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CALCULATION SUMMARY SHEET (CSS)

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Title Commercial Reactor Reactivity Analysis for Grand Gulf, Unit 1

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TITLE ENGINEER IV DATE 12/07/04

COST CENTER 212020 REF. PAGE(S) 8-9

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METHOD: ☒ DETAILED CHECK ☐ INDEPENDENT CALCULATION

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TM STATEMENT: REVIEWER INDEPENDENCE

PURPOSE AND SUMMARY OF RESULTS:

Purpose: The objective of this calculation is to document repeat Grand Gulf Unit 1 (GG1) reactivity calculations using only the principal isotopes (Ref. 5) for the sixteen critical statepoints evaluated in Rev. 00. Specifically, this calculation provides reactivity results using only the principal isotopes selected in Reference 5 for describing the fuel composition instead of the best estimate isotopes as in Rev. 00.

Summary of Results: The calculations show that for all statepoints the use of principal isotopes instead of best estimate isotopes results in a higher k-eff.

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:

CODE/VERSION/REV	CODE/VERSION/REV
MCNP4B2	

THE DOCUMENT CONTAINS ASSUMPTIONS THAT MUST BE VERIFIED PRIOR TO USE ON SAFETY-RELATED WORK

☐ YES ☒ NO

Record of Revisions		
Rev. Number	Date of Revision	Description of Changes
00	09/2003	Original Issue
01	02/2004	Adds results for Principal Isotopes to Rev. 00. All of Rev. 00 remains valid. Rev. 01 is an addendum to Rev. 00
02	12/2004	Revised Calculation Summary Sheet to note that this revision does not affect calculation results in any way. Revised title for Reference 6, page 6 of 13. Revised title for Reference 6, page 9 of 13. Completed Design Verification Checklist to reflect revisions.

1. PURPOSE

The objective of this calculation is to document repeat Grand Gulf Unit 1 (GG1) reactivity calculations using only the principal isotopes (Ref. 5) for the sixteen critical statepoints evaluated in Rev. 00 of Reference 5. Specifically, this calculation provides reactivity results using only the principal isotopes selected in Reference 5 for describing the fuel composition instead of the best estimate isotopes as in Rev. 00. The GG1 reactor is a boiling water reactor (BWR) owned and operated by Entergy Operations Inc. The Commercial Reactor Criticality (CRC) evaluations support the development and validation of the neutronic models used for criticality analyses involving commercial spent nuclear fuel to be placed in a geologic repository. This calculation is performed as part of the evaluation in the CRC program.

This report is an engineering calculation supporting the burnup credit methodology of Yucca Mountain Project (YMP) (Reference 5) and was performed under Framatome ANP Administrative Procedure 0402-01, Preparing and Processing FANP Calculations (Reference 4) and Framatome Fuel Sector Quality Management Manual (Reference 6).

2. METHOD

The calculational methods used in performing the reactivity analysis are the same as in Rev. 00 except the best estimate isotopes are replaced with the principal isotopes listed in Table 3-1 of Ref. 5 plus ^{16}O.

Table 1. Principal Isotopes for Commercial SNF Burnup Credit

^{95}Mo	^{145}Nd	^{151}Eu	^{236}U	^{241}Pu
^{99}Tc	^{147}Sm	^{153}Eu	^{238}U	^{242}Pu
^{101}Ru	^{149}Sm	^{155}Gd	^{237}Np	^{241}Am
^{103}Rh	^{150}Sm	^{233}U	^{238}Pu	^{242m}Am
^{109}Ag	^{151}Sm	^{234}U	^{239}Pu	^{243}Am
^{143}Nd	^{152}Sm	^{235}U	^{240}Pu	

In order to preserve the atomic densities for the principal isotopes, a factor was used to adjust the original density of the fuel mixtures to account for dropping the neglected isotopes when going from best estimate to principal isotopes. The factor is computed by the formula:

$$Factor = \frac{\sum_{\text{Pr.isot.}} (atomgrams)_{\text{Pr.isot.}} \times (atomic-weight)_{\text{Pr.isot.}}}{\sum_{BE} (atomgrams)_{BE} \times (atomic-weight)_{BE}}$$

Where BE stands for Best Estimate Isotopes and Pr. isot. is principal isotopes.

The calculation method uses the three dimensional MCNP Monte Carlo neutron transport computer code (Reference 1) to analyze the 16 measured critical condition statepoints that occurred in cycles 4 through 8 for the GG1 reactor. The geometry used in the MCNP code was developed in Rev. 00 to analyze the GG1 reactor using half core symmetric geometry and remained unchanged for the

YMP/TR-004Q, Rev. 02. Las Vegas, Nevada: Yucca Mountain Site Characterization Office. DOC.20031110.0005.

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

7. Framatome ANP, Administrative Procedure, Number: 0902-06, Software Certification, December 2003, Framatome ANP, Lynchburg, Virginia.

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DESIGN VERIFICATION CHECKLIST

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Title Commercial Reactor Criticality Reactivity Analysis for Grand Gulf Unit 1

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:	D.R. Moscalu	Dominic R. Moscalu	12/7/04
(First, MI, Last)	Printed / Typed Name	Signature	Date