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10 CFR 72.56

February 3, 2015

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Calvert Cliffs Nuclear Power Plant, Units Nos. 1 and 2
Renewed Facility Operating License Nos. DPR-53 and DPR-69
NRC Docket Nos. 50-317 and 50-318

Calvert Cliffs Nuclear Power Plant
Independent Spent Fuel Storage Installation, License No. SNM-2505
NRC Docket No. 72-8

Subject: Response to Amendment Request No. 1 to Renewed Materials License No. SNM-2505 for the Calvert Cliffs Specific ISFSI – First Request for Additional Information

References:
1. Letter from G. H. Gellrich (Exelon Generation) to Document Control Desk (NRC), dated March 26, 2014, License Amendment Request: High Burnup NUHOMS-32PHB Dry Shielded Canister
2. Letter from J. M. Goshen (NMSS) to G. H. Gellrich (Exelon Generation), dated December 5, 2014, Amendment Request No. 1 to Renewed Materials License No. SNM-2505 for the Calvert Cliffs Specific ISFSI – First Request for Additional Information

Reference 1 submitted a license amendment request for the Calvert Cliffs Nuclear Power Plant site-specific independent spent fuel storage installation. The amendment, if approved, would authorize the storage of Westinghouse and AREVA Combustion Engineering 14x14 fuel in the NUHOMS-32PHB Dry Shielded Canister system. As part of their review, the NRC staff has requested additional information (Reference 2). Responses to the requested additional information are provided in Attachment (1). Enclosures 1, 2, and 3 contain information that is proprietary to AREVA Inc., therefore, they are accompanied by an affidavit signed by AREVA, the owner of the information (Attachment 2). The affidavit sets forth the basis on which the information may be withheld form public disclosure by the Commission, and addresses, with specificity, the consideration listed in 10 CFR 2.390(b)(4). Accordingly, it is requested that the information that is proprietary to AREVA, Inc. be withheld from public disclosure. A non-proprietary version of the proprietary information is not available.

NMSS26

The additional information provided does not change the environmental assessment provided in Reference 1 and the categorical exclusion set forth in 10 CFR 51,22(c)(11) is still valid. There are no regulatory commitments contained in this correspondence.

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 February 3, 2015.

Respectfully,

George H. Gellrich
Site Vice President

GHG/PSF/bjm

Attachment: (1) Response to Request for Additional Information

Enclosures:

1. Thermal Conductivity Report PROPRIETARY
2. CE14_irrad_he_nitr.xls Excel spreadsheet to calculate radial effective properties of CE14x14 fuel assembly PROPRIETARY 32PHB_Input.xls Excel spreadsheet to calculate the input properties for basket plates PROPRIETARY
3. Calculation 1095-2, Revision 0, Effective Fuel Properties PROPRIETARY
4. GESC, NAC International, Atlanta Corporate Headquarters, 655 Engineering Drive, Norcross, Georgia (Engineering Report # NS3-020, Effects of 1300°F on Unfilled NS-3, while Bisco Products, Inc., 11/84).

(2) AREVA TN Affidavit

cc: NRC ISFSI Project Manager, Calvert Cliffs

(Without Enclosures 1, 2, 3)
NRC Project Manager, Calvert Cliffs
NRC Regional Administrator, Region I
NRC Resident Inspector, Calvert Cliffs
S. Gray, MD-DNR

ATTACHMENT (1)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

The Nuclear Regulatory Commission (NRC) staff has requested additional information concerning the March 26, 2014, License Amendment Request: High Burnup NUHOMS-32PHB Dry Shielded Canister (DSC). The request and the responses are provided below. As agreed with the NRC staff, noted responses will be provided by March 5, 2015.

NRC RAI 5-1:

Explain rationale behind the 0.5 multiplication factor for the calculations involving the HSM-HB overturning due to flood load and the Horizontal Storage Module (HSM) HB sliding due to flood load in reference 13.10 of the Updated Safety Analysis Report (USAR).

Reference 13.10 is Transnuclear Calculation No. NUH32PHB-0208, HSM-HB Structural Analysis for NUHOMS®-32PHB System Design Calculation. The staff notes that in these calculations, the drag force used for the overturning moment and the sliding force is multiplied by a factor of 0.5. The explanation for this factor is, "50% of the drag force is assumed to act on one face of one module and 50% on opposite face of the adjacent module." Assumption number 6 states, "For stability analysis of the HSM-HB subjected to flood load a minimum of two modules adjacent to each other are required to prevent overturning and sliding." It is not clear how the interaction of the two modules reduces the drag force by 50%.

This information is needed to demonstrate compliance with 10 CFR 72.122.

CCNPP RESPONSE TO RAI 5-1:

To be provided in a separate response by 3/5/15.

NRC RAI 5-2:

Provide NUH32PHB-0203, Rev 1, "PWR Fuel Rod Accident Side Drop Loading Stress Analysis for NUHOMS®-32PHB System."

