fire spalling would result in a dose rate of 59.3 mrem/hr at the HSM-HB surface (9.5 x 6.27 mrem/hr from 13.31, Table 8-1) which is still significantly below the 1 rem/hr design goal for spalling repair. Thus, it can be concluded that the NUHOMS-32PHB DSC would also not adversely impact the ability to repair spalled concrete following a forest fire. Actions to mitigate the fire and repair the HSM-HBs will ensure that off-site dose consequences will be limited and of short duration and will remain within the limits of 10 CFR 72.106.

13.8.2.10.3 Accident Dose Consequences

There are no accident dose consequences associated with the postulated forest fire accident.

13.8.2.11 Liquefied Natural Gas Plant or Pipeline Spill or Explosion

Discussion in USAR Section 8.2.11 is applicable to the modular constructed HSM-HB and NUHOMS-32PHB DSC system.

A more recent evaluation of the expanded LNG plant was performed by the Maryland Department of Natural Resources (the 2006 PPRP Study) and was submitted to the NRC by CCNPP for Units 1&2 and the ISFSI on February 20, 2008. In addition, in response to RAI questions on CCNPP3, Unistar submitted additional analyses of the hazards associated with LNG pipeline on November 11, 2008 (ADAMS Accession No. ML083180126). Based on the combination of the two analyses, the NRC issued a Safety Evaluation Report on October 28, 2009 indicating that the likelihood of exceeding 1 psi overpressures at the CCNPP (considered the NRC minimum threshold for structural damage due to explosion), associated with two scenarios identified in the 1993 A.D. Little study (i.e., tanker approach collisions and loading dock LNG releases) meets the acceptance criterion of about 10^{-6} per year. The increase in the storage tank size from 600,000 to 1,000,000 barrels was found to be acceptable in that the estimated overpressure at the CCNPP was still less than 1 psi.

13.8.2.12 Load Combinations

The load categories associated with normal, off-normal, and accident conditions have been described and analyzed in previous chapters. Evaluation of the load combination for the NUHOMS-32PHB DSC important to safety components is addressed in this section.

The methodology used in combining normal, off-normal, and accident loads and their associated overload factors for various NUHOMS-32PHB DSC components is presented in Reference 13.6, Table 5-1. The load combination analysis results showed that the calculated stresses are less than the code allowable limits for various load combinations shown in Tables 13.8-1, 13.8-2, 13.8-3, 13.8-4, 8.2-14, 8.2-15, and 8.2-16.

When compared to the NUHOMS-24P DSC, the confinement boundary stress allowable limits (Table 13.8-3) have been altered to an elastic/plastic analysis for all accident conditions except for the 100 psig applied to the inner pressure boundary combinations (D_3, D_4, & D_5)

Horizontal storage module enveloping load combination results were obtained based on a conservative interpretation of the CCNPP calculation. The forces and moments, including thermal loads, are taken from the ANSYS output presented in Reference 13.10, Table 7-2.

The load combination analysis results show that the calculated stresses are less than the code allowable stresses for all the specified normal, off-normal, and accident condition load combinations.

13.8.2.13 Other Event Considerations

Use of the NUHOMS-32PHB DSC design does not change the analysis described in USAR Section 8.2.13.

13.8.3 SITE CHARACTERISTICS AFFECTING SAFETY ANALYSIS

All site characteristics affecting safety analyses presented in this document are noted where they apply.

TABLE 13.8-1
NUHOMS-32PHB DRY SHIELDED CANISTER ENVELOPING LOAD COMBINATION RESULTS FOR NORMAL AND OFF-NORMAL LOADS

(ASME Service Levels A and B)

DSC COMPONENTS	STRESS TYPE	CONTROLLING[a] LOAD COMBINATION A/B	ALLOWABLE[b][c] STRESS (ksi)A/B
DSC Shell	Primary Membrane	4.9/5.1	18/18
	Membrane + Bending	24.4/19.1	27/27
	Primary + Secondary	36.39/31.1	53.9/53.9
Bottom Cover Plate	Primary Membrane	1.5/1.5	19/19
	Membrane + Bending	15/20.6	28.4/28.4
	Primary + Secondary	27/32.6	56.9/56.9
Top Pressure Plate (top inner plate)	Primary Membrane	0.9/0.9	19/19
	Membrane + Bending	4.8/4.8	28.4/28.4
	Primary + Secondary	16.8/16.8	56.9/56.9
Top Structural Plate (top outer plate)	Primary Membrane	2.9/2.9	19/19
	Membrane + Bending	8.1/8.1	28.4/28.4
	Primary + Secondary	20.1/20.1	56.9/56.9

[a] See Table 13.3-6 for load combination nomenclature.

[b] See Table 7-3 and 7-4 of Reference 13.6 for allowable stress criteria. Material properties were obtained from Table 5-2 and 5-3 of Reference 13.6 at a design temperature.

[c] Allowable limits are for stainless steel material at 595°F.

NOTE: Refer to Table 5-1 of Reference 13.6 for Bounding Load Combinations A, B, C, and D.

TABLE 13.8-2
NUHOMS-32PHB DRY SHIELDED CANISTER ENVELOPING LOAD COMBINATION RESULTS FOR ACCIDENT LOADS

(ASME Service Level C)

DSC COMPONENTS	STRESS TYPE	CONTROLLING[a] LOAD COMBINATION	ALLOWABLE[b][c] STRESS (ksi)
DSC Shell	Primary Membrane	4.3	21.6
	Membrane + Bending	31.3	32.4
Bottom Cover Plate	Primary Membrane	1.7	22.8
	Membrane + Bending	4.3	34.1
Top Pressure Plate(inner)	Primary Membrane	.5	22.8
	Membrane + Bending	3.2	34.1
Top Structural Plate (outer)	Primary Membrane	2.5	22.8
	Membrane + Bending	6.1	34.1

(a) See Table 13.3-6 for load combination nomenclature.
(b) See Table 12-2 and 7-6 of Reference 13.6 for allowable stress criteria. Material properties were obtained from Table 5-2 of Reference 13.6 at a design temperature.
(c) Allowable limits are for stainless steel material at 610°F.

TABLE 13.8-3
NUHOMS-32PHB DRY SHIELDED CANISTER ENVELOPING LOAD COMBINATION RESULTS FOR ACCIDENT LOADS

(ASME Service Level D)[c]

DSC COMPONENTS	STRESS TYPE	CONTROLLING[a] LOAD COMBINATION	ELASTIC ALLOWABLE[b] STRESS (ksi)	ELASTIC-PLASTIC ALLOWABLE[d] STRESS (ksi)
DSC Shell	Primary Membrane	18.3	39.6	38.8
	Membrane + Bending	32.5	59.4	58.32
Bottom Cover Plate	Primary Membrane	9.8	44.38	44.38
	Membrane + Bending	42.2	63.4	63.4
Top Pressure Plate	Primary Membrane	3	44.38	44.38
	Membrane + Bending	31.4	63.4	63.4
Top Structural Plate	Primary Membrane	5.7	44.38	44.38
	Membrane + Bending	28.6	63.4	63.4
Basket Assembly	Primary Membrane	20.22	44.38	44.4
	Membrane + Bending	28.83	63.4	57.1
Top End Structural DSC Closure Weld	Primary Membrane + Bending	2.3	44.38	47.23
Bottom End Structural Fillet Weld	Primary	2	19.68	19.68

For more information see Reference 13.6.

(a) See Table 13.3-6 for load combination nomenclature.
(b) See Table 12-2 and 7-6 of Reference 13.6 for allowable stress criteria. Material properties were obtained from Table 5-2 of Reference 13.6 at a design temperature.
(c) Allowable limits are for stainless steel material at 460°F for normal conditions and 595°F for accident conditions (storage)
(d) Used on 100 psi pressure applied at outer boundary case.

TABLE 13.8-4
NUHOMS-32PHB DRY SHIELDED CANISTER SUPPORT ASSEMBLY
ENVELOPING LOAD COMBINATION RESULTS

		AISC Allowable Stress		
Component	**Load Combination**	**Axial (Pm) (ksi)**	**Bending (Pl+Pb) (ksi)**	**Shear (Pl+Pb+Q) (ksi)**
Bottom Cover Plate	Normal Operation (3)	19	28.4	56.9
	Off-Normal Operation (2)	19	28.4	56.9
	Accident (1)	44.38	63.4	
Lead Casing Bottom Plate	Normal Operation (3)	19	28.4	56.9
	Off-Normal Operation (2)	19	28.4	56.9
	Accident (1)	44.38	63.4	

KEY:
(1) 13.6, Table 7-6
(2) 13.6, Table 7-1
(3) 13.6, Table 7-3

NOTES:
Allowable stresses taken at 505°F to conservatively envelope all ambient temperature cases (13.6, Section 5.4, Table 5-4 and 5-5).

TABLE 13.8-5
MAXIMUM HORIZONTAL STORAGE MODULE (Model H) REINFORCED CONCRETE BENDING MOMENTS AND SHEAR FORCES FOR NORMAL AND OFF-NORMAL LOADS

Structural Section	Force[(a)] Component	Dead Weight	Creep Effects	Live Loads	Normal Thermal	Off-normal Thermal	Ultimate[(b)(c)] Capacity
Inner Wall (side wall)	Shear						54.4 k/ft
	Moment						196.9 k-in/ft
End Wall (rear wall)	Shear						96.8 k/ft
	Moment						757.9 k-in/ft
Roof Slab	Shear						174.6 k/ft
	Moment						2375 k-in/ft

This table applies to modular constructed HSM-HBs.

Ultimate Shear Capacity based on ACI 349 Section 11.8 for deep flexural members except for inner wall which is based on Section 11.10.

(a) Shear values are in kips/ft. Moment values are in inch-kips/ft.

(b) Concrete and reinforcing steel properties were taken at 500°F (accident thermal conditions) to conservatively envelope all ambient cases.

(c) Ultimate capacities are reported for a 12 inch section of HSM-HB using f_c and f_y values at 200°F (Normal thermal condition 500°F (Accident thermal condition).

Reference 13.10, Table D.5-1 and Table F-1

13.9 CONDUCT OF OPERATIONS

The CCNPP ISFSI is operated under the same corporate management organization responsible for operation of the CCNPP. The conduct of operations for the CCNPP ISFSI is described in Chapter 9.0. The discussion presented in Chapter 9.0 is applicable to the NUHOMS-32PHB DSC, except for USAR Sections 9.2.2.1.4, 9.2.2.1.5, and 9.4.

USAR Section 9.2.2.1.4 discusses the test performed with a transfer cask in the non-forced-cooling configuration, the transfer trailer/self-propelled modular transporter, and the original poured in place HSM.

USAR Section 9.2.2.1.5 discusses the off-normal test of the transfer trailer, self-propelled modular transporter, and the original poured in place HSM.

In USAR Section 9.4, it is stated that the failure or unavailability of any operational component can result in delay in transfer of the DSC to the HSM, but will not result in an unsafe condition.

13.10 OPERATING CONTROLS AND LIMITS

The discussion presented in Chapter 10 is applicable to the CCNPP ISFSI NUHOMS-32PHB DSC, the HSM-HB, the self-propelled modular transporter, the hydraulic ram and transfer cask support skid used with the self-propelled modular transporter and the transfer cask in the forced-cooling configuration.

13.11 QUALITY ASSURANCE

The quality assurance program for the CCNPP ISFSI covers the construction phase, the operational phase, and the decommissioning phase of structures, systems, and components of the CCNPP ISFSI which are important to safety. The CCNPP ISFSI quality assurance program is discussed in Chapter 11. The discussion presented in Chapter 11 is applicable to the CCNPP ISFSI NUHOMS-32PHB DSC, the modular constructed HSM-HB, the self-propelled modular transporter, the hydraulic ram and transfer cask support skid used with self-propelled modular transporter and the transfer cask in the forced-cooling configuration.

13.12 NUHOMS-32PHB DRY SHIELDED CANISTER

Chapter 12 presents an evaluation of the NUHOMS-32P DSC dry storage system used at the CCNPP ISFSI. Chapter 1 is revised to include information for the NUHOMS-24P, NUHOMS-32P, and NUHOMS-32PHB DSCs. Chapters 2 through 11 primarily apply to the NUHOMS-24P DSC, whereas USAR Sections 12.2 through 12.11 provide the same information as it applies to the NUHOMS-32P DSC and USAR Sections 13.2 through 13.11 provides similar information as it applies to the NUHOMS-32PHB DSC, the modular constructed HSM-HB, the self-propelled modular transporter, the hydraulic ram and transfer cask support skid used with the self-propelled modular transporter and the transfer cask in the forced-cooling configuration. Therefore, the discussion presented in Chapter 12 is not applicable to the CCNPP ISFSI NUHOMS-32PHB DSC and the modular constructed HSM-HB.

