GNF

Global Nuclear Fuel

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Docket No. 52-010

FLN-2006-015

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555-0001

Subject: Transmittal of GNF Response to NRC RAI 4.2-1

References:

1. MFN 05-115, GE Response to Results of NRC Acceptance Review for ESBWR Design Certification Application – Items 1 and 3 (TAC # MC8168), October 24, 2005.

General Electric is submitting response (proprietary and non-proprietary versions) to the NRC Request for Additional Information (RAI) 4.2-1.

If you have any questions about the information provided here, please contact me at (910) 675-5954 or George Stramback at (408) 779-2317.

Best regards,

Andrew A. Lingenfelter
Manager, Engineering
Global Nuclear Fuel – Americas, LLC

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Enclosures

1. Affidavit, Andrew A. Lingenfelter, dated March 24, 2006
2. GNF Response to NRC RAI 4.2-1 (Proprietary and Non-proprietary)

cc: AE Cubbage - USNRC (with enclosures)
DH Hinds - GE/Wilmington (with enclosures)
GB Stramback - GE/San Jose (with enclosures)

Affidavit

I, Andrew A. Lingenfelter, state as follows:

(1) I am Manager, Engineering, Global Nuclear Fuel – Americas, L.L.C. ("GNF-A") and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in the attachments, (proprietary and non-proprietary versions), "GNF Response to NRC RAI 4.2-1". GNF proprietary information is indicated by enclosing it in double brackets. In each case, the superscript notation {3} refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination.

(3) In making this application for withholding of proprietary information of which it is the owner or licensee, GNF-A relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4) and 2.390(a)(4) for "trade secrets and commercial or financial information obtained from a person and privileged or confidential" (Exemption 4). The material for which exemption from disclosure is here sought is all "confidential commercial information," and some portions also qualify under the narrower definition of "trade secret," within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975F2d871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704F2d1280 (DC Cir. 1983).

(4) Some examples of categories of information which fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by GNF-A's competitors without license from GNF-A constitutes a competitive economic advantage over other companies;

b. Information which, if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information which reveals cost or price information, production capacities, budget levels, or commercial strategies of GNF-A, its customers, or its suppliers;

d. Information which reveals aspects of past, present, or future GNF-A customer–funded development plans and programs, of potential commercial value to GNF-A;

e. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a. and (4)b., above.

(5) To address the 10 CFR 2.390 (b) (4), the information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GNF-A, and is in fact so held. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in (6) and (7) following. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GNF-A, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence.

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge, or subject to the terms under which it was licensed to GNF-A. Access to such documents within GNF-A is limited on a "need to know" basis.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist or other equivalent authority, by the manager of the cognizant marketing function (or his delegate), and by the Legal Operation, for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GNF-A are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary agreements.

(8) The information identified in paragraph (2) is classified as proprietary because it contains details of GNF-A's fuel design and licensing methodology.

The development of the methods used in these analyses, along with the testing, development and approval of the supporting methodology was achieved at a significant cost, on the order of several million dollars, to GNF-A or its licensor.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GNF-A's competitive position and foreclose or reduce the availability of profit-making opportunities. The fuel design and licensing methodology is part of GNF-A's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical, and NRC review costs comprise a substantial investment of time and money by GNF-A or its licensor.

The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

GNF-A's competitive advantage will be lost if its competitors are able to use the results of the GNF-A experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GNF-A would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GNF-A of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing and obtaining these very valuable analytical tools.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information, and belief.

Executed at Wilmington, NC, this 24th day of March, 2006.

Andrew A. Lingenfelter
Global Nuclear Fuel – Americas, LLC

GNF Response to NRC RAI 4.2-1

RAI Number	Reviewer	Summary	Full Text
4.2-1	Clifford, P	Provide detailed information to support NRC confirmatory FRAPCON-3 benchmark cases	Provide information listed below. Include the nominal value and the range of expected values (e.g. manufacturing tolerance) for each parameter.

