GE Energy

David H. Hinds
Manager, ESBWR

PO Box 780 M/C L60
Wilmington, NC 28402-0780
USA

T 910 675 6363
F 910 362 6363
david.hinds@ge.com

<u>*Proprietary Notice*</u>
This letter forwards GNF proprietary information in accordance with 10CFR2.390. Upon the removal of Enclosure 1, the balance of this letter may be considered non-proprietary.

MFN 06-405

Docket No. 52-010

October 18, 2006

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

Subject: **Response to Portion of NRC Request for Additional Information Letter No. 53 Related to ESBWR Design Certification Application – DCD Chapter 4 and GNF Topical Reports – RAI Numbers 4.4-26, 4.4-28, and 4.4-29**

Enclosure 1 contains GE's response to the subject NRC RAIs transmitted via the Reference 1 letter.

Enclosure 1 contains GNF proprietary information as defined by 10 CFR 2.390. GNF customarily maintains this information in confidence and withholds it from public disclosure. A non proprietary version is provided in Enclosure 2.

The affidavit contained in Enclosure 3 identifies that the information contained in Enclosure 1 has been handled and classified as proprietary to GNF. GE hereby requests that the information of Enclosure 1 be withheld from public disclosure in accordance with the provisions of 10 CFR 2.390 and 9.17.

If you have any questions about the information provided here, please let me know.

Sincerely,

Kathy Sedney for

David H. Hinds
Manager, ESBWR

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Enclosures:

1. MFN 06-405 - Response to Portion of NRC Request for Additional Information Letter No. 53 Related to ESBWR Design Certification Application – DCD Chapter 4 and GNF Topical Reports – RAI Numbers 4.4-26, 4.4-28, 4.4-29 – GNF Proprietary Information
2. MFN 06-405 - Response to Portion of NRC Request for Additional Information Letter No. 53 Related to ESBWR Design Certification Application – DCD Chapter 4 and GNF Topical Reports – RAI Numbers 4.4-26, 4.4-28, 4.4-29 – Non Proprietary Version
3. Affidavit – Jens G. M. Andersen – dated October 18, 2006

Reference:

1. MFN 06-288, Letter from U. S. Nuclear Regulatory Commission to Mr. David H. Hinds, *Request for Additional Information Letter No. 53 Related to ESBWR Design Certification Application,* August 16, 2006

cc:	AE Cubbage	USNRC (with enclosures)
	AA Lingenfelter	GNF/Wilmington (w/o enclosures)
	GB Stramback	GE/San Jose (with enclosures)
	eDRFs	58-7714, 58-7488, 58-8126

ENCLOSURE 2

MFN 06-405

Partial Response to RAI Letter No. 53 Related to ESBWR Design Certification Application

DCD Chapter 4 and GNF Topical Reports

RAI Number 4.4-26, 4.4-28, 4.4-29

Non Proprietary Version

NRC RAI 4.4-26

During the closed meeting at the GE facility in Wilmington, NC (6/19-22/06), the staff informed GE that the qualitative information GE provided in Topical Report NEDC-33237P, regarding the development of the CHF correlation for the GE14E fuel design, does not contain sufficient quantitative technical data to justify the uncertainties provided in the topical report. As a result, GE agreed to re-write NEDC-33237P, to include additional qualitative and quantitative technical information in support of all the uncertainties provided in the report. GE suggested that they will rewrite the topical report to further address the following major areas::

A. *GE will provide additional qualitative and quantitative technical data in the report to be revised pertaining to the application of GE14 12-foot fuel data to GE14E 10-foot fuel.*

B. *GE will provide additional qualitative and quantitative technical data (including data from the ATLAS test facility) in support of the spacer sensitivity studies, and in support of the part-length rod sensitivity studies. This data is used by GE in the COBRAG computer code to perform spacer sensitivity studies. The NRC staff and GE have agreed that the code COBRAG does not need to be reviewed at this time, but the staff reserves the right to review the code at a later date, if necessary.*

C. *Chapter 5,Table 5-1 of NEDC-33237P, will include detailed quantitative technical basis for three of the uncertainty values. The three uncertainty values alluded to are those uncertainties that pertain to the parameters that are unique to the ESBWR. Additional qualitative technical basis should be provided for the remainder of the uncertainties listed in Table 5-1, stating why these uncertainties are still valid for ESBWR application.*

D. *Each determined uncertainty in the text and the tables, including the total correlation uncertainty, such as those in Table 4.2, must be determined via a 95/95 methodology, where applicable.*

GE Response:

There will not be a change to the DCD per this RAI response. Appendices A, B, and C will be included in the revision to NEDC-33237P.