13.13 REFERENCES

13.1 Unused

13.2 Transnuclear Calculation No. NUH32PHB-0101, DESIGN CRITERIA DOCUMENT (DCD) FOR NUHOMS 32PHB SYSTEM FOR STORAGE DESIGN CALCULATION

13.3 Transnuclear Calculation No. NUH32PHB-0201, NUHOMS 32PHB WEIGHT CALCULATION OF DSC/TC SYSTEM DESIGN CALCULATION

13.4 Unused

13.5 Unused

13.6 Transnuclear Calculation No. NUH32PHB-0204, NUHOMS 32PHB CANISTER STRUCTURAL EVALUATION FOR STORAGE AND ONSITE TRANSFER LOADS DESIGN CALCULATION

13.7 Transnuclear Calculation No. NUH32PHB-0205, NUHOMS 32PHB BASKET EVALUATION FOR STORAGE AND TRANSFER LOADS DESIGN CALCULATION

13.8 Transnuclear Calculation No. NUH32PHB-0206, NUHOMS 32PHB TRANSFER CASK - LOCAL SHELL STRESSES AT TRUNNION LOCATIONS DESIGN CALCULATION

13.9 Transnuclear Calculation No. NUH32PHB-0207, FUEL ROD END DROP ANALYSIS FOR NUH32PHB USING LS-DYNA DESIGN CALCULATION

13.10 Transnuclear Calculation No. NUH32PHB-0208, HSM-HB STRUCTURAL ANALYSIS FOR NUHOMS 32PHB SYSTEM DESIGN CALCULATION

13.11 Transnuclear Calculation No. NUH32PHB-0209, CCNPP-FC TRANSFER CASK IMPACT ONTO THE CONCRETE PAD, LS-DYNA ANALYSIS (80 INCH SIDE, CORNER, AND END DROPS)

13.12 Transnuclear Calculation No. NUH32PHB-0210, NUHOMS 32PHB CANISTER, BASKET AND FUEL ASSEMBLIES DYNAMIC LOAD FACTORS DESIGN CALCULATION

13.13 Transnuclear Calculation No. NUH32PHB-0211, RECONCILIATION FOR TRANSFER CASK CCNPP-FC STRUCTURAL EVALUATION FOR 32PHB DESIGN CALCULATION

13.14 Transnuclear Calculation No. NUH32PHB-0212, CCNPP-FC TRANSFER CASK STRUCTURAL EVALUATION - ACCIDENT CONDITIONS, 75G SIDE DROP AND 75G TOP END DROP CASES

13.15 Transnuclear Calculation No. NUH32PHB-0213, LIFTING LUG STRUCTURAL EVALUATION FOR 32PHB DESIGN CALCULATION

13.16 Transnuclear Calculation No. NUH32PHB-0214, NUHOMS 32PHB RECONCILIATION OF CIVIL STRUCTURES DESIGN CALCULATION

13.17 Unused

13.18 Unused

13.19 Unused

13.20 Transnuclear Calculation No. NUH32PHB-0400, BENCHMARKING OF ANSYS MODEL OF THE OS200FC TRANSFER CASK

13.21 Transnuclear Calculation No. NUH32PHB-0401,THERMAL EVALUATION OF NUHOMS 32PHB TRANSFER CASK FOR NORMAL, OFF NORMAL AND ACCIDENT CONDITIONS WITH FORCED COOLING (STEADY STATE) DESIGN CALCULATION

13.22 Transnuclear Calculation No. NUH32PHB-0402,THERMAL EVALUATION-NUHOMS 32PHB TRANSFER CASK FOR NORMAL, OFF NORMAL AND ACCIDENT CONDITIONS DESIGN CALCULATION

13.23 Transnuclear Calculation No. NUH32PHB-0403,THERMAL EVALUATION FOR NUHOMS 32PHB CANISTER FOR STORAGE AND TRANSFER CONDITIONS DESIGN CALCULATION

13.24 Transnuclear Calculation No. NUH32PHB-0404,INTERNAL PRESSURE FOR NUHOMS 32PHB DSC FOR STORAGE AND TRANSFER CONDITIONS DESIGN CALCULATION

13.25 Unused

13.26 Transnuclear Calculation No. NUH32PHB-0406,THERMAL EVALUATION-NUHOMS 32PHB TRANSFER CASK FOR NORMAL, OFF- NORMAL AND ACCIDENT CONDITIONS (HEAT LOAD <29.6KW) DESIGN CALCULATION

13.27 Transnuclear Calculation No. NUH32PHB-0407,EFFECTIVE THERMAL PROPERTIES OF BOUNDING CE 14X14 FUEL ASSEMBLY FOR 32PHB DSC DESIGN CALCULATION

13.28 Transnuclear Calculation No. NUH32PHB-0408, THERMAL ANALYSIS OF NUHOMS 32PHB DSC FOR VACUUM DRYING OPERATIONS DESIGN

13.29 Unused

13.30 Transnuclear Calculation No. NUH32PHB-0502, CALVERT CLIFFS NUHOMS 32PHB RADIATION DOSE RATES FOR LOADING AND TRANSFER DESIGN CALCULATION

13.31 Transnuclear Calculation No. NUH32PHB-0503, HSM-H SHIELDING ANALYSIS FOR 32PHB SYSTEM DESIGN CALCULATION

13.32 Transnuclear Calculation No. NUH32PHB-0505, SITE DOSE ANALYSIS FOR NUHOMS 32PHB SYSTEM DESIGN CALCULATION

13.33 Transnuclear Calculation No. NUH32PHB-0600, CRITICALITY EVALUATION FOR NUHOMS 32PHB SYSTEM DESIGN CALCULATION

13.34 Transnuclear Calculation No. NUH32PHB-0603, CRITICALITY EVALUATION FOR NUHOMS 32PHB SYSTEM DESIGN CALCULATION

13.35 Unused

13.36 Unused

13.37 Unused

13.38 ASME Boiler and Pressure Vessel Code, 1998 edition with all addenda up to and including 1999 Addenda for DSC/ Basket design and 1992 edition for the transfer cask design.

13.39 USNRC, Spent Fuel Project Office Interim Staff Guidance, ISG-15, "Materials Evaluation", 2001.

13.40 Transnuclear Calculation No.NUH32PHB-0409, Forest Fire Thermal Evaluation for CCNPP ISFSI

13.41 CCNPP Calculation CA07625 SPMT stability calculation due to overturning wind force.

13.42 Transnuclear Calculation No. NUH32PHB-0111, Design Report for 32PHB DSC

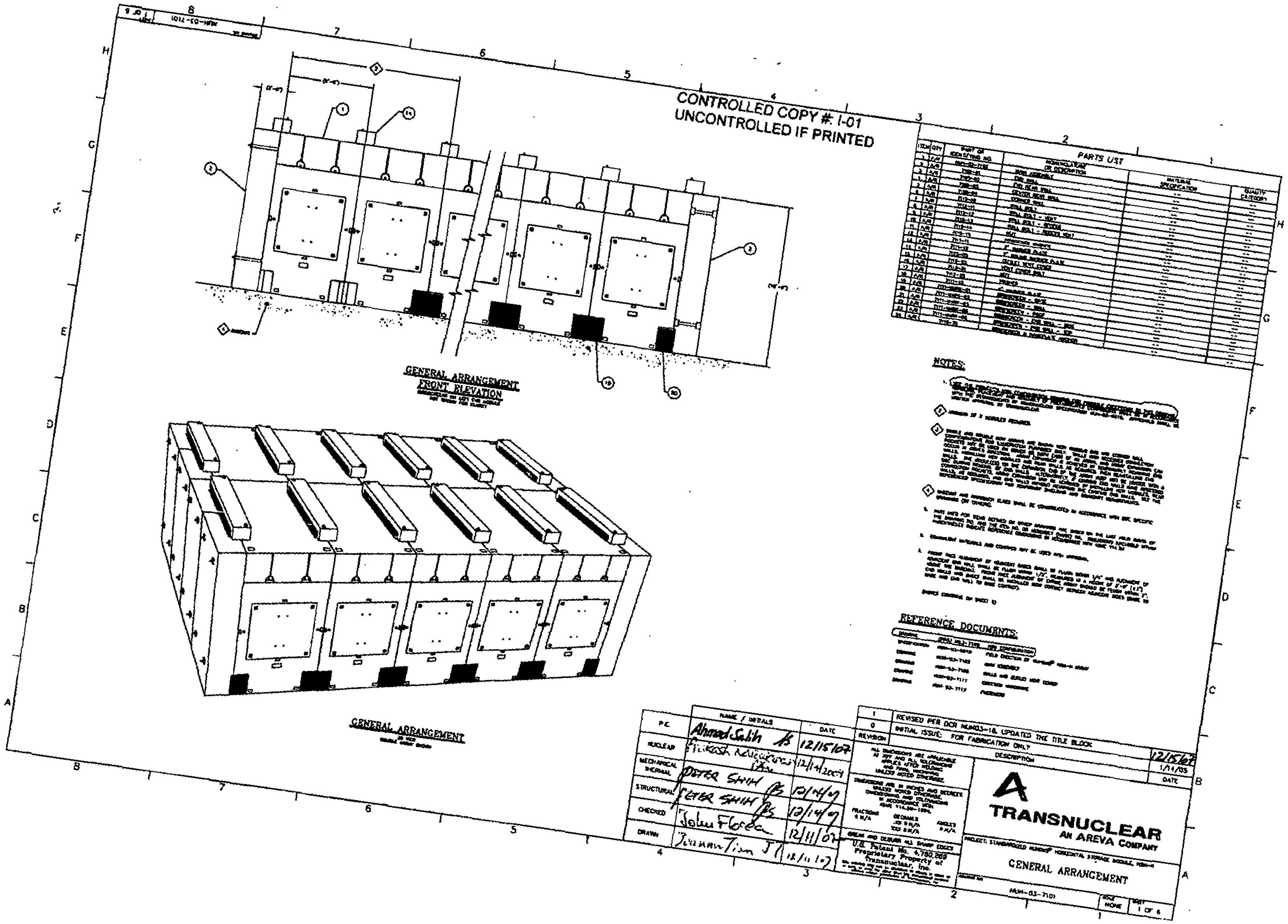
13.43 Unused

13.44 Transnuclear Calculation No. NUH32PHB-0410, RECONCILIATION OF THERMAL ANALYSIS RESULTS FOR 32PHB DSC STORAGE IN HSM-HB MODULE DESIGN CALCULATION

13.45 Topical Report for the Nutech Modular Storage System (NUHOMS 24P) for Irradiated Nuclear Fuel, NUH-002, Revision 1A, July 1989

ENCLOSURE 3

Drawings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GENERAL ARRANGEMENT
FRONT ELEVATION
GENERAL ARRANGEMENT
P.E.
NUCLEAR
MECHANICAL THERMAL
STRUCTURAL
CHECKED
DRAWN
NAME / INITIALS
DATE
Ahmad Salih
12/15/07
12/14/2007
PETER SHIH
12/14/07
PETER SHIH
12/14/07
John Flores
12/11/07
12/11/07
1
REVISED PER DCR NUH03-18, UPDATED THE TITLE BLOCK
12/15/07
0
INITIAL ISSUE: FOR FABRICATION ONLY
1/14/05
REVISION
DESCRIPTION
DATE
U.S. Patent No. 4,780,269
Proprietary Property of
Transnuclear, Inc.
TRANSNUCLEAR
AN AREVA COMPANY
GENERAL ARRANGEMENT
NUH-03-7101
NONE
1 OF 6

NOTES:

1. [illegible] PROJECT'S HSM CONFIGURATION DRAWING FOR POSSIBLE EXCEPTIONS TO THIS DRAWING. [illegible] WITH THE REQUIREMENTS OF TRANSNUCLEAR SPECIFICATION NUH-03-0210. [illegible]
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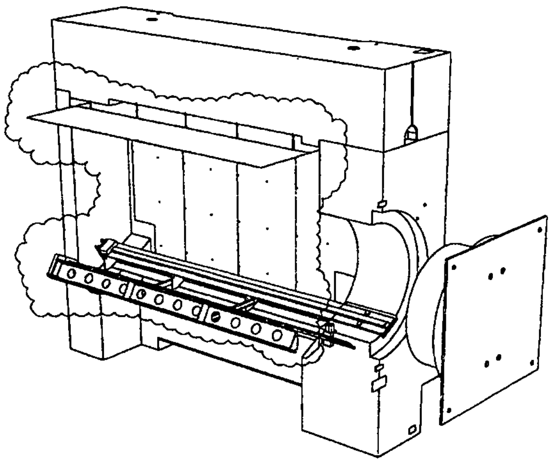
11. [illegible]
12. [illegible]
13. [illegible]
14. [illegible]
15. [illegible]
16. [illegible]

ITEM	QTY	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	QUALITY CATEGORY
PARTS LIST					
1	1	NUH-03-7103	BASE	--	--
2	1	NUH-03-7104	ROOF	--	--
3	1	NUH-03-7107	DSC SUPPORT STRUCTURE	--	--
4	4	7112-16	DSC SUPPORT STRUCTURE FRONT BOLT	--	--
5	4	7112-29	DSC SUPPORT STRUCTURE RAIL SET SCREW	--	--
6	2	7107-13	REAR CONNECTION PLATE	--	--
7	2	7112-28	DSC SUPPORT STRUCTURE REAR WASHER	--	--
8	2	7112-36	DSC SUPPORT STRUCTURE REAR STUD	--	--
9	4	7112-37	DSC SUPPORT STRUCTURE REAR NUT	--	--
10	4	7110-02	SIDE HEAT SHIELD - TYPE A	--	--
11	4	7110-03	SIDE HEAT SHIELD - TYPE B	--	--
12			DELETED		
13	2	7110-01	ROOF HEAT SHIELD	--	--
14	12	7112-MARK-01	ROOF HEAT SHIELD SUPPORT - LONG	--	--
15	3	7112-MARK-02	ROOF HEAT SHIELD SUPPORT - SHORT	--	--
16	16	7112-MARK-03	SIDE HEAT SHIELD SUPPORT	--	--
17	1	NUH-03-7105	DOOR - TYPE A	--	--
18	4	7111-18	4" WASHER PLATE	--	--
19	4	7112-23	DOOR BOLT	--	--
20	4	7112-25	WASHER	--	--
21	4	7112-17	DOOR PROTECTIVE PLUG	--	--
22	1	NUH-03-7108	DOOR - TYPE B	--	--
23	4	7111-08	DOOR CLAMP	--	--
24	4	7112-24	DOOR CLAMP BOLT	--	--
25	4	7112-25	WASHER	--	--
26	4	7112-17	DOOR PROTECTIVE PLUG	--	--
27	4	7111-MARK-04	ROOF ANGLE	--	--
28	16	7112-31	ROOF ANGLE WASHER	--	--
29	8	7112-18	ROOF ANGLE BOLT	--	--
30	8	7112-19	ROOF ANGLE STUD	--	--
31	8	7112-20	ROOF ANGLE NUT	--	--
32	1	7111-08	DSC AXIAL RETAINER	--	--
33	4	BRUNSON 277P OR EQUIV	ADHESIVE TARGET		NTS
34	3	7112-00	CASK RESTRAINT PROTECTIVE PLUG	--	--
35	1		NAMEPLATE	--	--
36	4	7112-30	SHROUDSCREW & NAMEPLATE ANCHOR	--	--
37	8	7107-14	SPACER - BOLTED	--	--
38	4	7112-32	HOOK BOLT	--	--
39	8	7112-33	PREVAILING TORQUE NUT	--	--
40	8	7112-34	WASHER	--	--