Rod Size

Parameter	Nominal Value	Tolerance
Cladding Outer Diameter (mm)	[[	
Cladding Inner Diameter (mm)		
Pellet Diameter (mm)		
Stack Length (mm)[1]		
UO_2 Rod		
$(U,Gd)O_2$ Rod		
Part Length Rod		
Plenum Length (mm)		
UO_2 Rod		
$(U,Gd)O_2$ Rod		
Part Length Rod		]]

[1]Includes natural zones (mm) at each end as follows:

UO_2 Rod	[[	(bottom)
		(top)
$(U,Gd)O_2$ Rod		(bottom)
		(top)
Part Length Rod		(bottom)
	]]	(top)

Spring Dimensions

Spring outer diameter(in)	[[	
Spring wire diameter (in)		
Number of spring turns		(UO_2 and $(U,Gd)O_2$ Rods)
		(Part Length Rod)
Spring volume (in^3)		(UO_2 Rod)
		($(U,Gd)O_2$ Rod)
	]]	(Part Length Rod)

Pellet Shape

Pellet Height (mm)	[[	
Central Hole Radius (mm)		
Dish Radius (mm)		(no dish)
Dish Depth (mm)	]]	(no dish)

Pellet Isotopics

U-235 Enrichment (%)	
Range	0.71 (natural) to 5.0
Average	[[ ]]
UO_2 or MOX?	UO_2
O/M ratio	[[
Gadolinia content (weight fraction)	]]
Water in pellet (ppm)	None
Nitrogen in pellet (ppm)	[[
Hydrogen in pellet (ppm)	]]

Pellet Fabrication

Pellet density (%TD)	[[	
Open porosity (%TD)		
Pellet surface roughness (microns)		
Expected density increase (%TD)		(as measured in resinter test)
Sintering temperature (^oF)		(target maximum)
Theoretical density (gram/cc)		(UO_2)
	]]	(8 wt/% Gd)

Cladding Fabrication

Cladding type	Zircaloy-2 with zirconium barrier
Cladding CW	0 (fully recrystallized)
Cladding surface roughness (microns)	[[
Basal pole alignment[2]	
Hydrogen (from fabrication) (ppm)	
Zirconium liner thickness (microns)[3]	]]

[2]The range of basal pole texture factors in the longitudinal, circumferential and radial directions were provided in the LTR. Based upon FRAPCON-3 documentation, the nominal texture factor in the longitudinal direction (fraction of basal poles parallel to the longitudinal axis) is provided for use in FRAPCON-3 benchmarking.
[3]In GSTRM analyses, the liner can be explicitly addressed. In some analyses, such as calculation of the critical rod internal pressure (the pressure at which the cladding creep-out rate equals the pellet swelling rate) the presence of the liner is neglected. If FRAPCON-3 cannot address the liner, it is suggested that the liner be treated as Zircaloy-2. Although GE14E includes a liner, GNF performs GSTRM calculations for, and reports results for, the more limiting case of the liner or non-liner design, which is typically the non-liner design. Results for the non-liner case are provided in Attachment 2. Results for the liner case are also included for comparison purposes if such results are available.

Rod Fill Conditions

Fill gas pressure (bar)	[[ ]]
Fill gas	Helium

Reactor Conditions

Plant type	ESBWR
Rod pitch (mm)	[[
Crud deposition	
Initial thickness (mils)	
Deposition rate (mils/hr)	
Corrosion (oxidation)	
Initial thickness (mils)	
Corrosion rate (mils/hr)	
Coolant pressure (MPa)	
Coolant inlet temperature (^{o}C)	
Coolant mass flux ($lb/hr\text{-}ft^2$)	]]

Power History

Time Step	Duration (days)	Power (kW/m)

(Provide thermal mechanical operating limit (TMOL) depletion, AOO case, etc....)
(Identify axial power distribution at each time step)

Please see Attachment 1.

Axial Power Distribution

<u>Axial Position (mm)</u> <u>Relative Power</u>

(Provide BOC, MOC, EOC shapes)

Please see Attachment 1.