Response to Part A and B:

The critical power data supporting the statistical information in Table 4-2 are provided in a tabulated format in Appendix C. A total of [[ ]] modified ATLAS critical power data is included. The tabulated data corresponds to mass fluxes lesser or equal to [[ ]]. The first [[ ]] data points support the statistical information given in the second row of Table 4-2.

Sections 4.2.2 and 4.2.3 of NEDC-33237P will be revised to include the following description on the use of the COBRAG program to quantify the effects of axial spacer pitch and PLR length differences between GE14 and GE14E. Additional information on the COBRAG model for GE14 and the qualification of the COBRAG model against the ATLAS GE14 critical power data is available in NEDC-32851P Revision 2 titled "GEXL14 Correlation for GE14 Fuel." NEDC-33237P will be revised to include this additional information in its Appendix A. The transmittal of COBRAG analytics and the executable code for staff review will be handled separately from this RAI response.

4.2.2. Change in Spacer Locations

Changes in axial distance between spacers can affect critical power performance for reasons outlined in Section 3.0. The spacer locations for the GE14 and GE14E designs are shown in Figure 2.3. For spacers 4 and above, the relative position and spacer pitch (distance between spacers) are [[ ]] between the two designs. For GE14E, the distance between spacer 4 and 5 is [[ ]] that in the conventional design. Hence, the critical power will be slightly larger in GE14E than measured in ATLAS. This spacer difference effect has been evaluated with the subchannel program COBRAG, where a subset of the test matrix has been used to compare the GE14E spacer pitch with the GE14 spacer pitch using the GE14E fuel length.

COBRAG (see Reference 4) is a steady-state subchannel analysis code for performing analysis on BWR fuel bundles. It can be used to predict bundle critical powers and dryout locations, bundle planar averaged and local void fractions and bundle pressure drops. A description of COBRAG model for GE14, its qualification against the ATLAS GE14 critical power data, and a study of axial power shape effect on the GE14 critical power are provided in Appendix A.

First, COBRAG is used to predict the critical power of GE14 with the heated length truncated at [[ ]] for a total number of [[ ]] ATLAS test runs, mainly the data from the GE14 tests with a Cosine axial power shape. The mean and standard deviation of the ratios of COBRAG calculated vs. critical power for these test runs are [[ ]] and [[ ]], respectively. The mean and standard deviation of the COBRAG calculated vs. the measured critical power for GE14 were reported as [[ ]] and [[ ]], respectively (see Table A-1 of Appendix A). The [[ ]] increase in the mean of the calculated vs. measured critical power data ratios supports the conservatism expected due to including dryout data from Spacers 1 and 2 (see the discussion in Subsection 4.2.1).

Next, the axial spacer locations in the COBRAG model for GE14 with the truncated heated length is adjusted to match the elevations of GE14E spacer locations. The average difference between the critical power calculated for the truncated GE14 with adjusted spacer locations and the critical power calculated for the truncated GE14 with the original spacer locations is [[ ]] with a standard deviation of [[ ]]. Therefore, it is concluded that on average the GE14E spacer configuration yields [[ ]] critical powers, spacer height differences therefore play a small role, and most importantly, use of the GEXL correlation for GE14E with no correction for spacer height is conservative.