MAIN ASSEMBLY

3D VIEW

REFERENCE DOCUMENTS:

DRAWING	(PROJ NO.)-7100	HSM CONFIGURATION
SPECIFICATION	NUH-03-0210	FIELD ERECTION OF NUHOMS® HSM-H ARRAY
DRAWING	NUH-03-7103	BASE
DRAWING	NUH-03-7104	ROOF
DRAWING	NUH-03-7105	DOOR - TYPE A
DRAWING	NUH-03-7107	DSC SUPPORT STRUCTURE
DRAWING	NUH-03-7108	DOOR - TYPE B
DRAWING	NUH-03-7110	HEAT SHIELDS
DRAWING	NUH-03-7111	ERECTION HARDWARE
DRAWING	NUH-03-7112	FASTENERS

REVISION	DESCRIPTION	DATE
1	INCORPORATED DCR NUH03-002	12/29/05
0	INITIAL ISSUE. FOR FABRICATION ONLY	1/14/05

	SIGNATURE	DATE
P.E.	[signature]	12/20/05
CONFORMANCE	[signature]	12/29/05
CRITICALITY	N/A	
SHIELDING	N/A	
STRUCTURAL	[signature]	12-20-05
THERMAL	N/A	
CHECKED	[signature]	12/20/05
DRAWN	[signature]	12/20/05

ALL DIMENSIONS ARE APPLICABLE AT 70°F UNLESS NOTED OTHERWISE.

DIMENSIONS ARE IN INCHES AND DEGREES UNLESS NOTED OTHERWISE. DIMENSIONING AND TOLERANCING IN ACCORDANCE WITH ASME Y14.5M-1994.

FRACTIONS ± N/A DECIMALS ± N/A ANGLES ± N/A

3rd ANGLE PROJECTION

DO NOT SCALE DRAWING

TRANSNUCLEAR
AN AREVA COMPANY

TITLE: STANDARDIZED NUHOMS® HORIZONTAL STORAGE MODULE, HSM-H

MAIN ASSEMBLY

DRAWING NO. NUH-03-7107 | SCALE NONE | SHEET 1 OF 6

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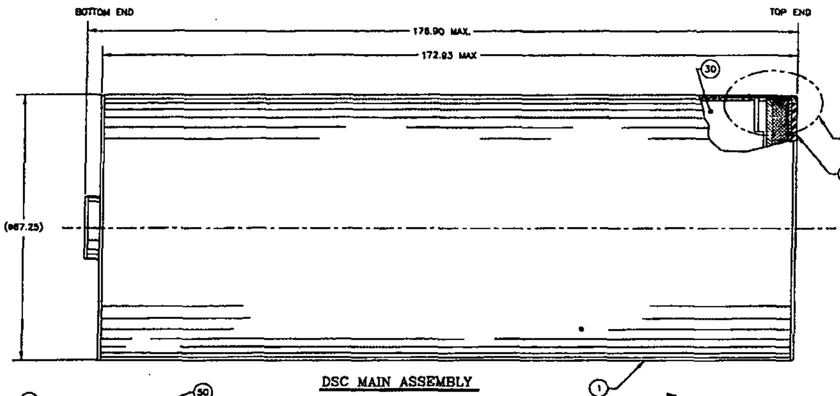
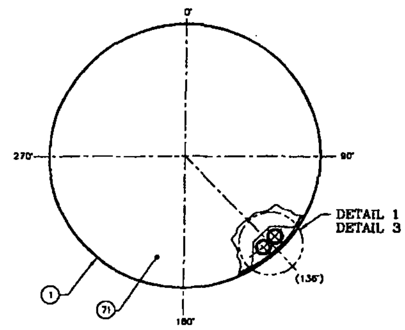
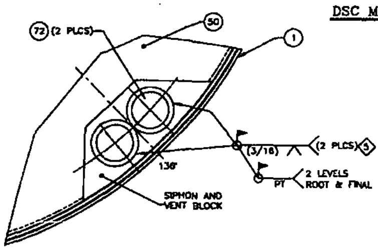


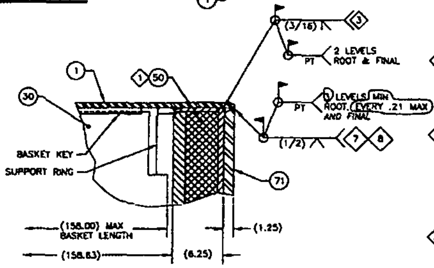
DSC MAIN ASSEMBLY



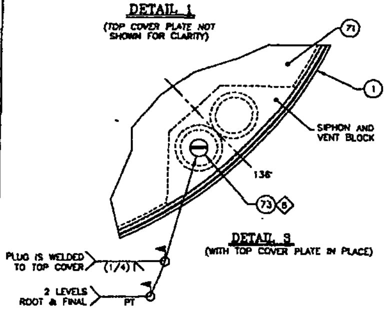
DSC MAIN ASSEMBLY-TOP VIEW



DETAIL 1
(TOP COVER PLATE NOT SHOWN FOR CLARITY)



DETAIL 2



DETAIL 3
(WITH TOP COVER PLATE IN PLACE)

NOTES:

1. PRIOR TO INSTALLING ITEM 50 (TOP SHIELD PLUG ASSEMBLY) LUBRICATE O-RINGS (ITEMS 20 & 23- FROM DWG NUH32PHB-30-2) WITH PARKER SUPER-O-LUBE OR EQUIVALENT.

2. AFTER REMOVAL OF THE TRANSFER CASK (WITH TOP SHIELD PLUG (TSP) IN PLACE) FROM THE SPENT FUEL POOL (SFP), INSTALL ONE COUPLING ASSEMBLY INTO THE PORT MARKED SIPHON ATOP THE TSP. APPLY THREAD SEALANT (CCNPP APPROVED AND SUPPLIED) TO NIPPLE THREADS. HAND TIGHTEN PLUS 1/4 TURN. TEST FIT SIPHON PORT COVER (ITEM 72) TO ASSURE COUPLING ASSEMBLY IS PROPERLY INSTALLED AND NOT INTERFERING WITH THE PORT COVER.

3. FIELD WELD TOP SHIELD PLUG ASSEMBLY (ITEM 50) TO SHELL ASSEMBLY (ITEM 1) AFTER SPENT FUEL ASSEMBLIES HAVE BEEN PLACED IN THE DSC. GAP BETWEEN TOP PLUG ASSEMBLY AND SHELL ASSEMBLY SHALL BE DOCUMENTED. ASSURE THAT THE TACK WELDING IS PERFORMED UNIFORMLY, THUS NOT ALLOWING THE GAP TO OPEN UP. AVOID EXCESS FILLER METAL DEPOSITION TO LIMIT DISTORTION OF SHELL. THE CROWN OF THE WELD SHALL NOT PROJECT MORE THAN .06 INCHES ABOVE THE TOP SHIELD PLUG ASSEMBLY. THE CROWN OF THE WELD SHALL NOT PROJECT MORE THAN .25 INCHES ABOVE THE TOP SHIELD PLUG ASSEMBLY SURFACE AT THE SHELL INTERFACE. IF GRINDING IS REQUIRED, GRINDING SHALL BE MINIMIZED.

4. AFTER WELDING OF TSP, INSTALL ONE COUPLING ASSEMBLY INTO THE PORT MARKED VENT ATOP THE TSP. APPLY THREAD SEALANT (CCNPP APPROVED AND SUPPLIED) TO NIPPLE THREADS. HAND TIGHTEN PLUS 1/4 TURN. TEST FIT VENT PORT COVER (ITEM 72) TO ASSURE COUPLING ASSEMBLY IS PROPERLY INSTALLED AND NOT INTERFERING WITH THE PORT COVER.

5. AFTER COMPLETION OF STEP 4,
A) DRY THE PARTS (ITEM 72- SIPHON/VENT COVERS) THOROUGHLY WITH ABSORBENT CLOTH AND COMPRESSED AIR.
B) RUN THE HELIUM IN THE SUPPLY LINE LONG ENOUGH TO PURGE THE LINE OF AIR.
C) INSERT THE HELIUM NEEDLE INTO THE SMALL PORT AT THE OPENING (COUNTERSINK) OF THE SIPHON/VENT PORT AS FAR AS POSSIBLE, AND PLACE THE COVER PLATE OVER THE PORT.
D) *RUN THE HELIUM PURGE AT A RATE SLOW ENOUGH NOT TO LIFT THE COVER OR TO DRAW AIR TURBULENCE OR* VENTURI EFFECT. PURGE LONG ENOUGH TO TURN OVER THE PORT VOLUME (4 CUBIC INCHES) AT LEAST 50 TIMES, BASED ON THE MEASURED FLOWRATE. FOR EXAMPLE, 2 MINUTES AT 100 CUBIC INCHES/MINUTE (0.06 CFM, 3.5 CFH).
E) WITHDRAW THE NEEDLE.
F) IMPORTANT! HOLD THE COVER DOWN FIRMLY WHILE TACKING OPPOSITE SIDES.
G) AFTER TACKING COMPLETE ROOT PASS WITHOUT ALLOWING THE BLOCK TO COOL AS THIS COULD DRAW IN AIR.
H) COMPLETE WELD PER NORMAL PROCEDURE.

6. WELD FILLER METAL SHALL MEET THE REQUIREMENTS OF ASME SECTION III. ACCEPTANCE CRITERIA NB.

7. AFTER WELDS OF TOP SHIELD PLUG ASSEMBLY (ITEM 50) & SIPHON/VENT PORT COVERS (ITEM 72) ARE COMPLETE, WELD ITEM 71 TO ITEM 1 AS SHOWN. GAP BETWEEN TOP COVER PLATE AND SHELL ASSEMBLY TO BE .09 MIN., .19 MAX. MINIMUM EFFECTIVE THROAT IS 1/2. THE CROWN OF THE WELD BETWEEN THE TOP COVER PLATE AND THE DSC SHELL MAY PROJECT ABOVE THE LIP OF THE DSC SHELL PROVIDED THE TOTAL DSC LENGTH INCLUDING WELD BUILD-UP DOES NOT EXCEED THE MAXIMUM SHELL LENGTH OF 172.93 INCHES. THE ACTUAL DSC SHELL LENGTH IS DOCUMENTED IN EACH DSC'S DATA PACKAGE.

8. AFTER ROOT OR FILL PASS IS COMPLETE, PERFORM HELIUM LEAK TEST IN ACCORDANCE WITH ANSI N14.5, 1997 OF TOP SHIELD PLUG ASSEMBLY (ITEM 50) WELD AND SIPHON/VENT COVERS (ITEM 72) WELD THRU THE TEST PORT (WHICH IS LOCATED ON THE TOP COVER PLATE (ITEM 71), WITH THE TEST PLUG (ITEM 73 NOT INSTALLED). THE ACCEPTANCE CRITERIA IS: $\boxed{1.0 \times 10^{-7}}$ atm cc/s HELIUM.

9. IN THE EVENT BOWING OF TOP CASING PLATE COMPONENT OF TOP SHIELD PLUG ASSEMBLY OCCURS DURING FIELD CLOSURE ACTIVITIES, STRONGBACK DEVICE MAY BE USED IN CONJUNCTION WITH INSTALLATION OF TOP COVER PLATE TO FLATTEN BOWED CONDITION.

REVISION	DESCRIPTION	DATE
1	REVISED PER DCR NUH32PHB-012	2/17/12
0	FIRST ISSUE	03/31/10

	NAME / INITIALS	DATE
P.E.	[signature]	2/17/12
NUCLEAR	Prakash Narayanan / PAN	02/17/2012
MECHANICAL THERMAL	K.Tavassoli / KT	2/17/12
STRUCTURAL	R. Haroon / RH	2/17/12
CHECKED	E. Villagrana / EV	02.16.12
DRAWN	J. Tian / JT	02.16.12

ALL DIMENSIONS ARE APPLICABLE AT 70°F AND ALL TOLERANCING APPLIES AFTER WELDING AND FINAL MACHINING UNLESS NOTED OTHERWISE.

DIMENSIONS ARE IN INCHES AND DEGREES UNLESS NOTED OTHERWISE. DIMENSIONING AND TOLERANCING IN ACCORDANCE WITH ASME Y14.5M-1994.