This reference is not included in Section 13.13 of the USAR, but is referenced in Reference 13.9, Transnuclear Calculation No. NUH32PHB-0207, "Fuel Rod End Drop Analysis for NUHOMS®-32PHB System Design Calculation." This document contains the material properties of Zircaloy-4 and M-5 cladding at 750°F that establishes the scaling factor of 1.082 that was used to calculate the maximum principle strain in the M-5 cladding as a result of the end drop.

This information is needed to demonstrate compliance with 10 CFR 72.122.

CCNPP RESPONSE TO RAI 5-2:

To be provided in a separate response by 3/5/15.

NRC RAI 5-3:

Provide ANSYS input and output files associated with the structural calculations of section 13.13 of the USAR.

The staff requested these calculations in the Request for Supplemental Information. Much of the structural analysis is completed through the use of finite element analysis with ANSYS and *cannot be evaluated without the input and output files. The staff specifically prefers text based files (i.e. .inp) with an appropriate level of comments to allow for a timely technical review.*

This information is needed to demonstrate compliance with 10 CFR 72.122.

CCNPP RESPONSE TO RAI 5-3:

To be provided in a separate response by 3/5/15.

NRC RAI 5-4:

Provide a time-limited aging analysis (TLAA) or an aging management program (AMP) to address the aging effect of cracking due to thermal cycling fatigue in the HSM-HB concrete.

Fatigue is an age-related degradation mechanism caused by cyclic stressing of a component by either mechanical or thermal stresses, which becomes evident by cracking of the component. The license amendment request (LAR) does not address thermal cycling fatigue of the concrete of the HSM-HB. A fatigue analyses may be submitted as a TLAA if based on design thermal transients involving time-limited assumptions. Otherwise, the LAR should justify the adequacy of the AMP approved in the renewed license (ML14274A03B) or include a revised AMP to address this aging mechanism.

This information is needed to demonstrate compliance with 10 CFR 72.24(c), 72.122(b)(1) and (f), 10 CFR 72.162 and 10 CFR 72.172.

CCNPP RESPONSE TO RAI 5-4:

To be provided in a separate response by 3/5/15.

NRC RAI 6-1a:

Provide a technical basis for the revised maximum air temperature rise of 80°F for the HSM-HB currently provided in Technical Specification 3.4.1.1.

The applicant retains the current limit of 64°F for the maximum air temperature rise in a HSM containing a 24P or 32P DSC, but is requesting an increased limit of up to 80°F for the maximum air temperature rise in the HSM-HB storage module when loaded with a 32PHB DSC. The increase seems excessive in comparison to the magnitude of the changes in the limiting total decay heat loads for the 32 PHB in the HSM-HB.

It is expected that the HSM-HB storage modules would be somewhat more efficient than the older HSMs in the ISFSI. The 80°F temperature rise limit means that with high ambient temperatures (with peaks typically in the range of 90°F for sustained periods of time in the summer), the exit air temperature could approach 170°F or higher for the HSM-HB, if loaded with a 32PHB at design basis decay heat (29.6 kW). The applicant should provide the basis explaining why an increase of the maximum air temperature rise limit is needed for the inlet-to-exit of the storage module when loaded with 32PHB DSC.

CCNPP RESPONSE TO RAI 6-1a:

To be provided in a separate response by 3/5/15.

NRC RAI 6-1b:

Explain the methodology that is used to determine the inlet-to-exit temperature rise in the storage module (HSM and HSM-HB.) How is the measured temperature data processed and evaluated to determine the overall temperature rise through the module?

The staff is seeking to understand how compliance is evaluated with respect to the limit defined in Technical Specification 3.4.1.1.

This information is required by the staff to determine compliance with 10 CFR 72.128(a)(4).

CCNPP RESPONSE TO RAI 6-1b:

To be provided in a separate response by 3/5/15.

NRC RAI 6-2a:

Provide the technical basis for allowing up to 8 hours to initiate corrective action when these time limits are exceeded, and show that the peak temperatures within the DSC, including the peak cladding temperature, do not exceed the specified limits.

The proposed new Technical Specification (TS) 3.4.3.2 "Time Limit for Completion of NUHOMS®-32PHB DSC Transfer Operation", defines specific time limits for operations from initiation of draining water from the DSC/TC annulus to completion of insertion of the DSC into the HSM-HB (72 hours for decay heat loads up to 23.04 kW, 48 hours for decay heat loads up to 25.6 kW, or 20 hours for decay heat loads up to 29.6 kW). If the specified time limit is exceeded, the "required ACTION" section states that the operators have 8 hours to INITIATE the corrective action, one of which is "complete the transfer of the DSC to the HSM." This in effect adds 8 hours to the stated time limits defined in 3.3.2.1. Therefore the operators actually have up to 80 hours, 56 hours, or 28 hours, respectively, as the corresponding limiting decay heat loads for completion of transfer operations. The thermal analyses presented in the Calculation Packages provided in support of this review include analyses only to the specified limits of 72 hours, 48 hours and 20 hours.

CCNPP RESPONSE TO RAI 6-2a:

To be provided in a separate response by 3/5/15.