4.2.3. Change in Part Length Rod Length

Table 2-1 gives the heated length of the part length rod as [[ ]] for GE14 and [[ ]] for GE14E. Hence the difference in the heated length is [[ ]] between the GE14 ATLAS tests and the GE14E design. The GE14 tests therefore have an additional amount of heat generated in the PLR and will indicate a slightly larger critical power than the prototypical GE14E design. The COBRAG subchannel program was used over the same subset of the test matrix as mentioned in Section 4.2.2 to evaluate the impact of the PLR length change. The average difference between the critical power calculated for the truncated GE14 with the GE14E PLRs and the critical power calculated for the truncated GE14 with the original GE14 PLRs is [[ ]] with a standard deviation of [[ ]]. It should also be noted that the axial spacer pitch was restored back to that of GE14 in this study to isolate the effect of PLR length differences. Therefore, it is concluded that on average the [[ ]] GE14E PLRs yield [[ ]] critical power with a standard deviation of [[ ]]. The effect of [[ ]] PLRs on critical power can also be evaluated by the GEXL correlation where the PLR length is reflected in GEXL through the R-factor, which depends on the bundle peaking pattern. The change in R-factor due to the PLR length change yields a critical power difference of [[ ]].

The combination of the spacer pitch and PLR length change is summarized in Table 4-1. The studies presented in this section suggest a decrease in critical power performance due to the shorter PLR lengths of GE14E, which is compensated by an increase due to the new axial spacer pitch. The use of the GEXL14 for the GE14E can be easily justified considering the results showing that the percent changes in critical power due to the differences in spacer location and PLR length change between GE14 and GE14E remain below the correlation uncertainty.

Table 4-1 Summary of PLR and Spacer Pitch Effects

GE14E vs. GE14 CP Difference	**COBRAG**	**GEXL14**
Spacer Pitch	[[ ]]	[[ ]]
PLR Length	[[ ]]	[[ ]]
Total (includes interaction effects)	[[ ]]	[[ ]]

The critical power data supporting the statistical information in Table 4-1 are provided in a tabulated format in Appendix B.

Response to Part C:

The three uncertainty values in Chapter 5, Table 5-1 of NEDC-33237P that are considered unique to the ESBWR (other than the "GE14E Critical Power Correlation" which is being addressed separately) are the "Total Core Flow Measurement", "Core Neutron Monitoring System Bundle Power", and "Transient delta CPR/ICPR". As discussed in section 5.6 of NEDC-33237P, the "Total Core Flow Measurement" uncertainty is a design requirement for the ESBWR; thus the specification for the systems impacting total core flow will require that this uncertainty be achieved. As discussed in section 5.10 of NEDC-33237P, Reference 10 of NEDC-33237P contains the detailed quantitative technical basis for the "Core Neutron Monitoring System Bundle Power" uncertainty. As discussed in section 5.12 of NEDC-33237P, Figure 5-1 and Figure 5-2 of NEDC-33237P provides the detailed quantitative technical bases for the "Transient delta CPR/ICPR" uncertainty utilizing the process demonstrated in Section 8 of Reference 11 of NEDC-33237P.

Qualitative and quantitative technical basis for the remainder of the uncertainties listed in Table 5-1 of NEDC-33237P are discussed in the various sections as specified by Table 5-1 of NEDC-33237P along with the various references identified in these sections.

Response to Part D:

As discussed in section 6.0 of NEDC-33237P, the NRC approved methodology defined in reference 1 and 5 of NEDC-33237P is utilized to determine the OLMCPR. This methodology is based on establishing the OLMCPR such that at least 99.9% of the fuel rods in the core would not be expected to experience boiling transition during normal operation or anticipated operational occurrences, which is consistent with Standard Review Plan 4.4 II.1.b acceptable approach.

APPENDIX A. COBRAG SUBCHANNEL ANALYSIS

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APPENDIX B : SUMMARY OF COBRAG AND GEXL14 ANALYSIS FOR GE14E WITH SELECTED ATLAS TEST CONDITIONS

Table B-1 summarizes the results previously discussed in sections 4.2.2 and 4.2.3 of NEDC-33237P. The first column in this table is the ATLAS critical power test run number. The second and the third columns of Table B-1 give the pressure and the mass flux for each test number, respectively. The inlet subcooling is given in column 5. The modified critical power data based on the truncated axial power profile is tabulated in column 4. Columns 6 through 9 present the results of the COBRAG calculations for each test run. Column 6 tabulates the COBRAG critical power estimate based on the GE14 bundle with the truncated axial power profile. The results shown in column 6 are used as reference case when the individual effects of the axial spacer pitch and the PLR length on the critical power performance of the GE14E are studied. The COBRAG calculated critical power with the GE14E axial spacer pitch and PLR length are given in columns 7 and 8, respectively. Finally, the combined effect of the axial spacer pitch and the PLR length of GE14E is given in column 9. The last two columns provide the critical powers predicted using GEXL14 for GE14E.