FRACTIONS	DECIMALS	ANGLES
± N/A	.XX ± .06 .XXX ± .015	± N/A

BREAK AND DEBURR ALL SHARP EDGES

U.S. Patent No. 4,780,269
Proprietary Property of Transnuclear, Inc.

TRANSNUCLEAR
AN AREVA COMPANY

PROJECT: 10955 (CALVERT CLIFFS NUCLEAR POWER PLANT)

NUHOMS® 32PHB
CANISTER FOR PWR FUEL
FINAL ASSEMBLY, FIELD WELDING & TESTING

DRAWING NO. NUH32PHB-30-20 | SCALE NONE | SHEET 1 OF 1

CONTROLLED COPY #: I-01
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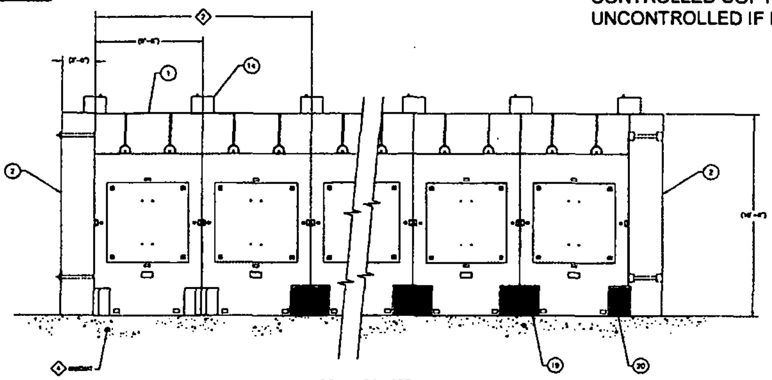
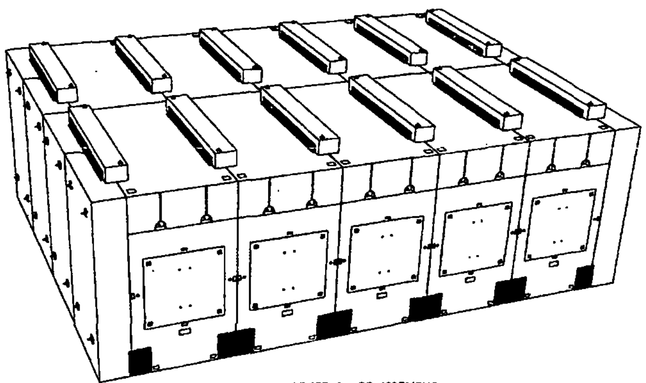


GENERAL ARRANGEMENT
FRONT ELEVATION



GENERAL ARRANGEMENT

PARTS LIST

ITEM	QTY	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	QUALITY CATEGORY
1	A/R	NUH-03-7102	UNIT ASSEMBLY	--	--
2	A/R	7103-01	END WALL	--	--
3	A/R	7103-02	END REAR WALL	--	--
4	A/R	7103-03	CENTER REAR WALL	--	--
5	A/R	7103-04	CORNER WALL	--	--
6	A/R	7112-10	WALL BOLT	--	--
7	A/R	7112-11	WALL BOLT - VENT	--	--
8	A/R	7112-12	WALL BOLT - RECESS	--	--
9	A/R	7112-13	WALL BOLT - RECESS VENT	--	--
10	A/R	7112-14	NUT	--	--
11	A/R	7112-15	HARDENED WASHER	--	--
12	A/R	7111-11	[illegible] WASHER PLATE	--	--
13	A/R	7111-12	[illegible] SQUARE WASHER PLATE	--	--
14	A/R	7103-05	OUTLET VENT COVER	--	--
15	A/R	7112-20	VENT COVER BOLT	--	--
16	A/R	7112-21	NUT	--	--
17	A/R	7112-22	WASHER	--	--
18	A/R	7111-13	[illegible] WASHER PLATE	--	--
19	A/R	[illegible]-01	[illegible] - BASE	--	--
20	A/R	[illegible]-02	[illegible] - WALL	--	--
21	A/R	[illegible]-03	[illegible] - ROOF	--	--
22	A/R	[illegible]-04	[illegible] - END WALL - SIDE	--	--
23	A/R	[illegible]-05	[illegible] - END WALL - TOP	--	--
24	A/R	[illegible]	[illegible] & NAMEPLATE ANCHOR	--	--

NOTES:

[illegible]

REFERENCE DOCUMENTS:

SPECIFICATION	NUH-03-6010	FIELD ERECTION OF NUHOMS® HSM-H ARRAY
DRAWING	NUH-03-7102	UNIT ASSEMBLY
DRAWING	NUH-03-7105	WALLS AND OUTLET VENT COVER
DRAWING	NUH-03-7111	ERECTION HARDWARE
DRAWING	NUH-03-7112	FASTENERS

REVISION	DESCRIPTION	DATE
1	REVISED PER DCR NUH03-18, UPDATED THE TITLE BLOCK	12/15/07
0	INITIAL ISSUE: FOR FABRICATION ONLY	1/14/05

	NAME / DETAILS	DATE
P.E.	Ahmad Salih AS	12/15/07
NUCLEAR	Prakash Narayanan PN	12/14/2007
MECHANICAL THERMAL	PETER SHIH PS	12/14/07
STRUCTURAL	PETER SHIH PS	12/14/07
CHECKED	John Florea	12/11/07
DRAWN	Joanna Tian JT	12/11/07

ALL DIMENSIONS ARE APPLICABLE AT 20°F AND ALL TOLERANCES APPLIES AFTER WELDING AND FINAL MACHINING UNLESS NOTED OTHERWISE.

DIMENSIONS ARE IN INCHES AND DEGREES UNLESS NOTED OTHERWISE. DIMENSIONING AND TOLERANCING IN ACCORDANCE WITH ASME Y14.5M-1994.

FRACTIONS ± N/A — DECIMALS .XX ± N/A, .XXX ± N/A — ANGLES ± N/A

BREAK AND DEBURR ALL SHARP EDGES

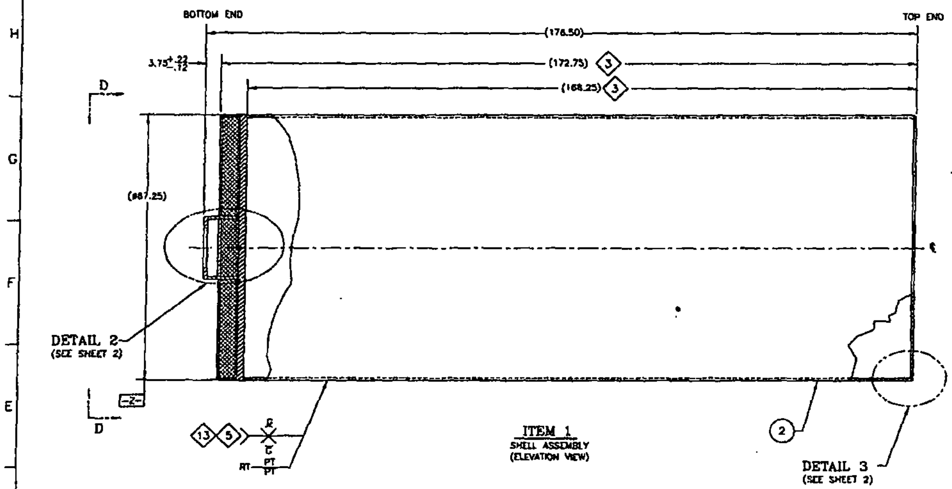
U.S. Patent No. 4,780,269
Proprietary Property of Transnuclear, Inc.

TRANSNUCLEAR
AN AREVA COMPANY

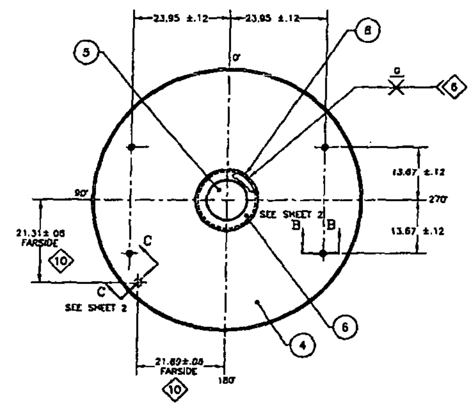
PROJECT: STANDARDIZED NUHOMS® HORIZONTAL STORAGE MODULE, HSM-H

GENERAL ARRANGEMENT

DRAWING NO. NUH-03-7101 — SCALE NONE — SHEET 1 OF 6



ITEM 1
SHELL ASSEMBLY
(ELEVATION VIEW)



VIEW D–D
(SHELL ASSEMBLY BOTTOM VIEW)

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NOTES:

1. WELD SIZES ARE MINIMUM. INTERPRET WELDS PER ANSI/AWS 2.4-98.
2. ALL MACHINED SURFACES FINISHED TO 250/ RMS OR BETTER.
3. SEE DWG NUH32PHB-30-2 FOR FINAL CANISTER CAVITY TOLERANCE AND OVERALL LENGTH TOLERANCE. FOR PARTS LIST SEE DWG NUH32PHB-30-10.
4. ALL STAINLESS STEEL PLATE SURFACES TO BE ASTM A-480 #1 FINISH OR BETTER.
5. FULL PENETRATION LONGITUDINAL AND CIRCUMFERENTIAL WELDS ARE REQUIRED FOR ITEM 2 WITH 100% RADIOGRAPHIC EXAMINATION PER TN FABRICATION SPECIFICATION. WELD JOINT DETAIL BY FABRICATOR SHALL BE IN ACCORDANCE WITH TN FABRICATION SPECIFICATION. FINISHED LONGITUDINAL AND CIRCUMFERENTIAL SHELL WELDS SHALL HAVE A MAXIMUM REINFORCEMENT OF .03 INCHES AND HAVE A TAPERED TRANSITION TO THE BASE METAL SURFACE. GROUND WELD OR BASE METAL SHALL NOT BE REDUCED BELOW .563 INCHES. MINIMUM THICKNESS SHALL BE VERIFIED PER TN FABRICATION SPECIFICATION.
6. ITEM 8 MAY BE A ROLLED RING WITH LONGITUDINAL WELD AT LOCATION OF FABRICATORS CHOICE. FINISHED SURFACE SHALL BE FLUSH WITH SURROUNDING SURFACE.
7. PENETRATIONS FOR LEAD POUR ARE AT FABRICATOR'S OPTION ANYWHERE IN ITEMS 4, 5, 7 AND 8 ONLY. PLUG AND SEAL WELD ALL EXPOSED PENETRATIONS AFTER POURING. FINISHED SURFACE OF ALL WELDED PLUGS SHALL BE FLUSH WITH SURROUNDING SURFACES. PLUG MATERIAL MAY BE ASME SA-479, TYPE 304.
8. LEAD CASTING SHALL BE INSPECTED FOR VOIDS AND FOR CONFIRMATION OF MINIMUM EFFECTIVE SHIELDING THICKNESS AS REQUIRED BY THE TN FABRICATION SPECIFICATION.
9. A .12 INCH MINIMUM MACHINED RADIUS TRANSITION BETWEEN ITEMS 4 & 8 IS AN ALTERNATE TO THE 1/4 INCH COVER FILLET WELDS. MACHINED RADIUS MAY BE ONE OR BOTH SIDES. PT OF MACHINED RADIUS IS REQUIRED. GAPS BETWEEN LEAD AND STEEL AT ALL LOCATIONS TO BE 0.0 TO 1/16 RADIAL. .38 MAX. OUTSIDE FILLET WELD (THIS IS TO ACCOMODATE CLEARANCE INSIDE TRANSFER CASK).
10. ⌀2.00 TREPANNED HOLE IN ITEM 10 APPEARS IN THIS VIEW IN ORDER TO SHOW LOCATION DIMENSIONS.
11. FABRICATOR MAY SUBSTITUTE EQUIVALENT WELD DETAILS WITH TN APPROVAL.
12. FINISHED OUTSIDE SURFACE SHALL BE FLUSH WITH SURROUNDING SURFACE.
13. LONGITUDINAL WELD SEAM PERMITTED WITH FULL PENETRATION WELD.
14. LABEL SHELL ASSEMBLY WITH DSC SERIAL NUMBERS AND U.S. PATENT NO. USING 14PT. LOW STRESS STAMP LETTERS. SEE NOTE 5 ON DWG NUH32PHB-30-4 FOR ADDITIONAL INFORMATION.
15. DRILL DRAIN HOLE AT 180° AZIMUTH IN ITEM 8.
16. WELD JOINT DESIGN SHALL COMPLY WITH THE REQUIREMENTS OF ASME CODE SECTION III, DIVISION 1, SUBSECTION NB, FIGURE NB-4243-1
17. INSPECTION SHALL BE PERFORMED IN ACCORDANCE WITH ASME CODE SECTION III DIVISION 1, SUBSECTION NB, ARTICLE NB-5231.
18. ALTERNATE FULL PENETRATION CORNER JOINT GEOMETRY USING TYPE 1 (C) WELD IN ASME CODE SUBSECTION NB FIGURE NB-4243-1 IS ACCEPTABLE.

REVISION	DESCRIPTION	DATE
1	REVISED PER DCR NUH32PHB-012	2/17/12
0	FIRST ISSUE	03/31/10

	NAME / INITIALS	DATE
P.E.	[illegible]	2/17/12
NUCLEAR	Prakash Narayanan PRN	02/17/2012
MECHANICAL THERMAL	K. Tavassoli / KT	02/17/12
STRUCTURAL	R. Haroon / RH	2/17/12
CHECKED	E-VILLAFUERTE / EV	02.16.12
DRAWN	J. Tran / JT	02.16.12

ALL DIMENSIONS ARE APPLICABLE AT TOT AND ALL TOLERANCING APPLIES AFTER WELDING AND FINAL MACHINING UNLESS NOTED OTHERWISE.