NRC RAI 6-2b:

Provide additional analysis, justifying that the 8-hour time limit is conservative for this bounding configuration, as well as for the more benign failure from steady-state with forced cooling (FC).

The thermal analysis in the calculation package NUH32PHB-0401 is presented to show that an 8-hour time limit for initiating corrective action in response to loss of the forced air in the DSC/TC annulus during transfer operations is sufficient to assure that temperature limits, including peak cladding temperature, are not exceeded. This analysis assumes that loss of FC occurs from a steady-state condition with FC, which has no time limit for completion of transfer operations. (The calculation package reports a steady-state PCT of 689°F for the maximum permitted decay heat load case of 29.6 kW.)

The staff has noted that the failure of FC from a steady-state condition is not bounding and may not be conservative. The bounding case for failure of FC would be at the point where the time limit applicable to the DSC (depending on its decay heat load), as defined in TS 3.3.3.1, has been exceeded, and FC has just been initiated as a corrective action. The PCT at this point in the transient would be expected to be much higher than the steady-state PCT with FC active.

The staff has noted that the failure of FC from a steady-state condition with FC is not bounding and may not be conservative. The applicant should provide additional analysis for determining the time period to complete the transfer operation without exceeding peak temperature limits, as a function of the period of time that FC was in operation before failure.

This information is required by the staff to determine compliance with 10 CFR 72.128(a)(4).

CCNPP RESPONSE TO RAI 6-2b:

To be provided in a separate response by 3/5/15.

NRC RAI 6-3:

Explain why a temperature of 280°F is considered in the thermal evaluation for the NS-3 neutron shield.

The applicant stated in calculation package NUH32PHB-0101 that a maximum bulk temperature of 280°F is considered in the thermal evaluation for the NS-3 neutron shield to limit the off-gas pressure and to limit the hydrogen loss to less than 10% within the NS-3 neutron shield.

The applicant should provide more information to explain why a maximum temperature of 280°F is considered for the NS-3 neutron shield and how this temperature considered in the thermal analysis will limit the off-gas pressure and the hydrogen loss (to less than 10%) in the NS-3 neutron shield.

This information is required by the staff to determine compliance with 10 CFR 72.128(a)(4).

CCNPP RESPONSE TO RAI 6-3:

The Transfer Cask (TC) proposed for use with the 32PHB DSC is identical to the TC currently in use at CCNPP with the 24P and the 32P dry storage canisters (DSCs). The only exception is the modification to the TC to enable forced air circulation as shown in drawings NUH32PHB-30-11, NUH32PHB-30-12 and NUH32PHB-30-13. This modification does not alter the NS-3 neutron shielding material.

As a result of no change to the NS-3 neutron shielding material, the temperature limit of 280°F, as previously approved for use in the TC with 24P or 32P DSC from Section 8.1.3.3 of the ISFSI USAR is used without any change. The 280°F temperature limit is based on a series of tests conducted by the manufacturer as described in Section 8.1.3.3 of the ISFSI USAR.

NRC RAI 6-4:

Provide more information to support the bounding correlation of the DSC shell temperatures, comparing the HSM-H model with 61BTH DSC and HSM-HB model with 32PHB DSC.

The applicant provided the summary of boundary conditions in Section 5.1.2 of calculation package NUH32PHB-0403 as (a) the 32PHB DSC length of 176.5 inches is shorter than the 61BTH DSC length of 195.8 inches, (b) the 32PHB DSC heat load of 29.6 kW is less than the 61BTH DSC heat load of 31.2 kW, and (c) the shorter 32PHB DSC in HSM-HB has a lower hydraulic resistance than the 61BTH DSC in HSM-H. Therefore based on these assumptions the applicant assumed the DSC shell temperatures from the HSM-H model with 61BTH DSC are bounding for the 32PHB, and can be used as the DSC shell temperatures for the thermal analysis of HSM-HB model with 32PHB DSC.

There are significant configuration differences between the HSM-H (containing the 61BTH DSC) and the HSM-HB (containing the 32PHB DSC). Therefore, the DSC shell temperatures of 61BTH DSC in HSM-H may not bound the DSC shell temperatures of 32PHB DSC in HSM-HB. The applicant should provide more information to support the bounding correlation for the DSC shell temperatures between HSM-H model with 61BTH DSC and HSM-HB model with 32PHB DSC.

This information is required by the staff to determine compliance with 10 CFR 72.128(a)(4).

CCNPP RESPONSE TO RAI 6-4:

To be provided in a separate response by 3/5/15.

NRC RAI 6-5:

Justify why an ambient temperature of 0°F is selected as the design basis DSC shell temperatures under normal storage for 32PHB DSC storage conditions.

The applicant stated in Section 5.1.2 of calculation package NUH32PHB-0403 that the DSC shell temperatures for the 31.2 kW heat load in the HSM-H model are used to map the surface temperatures for 32PHB DSC shell surface temperatures. The DSC shell temperatures based on normal ambient 0°F, off-normal ambient 117°F and accident 40-hour blocked vent from the HSM-H model are the design basis DSC shell temperatures for 32PHB DSC storage conditions.

