ENCLOSURE 14

Non-Proprietary 10955-TLAA01,

Time Limited Aging Analysis (TLAA) of HSM-HB Concrete for Thermal Considerations

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Calvert Cliffs Nuclear Power Plant
March 10, 2015

AREVA	Form 3.2-1 Calculation Cover Sheet Revision 8	Calculation No.:	10955-TLAA01
		Revision No.:	0
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DCR NO (if applicable): 10955-005	**PROJECT NAME:** NUHOMS® 32PHB System
PROJECT NO: 10955	**CLIENT:** CENG – Calvert Cliffs Nuclear Power Plant (CCNPP)

CALCULATION TITLE:

Time-Limited Aging Analysis (TLAA) of HSM-HB Concrete for Thermal Considerations

SUMMARY DESCRIPTION:

1) Calculation Summary

This Time-Limited Aging Analysis (TLAA) evaluates time-dependent aging mechanisms associated with potential degradation of HSM-HB components due to elevated temperature and thermal cyclic fatigue.

2) Storage Media Description

N/A

If original issue, is licensing review per TIP 3.5 required?

Yes ☐ **No** ☒ **(explain below)** **Licensing Review No.:** _____

This calculation is prepared to support a Site Specific License Renewal Application by CCNPP that will be reviewed and approved by the NRC. Therefore, a licensing review per TIP 3.5 is not applicable.

Software Utilized:	**Version:**
None	N/A

Calculation is complete:

Originator Name and Signature: Sita Ram Pandey

Digitally signed by PANDEY Sita Ram
Date: 2015.02.06 10:24:33 -05'00'

Date: 02/06/2015

Calculation has been checked for consistency, completeness and correctness:

Checker Name and Signature: Si-Hwan Park

Digitally signed by PARK SI-Hwan
Date: 2015.02.06 11:05:56 -05'00'

Date: 02/06/2015

Calculation is approved for use:

Project Engineer Name and Signature: Girish Patel

PATEL Girish
o=AREVA GROUP, 2.5.4.45=111D2D8D413995674D417FC F, cn=PATEL Girish
2015.03.03 16:34:38 -05'00'

Date:

REVISION SUMMARY

REV.	DESCRIPTION	AFFECTED PAGES	AFFECTED DISKS
0	Initial Issue	All	N/A

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1.0 PURPOSE

This TLAA evaluates time-dependent aging mechanisms associated with potential degradation of HSM-HB components due to elevated temperature and thermal cyclic fatigue. Conservatively, the assessment is based on the temperatures at initial storage conditions.

2.0 REFERENCES

2.1 AREVA Inc. Document NUH003.0103, "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel", Revision 14, September 2014.

2.2 Calvert Cliffs Independent Spent Fuel Storage Installation Updated Safety Analysis Report, Revision 17, September 2008.

2.3 Safety Evaluation Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel, US Nuclear Regulatory Commission, December 1994.

2.4 ACI 349-97, "Code Requirements for Nuclear Safety Related Concrete Structures & Commentary".

2.5 ACI 318-95, "Building Code Requirements for Reinforced Concrete".

2.6 NUREG-1536, Revision 1, "Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility", Final Report, July 2010.

2.7 Transnuclear Specification NUH-03-0214, Revision 7, "Precast Concrete Construction of NUHOMS® HSM".

2.8 TN Calculation 67009-TLAA04, Revision 0, "Time-Limited Aging Analysis (TLAA) of Horizontal Storage Module (HSM) for CoC 1004 Renewal".

2.9 TN Calculation 67009-TLAA11, Revision 0, "Outer Surface Weld Temperature of the NUHOMS® DSCs Stored in the HSM-H".

2.10 TN Calculation NUH32PHB-0208, Revision 0, "HSM-HB Structural Analysis for NUHOMS® 32PHB System".

3.0 ASSUMPTIONS

1. The maximum predicted temperatures in the HSM concrete surface are assumed to be based on the temperatures at the beginning of storage.

