GE Energy

James C. Kinsey
Project Manager, ESBWR Licensing

PO Box 780 M/C J-70
Wilmington, NC 28402-0780
USA

T 910 675 5057
F 910 362 5057
jim.kinsey@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 06-467, Supplement 1

Docket No. 52-010

March 6, 2007

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. 66 Related to ESBWR Design Certification Application – DCD Chapter 4 and GNF Topical Reports – RAI Numbers 21.6-86 S01 and 21.6-88 S01**

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,

James C. Kinsey

James C. Kinsey
Project Manager, ESBWR Licensing

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Reference:

1. MFN 06-377, Letter from U. S. Nuclear Regulatory Commission to Mr. David H. Hinds, *Request for Additional Information Letter No. 66 Related to ESBWR Design Certification Application,* October 10, 2006

Enclosures:

1. MFN 06-467, Supplement 1 - Response to Portion of NRC Request for Additional Information Letter No. 66 Related to ESBWR Design Certification Application – DCD Chapter 4 and GNF Topical Reports – RAI Numbers 21.6-86 S01 and 21.6-88 S01 – GNF Proprietary Information
2. MFN 06-467, Supplement 1 - Response to Portion of NRC Request for Additional Information Letter No. 66 Related to ESBWR Design Certification Application – DCD Chapter 4 and GNF Topical Reports – RAI Numbers 21.6-86 S01 and 21.6-88 S01 – Non Proprietary Version
3. Affidavit – Jens G. M. Andersen – dated March 6, 2007

cc: AE Cubbage USNRC (with enclosures)
AA Lingenfelter GNF/Wilmington (w/o enclosures)
GB Stramback GE/San Jose (with enclosures)
eDRF 0000-0063-7349

Enclosure 2

MFN 06-467, Supplement 1

Response to Portion of NRC Request for
Additional Information Letter No. 66
Related to ESBWR Design Certification Application

DCD Chapter 4 and GNF Topical Reports

RAI Numbers 21.6-86 S01, 21.6-88 S01

Non-Proprietary Version

NRC RAI 21.6-86 S01:

Confirm whether or not GE is seeking NRC approval of the PANAC11 isotopic tracking methods, referred to in the response to RAI 21.6-86, for application to the ESBWR.

GE Response:

GE is not seeking NRC approval of the PANAC11 isotopic tracking method for application to the ESBWR.

DCD Impact:

There are no DCD or LTR changes in response to this RAI.

NRC RAI 21.6-88 S01:

In the linear interpolation calculation for the individual channel flow rates, the response reiterates that the bundle flows are based on linear interpolation from characteristic channel flow rates. To evaluate the efficacy of the individual flow rate calculation for the ESBWR, the staff must understand:

1. How are characteristic channels selected? If they are based on user supplied information, what procedure or internal guidance is used to make the selection?

2. Are the characteristic channels that exist found in the PANACEA core model or hypothetical channels?

3. If the channels are hypothetical channels, are there any administrative controls that ensure that the hypothetical channels include a spectrum of bundle characteristics that encompass those likely to be experienced by the bundles in the core? Specifically, is there any requirement that the characteristic channels include: radial and axial power shapes that bound those experienced in the core, clean and maximum crud thicknesses, channel geometries for each fuel type in the core, and minimally and maximally orificed geometries? For the five characteristic channels provide: the channel powers, axial power shapes, the crud thicknesses, geometries, and orifices considered. Compare these quantities to the maximum and minimum values of the channels in the PANACEA ESBWR core model at BOC and EOC.

4. The characteristic channel flow is based on pressure drop equalization, however, the only flow input is the total core flow. How is the total core flow rate number used mathematically to determine the flow that must be subdivided across the five characteristic channels (if they are hypothetical or otherwise)?

5. Provide two examples, one for the channel power and one for the axial power shape, how a difference in these quantities between a PANACEA bundle and one of the characteristic channels mathematically translates into the PANACEA bundle flow rate.

6. If the five characteristic channels are used to correlate flow (linearly or otherwise) to channel characteristic parameters, provide the mathematical representation of the response surface.

Update the LTR to include this information.

GE Response:

Item 1

Characteristic channels are defined by combinations of the parameters primarily affecting pressure drop:

1. Radial power
2. Axial power shape
3. Crud thickness
4. Orifice type

5. Bundle geometry

To calculate the radial power effects, the maximum (RADMAX) and minimum (RADMIN) bundle powers are determined from the bundle power distribution $AVGBP_{ij}$. The characteristic radial powers are determined as follows:

[[

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The total number of radial powers NRAD is:

[[

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The axial power shape of each channel is characterized by the fraction of the power, which is below the core midplane. This fraction is calculated as follows:

[[ ]]

where,

[[

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As with the radial power, the maximum (*AXMAX*) and minimum (*AXMIN*) axial shape factors are calculated and used to determine the axial power shapes for the characteristic channels.

[[

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The total number of axial power shapes, *NAX*, to be considered is:

[[

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The crud parameter is taken to be the average crud thickness in a bundle, $CRUD_{ij}$. This parameter is calculated assuming equal nodal volumes as:

[[ ]]

where $TCRU_{kij}$ is the crud array.

The maximum (*CRDMAX*) and minimum (*CRDMIN*) crud values are determined and used to calculate the crud

[[

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The total number of crud sizes, *NKRD*, is:

[[

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The effects of bundle geometry on the flow distribution are determined by two parameters: (1) the orifice loss and (2) the local losses in the bundle itself. These local losses are related to the lower tie plate and the spacers, which define a characteristic geometry (channel) type.