The staff questions the description of an ambient temperature of 0°F as "normal". This temperature is in some cases used as "cold, normal", but a more appropriate mapping of the DSC shell temperatures would be at "hot, normal" ambient, which is more typically 100°F, and is usually selected as the design basis ambient temperature for normal storage conditions. A lower ambient temperature of 0°F would be less conservative in thermal calculations under normal storage. The applicant is required to clarify use of 0°F ambient to define normal storage conditions in the evaluations in calculation package NUH32PHB- 0403.

This information is required by the staff to determine compliance with 10 CFR 72.128(a)(4).

CCNPP RESPONSE TO RAI 6-5:

As shown in Table 4-9 of Reference 1, the maximum ambient temperature of 104°F and the minimum ambient temperature of -8°F are specified for both the normal and off-normal storage conditions for 32PHB DSC. These ambient temperatures bound the site specific ambient conditions at CCNPP as noted in Section 12.3.6, Table 12.3-3 of the ISFSI USAR.

Section 5.1.2 of Reference 1 only describes the various load cases that are considered for mapping the DSC shell temperatures from a previously evaluated model of HSM-H. These mapped temperatures are applied in the 32PHB DSC evaluation as follows:

Mapped Temperature from HSM-H	Load Cases of 32PHB DSC from Table 4-9 of Reference 1
Normal ambient 0°F	"Normal, Cold at -8°F" "Off-Normal, Cold at -8°F"
Off-Normal ambient 117°F (105°F daily average)	"Normal, Hot at 104°F" "Off-Normal, Hot at 104°F"

The above table identifies DSC shell temperatures from the HSM-H model based on maximum ambient temperature of 117°F (105°F daily average) to evaluate the (normal and off-normal) hot storage conditions for the 32PHB DSC in an HSM-HB. Since this ambient temperature of 117°F (105°F daily average) is higher than the ambient temperature of 104°F specified in Table 4-9 of Reference 1 for normal, hot and off-normal, hot storage conditions, the analysis remains bounding.

Similarly, the DSC shell temperatures from the HSM-H model with an ambient temperature of 0°F are used to evaluate the normal and off-normal, cold storage conditions for 32PHB DSC in an HSM-HB. Considering the ambient temperature of 0°F is higher than the ambient temperature of -8°F as specified in Table 4-9 of Reference 1 for normal, cold and off-normal, cold storage conditions, the analysis remains bounding.

The results of these analyses are presented in Table 6-1 of Reference 1, where Table 6-1 of Reference 1 considers, "hot, normal" or "hot, off-normal" refer to "ambient temperature of 104°F" and "cold, normal" or "cold, off-normal" refer to "ambient temperature of -8°F".

<u>NRC RAI 6-6</u>:

Justify the application of the solar heat load to only the top half of the horizontal package during outdoor transfer operations. Perform sensitivity studies of the effect of this assumption by applying the solar heat load to the full circumference of the cask when in the horizontal orientation.

The applicant assumes that only the 'top half' of the cask sees the solar heat load when in the horizontal orientation. However, the heat load values specified in 10 CFR 71.71 are based on a circumferential average, calculated from detailed studies of specular solar radiation on exposed surfaces of various shapes, taking into account the fact that the lower half of a horizontal cylinder still sees some solar radiation, due to reflection from the ground, and the changing angle of the sun throughout the day. The averaged values specified in 10 CFR 71.71 should therefore be applied to the full circumference of the cask. The applicant should explain in detail (including analyses of specular radiation on horizontal cylinders, if appropriate) why it might be appropriate to apply the 10 CFR 71.71 solar heat load value to only the top half of the cask when in the horizontal orientation.

This information is required by the staff to determine compliance with 10 CFR 72.128(a)(4).

CCNPP RESPONSE TO RAI 6-6:

To be provided in a separate response by 3/5/15.

NRC RAI 6-7:

Analyze meshing sensitivity and spatial discretization error with the GCI method and provide the calculations for review.

The applicant performed the thermal calculations of 32PHB DSC using 3-D ANSYS finite element model. The sensitivity of meshing on temperature distribution was investigated for 32P DSC (not 32PHB DSC) and the results show the maximum fuel cladding temperature change is within 1°F for 14x14 meshing when compared to the coarse meshing. The applicant stated in calculation package NUH32PHB-0403 that the results from the model meshing sensitivity analysis of 32P DSC can be applied to 32PHB DSC model with a meshing of 14x14.

Given that the application is aimed for 32PHB DSC and the 32PHB DSC model is available, the applicant should analyze the spatial discretization error directly using the 32PHB DSC model with the grid convergence index (GCI) method which is described in NUREG-2152 "Computational Fluid Dynamics Best Practice Guidelines for Dry Cask Applications".

When using the GCI method to estimate the discretization error, the following criteria should be met:

- *The solution from the different grids used display monotonic convergence.*
- *The solution from the different grids used should be in the asymptotic range*

The applicant should provide the calculations for review.