DIMENSIONS ARE IN INCHES AND DEGREES UNLESS NOTED OTHERWISE. DIMENSIONING AND TOLERANCING IN ACCORDANCE WITH ASME Y14.5M-1994.

FRACTIONS	DECIMALS	ANGLES
± N/A	.XX ± .03 / .XXX ± .015	± 1°

BREAK AND DEBURR ALL SHARP EDGES

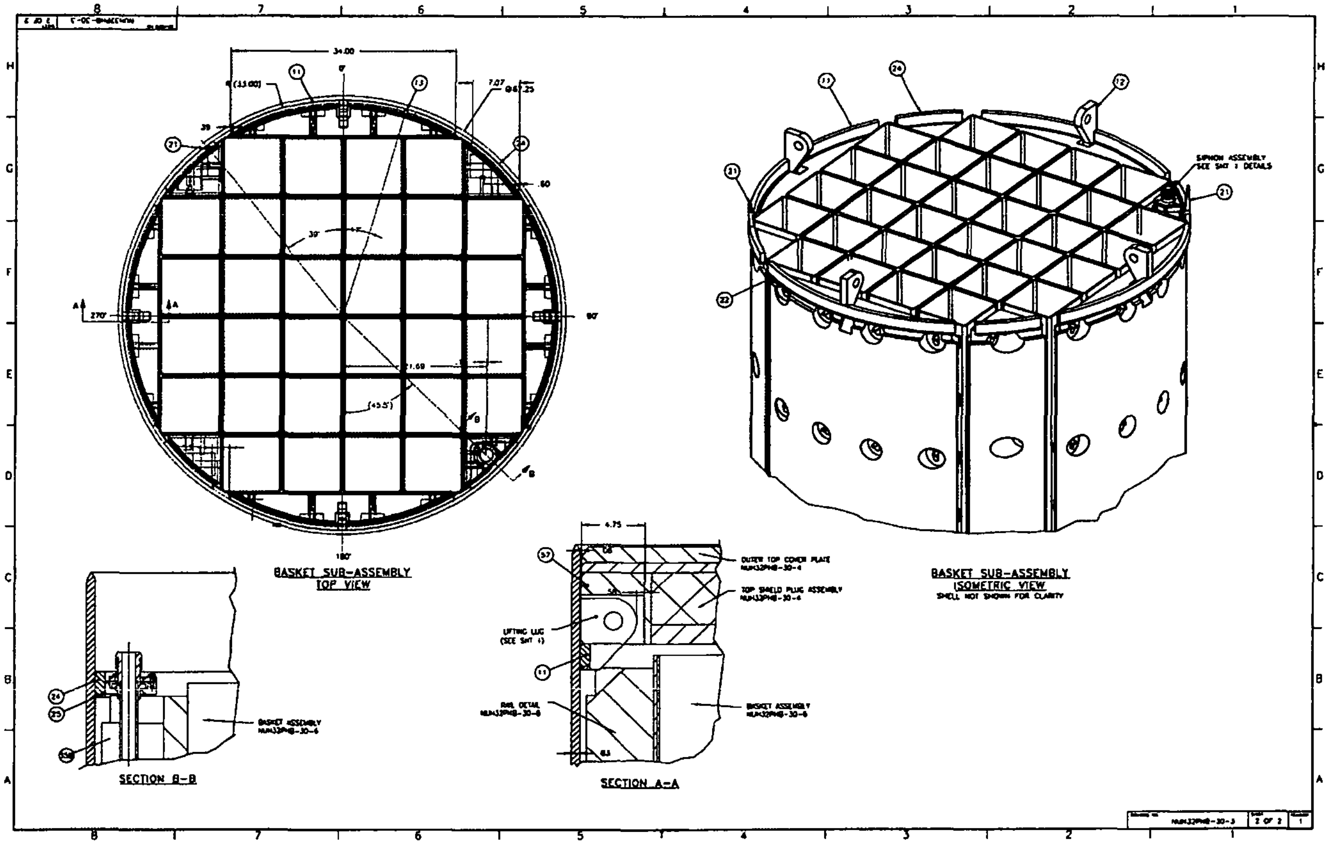
U.S. Patent No. 4,780,269
Proprietary Property of Transnuclear, Inc.

TRANSNUCLEAR
· AN AREVA COMPANY

PROJECT: 10955 (CALVERT CLIFFS NUCLEAR POWER PLANT)

NUHOMS® 32PHB
CANISTER FOR PWR FUEL
SHELL & BOTTOM PLUG ASSEMBLY

DRAWING NO. NUH32PHB-30-1 | SCALE NONE | SHEET 1 OF 2



REV	DATE	DESCRIPTION	DWN	DSGN	DE	IR	APPROVED
0A		PLACE DRAWING REV DESCRIPTION HERE					

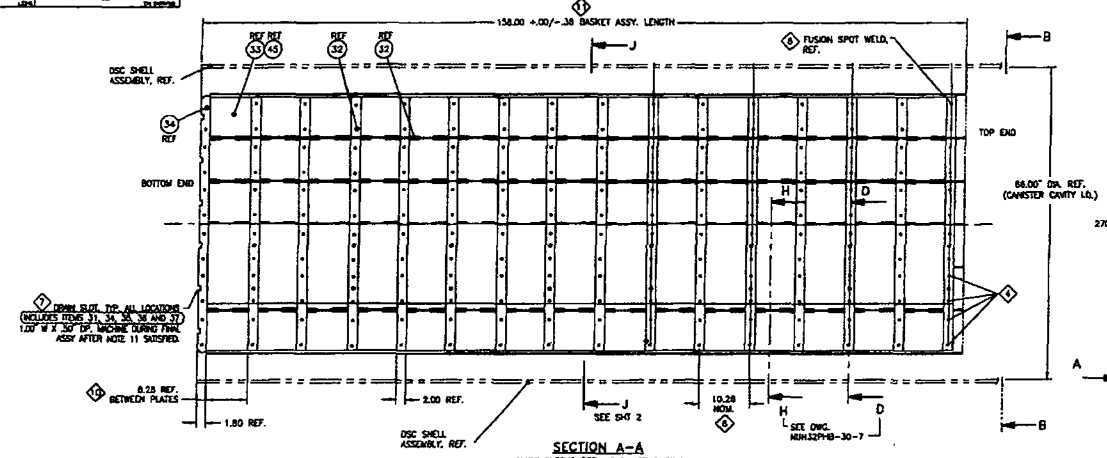
NUHOMS 32PHB CANISTER FOR PWR FUEL SIPHON PIPE/ADAPTER & LIFTING LUG DETAILS

CALVERT CLIFFS NUCLEAR POWER PLANT
ENGINEERING SERVICES DEPARTMENT

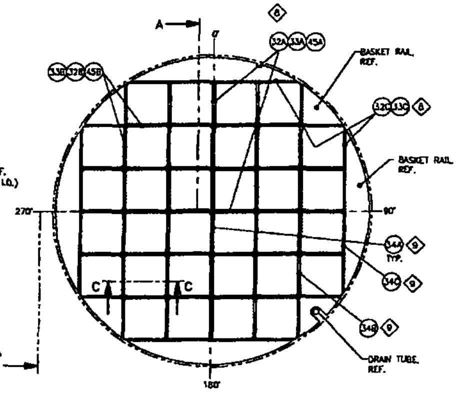
CALVERT CLIFFS UNIT 7 | SIZE C | CAT. 3

SCALE: NONE | VENDOR DWG. NO. NUH32PHB-30-3 | REV. 0

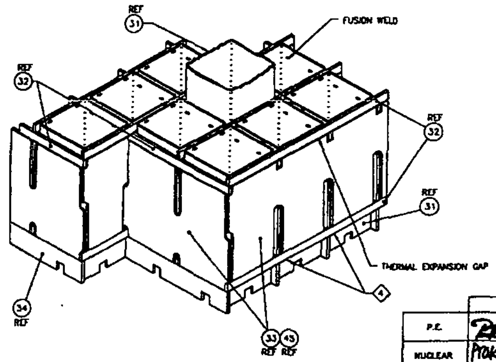
DWG. NO. 84238SH0002



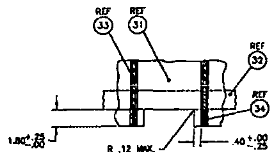
SECTION A-A
GUIDE SLEEVE (ITEM 31) NOT SHOWN
BASKET RAILS (ITEM 35, 38) NOT SHOWN
THERMAL EXPANSION GAP NOT SHOWN FOR CLARITY



VIEW B-B
1 BASKET ASSEMBLY
(SEE SHT 2 FOR RAIL DETAILS)



PARTIAL TYPICAL ISOMETRIC VIEW
BOTTOM END
(ONLY SHOWS PLATES ORIENTATION AND NOT TYPICAL CELLS ARRANGEMENT)
(NOT TO SCALE)



SECTION C-C
(LIFTING SLOT DETAIL)
BOTTOM ONLY, TYP. 4 PLACES

NOTES:

1) FOR FINAL ASSEMBLY SEE DWG. NUH32PHB-30-20
2) FOR ADDITIONAL BASKET DETAILS, SEE DWG. NUH32PHB-30-7
3) FOR PARTS LIST SEE DWG. NUH32PHB-30-10
4) BOTH ENDS OF GUIDE SLEEVE MAY BE TACK WELDED TO BASKET PLATE IF NECESSARY. TACK WELDS SHALL BE FLUSH AT THE EDGE OF THE GUIDE SLEEVE. TACK WELDS MAY BE MADE AT PERIPHERAL LOCATIONS BETWEEN THE TOP/BOTTOM SST PLATE AND THE GUIDE SLEEVE.
5) ALL MACHINED SURFACES TO BE 125/ UNLESS OTHERWISE SPECIFIED.
6) FABRICATOR SHALL ENSURE THAT THE FUSION WELD COMPLETELY LANDS ON ITEMS 32 & 34 DURING FABRICATION.
7) +/- .25" MISMATCH IS ACCEPTABLE BETWEEN THE DRAIN SLOTS.
8) ITEMS 32 (SST), 33 (ALUMINUM) & 45 (POISON) ARE PLATE TYPES, AND LETTERS A, B & C ARE PLATE LENGTHS. SEE DWG. NUH32PHB-30-9 FOR PLATE DETAILS.
9) PLATES 34A, 34B AND 34C (1.80" HIGH SST) ARE ONLY LOCATED ON THE BOTTOM COURSE, 0°-180° DIRECTION ONLY.
10) PROVIDE A .03"+.08/-.00" TOTAL (TOP & BOTTOM) GAP BETWEEN SST & ALUM. FOR THERMAL EXPANSION.
11) HEIGHT OF BOTTOM PLATE (ITEM 34) MAY BE ADJUSTED TO MAINTAIN MAX. 158" OVERALL HT. CHAMFER ITEMS 31, 34, 35 & 38 AT BOTTOM CORNERS IF THEY INTERFERE WITH THE BOTTOM PLATE CORNER WELD TO ENSURE THAT THEY DO NOT INTERFERE WITH CANISTER RADIUS.
12) PLATE (STOCK) THICKNESS TOLERANCE PER MANF. UNLESS OTHERWISE SPECIFIED.
13) WELD SIZES ARE MINIMUM, INTERPRET WELDS PER ANSI/AWS 2.4-98.
14) THIS DIMENSION TO MATCH RAILS RADIUS.

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REVISION	DESCRIPTION	DATE
2	REVISED PER DCR NUH32PHB-012	2/17/12
1	REVISED PER DCR NUH32PHB-006	08/12/10
0	FIRST ISSUE	03/31/10

	NAME/INITIALS	DATE
P.E.	[illegible]	2/17/12
NUCLEAR	Prakash Narayanan PAN	02/17/2012
MECHANICAL THERMAL	K. Tavassoli /KT	2/17/12
STRUCTURAL	R. Haroon /RH	2/17/12
CHECKED	E. VILLAFLORES /EV	02.16.12
DRAWN	J. Tih /JT	02.16.12

ALL DIMENSIONS ARE APPLICABLE AT 70°F AND ALL TOLERANCING APPLIES AFTER WELDING AND FINAL MACHINING UNLESS NOTED OTHERWISE.

DIMENSIONS ARE IN INCHES AND DEGREES UNLESS NOTED OTHERWISE. DIMENSIONING AND TOLERANCING IN ACCORDANCE WITH ASME Y14.5M-1994.