Calculated Results

In addition to the Mechanical Overpower (MOP) and Thermal Overpower (TOP) values, please provide the calculated fuel temperatures, clad strains, void volumes, and rod internal pressures along with a brief description of the input parameters for each limiting case.

Please see Attachment 2.

Attachment 1

As per discussion with the NRC (Teleconference, 3/13/06 3:00 PM EST), power histories are provided in GSTRM input format UO2 and GD8 (attached). Power history UO2 is for the full length UO_2 rod and power history GD8 is for the 8 weight percent $(U,Gd)O_2$ rod. These histories are based upon the LHGR limits curves for each fuel rod.

The structure of both histories is as follows. Each time step begins with a (and ends with a $$. The (is followed by a comment with the step number and the accumulated time in hours and years. The first step includes the parameter XXTAU1, which is the time increment for the step in hours, and the parameters QAVG, EAVG and FAVG and AXP(I), AXE(I) and XPHI(I), where I is a node number and runs from 1 to 10 (node 1 is the bottom node). For the step, the power in kW/ft at node I is given by

Q(I) = QAVG x AXP(I)

The power axial peaking factors include a factor of [[ ]], which is included in the results previously reported and in the results in Attachment 2.

Similarly, the exposure in MWd/MTU and fast fluence in n/cm2 at node I are given by

E(I) = EAVG x AXE(I)

and

FLU(I) = FAVG x XPHI(I)

The second and subsequent steps include XXTAU1, QAVG, EAVG and in some cases AXP(I). The values for Q(I), E(I) and FLU (I) for these steps are obtained as noted above, where it is assumed that AXP(I), AXE(I) and XPHI(I) are the same as for the previous step unless they are explicitly input.

Core-wide AOOs (pressurization transients) are simulated by inserting a thermal overpower (TOP) for fuel centerline temperature or mechanical overpower (MOP) for cladding permanent strain at several exposure points. Limiting or near limiting results in terms of fuel centerline temperatures and cladding permanent strains are obtained at the knee of the LHGR limits curve. The TOP consists of a minimum [[ ]] power increase followed by a [[ ]] minute hold and the MOP consists of a minimum [[ ]] power increase followed by a [[ ]] minute hold. AOO analyses are performed with a [[ ]] factor applied to the power both before and during the AOO. Additionally, the MOP analyses are performed on a worst tolerance basis. The worst tolerance pellet-cladding gap is [[ ]] inches.

Power History UO2

[[

]]

Power History GD8

[[

]]

Attachment 2

For comparison with FRAPCON-3, limiting GSTRM results are presented in Tables 2-1 and 2-2. These tables includes (1) fuel centerline temperature at the knee of the LHGR limits curve before initiation of the TOP and at the end of the TOP, (2) cladding permanent strain Plastic plus creep) at the knee of the LHGR limits curve before initiation of the MOP and at the end of the MOP, and (3) end of life fuel rod fission gas release fraction and internal pressure. The TOP and MOP results include the 1.05 power factor discussed in Attachment 1. Table 2-1 includes results for the UO_2 rod and Table 2-2 includes results for the 8 weight percent gadolinia rod. The TOP and MOP values used for each case are specified in the tables. Non-liner results and liner results if available are presented for both rods.

As noted, these results are typically limiting in terms of GSTRM analyses. If other results are desired for the comparison with FRAPCON-3, they will be provided upon request.

Table 2-1
Results for UO_2 Rod

Parameter	No Liner	Liner
Fuel Centerline Temperature (°F)	[[	
Power Increase (%)		
Before TOP		
After TOP		
Cladding Permanent Strain (%)		
Power Increase (%)		
Before MOP		
After MOP		
EOL Fission Gas Release (%)		
EOL Rod internal Pressure (psia)		]]

Table 2-2
Results for 8 wt/% Gd Rod

Parameter	No Liner	Liner[4]
Fuel Centerline Temperature (°F)	[[	
Power Increase (%)		
Before TOP		
After TOP		
Cladding Permanent Strain (%)		
Power Increase (%)		
Before MOP		
After MOP		
EOL Fission Gas Release (%)		
EOL Rod interna; Pressure (psia)	]]	

[4]Not available