Global Nuclear Fuel

A Joint Venture of GE, Toshiba, & Hitachi

Global Nuclear Fuel – Americas, LLC
Mail Code K-84
3901 Castle Hayne Rd, Wilmington, NC 28401
(910) 675-5950, Fax (910) 362-5950

February 29, 2008

Mr. Stewart W. Brown
Licensing Branch – Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Dear Mr. Brown:

Subject: Response to NRC Request for Additional Information Dated 12/21/07 for Model No. RAJII Package

References:
(1) Docket Number 71-9309
(2) Request for Revision to the Certificate of Compliance No. 9309 for the RAJ-II Container To Include Uranium Carbide Fuel Rods 6/12/07 (TAC No. L24102)
(3) NRC Request for Addition Information for Model No. RAJ-II Package 10/5/07
(4) GNF-A Response to NRC RAI 11/8/07
(5) NRC Request for Addition Information for Model No. RAJ-II Package 12/21/07
(6) GNF-A Licensee Management Meeting to Discuss NRC RAJ RAI 1/22/08

Global Nuclear Fuel - Americas, LLC (GNF-A) facility in Wilmington, N.C. has reviewed the NRC request for additional information dated 12/21/07 (Reference 5) and is providing our responses in Attachment 1 to this letter. We appreciate the opportunity to discuss the NRC RAI with you and your staff during our 1/22/08 licensee management meeting.

In addition, as we also discussed at our 1/22/08 meeting, Attachment 2 to this letter provides revised RAJ CoC Tables 3 and 4 that describe fuel assembly and fuel rod parameters. The changes are needed to clarify the table information and correct an omission regarding fuel rod cladding thickness.

Please contact on (910) 675-5950 if you have any questions or would like to discuss this matter further.

Sincerely,

Scott P. Murray

Scott P. Murray, Manager
Licensing & Liabilities, COE

Attachments
cc: SPM-08-016

ATTACHMENT 1

GNF Responses to RAIs Documented in NRC Request for Additional Information Dated 12/21/07 (TAC No. L24102)

RAI #6-1

Provide the basis for validating the GEMER computer code with the results of the MCNP5 computer code calculations.

The staff has a reduced level of confidence in the analytical results from a computer code that was validated by the results from a second computer code rather than actual physical benchmarks.

GNF Response to RAI 6-1

As discussed in the meeting on 1/22/08, the GEMER code is not validated by comparison to MCNP5. The GEMER code is validated by benchmark comparison directly with experiments for pin-lattice critical tests as documented in Reference 6.

RAI #6-2

Provide a discussion addressing the implications of and the measures taken to address the resulting phenomenon of the GEMER computer code systematically underestimating the eigenvalues in the criticality analysis.

Based on the information submitted it appears that the GEMER computer code systematically underestimates the eigenvalues of all the benchmark experiments.

GNF Response to RAI 6-2

Comparisons of GEMER (ENDF/B-IV) with MCNP5 (ENDF/B-VII) were made in the GNF responses to the NRC RAIs dated 11-08-07. In this table, the results showed comparisons between the two codes and cross-section data sets for a representative set of eight (8) pin-lattice benchmark experiments. The results showed a systematic under-prediction of the GEMER code of ~0.01 Δk in comparison to MCNP5 and critical experiment. Discussion at the 1/22/08 between GNFA and the NRC provided additional information concerning the implications and measures taken to address this known, systematic under-prediction bias associated with the GEMER code.

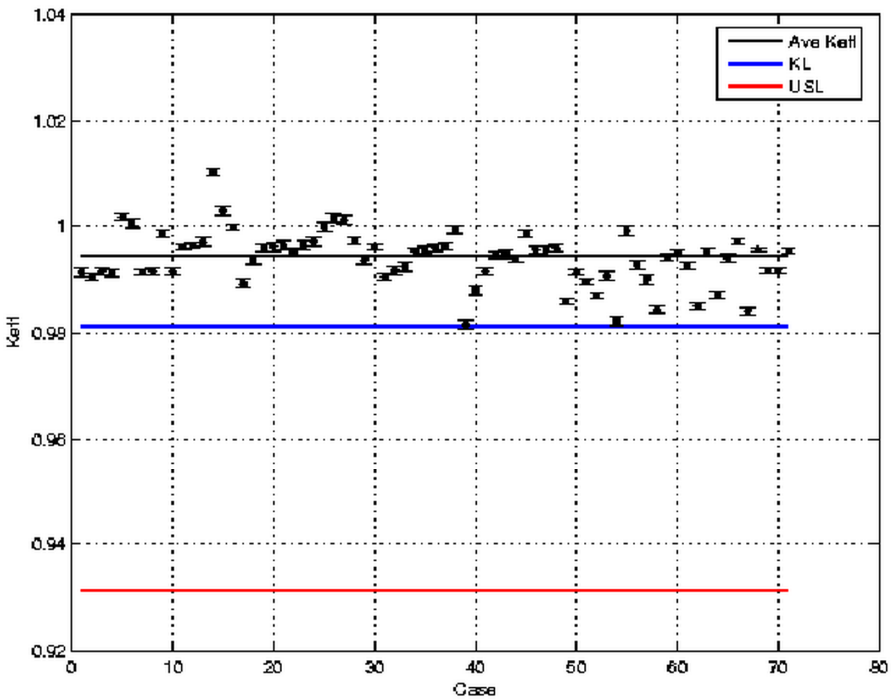
The GEMER validation consists of direct comparison between GEMER and 280 critical benchmark experiments. Of these 280, seventy-one (71) are applicable to low-enriched UO2 fuel rods in water with surrounding and intervening structural materials similar to the RAJ-II shipping container. This validation has been provided to the NRC in Reference 6.