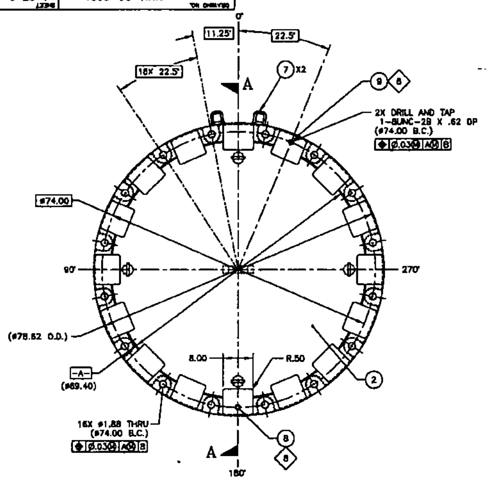
FRACTIONS ± N/A DECIMALS .XX ± .12 .XXX ± .03 ANGLES ± 1°

BREAK AND DEBURR ALL SHARP EDGES

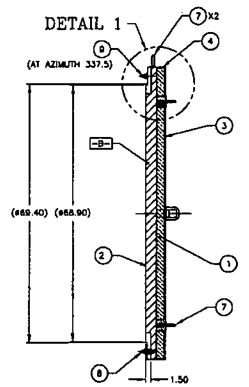
TRANSNUCLEAR
AN AREVA COMPANY

PROJECT: 10935 (CALVERT CLIFFS NUCLEAR POWER PLANT)
NUHOMS® 32PHB
BASKET
ASSEMBLY

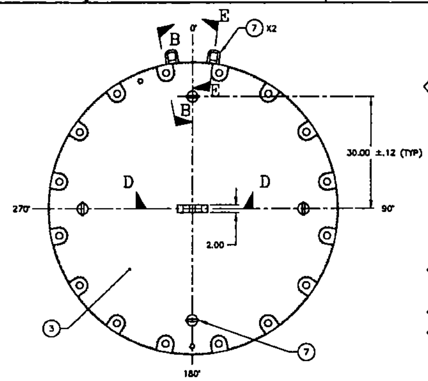
DRAWING NO. NUH32PHB-30-6 SCALE NONE SHEET 1 OF 2



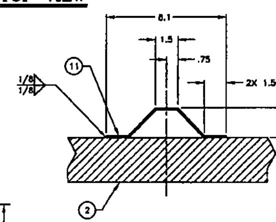
TOP COVER ASSEMBLY - BOTTOM VIEW



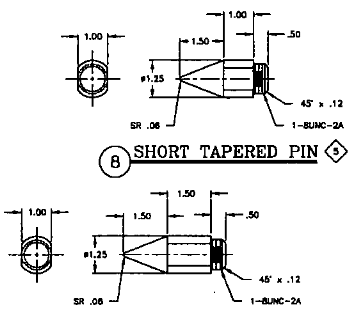
BOTTOM TOP
SECTION A-A



TOP COVER ASSEMBLY - TOP VIEW

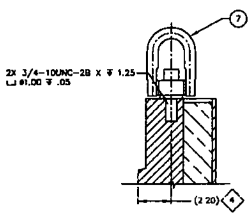


SECTION D-D
FOR OPTIONAL DETAIL ITEM 11
(ITEMS 1 & 3 NOT SHOWN FOR CLARITY)

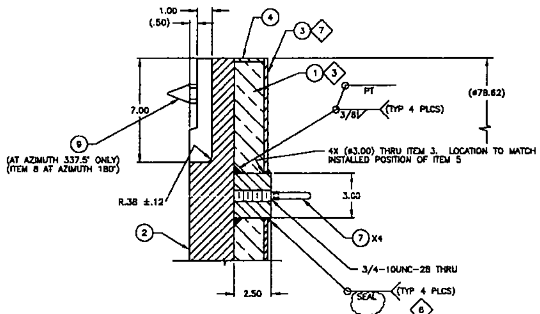


8 SHORT TAPERED PIN ◇5

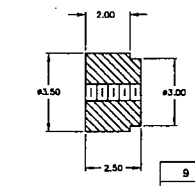
9 LONG TAPERED PIN ◇5



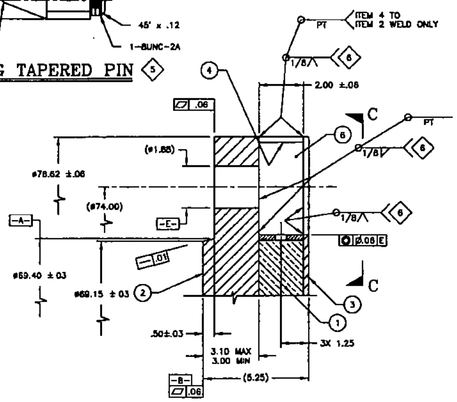
SECTION E-E
AZIMUTH 8° & 352°



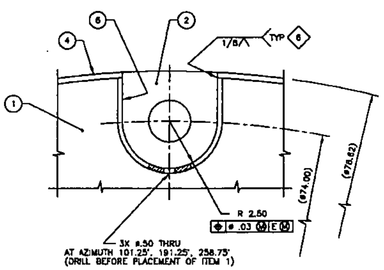
DETAIL 1



OPTIONAL DETAIL ITEM 5



SECTION B-B
(TYP 16 PLCS)



VIEW C-C
(ITEM 3 OMITTED FOR CLARITY)
(TYP 16 PLCS)

PARTS LIST					
ITEM	QTY	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	QUALITY CATEGORY
1	1	NS-3	CASTABLE NEUTRON SHIELDING MATERIAL	–	NITS
◇9 2	1	–	3" NOM THK TOP COVER PLATE	ASME SA-240 TYPE 304	B
3	1	–	1/4" THK PLATE FOR TOP COVER	ASTM A240 TYPE 304	NITS
4	16	–	1/4" THK PLATE FOR TOP COVER	ASTM A240 TYPE 304	NITS
5	4	–	ø3.00 STANDOFF FOR EYEBOLTS	ASTM A240 TYPE 304 OR A276 TYPE 304	NITS
6	16	–	1/4" THK PLATE FOR TOP COVER	ASTM A240 TYPE 304	NITS
7	6	AMERICAN 23009	3/4-10UNC HOIST RING	ALLOY STEEL	NITS
8	1	–	1-8UNC-2A X 1.00 LG TAPERED PIN	ASTM A240 TYPE 304 OR ASTM A193 GR B7	NITS
9	1	–	1-8UNC-2A X 1.50 LG TAPERED PIN	ASTM A240 TYPE 304 OR ASTM A193 GR B7	NITS
◇12 10	16	NUH-06-8003 ITEM 13	CADMIUM PLATED BOLT 1 3/4-8UNC-2A X 6.00 LG	ASME SA193 GR. B7	B
11	1	–	1/8" THK SPACER	304	NITS
◇19 12	8	–	1/2" THK WEDGES	ASTM A240 TYPE 304	C
◇19 12A	2	–	1/2" THK WEDGES	ASTM A240 TYPE 304	C
13	30	–	1/2-12UNC-2A X 1.00 LG ANS HEX SOCKET FLAT COUNTERSUNK HEAD CAP SCREW	ALLOY STEEL	NITS

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NOTES:

1. BUYERS SPECIFICATION NUH-06-101 PROVIDES THE REQUIREMENTS FOR A COMPLETE OS197 CASK. ALL WORK ASSOCIATED WITH THE FABRICATION OF THE CASK LID ARE A SUB-SET OF THIS SPECIFICATION. ALL MATERIAL AND WELDING REQUIREMENTS FOR THE CASK LID SHALL BE IN ACCORDANCE WITH THE APPLICABLE SECTIONS OF SPECIFICATION NUH-06-101 EXCEPT IN SECTION 5.2.1.C DELETE REQUIREMENT THAT "EACH HEAT OR LOT OF FILLER MATERIALS SHALL BE TESTED FOR THE AS-DEPOSITED TENSILE STRENGTH". FILLER METAL CMTR'S MEETING TABLE 1, SCHEDULE I OF AWS SPECIFICATION SFA 5.01 ARE ACCEPTABLE.
2. ALL EXPOSED SURFACES SHALL BE FINISHED TO 64µ RMS OR BETTER. TOP COVER ASSEMBLY WELDS ARE NOT EXPOSED TO FUEL POOL AND NEED NOT MEET SURFACE FINISH REQUIREMENTS. THESE WELDS SHALL BE GROUND TO PERMIT NDE AS REQUIRED.

◇3 NEUTRON SHIELD MATERIAL SHALL BE PLACED IN STRICT ACCORDANCE WITH BUYER FABRICATION SPECIFICATION AND MANUFACTURER'S REQUIREMENTS.

◇4 THIS DIMENSION SHALL BE ADJUSTED AS NECESSARY BY FABRICATOR TO ENSURE THAT TOP COVER PLATE HANGS VERTICALLY WHEN SUPPORTED BY HOIST RINGS (ITEM 7) AND HOIST RING SHOULDERS DO NOT EXTEND BEYOND PLATE EDGE.

◇5 FABRICATOR MAY SUBSTITUTE COMMERCIALLY AVAILABLE TAPERED PINS OF SIMILAR DIMENSIONS. AT BUYER'S OPTION, CARBON STEEL TAPERED PINS MAY BE CADMIUM COATED.

◇6 FABRICATOR MAY SUBSTITUTE ALTERNATE EQUIVALENT WELD DETAIL WITH BUYER APPROVAL.

◇7 FINAL LOCATION OF POUR HOLES IN ITEM 3 FOR PLACEMENT OF NS-3 SHALL BE BY FABRICATOR WITH BUYERS APPROVAL. ALL HOLES SHALL BE PLUGGED AND SEAL WELDED WITH PT EXAMINATION OF WELD FOLLOWING PLACEMENT AND CURING OF THE NS-3 MATERIAL.

(NOTES CONTINUED ON SHEET 2)

REVISION	DESCRIPTION	DATE
9	REVISED PER DCR NUH06-032	7/21/11
8	REVISED PER DCR NUH-06-033	02/23/10
7	REVISED PER DCR NUH-06-030	10/19/09
6	REVISED PER DCR NUH-06-028	12/19/08
5	REVISED PER DCR NUH-06-020	03/13/08
4	REVISED PER DCR NUH-06-018	02/13/08
3	REVISED PER DCR NUH-06-017	01/08/08
2	REVISED PER DCR NUH06-15	10/22/07

	NAME / INITIALS	DATE
P.E.	Stuart Horgan for I.M. / SH	7/21/11
NUCLEAR	Prakash Narayanan / PAN	07/21/2011
MECHANICAL THERMAL	S. Guzeyev / SG	7/21/11
STRUCTURAL	S.R. Streutker / SRS	7/19/11
CHECKED	E. Villafuertes / EV	07.05.11
DRAWN	J. Tian / JT	07.05.11

ALL DIMENSIONS ARE APPLICABLE AT 70°F AND ALL TOLERANCING APPLIES AFTER WELDING AND FINAL MACHINING UNLESS NOTED OTHERWISE.

DIMENSIONS ARE IN INCHES AND DEGREES UNLESS NOTED OTHERWISE. DIMENSIONING AND TOLERANCING IN ACCORDANCE WITH ASME Y14.5M-1994.

FRACTIONS ± N/A
DECIMALS .XX ± .06 .XXX ± .015
ANGLES ± .10°

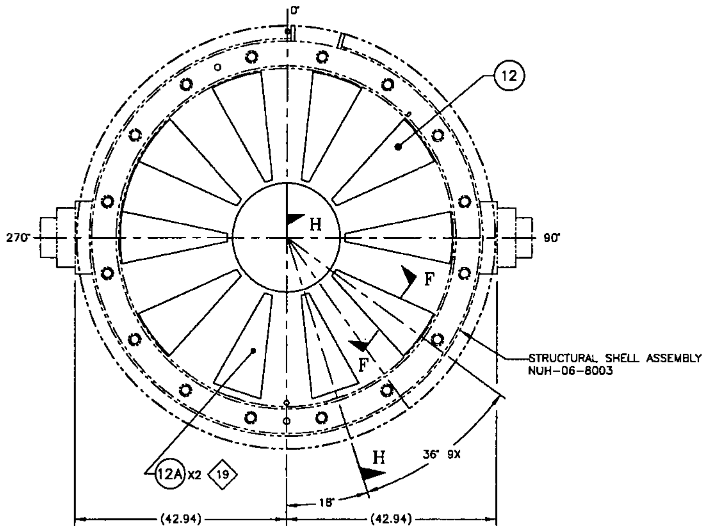
BREAK AND DEBURR ALL SHARP EDGES

U.S. Patent No. 4,780,269
Proprietary Property of Transnuclear, Inc.