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APPENDIX C : MODIFIED ATLAS GE14 CRITICAL POWER DATA TO SUPPORT THE STATISTICS GIVEN IN TABLE 4-2

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NRC RAI 4.4-28

The second paragraph on page 3-1 of NEDC-33237P discusses the use of the ATLAS facility to develop correlation data. It states that BWR flows, pressures, and temperatures were used.

(a) *Address the range of test conditions and configuration in relation to the ESBWR design considering the natural circulation cooling and higher output thermal power of the ESBWR.*

(b) *Was any adjustment made to the test data to account for magnetic biasing attributed to the electrically-heated rods of the ATLAS facility? If no adjustment is made, how is the use of the data justified?*

GE Response:

The second paragraph on Page 3-1 of NEDC-33237P is revised to include the following response to Part (a):

> The ATLAS facility has been used to develop the correlation data for all GE fuel designs beginning with GE6 and ending with GE14. The ATLAS facility is an electrically heated mockup of a BWR fuel bundle containing prototypical spacers and operating at BWR flows, pressures, and temperatures. For a given bundle flow, pressure, and inlet temperature the bundle power is continually increased until temperature sensors detect a sudden rise in fuel rod surface temperature. This rise indicates that the annular liquid flow surrounding the fuel rods near the top of the core can no longer sustain adequate heat transfer. This condition is known as the bundle critical power for a given set of inlet flow, temperature, and pressure conditions. This test procedure is applicable to the critical power testing of BWR fuels regardless of the coolant flow circulation mode, i.e. forced vs. natural. As the inlet flow, temperature, and pressure boundary conditions are the controlled test parameters, the mode of circulation does not play any role on the critical power data. It should also be noted that the expected fluid conditions for ESBWR fuel due to lower mass flow rates and higher thermal output conditions are enveloped by the fluid conditions achieved at critical power inside the test assembly.

Table 4.4-28-1 shows that all parameters for the ESBWR are well within the application range of the GEXL14 considering the steady state operation at rated conditions and the AOOs.

In the application of the test data for the ESBWR design, no adjustment was made to account for the magnetic biasing attributed to the electrically heated rods of the ATLAS facility. Table 4-2 of NEDC-33237P will be revised with the studies which will account for the potential magnetic bias in the ATLAS GE14 critical power data.

Table 4.4-28-1
The Application Range of GEXL14 and The Ranges of ESBWR Parameters during Steady State and AOO

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NRC RAI 4.4-29

Section 4.1 of NEDC-33237P shows the expected operating parameter range (including transients) for the ESBWR (i.e., pressure, mass flux, inlet subcooling, and R-factor). For any parameter which is outside the tested range, provide justification for use of existing GE14 data.

GE Response:

ENCLOSURE 3

MFN 06-405

Affidavit

I, Jens G. M. Andersen, state as follows:

(1) I am Consulting Engineer, Thermal Hydraulic Methods, 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 Enclosure 1 of GE letter MFN 06-405, David H. Hinds to U. S. Nuclear Regulatory Commission, *Response to Portion of NRC Request for Additional Information Letter No. 53 Related to ESBWR Design Certification Application – DCD Chapter 4 and GNF Topical Reports – RAI Numbers 4.4-26, 4.4-28, 4.4-29* dated October 18, 2006. The proprietary information in Enclosure 1, *Response to Portion of NRC Request for Additional Information Letter No. 53 Related to ESBWR Design Certification Application – DCD Chapter 4 and GNF Topical Reports – RAI Numbers 4.4-26, 4.4-28, 4.4-29 – GNF Proprietary Information,* is delineated by double underlined dark red font text and is enclosed inside double square brackets. Figures and large equation objects are identified with double square brackets before and after the object. 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 " (Exemption 4). The material for which exemption from disclosure is here sought 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 aspects of past, present, or future GNF-A customer–funded development plans and programs, of potential commercial value to GNF-A;

d. 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, North Carolina this 18th day of October 2006.

Jens G. M. Andersen
Global Nuclear Fuels – Americas, LLC