This information is required by the staff to determine compliance with 10 CFR 72.128(a)(4).

CCNPP RESPONSE TO RAI 6-7:

To be provided in a separate response by 3/5/15.

NRC RAI 6-8:

Explain how the 1.3% increase of the loss coefficient due to the dose reduction inserts is determined when calculating the maximum air temperature rise limit in the cask annulus.

The applicant stated in Section M of Calvert Cliffs ISFSI USAR that the dose reduction inserts for inlet vents of HSM-HB are included in the models developed for the thermal analysis to determine the maximum air temperature rise limit in the storage module. 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 evaluating the NUHOMSO-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 the HSM-H-B.

The applicant should explain how the loss coefficient increase of 1.3% due to the dose reduction inserts was determined. The applicant should provide the estimate or calculations for staff's review and evaluation.

This information is required by the staff to determine compliance with 10 CFR 72.128(a)(4).

CCNPP RESPONSE TO RAI 6-8:

The methodology to determine the loss coefficients due to the presence of dose reduction hardware in inlet vents is described in Appendix A of Reference 2. This methodology is similar to the methodology approved for use with the HSM-H storage module under Amendment 13 to CoC 1004 generic license (Reference 3) and is also described in Appendix P, Section P.4.4.3.1 of Reference 4.

Based on this methodology, the increase of the loss coefficient due to the inserts in HSM-HB constitutes approximately 1.3% of the overall loss coefficient as noted in Appendix A of Reference 2. A review of the analysis performed for HSM-H storage module with 40.8 kW heat load in Appendix P, Section P.4.4.3.1 of Reference 4 shows that the exit air temperature increase by 0.4°F for a 1% increase in the loss coefficients. Considering the HSM-HB is identical to the HSM-H storage module as shown in Section 3.0 of Reference 5, a similar behavior is expected wherein the effect on the exit air temperature would be less than 1°F. This small increase in the exit air temperature is bounded by the 5% reduction of the heat load for 32PHB DSC (31.2 kW for HSM-H to 29.6 kW for HSM-HB) and other conservatism discussed in Section 6.0 from Reference 2.

Therefore, the dose reduction hardware in HSM-HB has negligible effect on inlet-to-outlet air temperature rise and no negative effect on the thermal evaluation of 32PHB DSC storage in HSM-HB.

NRC RAI 6-9

Evaluate the impact to thermal performance of the poison plate when adding the required minimum areal densities for basket types A and B of 32PHB DSC.

The applicant stated in Calvert Cliffs ISFSI USAR that the proposed amendment will add the required minimum areal density for 32PHB DSC poison plates. The 32PHB DSC poison plate shall have a minimum B^{10} areal density of 0.019 g/cm² for basket type A and 0.027 g/cm² for basket type B. Given that the change in the properties of the poison plate may affect the heat removal capability, the applicant should evaluate the impact to the thermal performance of the poison plate when adding the required minimum areal densities for basket types A and B of the 32PH DSC.

This information is required by the staff to determine compliance with 10 CFR 72.128(a)(4).

CCNPP RESPONSE TO RAI 6-9:

The thermal performance and evaluation of the poison plate for the 32PHB DSC, as documented in Reference 1 and Reference 6, Section 3.2.3 / Appendix M, requires a thickness of 0.125" with a thermal conductivity of 6.26 Btu/hr-in-°F (130 W/m-K) for both Type-A and Type-B Baskets. The required B^{10} aerial density for Basket Type-A is 0.019 mg/cm² and 0.027 mg/cm² for Basket Type-B.

Actual thermal conductivity testing of the poison plate has since been performed to ensure the required thermal conductivity requirement of 130 W/m-K is met. As a result of the greater areal density requirement of Basket Type-B, Type-B poison was tested to envelope the thermal performance required for Basket Type-A and to ensure there is no impact on thermal performance due to the different aerial densities of the poison plates. Actual test data recorded identified the Basket Type- B poison plate having thermal conductivity of 132 W/m-k. (See test results, Enclosure 1)

Calvert Cliffs Nuclear Power Plant has elected to make use of the Basket Type-B poison plate. Therefore Type-A poison is currently not being considered for use in 32PHB DSC. However, Type-A can be tested for thermal conductivity to measure and qualify thermal performance with evaluated value, as required, should it be used in the future.

NRC RAI 6-10:

Justify the removal of the additional conservatism included in 32P thermal analysis.

The applicant noted in calculation package NUH32PHB-0407 that the radial effective thermal conductivity for the 32PHB DSC are provided up to 1100°F (Figure 8-3) by removing additional conservatism included in the 32P DSC thermal analysis, due to limiting of the temperature scale to 614°F.

The staff needs to understand what additional conservatism is removed from 32P DSC thermal analysis and assure the removal of conservatism from 32P DSC is reasonable and will not affect the thermal evaluation of 32PHB DSC.

This information is required by the staff to determine compliance with 10 CFR 72.128(a)(4).