The figure below shows the results of the GEMER validation using the 71-benchmark critical experiments for low-enriched UO_2 pin lattice in water critical experiments. As can be seen from

these results, the GEMER code does show an under-prediction of eigenvalues relative to the critical (keff = 1.0) experimental result consistent with historical behavior. However, the determination of the GEMER bias (-0.0055) and bias uncertainty (-0.0132) from Reference 6 results in a very conservatively calculated Upper Safety Limit (USL) for UO_2 fuel rods in water for the GEMER code of:

USL = 1.0 + (bias – bias uncertainty)- MMS

USL = 1.0 + [(-0.0055) -0.0132)] – 0.05 = **0.9313**



It is GNF's position that this very conservative derivation of the GEMER Upper Safety Limit based on comparison to experimental data is adequate to bound its application to the RAJ-II shipping container analysis.

RAI 6-3

Provide the basis, using statistical confidence margin of 68% [one (1)σ], for k_{eff}.

The normal practice is to set a 95% statistical confidence margin [two (2)σ] k_{eff}.

GNF Response to RAI 6-3

As discussed in the 1/22/08 meeting, GNF does not use a 1σ (68%) confidence interval statistical confidence limit basis for the derivation of the eiganvalue results for the GEMER validation. Reference 6 documents a 2σ (95%) statistical confidence limit basis for the GEMER validation.

RAI 6-4

Revise the SCALE single package and the array of packages HAC models to include flooded conditions in the pellet/cladding gap volumes.

The non-flooded pellet/cladding gap volumes assumptions do not result in the "most reactive credible configuration."

GNF Response to RAI 6-4

As discussed in the 1/22/08 meeting, the Chapter 6 Criticality Safety Analysis documented in the 2004 SAR for the RAJ-II shipping container took no credit for the presence of the zircalloy cladding surrounding the fuel rods in the model. All results assumed full water flooding between fuel rods in the single package and array of packages for the HAC models.

RAI 6-5

Provide the criticality evaluation model and analysis for the Uranium Carbide (UC) system when shipping loose rods.

Reference 13 of the Safety Analysis Report (SAR), "Criticality Safety Analysis, Shipment of Loose Rods in RAJ-II Shipping Container (Rev. 1)" did not include this information.

GNF Response to RAI 6-5

Reference 13 of the Safety Analysis Report (SAR) which documents the criticality safety analysis of the shipment of loose rods in the RAJ-II shipping container will be updated to include the input model for the Uranium Carbide fuel loose rod case.

RAI 6-6

Provide a criticality analysis for the shipping container with loose rods case assuming flooded conditions in the pellet/cladding gap volumes.

The non-flooded pellet/cladding gap volumes assumptions do not result in the "most reactive credible configuration."

GNF Response to RAI 6-6

Reference 13 of the Safety Analysis Report (SAR) which documents the criticality safety analysis of the shipment of loose rods in the RAJ-II shipping container will be updated to include calculations of the loose rod case assuming flooded conditions in the pellet/cladding gap volumes.

The results of these calculations summarizes in Figure 1 below show essentially no reactivity increase for the most limiting case with the final result still being less than the calculated USL of 0.9213 for UC rods:

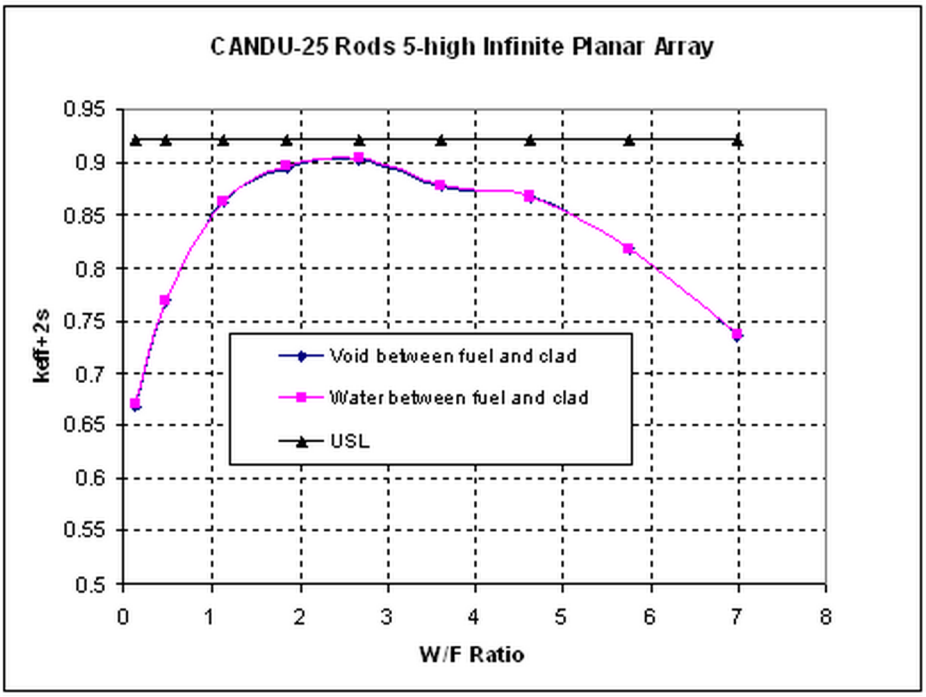


Figure 1 – Results of Void vs. Water in Fuel/Cladding Region

RAI 6-7

Provide the criticality model, including the geometry, and analysis for the 5 inch loose fuel container, when filled with loose rods case.

Reference 13 of the Safety Analysis Report (SAR), "Criticality Safety Analysis, Shipment of Loose Rods in RAJ-II Shipping Container (Rev. 1)" did not include this information.

GNF Response to RAI 6-7

Reference 13 of the Safety Analysis Report (SAR) which documents the criticality safety analysis of the shipment of loose rods in the RAJ-II shipping container will be updated to include the criticality model for the analysis of the 5 inch loose fuel container rod case.

RAI 6-8

Provide clarification as to which GEMER input file in reference 13 of the (SAR) modeled the 130 CANDU-25 UC loose rods case. Also, clearly indicate the applicable resulting k_{eff}.

GNF Response to RAI 6-8

As discussed in the 1/22/08, the GEMER input files for the 130 CANDU-25 UC loose fuel rod case will be included and clearly identified in Reference 13 along with the resulting k_{eff} value.

ATTACHMENT 2

Proposed Word Changes to NRC Certificate of Compliance (COC) 9309

(1) Condition 5.(a)(2), "Description", on the second line, "low-enriched uranium oxide powder and compounds of uranium" should be changed to "enriched commercial grade uranium, enriched re-processed uranium, and uranium carbide".

(2) Table 4 – modifications to fuel rod parameters

Fuel Rod Parameters

Parameter	**Units**	**Type**					
Fuel Assembly Type		8x8 (UO_2)	9x9 (UO_2)	10x10 (UO_2)	CANDU-14 (UC)	CANDU-25 (UC)	Generic PWR (UO_2)
UO_2 or UC Fuel Density		<98% theoretical	<98% theoretical	<98% theoretical	<98% theoretical	<98% theoretical	<98% theoretical
Fuel rod OD	cm	≥1.10	≥1.02	≥1.00	≥1.340	≥0.996	≥1.118
Fuel Pellet OD	cm	≤1.05	≤0.96	≤0.90	≤1.254	≤0.950	≤0.98
Cladding Type		Zirc. Alloy	Zirc. Alloy	Zirc. Alloy	Zirc. Alloy or SS	Zirc. Alloy or SS	Zirc. Alloy or SS
Cladding ID	cm	≤1.10	≤1.02	≤1.00	≤1.267	≤0.951	≤1.004
Cladding Thickness	cm	≥0.038	≥0.036	≥0.038	≥0.033	≥0.033	≥0.033
Active fuel Length	cm	≤381	≤381	≤385	≤47.752	≤40.013	≤450
Maximum U-235 Pellet Enrichment	wt.%	≤5.0	≤5.0	≤5.0	≤5.0	≤5.0	≤5.0
Maximum Average fuel rod Enrichment	wt.%	≤5.0	≤5.0	≤5.0	≤5.0	≤5.0	≤5.0
Loose Rod Configuration							
Freely Loose	≤25	≤25	≤25	N/A	N/A	N/A	Freely Loose
Packed in 5" SS Pipe or Protective Case	≤22	≤26	≤30	≤74**	≤130**	≤105**	Packed in 5" SS Pipe or Protective Case
Strapped Together	≤25	≤25	≤25	N/A	N/A	N/A	Strapped Together