4.0 METHODOLOGY

The concrete HSM is evaluated for sustained elevated temperature effects and thermal fatigue over 60 years.

5.0 COMPUTATION

5.1 Concrete Horizontal Storage Module (HSM)

Concrete HSM Elevated Temperature Effects Evaluation

Per [2.10], the HSM-HB is designed to meet the requirements of ACI 349-97 [2.4] and constructed per the requirements in ACI 318-95 [2.5]. HSM temperature limits are per ACI 349-97 [2.4]. The temperature limits specified in Section A.4 of ACI 349-97 [2.4] are as follows:

Temperatures shall not exceed 150°F except for local areas, such as around penetrations, which are allowed to reach a maximum of 200°F for normal operation or any other long term period. For accident or any other short term period, the temperatures shall not exceed 350°F for the surface. Higher temperatures may be allowed for concrete if tests are provided to evaluate the reduction in strength and this reduction is applied to design allowables.

Additionally, the following temperature criteria are used for the HSM concrete per Section 3.0 of [2.3]:

1. *If concrete temperatures of general or local areas do not exceed 93.3°C (200°F) in normal or off-normal conditions/occurrences, no tests or reduction of concrete strength are required.*

2. *If concrete temperatures of general or local areas exceed 93.3°C (200°F) but would not exceed 149°C (300°F), no tests or reduction of concrete strength are required if Type II cement is used and aggregates are selected which are acceptable for concrete in this temperature range. The staff has accepted the following criteria for aggregates (fine and coarse) which are considered suitable:*

a. *Satisfy ASTM C33 requirements and other requirements as referenced in ACI 349 for aggregates.*

b. *Have demonstrated a coefficient of thermal expansion (tangent in temperature range of 21°C to 37.8°C (70°F to 100°F)) no greater than $1x10^{-5}$ cm/cm/°C ($6x10^{-6}$ in/in/°F) or be one of the following minerals: limestone, dolomite, marble, basalt, granite, gabbro or rhyolite.*

The above criteria in lieu of the ACI 349 requirements (for ISFSI only) do not extend above 149°C (300°F) for normal or off-normal temperatures for general or local areas and do not modify the ACI requirements for accident situations. For an ISFSI, use of any Portland cement based concrete, where normal or off-normal temperatures of general or local areas may exceed 149°C (300°F), or where "accident" temperatures may exceed 177°C (350°F), require tests on the exact concrete mix (cement type, additives, water-cement ratio, aggregates, proportions) which is to be used. The tests are to acceptably demonstrate the level of strength reduction which needs to be applied, and to show that the increased temperatures do not cause deterioration of the concrete either with or without load.

The NRC staff considered an exception to the second criteria above for the requirements for fine aggregates only. This exception should not be construed as general acceptance for ISFSI usage for any normal temperatures exceeding 93.3°C (200°F) or any off-normal temperatures exceeding 107°C (225°F).

1. *Fine aggregates composed of quartz sand, sandstone sands, or any sands of the following minerals: limestone, dolomite, marble, basalt, granite, or rhyolite; or any mixture of these may be used without further documentation as to the coefficient of thermal expansion.*

2. *Fine aggregates must satisfy requirements of ASTM C33 and ACI 349, and of the documents incorporated in those by reference.*

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6.0 RESULTS

This TLAA evaluated the effects of temperature, and thermal cyclic fatigue of the HSM-HB components. The evaluation conclusions are as follows:

Degradation due to elevated temperature is not an aging effect requiring management for the HSM concrete. The long-term temperatures corresponding to maximum design basis heat loads trend toward the allowed long-term temperature limits of the ACI 349 Code. The thermal cyclic fatigue is also not an aging effect requiring management for the HSM concrete.

7.0 CONCLUSIONS

In summary, all of the concrete components of the HSM-HB will not be impaired by thermal cyclic effect or elevated temperature and will be functionally adequate for a total service life of 60 years.