CCNPP RESPONSE TO RAI 6-10:

The conservatism eliminated for the 32PHB DSC relates to the behavior of the ANSYS Mechanical APDL code and not the system itself. The ANSYS Mechanical APDL code used to evaluate the 32P DSC and the 32PHB DSC does not extrapolate the thermal conductivity beyond the specified range. For instance, if the temperature dependent thermal conductivity is specified for 600°F, the code would use this conductivity value for temperatures beyond 600°F without any extrapolation.

For 32P DSC thermal analysis, the radial effective thermal conductivity of fuel assembly is only computed up to 614°F as listed in Table 8-1 of Reference 7. Considering the ANSYS Mechanical APDL code does not extrapolate, the thermal conductivity at 614°F was conservatively used for regions of fuel assembly with temperature greater than 614°F in the analyses performed for 32P DSC.

This additional conservatism is removed in the 32PHB DSC analyses by increasing the temperature scale up to 1010°F for the radial effective fuel conductivity for 32PHB DSC as shown in Table 8-1 of Reference 7. Since the temperature scale for the radial effective thermal conductivity of fuel assembly in the 32PHB DSC covers the entire range of expected temperatures from 136°F to 1010°F, the ANSYS APDL code would interpolate as necessary without any limitations similar to the analyses performed for 32P DSC.

As shown in Table 7-1 from Reference 1, the maximum fuel cladding temperature for 32PHB DSC for storage and transfer conditions is 932°F and therefore, the maximum temperature of the fuel assembly remains within the temperature range considered for radial effective thermal conductivity.

NRC RAI 6-11:

Check the equations of air and helium thermal properties and assure that correct values are used in the actual model calculations.

For air thermal properties (Table 4-8, page 16) and helium thermal properties (Table 4-9, page 17) shown in calculation package NUH32PHB-0402, the equations reported on these two pages for polynomial fits of thermal conductivity, specific heat, and viscosity for air and helium appear to be in error. The equations are given as (for example, with thermal conductivity):

$$k = \sum C_i T_i$$

To be actual polynomial fits, the formula should be

$$k = \sum C_i T_i^t$$

Using the formula as documented (without exponents) yields erroneous values for thermal conductivity, specific heat, and viscosity. (The staff verified this by checking reported gas thermal properties in standard heat transfer textbooks). Using the formula as corrected, with exponents, yields correct and consistent values for these properties over the range reported for Table 4-8.

The applicant should check whether this is documentation error. The applicant should verify that the incorrect values, generated from incorrect equations which are "directly" setup in the model, were not used in the actual calculations. The applicant should verify the modeling input, and provide revised documentation, if appropriate. If modeling input errors are found, the applicant should provide revised calculations, and provide revised results for the thermal analyses.

This information is required by the staff to determine compliance with 10 CFR 72.128(a)(4).

CCNPP RESPONSE TO RAI 6-11:

To be provided in a separate response by 3/5/15.

NRC RAI 6-12:

Provide derivation of the effective thermal conductivity of nitrogen in the 0.02 Al/Poison contact gap and DSC-rail gap.

The applicant listed the effective thermal conductivity of nitrogen (N_2) for 0.02 Al/Poison contact gap in Table 5-3 and for DSC-rail gap in Table 5-8 of calculation package NUH32PHB-0403.

Explain how the "effective" thermal conductivity (both parallel and across effective thermal conductivities) was derived. The applicant should provide calculations (e.g., Excel spread sheets) to show how the effective thermal conductivity is derived for the 32PHB DSC which has different configuration from other DSCs.

This information is required by the staff to determine compliance with 10 CFR 72.128(a)(4).

CCNPP RESPONSE TO RAI 6-12:

The effective thermal conductivity of nitrogen in both the 0.02" Al/Poison contact gap and the effective thermal conductivity of nitrogen for the DSC-rail gap (as shown in Tables 5-3 and 5-8 of Reference 1, respectively) are calculated based on equation (5.2) and equation (5.3) for parallel and across the thickness of the gaps in Section 5.1.3 of Reference 1. Table 5-2 from Reference 1 lists the thicknesses of the nominal design gaps and the corresponding gaps considered in the thermal model.

The thermal conductivity for nitrogen gas used in equation (5.2) and equation (5.3) from Section 5.1.3 of Reference 1 is calculated based on Table 2.10 of Reference 8 and the rounded off values are listed in Table 4-7 of Reference 1.

The effective thermal conductivities of nitrogen in the Al/Poison contact gap and DSC-rail gap (listed in Table 5-3 and Table 5-8, respectively) are calculated in the spreadsheet titled "32PHB_Input.xls", worksheet "Cavity gas -Nitrogen" listed in Table 8-5 of Reference 1.

The spreadsheet "32PHB_Input.xls" is included as Enclosure 2 to facilitate NRC review.

NRC RAI 6-13:

Provide derivation of the radial effective thermal conductivity of CE 14x14 fuel assembly for nitrogen backfill/blowdown during vacuum drying.

The applicant listed the "radial" effective thermal conductivity of CE 14x14 fuel assembly in 32PHB DSC for nitrogen backfill/blowdown during vacuum drying, in Table 8-2 of the calculation package NUH32PHB-0407.

