ENCLOSURE 12

Non-Proprietary NUH32PHB-0203, Revision 1,

PWR Fuel Rod Accident Side Drop Loading Stress Analysis for

NUHOMS 32 PHB System

Calvert Cliffs Nuclear Power Plant
March 10, 2015

AREVA TRANSNUCLEAR INC.	Form 3.2-1 Calculation Cover Sheet TIP 3.2 (Revision 5)	Calculation No.:	NUH32PHB-0203
		Revision No.:	1
		Page 1 of 22	

DCR NO (if applicable) : NUH32PHB-009	PROJECT NAME: NUHOMS® 32PHB System
PROJECT NO: 10955	CLIENT: CENG - Calvert Cliff Nuclear Power Plant (CCNPP)

CALCULATION TITLE:

PWR Fuel Rod Accident Side Drop Loading Stress Analysis for NUHOMS 32PHB System

SUMMARY DESCRIPTION:

1) Calculation Summary

The purpose of this calculation is to verify the structural adequacy of the fuel cladding subject to side drop hypothetical accident loading condition for PWR fuel assemblies to be loaded in the NUH32PHB transfer cask. In addition, structural integrity of spacer grids is discussed to assess grid deformation impact onto fuel rod pitch as well as modal analysis for fuel cladding is conducted to determine lateral natural frequencies.

2) Storage Media Description

Secure network server initially, then redundant tape backup. (Same as Rev.0)

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

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

Software Utilized (subject to test requirements of TIP 3.3):	Version:
ANSYS	10.0A1

Calculation is complete:

Originator Name and Signature: Huan Li — Date: 11/8/10

Calculation has been checked for consistency, completeness and correctness:

Checker Name and Signature: Raheel Haroon — Date: 11/9/10

Calculation is approved for use:

Project Engineer Name and Signature: Kamran Tavassoli — Date: 11/9/10

REVISION SUMMARY

Rev.	Description of Changes	Affected Pages	Affected Computational I/O
0	Initial Issue	All	All
1	Add discussion about M-5 material for AREVA fuel assembly so that all the fuel assemblies for NUH32PHB are taken into account.	1,2,5-8,11,15	None

TABLE OF CONTENTS

List of Tables

List of Figures

1.0 Purpose

The purpose of this calculation is to verify the structural adequacy of the fuel assemblies to be loaded in the NUH32PHB transfer cask. Side drop analysis is performed for hypothetical accident load conditions. In addition, structural integrity of spacer grids is discussed to assess grid deformation impact onto fuel rod pitch. Modal analysis for fuel cladding is also conducted to determine lateral natural frequencies.

2.0 References

2.1 NUH32PHB.0101, Rev. 2, "Design Criteria Document (DCD) for the NUHOMS® 32PHB System for Storage".

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

2.3 ANSYS Computer Code and User's Manuals, Release 10.0.

2.4 DOE/RW-0184, Volume 3 of 6, December 1987, "Characteristics of Spent Fuel, High Level Waste, and Other Radiological Wastes which May Require Long-Term Isolation", USDOE, Office of Civilian Radioactive Waste Management.

2.5 TN Calculation NUH32PHB-0403, Rev. 0, "Thermal Evaluation of NUHOMS® 32PHB DSC for Storage and Transfer Conditions".

2.6 H.E. Adkins, Jr., B.J. Koeppel and T. Tang, "Spent Nuclear Fuel Structural Response when Subjected to an End Impact Accident", PVP2004, San Diego, CA, July 25-29, 2004.

2.7 An Swam, L.F., Strasser A.A., Cook J.D., Burger J.M., "Behavior of Zircaloy-4 and Zirconium Linear Zircaloy-4 Cladding at High Burnup", Proceedings of the 1997 International Topical Meeting on LWR Fuel Performance, Portland, Oregon March 2-6, 1997.

2.8 Raymond J. Roark and Warren C. Young, "Formulas For Stress and Strain", 5th edition, McDraw-Hill Book Company.

2.9 Calvert Cliffs Calculation CA06525, Rev. 0, "Calvert Cliffs Unit 2 Cycle 16 Bounding Fuel Performance Analysis for ZrB2 Implementation at 2746 MWt Core Power".

2.10 UCID - 21246, "Dynamic Impact Effects on Spent Fuel Assemblies", Lawrence Livermore National Laboratory, October 20, 1987.

2.11 NUREG/CR-0200, Vol. 3, Rev. 5 (Table M8.2.4), ORNL/NUREG/CSD-2/V3/R6, "SCALE, A Modular Code System for Performing Standardized Computer Analysis for Licensing Evaluation for Workstations and Personal Computers", Oak Ridge National Laboratory, RSIC Computer Code Collection.

2.12 Not used.

2.13 Not used.

2.14 Chun, R., M. Witte, M. Schwarz, "Dynamic Impact Effects on Spent Fuel Assemblies", October, 1987, pp.3.

2.15 Report SAND90-2406, "A Method for Determining the Spent-Fuel Contribution to Transport Cask Containment Requirements", Sandia National Laboratories, November 1992.

2.16 TN Calculation No. NUHPHB-0205, Rev. 1, "NUHOMS® 32PHB Basket Evaluation for Storage and Transfer Loads".

2.17 TN Calculation No. NUH-HBU-0249, Rev. 0, "M5 Cladding Mechanical Properties".

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8.0 Conclusion

The maximum stress under Accident drop conditions among all PWR fuels to be transported in the NUH32PHB Cask is 44.5 ksi for Zircaloy-4 and 47.1 ksi for M-5, respectively. Those stresses significantly lower than the yield stress of Zircaloy-4 (92 ksi) and M-5 (67.3 ksi) at 750 °F. It is, therefore, concluded that the fuel claddings will not fail under accident side drop load condition.

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