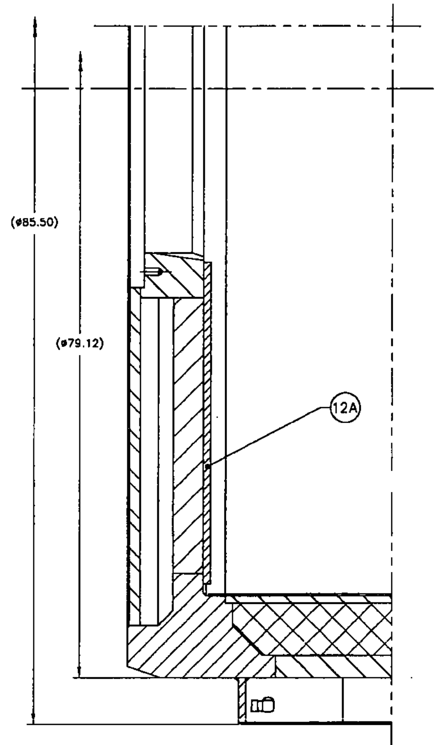
TRANSNUCLEAR
AN AREVA COMPANY

PROJECT: NUHOMS®
TRANSFER CASK
FORCED AIR COOLING MODIFICATIONS

DRAWING NO. NUH-06-8021 | SCALE NONE | SHEET 1 OF 2



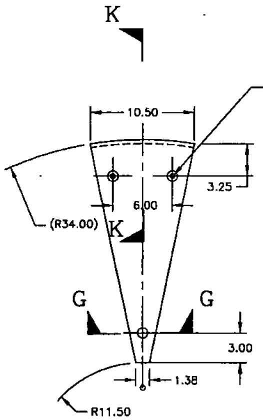
WEDGES AT BOTTOM OF CASK



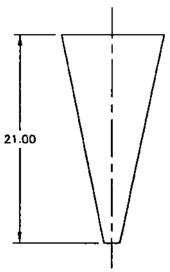
SECTION H-H

NOTES:

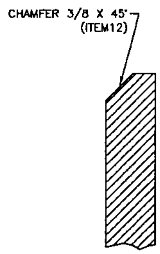
8. LABEL "LONG" ON CURVED OUTSIDE SURFACE OF TOP COVER ASSEMBLY (3" THICK PLATE) AT AZIMUTH 337.5°, AND LABEL "SHORT" ON CURVED OUTSIDE SURFACE OF TOP COVER ASSEMBLY (3" THICK PLATE) AT AZIMUTH 180.0° USING MINIMUM 1/8" HIGH LOW STRESS STAMP LETTERS.
9. ITEM 2 SHALL MEET THE REQUIREMENTS OF ASME BPV CODE SUBSECTION NC.
10. NOT USED
11. ITEMS 4 AND 6 MAY ALSO BE FABRICATED FROM ASTM A276 TYPE 304 OR ASTM A479 TYPE 304.
12. USE LONGER CASK LID BOLTS WITH FC COOLING LID IN LIEU OF ITEM 13 SHOWN ON TN DRAWING NUH-06-8003.
13. THE P.O. WILL DEFINE IF OPTION 1 OR OPTION 2 IS TO BE EMPLOYED FOR INSTALLING ITEMS 12 & 12A (WEDGES).
14. IF OPTION 2 IS CHOSEN FABRICATOR SHALL MATCH DRILL THE SCREW HOLES TO ENSURE CORRECT TOLERANCING FOR INSTALLING ITEM 13 (SCREWS).
15. ITEM 13 SHALL BE FLUSH OR COUNTERSUNK A MAXIMUM OF 0.05 BELOW SURFACE OF ITEM 12.
16. NOT USED
17. FOR PWR DSC USE FC SPACER SHOWN ON NUH-06-8020.
18. WHEN OS197FC LID IS UTILIZED ON CASK SHOWN ON DRAWING NUH-06-8003 THE OVERALL LENGTH OF THE CASK IS INCREASED BY 0.50" TO 207.72".
19. WHEN DISTANCE BETWEEN THE END OF THE RAIL (INCLUDING WELDING SEAM) AND THE BOTTOM OF THE SHELL IS LESS THAN 5/8" ITEM 12A MUST BE MANUFACTURED AND INSTALLED. OTHERWISE ONLY ITEM 12 TO BE MANUFACTURED (QTY 10) AND INSTALLED
20. HARDENED WASHERS USED WITH ORIGINAL OS-197 LID ARE TO BE USED WITH FORCED COOLING AIR LID AS WELL



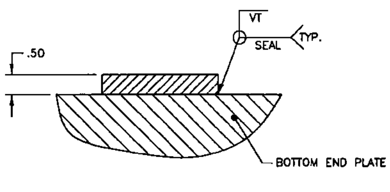
ITEM 12 - WEDGE



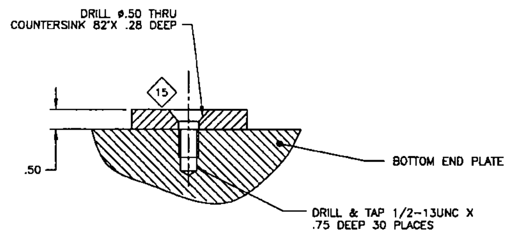
ITEM 12A - WEDGE



SECTION K-K
(NOT TO SCALE)



OPTION 1 13
SECTION F-F
TYPICAL 10X



OPTION 2
SECTION G-G 13 14
TYPICAL 10X

DRAWING NO.	SHEET	REVISION
NUH-06-8021	2 OF 2	9

REFERENCE DRAWINGS:

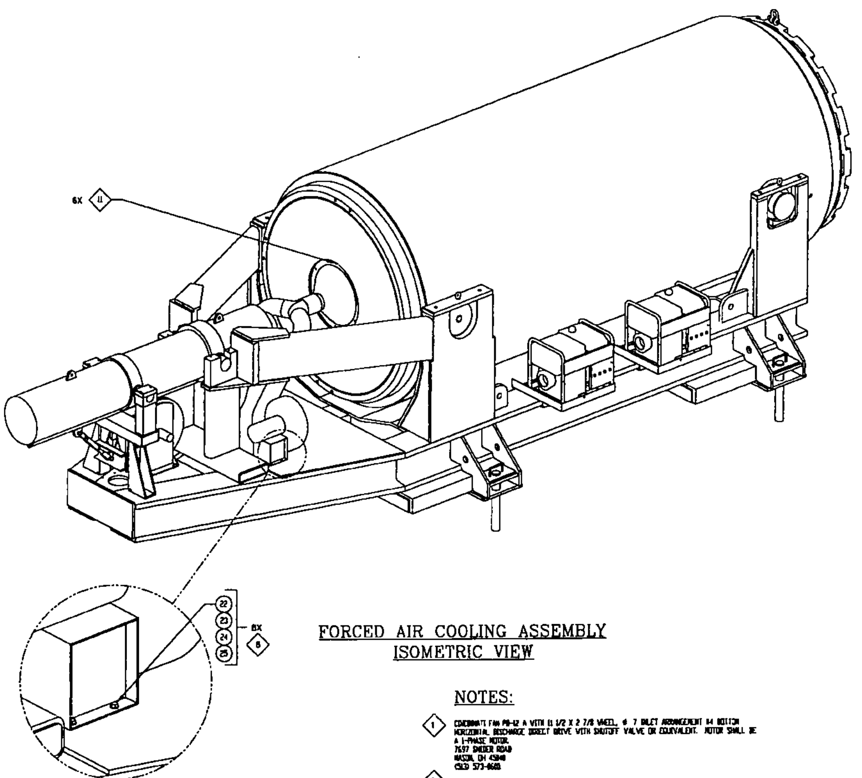
NUH-07-2200 – NUHOMS-OS197 CASK SUPPORT SKID ASSEMBLY

NUH-06-8003 – NUHOMS-OS197-1 ONSITE TRANSFER CASK MAIN ASSEMBLY

NUH-07-3210 – OS200 TRANSFER SKID SKID ASSEMBLY

NUH-08-8003 – NUHOMS-OS200 ONSITE TRANSFER CASK MAIN ASSEMBLY

PARTS LIST					
ITEM	QTY	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	QUALITY CATEGORY
1	1	NUH-07-2101	SKID ASSEMBLY		
2	2		L3 X 3 X 1/4 X 32.0	ASTM A36	NITS
3	2		L3 X 3 X 1/4 X 32.0	ASTM A36	NITS
4	2		L3 X 3 X 1/4 X 26.0	ASTM A36	NITS
5	2		L3 X 3 X 1/4 X 26.0	ASTM A36	NITS
6	1		PL, 1/8 THK X 26.5 DIA	ASTM A240, TYPE 304	NITS
7	1		PL, 1/8 THK X 10.3 X 69.3	ASTM A240, TYPE 304	NITS
8	1		PL, 1/8 THK	ASTM A240, TYPE 304	NITS
9	1		PL, 1/8 THK X 10.4 X 46.5	ASTM A240, TYPE 304	NITS
10	4		PL, 1/8 THK X 4.0 X 10.2	ASTM A240, TYPE 304	NITS
11	4		PL, 1 1/4 X 1 1/2 X 3.0	ASTM A36	NITS
12	4		HEX BOLT, 1/4-20UNC X 1 7/8 LG	ASTM A325 OR A193, GRADE B7	NITS
13	12		HEX NUT, 1/4-20UNC	ASTM A194	NITS
14	2	DG3E	GENERATOR	BALDOR	NITS
15	2		FAN	CINCINNATI FAN	NITS
16	AR	CG44	FLEXIBLE DUCTING	NFS-RPS	NITS
17	1	AS75 OR EQUIVALENT	Y FITTING	NFS-RPS	NITS
18	4		L3 X 3 X 1/4 X 32.75	ASTM A36	NITS
19	8		HEX BOLT, 1/4-20UNC X 3.0 LG	ASTM A325 OR A193, GRADE B7	NITS
20	8		LOCK WASHER, 1/4 DIA OIDIO	ASTM F436	NITS
21	8		FLAT WASHER, 1/4 DIA OIDIO	ASTM A36	NITS
22	8		HEX BOLT, 3/8-16UNC X 1 1/2 LG	ASTM A325 OR A193, GRADE B7	NITS
23	8		FLAT WASHER, 3/8 DIA OIDIO	ASTM F436	NITS
24	8		LOCK WASHER, 3/8 OIDIO	ASTM F436	NITS
25	8		HEX NUT, 3/8-16UNC	ASTM A194	NITS
26	1	4511K63	REDUCING COUPLING, 5" X 6"	MCMASTER-CARR	NITS
27	AR	CL-05	HOSE CLAMP	NFS-RPS	NITS



FORCED AIR COOLING ASSEMBLY
ISOMETRIC VIEW

NOTES:

1. CINCINNATI FAN PB-12 A WITH 11 1/2 X 2 7/8 WHEEL, # 7 INLET ARRANGEMENT #4 BOTTOM HORIZONTAL DISCHARGE DIRECT DRIVE WITH SHUTOFF VALVE OR EQUIVALENT. MOTOR SHALL BE A 1-PHASE MOTOR.
   7697 SNIDER ROAD
   MASON, OH 45040
   (513) 573-0600
2. SHERWIN-WILLIAMS SAFETY BLUE PER MANUFACTURERS INSTRUCTIONS.
3. NFS-RPS
   60 LEDYARD DR
   GROTON CT 06340
   (888) 637-7779
4. BALDOR CORPORATION
   5711 R.S. BOREHAM JR. ST
   PO BOX 2400
   FORT SMITH, AR 72901
   (479) 646-4711
   (479) 648-5792 – FAX
5. FABRICATOR MAY USE ALTERNATIVE VENDORS WITH BUYER'S APPROVAL.
6. BEND RELIEF UP TO 3/8" MAY BE ADDED. WELD END CLOSED.
7. WELD PER AWS D1.1-2004 EXCEPT STAINLESS STEEL COMPONENT PER AWS D1.6-1999.
8. USING ITEM 15 FAN AS A TEMPLATE LOCATE AND DRILL (4) ⌀ .44 MOUNTING HOLES THRU SKID STEP PLATE.
9. REQUIRED WIRING FROM GENERATOR TO FAN NOT SHOWN. SUFFICIENT WIRING TO REACH COMPONENTS WILL BE PROVIDED.
10. AN OPERATIONAL TEST WILL BE PERFORMED PRIOR TO PACKING COMPONENTS FOR SHIPMENT TO OTHERS FOR INSTALLATION.
11. USE NUH-06-8003, ITEM 14, RAM ACCESS CAP SCREWS, TO ATTACH DIFFUSER ASSEMBLY TO OS197 CASK.
    USE NUH-08-8003, ITEM 14, RAM ACCESS CAP SCREWS, TO ATTACH DIFFUSER ASSEMBLY TO OS200 CASK.
12. FAN LOCATION MAY BE ADJUSTED DURING FIELD INSTALLATION TO PREVENT INTERFERENCES WITH SURROUNDING EQUIPMENT. ENSURE THE PLACEMENT OF THE FANS DOES NOT KINK, BEND OR OTHERWISE CAUSE REDUCED AIR FLOW THROUGH THE HOSES.
13. NUH-06-116, FORCED AIR COOLING SYSTEM RETROFIT PROCEDURE, CURRENT REVISION, SHALL BE USED FOR FIELD ASSEMBLY OF THE FORCED AIR SYSTEM.
14. ITEMS 6, 8 AND 10 MAY ALSO BE FABRICATED FROM ASTM A276 TYPE 304 OR ASTM A479 TYPE 304.
15. ITEMS 7 AND 9 MAY BE FABRICATED IN MULTIPLE PIECES AT FABRICATORS OPTION.
16. EQUIVALENT SIZE WELD BEAD MAY BE SUBSTITUTED FOR SIMPLE.

REVISION	DESCRIPTION	DATE
6	REVISED PER DCR 13206-049	7/9/13
5	REVISED PER DCR NUH06-041, EDITORIAL CHANGE DWG NUH-08-3210 TO NUH-07-3210	10/20/11
4	REVISED PER DCR NUH06-034	09/29/10
3	REVISED PER DCR NUH-06-017	01/08/08
2	REVISED PER DCR NUH06-15; UPDATED TITLE BLOCK	10/22/07

	NAME / INITIALS	DATE
P.E.	N. Hansing / NH	7/9/13
NUCLEAR	P. Pham / P.P.	7/1/13
MECHANICAL THERMAL	K. Tavassoli / KT	6/28/13
STRUCTURAL	R. Haroon / RH	6/28/13
CHECKED	E. Villaflores / EV	06-26-13
DRAWN	J. Tian JT	06.26.13

ALL DIMENSIONS ARE APPLICABLE AT 70°F AND ALL TOLERANCING APPLIES AFTER WELDING AND FINAL MACHINING UNLESS NOTED OTHERWISE.

DIMENSIONS ARE IN INCHES AND DEGREES UNLESS NOTED OTHERWISE. DIMENSIONING AND TOLERANCING IN ACCORDANCE WITH ASME Y14.5M-1994.