Explain how the "radial effective" thermal conductivity is derived and provide the calculations (e.g., Excel spread sheets) to show how these radial effective thermal conductivity is derived for the 32PHB DSC which has different configuration from other DSCs.

This information is required by the staff to determine compliance with 10 CFR 72.128(a)(4).

CCNPP RESPONSE TO RAI 6-13:

As shown in Section 4.1 of Reference 7, the methodology for calculating the radial effective thermal conductivity of fuel assemblies in 32PHB DSC for helium or nitrogen backfill is based on methodology described in Section 4.5 of Reference 9 for the currently licensed 32P DSC.

A 2D finite element model of the fuel assembly shown in Figure 4-1 of Reference 7 was developed using ANSYS. The material properties listed for this evaluation are presented in Section 3.0 of Reference 7. The model was run with a series of isothermal boundary conditions applied to the fuel compartment walls to predict corresponding peak cladding temperatures.

From Section 4.5 of Reference 9, the isotropic effective thermal conductivity of a heat generating square can be calculated from

$$K_{eff} = \frac{Q}{4 \cdot L_a \cdot (T_o - T_s)} \cdot 0.2947$$

Q = Heat generation per fuel assembly (equal to 0.8 kW), Btu/hr,
L_a = Active fuel length, in,
T_0 = Peak cladding temperature, ^{0}F,
T_s = Basket wall temperature, ^{0}F.

In determining the temperature dependent effective fuel conductivity of the fuel assemblies, an average temperature, equal to (T_0 + T_s)/2, is used.

The spreadsheet for CE 14x14 fuel assembly "CE14_irrad_he_nitr.xls," with worksheet "k-rad_nitrogen" for nitrogen backfill from Table 7-2 of Reference 7 is included as Enclosure 2.

NRC RAI 6-14:

Provide derivation of the effective thermal properties of basket stainless steel plate and basket Al1100 plate used in the thermal evaluations of 32PHB DSC.

The applicant listed the "effective" thermal properties for basket stainless steel plate in Table 5-5 and for basket Al1100 plate in Table 5-7 for 32PHB DSC in the calculation package NUH32PHB-0403.

Explain how these "effective" thermal properties are derived and provide the calculations (e.g., Excel spread sheets) to show how these effective thermal properties are derived for the 32PHB DSC which has different configuration from other DSCs.

This information is required by the staff to determine compliance with 10 CFR 72.128(a)(4).

CCNPP RESPONSE TO RAI 6-14:

The effective thermal properties for basket stainless steel plate listed in Table 5-5 of Reference 1 and effective thermal properties for basket Al 1100 plate listed in Table 5-7of Reference 1 are calculated based on equation (5.2) and equation (5.3) for parallel and across the thickness of the plates in Section 5.1.3 of Reference 1. Table 5-2 of Reference 1 lists the basket plate thickness from the design and the analysis model.

The effective thermal properties for basket stainless steel plate listed in Table 5-5 of Reference 1 are calculated in the spreadsheet titled "32PHB_Input.xls", worksheet "Bask SS Keff (SA-240 Type 304)" listed in Table 8-5 of Reference 1.

The effective thermal properties for basket Al1100 plate in Table 5-7 of Reference 1 are calculated in the spreadsheet titled "32PHB_Input.xls", worksheet "Al Basket Keff" listed in Table 8-5 of Reference 1.

Thermal properties for stainless steel and Al1100 used in the above spreadsheet are listed in Table 4-3 and Table 4-4 of Reference 1.

The spreadsheet "32PHB_Input.xls" is included as Enclosure 2 to facilitate NRC review.

NRC RAI 6-15:

Provide References 6 and 7 cited in the calculation package NUH32PHB-0406.

The applicant set the short-term temperature limit of 1300°F for accident conditions per Reference 6 (Engineering Report #NS3-020) in calculation package NUH32PHB-0406. The applicant is required to provide this report for review, so the staff can assure the limit of 1300°F is acceptable.

This information is required by the staff to determine compliance with 10 CFR 72.128(a)(4).

CCNPP RESPONSE TO RAI 6-15:

As shown from Reference 10, when NS-3 material was heated in a furnace to a temperature of 1300°F ± 100°F (50 minutes to reach to 1300°F) for a period of one hour, the weight loss from NS-3 was 41 percent. After which, it was observed that a white smoke started to expel out of the furnace at a temperature of 600°F and continued for the duration of the test. Upon conclusion of the test, the NS-3 material was solid; it did not burn, and was brittle with no mechanical strength.

Reference 10 is enclosed (Enclosure 4). The ISFSI USAR has been previously provided in a letter dated 7/25/14.

NRC RAI 6-16:

Clarify the Action 4 under TS 3.3.2.1 to assure the specification is applicable to 32PHB DSC.

The applicant added new TS 3.3.2.1 in this amendment application, and stated, under Action 4 of TS 3.3.2.1 (see Attachment 2 of Enclosure 5, Marked Up Technical Specification Pages), "Return the transfer cask to the cask to the cask handling area and fill the transfer cask/DSC annulus with clean water, or initiate appropriate external cooling of the transfer cask outer surface by other means to limit the surface temperature increase."

