ENCLOSURE 7

Non-Proprietary Transnuclear Calculation NUH32P+.0204, Revision 1, Fuel End Drop Analysis for NUH32P+ Using LS-DYNA, August 2010

Calvert Cliffs Nuclear Power Plant, LLC
September 1, 2010

Non-Proprietary

AREVA TRANSNUCLEAR INC.	Form 3.2-1 Calculation Cover Sheet TIP 3.2 (Revision 4)	Calculation No.:	NUH32P+.0204
		Revision No.:	1
		Page: 1 of 38	
DCR NO (ifapplicable): NUH32P+-004	PROJECT NAME: NUH32P+ Dry Fuel Storage Project for CCNPP		
PROJECT NO: NUH32P+	CLIENT:CENG - Calvert Cliff Nuclear Power Plant (CCNPP)		

CALCULATION TITLE:

Fuel End Drop Analysis for NUH32P+ Using LS-DYNA

SUMMARY DESCRIPTION:

1) Calculation Summary

The purpose of this calculation is to evaluate the structural adequacy of NUH32P+ 14x14 fuel assembly Zircaloy-4 clad exposed to 80 inch end drop event condition.

2) Storage Media Description

Secure network server initially, then redundant tape backup.

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 Application by CCNPP that will be reviewed and approved by the NRC. Therefore, a 10CFR72.48 licensing review per TIP 3.5 is not applicable. The results contained in this revised calculation will be submitted to NRC as part of a RAI response.

Software Utilized (subject to test requirements of TIP 3.3):	Version:
LS-DYNA	ls971s R2 7600.1224
Calculation is complete: Huan Li Originator Name and Signature:	Date: 08/25/10
Calculation has been checked for consistency, completeness and correctness: Mrinal Bose Checker Name and Signature:	Date: 8/25/10
Calculation is approved for use: Project Engineer Name and Signature: Kamran Tavassoli	Date: 8/25/10

REVISIONS

REV.	DESCRIPTION OF CHANGES	AFFECTED PAGES	AFFECTED Computational I/O
0	Initial Issue	All	All
[redacted]			

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1.0 Purpose

The purpose of this calculation is to evaluate the structural adequacy of 32P+ 14x14 fuel assembly exposed to 80 inch end drop event conditions.

2.0 References

2.1. Harold E. Adkins, Jr., Brian J. Koeppel and David T. Tang, "Spent Nuclear Fuel Structural Response when Subject to An End Impact Accident". PVP-Vol. 483, Transportation Storage and Disposal of Radioactive Materials, July 25-29, 2004, San Diego, CA, USA.

2.2. Not used.

2.3. TN Calculation, NUH32P-1095-1, Rev. 0, "NUHOMS® 32P Weight Calculation of DSC/TC System".

2.4. TN Calculation, TN40HT-0217, Rev. 0, "TN40HT Fuel End Drop Analysis Using LS-DYNA".

2.5. NUREG-1864, "A Pilot Probabilistic Risk Assessment of a Dry Cask Storage System at a Nuclear Power Plant". Date published in March 2007.

2.6. TN Calculation, NUH32P+-0203, Rev. 0, "32P+ Transfer Cask Impact onto the Concrete Pad LS-DYNA Analysis (80 inch End Drop)".

2.7. DOE/RW-0184, Vol 3 of 6, "Characteristics of Spent Fuel, High Level Waste and other Radioactive Wastes which require Long Term Isolation – Physical Descriptions of LWR Fuel Assemblies," Appendix 2A, U.S. DOE, December, 1987.

2.8. Not used.

2.9. TN Calculation No. 972-179, Rev. 0, "TN-68 High Burnup Cladding Mechanical Properties".

2.10. CCNPP Calculation, DCALC No. CA06758, "Fuel Performance Data for Calvert Cliffs Dry Storage (ISFSI) Analysis for Batches C1N through C1T and C2M through C2S", October 19th, 2006.

2.11. Eric R. Siegmann, J. Kevin McCoy, Robert Howard, "Cladding Evaluation in the Yucca Mountain Repository Performance Assessment," Material Research Society Symp. Proc. Vol. 608, 2000.

2.12. Not used.

2.13. Standardized NUHOMS Horizontal Modular System, Docket No. 72-1004, UFSAR of Amendment 10.

2.14. Gordon S. Bjorkman, Jr., "The effect of Gaps on the Impact Response of a cask Closure Lid", 20th International Conference on Structural Mechanics in Reactor Technology, Espoo, Finland, August 9-14, 2009, SMiRT 20-Division V, Paper 1941.

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6.0 Model I

6.1 Geometry and Details

Figure 2 illustrates the finite element model (model I), which is composed of a single fuel rod, a lumped cask mass, springs representing the spacer grids, contact surfaces representing the basket compartment wall, and a spring representing the target stiffness.

Several views of the actual finite element mesh are shown in Figure 3 for model I. In this figure, the views shown are: (a) the entire model, (b) top of rod with basket compartment walls and spacer grid spring, (c) top of rod with fuel pellet springs, and (d) bottom of rod with nodes representing the cask and target (concrete and soil).

6.2 Fuel cladding

The fuel cladding geometry and other physical properties are presented in Table 1 and Figure 1.

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7.0 Model II

Model 2 is developed to calculate the maximum principle strain in the fuel pin using an unfiltered cask response.

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Based on the results of all the analyses performed, it is found that the maximum principal strains for the fuel cladding are 0.207% and 0.341% for model I and model II, respectively. These maximum principal strains are well below the yield strain of 0.926% at 750 °F. [redacted] Proprietary Information with Pursuant to 10CFR 2.390

Hence, based on all of the conservatisms in the current analyses [redacted] Proprietary Information with Pursuant to 10CFR 2.390 [redacted] it can be concluded with high degree of confidence that the fuel claddings will deform elastically with very small amount of maximum principal strain; and therefore the fuel claddings will maintain its structural integrity during the 80 inch end drop event.

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