* Previous analysis (Ref. 1) based on most conservative loose rod configuration (i.e., no credit taken for 5" SS pipe)
** Including partial rods (in reality, apply dense packing of congruent rods in the pipe) and only in 5" SS pipes

Table 3 – modifications to fuel assembly parameters – Attachment 2

Fuel Assembly Parameters

Parameter	**Units**	**Type**	**Type**	**Type**	**Type**
Fuel Assembly Type	Rods	8x8	9x9	FANP 10x10	GNF 10x10
UO_2 Density		≤ 98% Theoretical	≤ 98% Theoretical	≤ 98% Theoretical	≤ 98% Theoretical
Number of water rods	#	0, 2x2	0, 2-2x2 off-center diagonal, 3x3	0, 2-2x2 off-center diagonal, 3x3	0, 2-2x2 off-center diagonal, 3x3
Number of fuel rods	#	60 - 64	72 - 81	91 - 100	91 - 100
Fuel Rod OD	cm	≥ 1.176	≥ 1.093	≥ 1.000	≥ 1.010
Fuel Pellet OD	cm	≤ 1.05	≤ 0.96	≤ 0.895	≤ 0.895
Cladding Type		Zirconium Alloy	Zirconium Alloy	Zirconium Alloy	Zirconium Alloy
Cladding ID	cm	≤ 1.10	≤ 1.02	≤ 0.933	≤ 0.934
Cladding Thickness	cm	≥ 0.038	≥ 0.036	≥ 0.033	≥ 0.038
Active fuel length	cm	≤ 381	≤ 381	≤ 385	≤ 385
Fuel Rod Pitch	cm	≤ 1.692	≤ 1.51	≤ 1.350	≤ 1.350
U-235 Pellet Enrichment	wt%	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0
Maximum Lattice Average Enrichment	wt%	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0
Channel Thickness[a]	cm	0.17 – 0.3048	0.17 – 0.3048	0.17 – 0.3048	0.17 – 0.3048
Part Length Fuel Rods (1/3 through 2/3 normal length)	Max #	None	12	14	14
Gadolinia Requirements					
Lattice Average Enrichment[b]	#				
≤ 5.0 wt % U-235	@	7 @ 2 wt %	10 @ 2 wt %	12 @ 2 wt %	12 @ 2 wt %
≤ 4.7 wt % U-235	wt%	6 @ 2 wt %	8 @ 2 wt %	12 @ 2 wt %	12 @ 2 wt %
≤ 4.6 wt % U-235	Gd_2O_3	6 @ 2 wt %	8 @ 2 wt %	10 @ 2 wt %	10 @ 2 wt %
≤ 4.3 wt % U-235		6 @ 2 wt %	8 @ 2 wt %	9 @ 2 wt %	9 @ 2 wt %
≤ 4.2 wt % U-235		6 @ 2 wt %	6 @ 2 wt %	8 @ 2 wt %	8 @ 2 wt %
≤ 4.1 wt % U-235		4 @ 2 wt %	6 @ 2 wt %	8 @ 2 wt %	8 @ 2 wt %
≤ 3.9 wt % U-235		4 @ 2 wt %	6 @ 2 wt %	6 @ 2 wt %	6 @ 2 wt %
≤ 3.8 wt % U-235		4 @ 2 wt %	4 @ 2 wt %	6 @ 2 wt %	6 @ 2 wt %
≤ 3.7 wt % U-235		2 @ 2 wt %	4 @ 2 wt %	6 @ 2 wt %	6 @ 2 wt %
≤ 3.6 wt % U-235		2 @ 2 wt %	4 @ 2 wt %	4 @ 2 wt %	4 @ 2 wt %
≤ 3.5 wt % U-235		2 @ 2 wt %	2 @ 2 wt %	4 @ 2 wt %	4 @ 2 wt %
≤ 3.3 wt % U-235		2 @ 2 wt %	2 @ 2 wt %	2 @ 2 wt %	2 @ 2 wt %
≤ 3.1 wt % U-235		None	2 @ 2 wt %	2 @ 2 wt %	2 @ 2 wt %
≤ 3.0 wt % U-235		None	None	2 @ 2 wt %	2 @ 2 wt %
≤ 2.9 wt % U-235		None	None	None	None
Polyethylene Equivalent Mass (Maximum per Assembly)[c]	kg	11	11	10.2	10.2

a. Transport with or without channels is acceptable
b. Required gadolinia rods must be distributed symmetrically about the major diagonal
Polyethylene equivalent mass (refer to 6.3.2.2