Clarify (a) whether the transfer cask is in vertical orientation or horizontal orientation under Action 4, and (b) what can be the "other means" for limiting the surface temperatures? The clarification of actual activities allowed in Action 4 will help assure that the 32PHB DSC within the TC is maintained within acceptable thermal limits when transfer time limits are exceeded and FC is not available.

This information is required by the staff to determine compliance with 10 CFR 72.128(a)(4).

CCNPP RESPONSE TO RAI 6-16:

To be provided in a separate response by 3/5/15.

References

1. NUH32PHB-0403 Rev.0, "Thermal Evaluation of NUHOMS® 32PHB DSC for Storage and Transfer Conditions". (ML12173A182)
2. NUH32PHB-0410, Rev.1, "Reconciliation of Thermal Analyses Results for 32PHB DSC Storage in HSM-HB Module". PROPRIETARY Previously provided to the NRC in letter dated 7/25/14.
3. AREVA Inc., "Certificate of Compliance for Spent Fuel Storage Casks," Certificate No. 1004, Amendment 13.

4. "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," NUH003, Rev. 14.
5. NUH32PHB-0101, Rev.3, "Design Criteria Document (DCD) for the NUHOMS□ 32PHB System for Storage". (ML14288A128)
6. NUH-03-150 Rev. 2, "Procurement Specification for Metal Matrix Composite (MMC) Neutron Absorber Material for use in Baskets of NUHOMS®, NUHOMS® HD, TN-40HT, TN-LC, TN-68, and Advanced NUHOMS® Systems".
7. NUH32PHB-0407, Rev.0, "Effective Thermal Properties of Bounding CE 14x14 Fuel Assembly for 32PHB DSC". (ML12173A183)
8. Rohsenow, Hartnett, Cho, "Handbook of Heat Transfer", 3rd Edition, 1998.
9. 1095-2, Rev.0, "Effective Fuel Properties". PROPRIETARY (Provided as Enclosure 3)
10. NUH32PHB-0406 Rev.2, "Thermal Evaluation of NUHOMS 32PHB Transfer Cask for Normal, Off Normal, and Accident Conditions (Heat Loads of <29.6 kW)," (ML12093A103)

ATTACHMENT (2)

AREVA TN AFFIDAVIT

AFFIDAVIT PURSUANT
TO 10 CFR 2.390

AREVA Inc.)
State of Maryland) SS.
County of Howard)

I, Paul Triska, depose and say that I am a Vice President of AREVA Inc., duly authorized to execute this affidavit, and have reviewed or caused to have reviewed the information which is identified as proprietary and referenced in the paragraph immediately below. I am submitting this affidavit in conformance with the provisions of 10 CFR 2.390 of the Commission's regulations for withholding this information.

The information for which proprietary treatment is sought listed below:

- AREVA TN calculation 1095-2 R-0 "Effective Fuel Properties" with associated computational file(s)
- AREVA TN calculation NUH32PHB-403 R-0 "Thermal Evaluation for NUHOMS 32PHB Canister for Storage and Transfer Conditions" computational file(s) only
- Thermal Conductivity Test Results of Coupon Poison Plate Testing for 32PHB Type-B Poison (Thermal Conductivity Report R-WN-MS-1609A009-00)

This document has been appropriately designated as proprietary.

I have personal knowledge of the criteria and procedures utilized by AREVA Inc. in designating information as a trade secret, privileged or as confidential commercial or financial information.

Pursuant to the provisions of paragraph (b) (4) of Section 2.390 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure, included in the document described above, should be withheld.

1) The information, which is owned and have been held in confidence by AREVA Inc., sought to be withheld from public disclosure involves details regarding AREVA Inc.'s approach to Calvert Cliffs Nuclear Power Plant (CCNPP) intended use of the 32PHB dry spent fuel storage system.

2) The information is of a type customarily held in confidence by AREVA Inc. and not customarily disclosed to the public. AREVA Inc. has a rational basis for determining the types of information customarily held in confidence by it.

3) Public disclosure of the information is likely to cause substantial harm to the competitive position of AREVA Inc. because the information consists of details regarding AREVA Inc.'s approach to Calvert Cliffs Nuclear Power Plant (CCNPP) intended use of the 32PHB dry spent fuel storage system, the application of which provides a competitive economic advantage. The availability of such information to competitors would enable them to modify their product to better compete with AREVA Inc., take marketing or other actions to improve their product's position or impair the position of AREVA Inc.'s product, and avoid developing similar data and analyses in support of their processes, methods or apparatus.

Further the deponent sayeth not.

Paul Triska
Vice President, AREVA Inc.

Subscribed and sworn to me before this 3rd day of February, 2015.

Notary Public

My Commission Expires 10/17/2015

ZORA M. DOUGHERTY
NOTARY PUBLIC
My Commission Expires 10-17-2015
HOWARD COUNTY, MD