The geometric and power characteristics associated with each of the characteristic bundles are defined by all possible combinations of RADP(1), RADP(2), AXP(1), AXP(2), CRD(1), CRD(2) and by the geometry and orifice types.

The total number of characteristic channels is defined as

[[ ]]

where,

[[

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The characteristic channel at each core location (i,j) is assigned as follows:

[[ ]]

where,

[[

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The total number of characteristic channels is defined as

[[ ]]

Item 2

Based on the information above, the characteristic channels are not hypothetical channels. They are based on the power distribution of the actual core as well as user supplied information through the definition of orifice and geometry types.

Item 3

See response to Item 2.

Item 4

An iterative process is required to determine the flow in each characteristic channel, which results in an equal pressure drop for all channels while preserving the total core flow. The initial guess for flow in each characteristic channel is assumed to be equal to the total core flow rate divided by the total number of bundles. The first estimate of the core pressure drop is obtained by calculating the core pressure drop of one of the characteristic channels (for example, the one with the largest number of bundles associated with it). A separate iteration on flow is conducted for each characteristic channel. [[

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If the first estimate of the characteristic channel flow, WCB_N^1 does not produce the required pressure drop, a new flow guess is generated from the following ratio:

[[ ]]

For succeeding iterations, a simple linear interpolation is used:

[[ ]]

Convergence of the core pressure drop is gauged by summing all the characteristic channel flows and comparing the results against the total core flow, reduced by bypass flow:

[[ ]]

where,

[[

$WCT * 10^{\circ}$

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If the criteria are not met, then the core pressure drop is incorrect and is adjusted. This is accomplished by renormalizing the characteristic channel flows such that:

[[ ]]

and then repeating the iterations on channel flow.

<u>Item 5</u>

The characteristic channel flow rates are distributed to individual channels of the same geometry and orifice type by linear interpolation on total channel power, axial power shape, and crud thickness.

The flow rate in each fuel bundle, which is a member of the group of channels represented by the characteristic channel IX_{ij} is set equal to the characteristic channel flow, *WCB*(IX), modified by corrections which vary linearly with the amount that the actual bundle at (i,j) is removed from characteristic variables, namely radial power, axial power, and crud build-up. The bundle flow is then calculated as follows:

[[

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where $DWDRAD_{IX}$, $DWDAXP_{IX}$ and $DWDCRD_{IX}$ are derivatives of the flow with request to the radial power, axial power factor and crud thickness. These derivatives are determined by first calculating the flow rates, using the known converged pressure drop, *DELTP*, and the average values of the continuous variables RADP(3), *AXP*(3) and CRUD(3). For example, the flow versus radial power is shown in the figure below.

[[

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[[

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[[ ]]

and

[[ ]]

These calculations are performed for every combination of geometry and axial power shape.

In a similar way, derivatives are calculated for the axial power and crud thickness.

After the bundle flows have been calculated, they are normalized such that the sum of the bundle flows plus bypass flow will equal the total core flow, WCT:

[[ ]]

A steady-state case is run for an ESBWR core in the following conditions:

- EOC (End Of Cycle) : 16771 MWd/St
- Power : 4500 MWth (100% rated)
- Flow : 78.51 Mlb/hr (100% rated)
- Pressure : 1055 psia (mid-plan)

In this case, PANACEA calculates 8 different characteristic channels defined by the combinations of:

- 2 radial powers

  [[ ]]

- 2 axial power shape

  [[ ]]

- 1 crud thickness (equal to 0 since no crud is applied)
- 2 orifice types
- 1 bundle geometry

The bundle at location (1,15) has an exposure of 39035MWd/st. The radial power at this location is 0.29 and the axial power shape AXPF (fraction of the power, which is below the core midplane) is equal to 0.39. The bundle has an orifice type number equal to 2.

The characteristic channel associated with this bundle has the following parameters:

1. Radial power = 0.54
2. Axial power shape = 0.44
3. Crud thickness= 0
4. Orifice type = 2
5. Bundle geometry = 1

The flow obtained for this characteristic bundle is 40,355 Mlb/hr.

The flow obtained after correction from the characteristic channel for bundle at location (1,15) is 40,969 Mlb/hr (1.5% correction).

Item 6

See response to Item 5.

DCD Impact:

There are no changes to the DCD in response to this RAI.

Section 1.5.1 of the LTR NEDC-33239P will be revised by adding the information provided in the responses to Items 1, 4 and 5.

Enclosure 3

MFN 06-467, Supplement 1

Affidavit

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 06-467, Supplement 1, James C. Kinsey to U. S. Nuclear Regulatory Commission, *Response to Portion of NRC Request for Additional Information Letter No. 66 Related to ESBWR Design Certification Application – DCD Chapter 4 and GNF Topical Reports - RAI Numbers 21.6-86 S01 and 21.6-88 S01* dated March 6, 2007. The proprietary information in Enclosure 1, *MFN 06-467, Supplement 1 Response to Portion of NRC Request for Additional Information Letter No. 66 Related to ESBWR Design Certification Application – DCD Chapter 4 and GNF Topical Reports - RAI Numbers 21.6-86 S01 and 21.6-88 S01 – Contains 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 6th day of March 2007.

Jens G. M. Andersen

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