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CALCULATION SUMMARY SHEET (CSS)

Document Identifier 32 - 5030674 - 01

DOC.20050125.0015

Title RANGE OF PARAMETERS FOR PWR SNF IN A 21 PWR WP

PREPARED BY:		**REVIEWED BY:**	
		METHOD: ☒ DETAILED CHECK ☐ INDEPENDENT CALCULATION	
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PURPOSE AND SUMMARY OF RESULTS:

This calculation file uses the MCNP neutron transport code to determine the range of parameters (ROP) for Pressurized Water Reactor Spent Nuclear Fuel (PWR SNF) contained within a 21 PWR waste package (WP). Four base geometry patterns were considered in this work and included the following: intact fuel assemblies with intact WP internal components, intact fuel assemblies with degraded WP internal components, degraded fuel assemblies with intact WP internal components, and degraded fuel assemblies with degraded WP internal components. For the degraded fuel assemblies, the pitch of the fuel rods was varied such that the largest range of neutronics parameters could be obtained (i.e., average energy of neutrons causing fission (AENCF)). The calculations involved in this work span an initial U^{235} weight percent range of 2 to 5 wt%. The burnup values corresponding to k_{eff} values of 0.92 and 0.99 are found for each enrichment and geometry configuration. Results of this work will be used to support efforts of the Yucca Mountain Project (YMP) in predicting the range of various parameters for which the MCNP code must be benchmarked.

Tables 5-1 - 5-8 of this calculation report the results of the enrichment/burnup iteration calculations, including k_{eff}, AENCF, and fuel rod pitch to pellet diameter ratio. Considering only the configurations which yielded a k_{eff} of 0.99 or 0.92, the AENCF range over all cases was 0.17482 to 0.50332.

A brief discussion on the range of applicability is also given in this file, including initial U^{235} enrichment, AENCF values, fuel rod pitch to diameter ratios, and cladding and burnable absorber materials. Data is plotted for both the range of applicability and the range of parameters presented in this file.

This revision affects references only. Calculation results are not affected in any way by this revision.

THE FOLLOWING COMPUTER CODES HAVE BEEN USED IN THIS DOCUMENT:		THE DOCUMENT CONTAINS ASSUMPTIONS THAT MUST BE VERIFIED PRIOR TO USE ON SAFETY-RELATED WORK
CODE/VERSION/REV	CODE/VERSION/REV	
MCNP 4.B.2		☐ YES ☒ NO

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Record of Revision

Revision No.	Description	Release Date
00	Original Issue	September 2003
01		December 2004

- Revised Calculation Summary Sheet to note that this revision does not affect calculation results in any way.
- Revised title for Reference 3, page No. 6.
- Revised title for Reference 3, page No. 24.
- Completed Design Verification Checklist to reflect revisions.

1.0 PURPOSE

This calculation file uses the MCNP neutron transport code to determine the range of parameters (ROP) for Pressurized Water Reactor Spent Nuclear Fuel (PWR SNF) contained within a 21 PWR waste package (WP). Four base geometry patterns were considered in this work and included the following: intact fuel assemblies with intact WP internal components, intact fuel assemblies with degraded WP internal components, degraded fuel assemblies with intact WP internal components, and degraded fuel assemblies with degraded WP internal components. For the degraded fuel assemblies, the pitch of the fuel rods was varied such that the largest range of neutronics parameters could be obtained (i.e., average energy of neutrons causing fission (AENCF)). The calculations involved in this work span an initial U^{235} weight percent range of 2 to 5 wt%. The burnup values corresponding to k_{eff} values of 0.92 and 0.99 are found for each enrichment and geometry configuration. Results of this work will be used to support efforts of the Yucca Mountain Project (YMP) in predicting the range of various parameters for which the MCNP code must be benchmarked.

This report is an engineering calculation supporting the burnup credit methodology of YMP 2000 (Reference 1) and was performed under Framatome ANP Administrative Procedure 0402-01, Preparing and Processing FANP Calculations (Reference 2) and Framatome Fuel Sector Quality Management Manual (Reference 3).