FRACTIONS	DECIMALS	ANGLES
± N/A	.XX ± .13 .XXX ± .032	± 1°

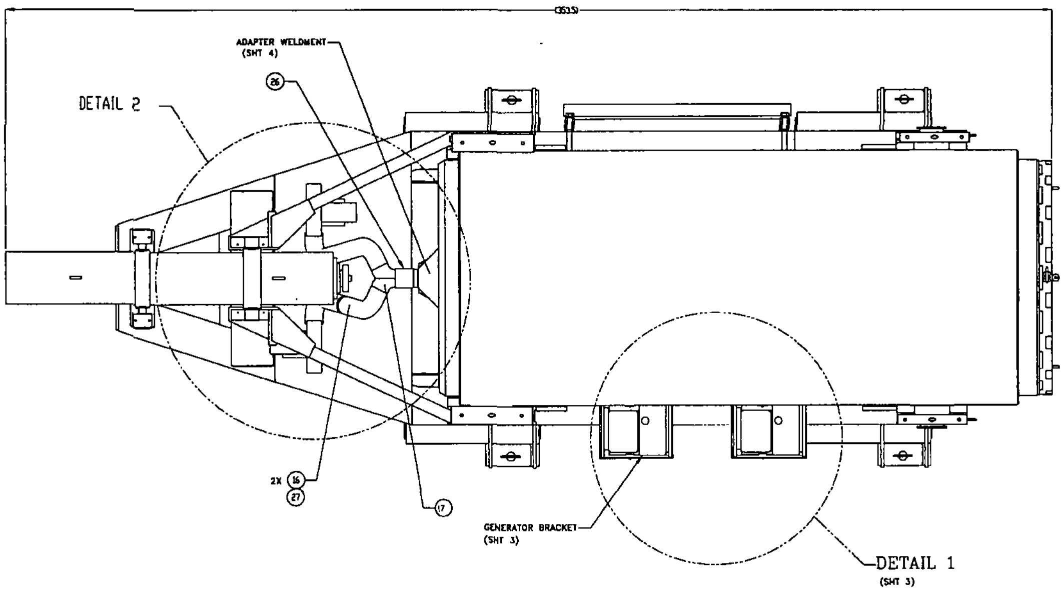
BREAK AND DEBURR ALL SHARP EDGES

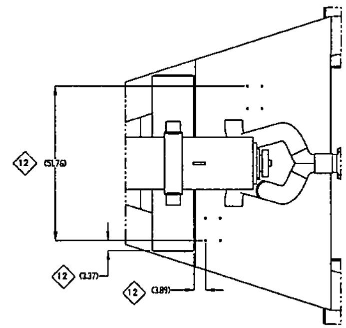
TRANSNUCLEAR
AN AREVA COMPANY

PROJECT: ONSITE TRANSFER CASK

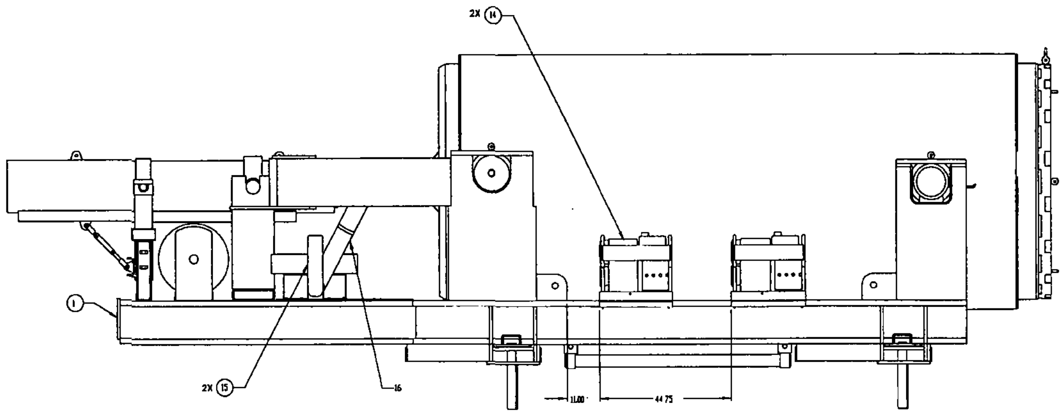
ONSITE TRANSFER CASK FORCED AIR COOLING ASSEMBLY

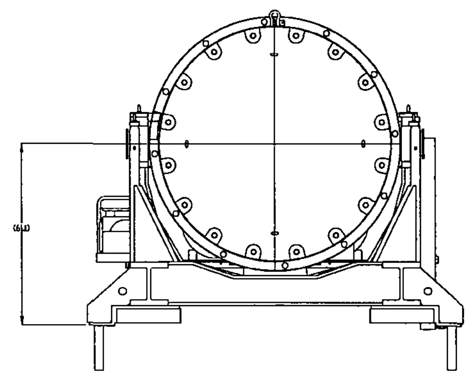
DRAWING NO. NUH-06-8022 SCALE NONE SHEET 1 OF 4





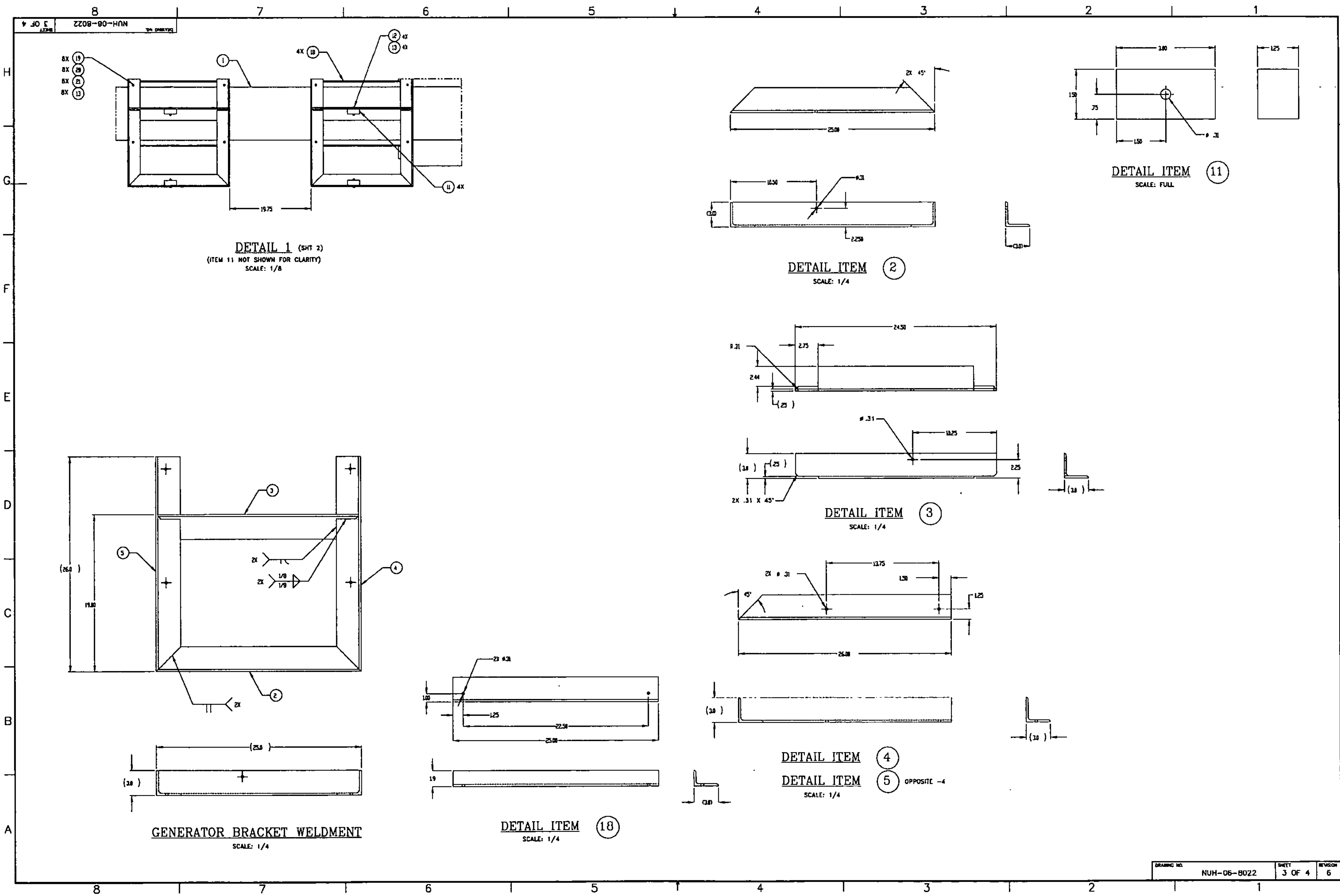
DETAIL 2
FAN INSTALLATION



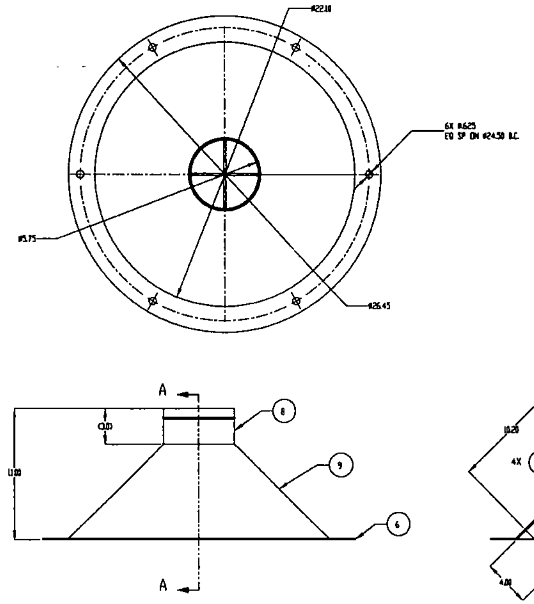


FORCED AIR COOLING ASSEMBLY

DRAWING NO.	SHEET	REVISION
NUH-06-8022	2 OF 4	6

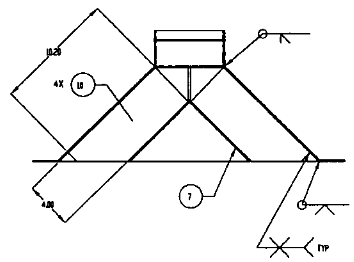


DETAIL 1 (SHT 2)
(ITEM 11 NOT SHOWN FOR CLARITY)
SCALE: 1/8
DETAIL ITEM 2
SCALE: 1/4
DETAIL ITEM 11
SCALE: FULL
DETAIL ITEM 3
SCALE: 1/4
DETAIL ITEM 4
DETAIL ITEM 5 OPPOSITE -4
SCALE: 1/4
GENERATOR BRACKET WELDMENT
SCALE: 1/4
DETAIL ITEM 18
SCALE: 1/4
DRAWING NO.
NUH-06-8022
SHEET
3 OF 4
REVISION
6

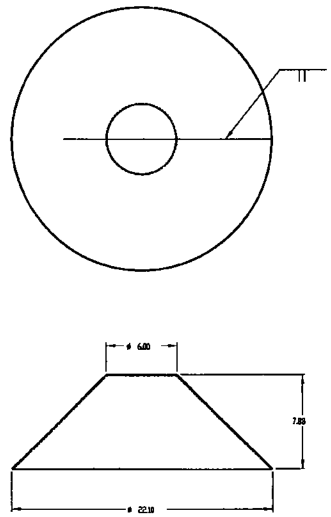


ADAPTER WELDMENT

SCALE: 1/4

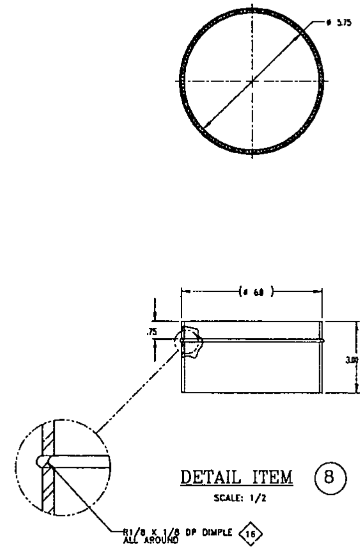


SECTION A–A



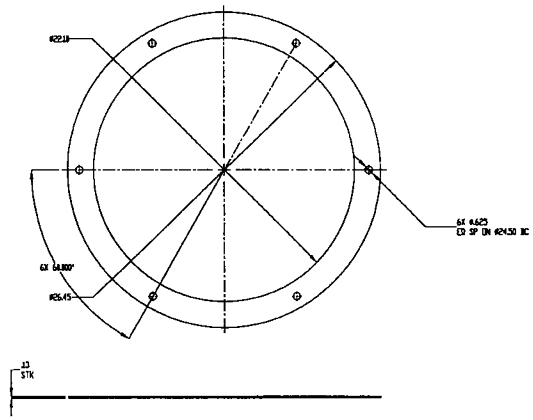
15 DETAIL ITEM 9

SCALE: 1/4



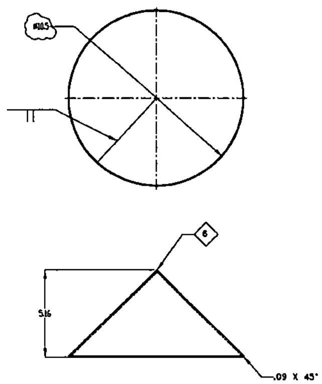
DETAIL ITEM 8

SCALE: 1/2



DETAIL ITEM 6

SCALE: 1/4



15 DETAIL ITEM 7

SCALE: 1/4

DRAWING NO.	SHEET	REVISION
NUH-06-8022	4 OF 4	6