2.0 KEY ASSUMPTIONS

There are no assumptions made for the current calculation.

6.0 REFERENCES

1. Framatome ANP Doc 38-5032055-00, September 2003: YMP (Yucca Mountain Site Characterization Project) 2000, *Disposal Criticality Analysis Methodology Topical Report*, YMP/TR-004Q, Rev. 1. Las Vegas, Nevada: Yucca Mountain Site Characterization Office. ACC: MOL.20001214.0001.

2. Framatome ANP, Administrative Procedure, Number: 0402-01, Preparing and Processing FANP Calculations, February 2003, Framatome ANP, Lynchburg, VA.

3. AREVA/FANP Document Number FQM Rev 01, Framatome ANP Inc., Fuel Sector Quality Management Manual (US Version), July, 2003, Framatome ANP, Lynchburg, VA, 24506.

4. Framatome ANP, Administrative Procedure, Number: 0902-06, Software Certification, November 2002, Framatome ANP, Lynchburg, VA.

5. Not used.

6. Briesmeister, J. F., Ed., "MCNP™ – A General Monte Carlo N-Particle Transport Code, Version 4B" LA-12625-M, Los Alamos National Laboratory (LANL), March 1997.

7. Framatome ANP Doc 38-5034166-00, September 2003: BSC (Bechtel SAIC Company) 2003, *Isotopic Generation and Confirmation of the PWR Application Model*, Bechtel Doc. # CAL-DSU-NU-000004 REV 00A. Las Vegas, Nevada; Bechtel SAIC Company.

8. 32-5029773-00, Critical Limit Development for 21 PWR Waste Package.

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DESIGN VERIFICATION CHECKLIST

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Title Range of Parameters for PWR SNF in a 21 PWR WP

1.	Were the inputs correctly selected and incorporated into design or analysis?	☐ Y	☐ N	☒ N/A
2.	Are assumptions necessary to perform the design or analysis activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?	☐ Y	☐ N	☒ N/A
3.	Are the appropriate quality and quality assurance requirements specified? Or, for documents prepared per FANP procedures, have the procedural requirements been met?	☒ Y	☐ N	☐ N/A
4.	If the design or analysis cites or is required to cite requirements or criteria based upon applicable codes, standards, specific regulatory requirements, including issue and addenda, are these properly identified, and are the requirements/criteria for design or analysis met?	☒ Y	☐ N	☐ N/A
5.	Have applicable construction and operating experience been considered?	☐ Y	☐ N	☒ N/A
6.	Have the design interface requirements been satisfied?	☐ Y	☐ N	☒ N/A
7.	Was an appropriate design or analytical method used?	☐ Y	☐ N	☒ N/A
8.	Is the output reasonable compared to inputs?	☐ Y	☐ N	☒ N/A
9.	Are the specified parts, equipment and processes suitable for the required application?	☐ Y	☐ N	☒ N/A
10.	Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?	☐ Y	☐ N	☒ N/A
11.	Have adequate maintenance features and requirements been specified?	☐ Y	☐ N	☒ N/A
12.	Are accessibility and other design provisions adequate for performance of needed maintenance and repair?	☐ Y	☐ N	☒ N/A
13.	Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?	☐ Y	☐ N	☒ N/A
14.	Has the design properly considered radiation exposure to the public and plant personnel?	☐ Y	☐ N	☒ N/A
15.	Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?	☐ Y	☐ N	☒ N/A
16.	Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?	☐ Y	☐ N	☒ N/A
17.	Are adequate handling, storage, cleaning and shipping requirements specified?	☐ Y	☐ N	☒ N/A
18.	Are adequate identification requirements specified?	☐ Y	☐ N	☒ N/A
19.	Is the document prepared and being released under the FANP Quality Assurance Program? If not, are requirements for record preparation review, approval, retention, etc., adequately specified?	☒ Y	☐ N	☐ N/A

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Comments:

See Record of Revisions for change in Reference 6. No other parts were affected.

Verified By:	J.W. Harwell	J.W. Harwell	12/7/04
(First, MI, Last)	Printed / Typed Name	Signature	Date