Global Nuclear Fuel

A Joint Venture of GE, Toshiba, & Hitachi

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Proprietary Notice

This letter transmits proprietary information in accordance with 10CFR2.390. Upon removal of Enclosure 1, the balance of the letter may be considered non-proprietary.

FLN-2007-016
April 13, 2007

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

Subject: Supplement 1 to GEXL14 Correlation for GE14 Fuel, NEDC-32851P, Revision 2, September 2001.

This letter transmits Supplement 1 to GEXL14 Correlation for GE14 Fuel, NEDC-32851P, Revision 2, September 2001. Reference 1 transmitted NEDC-32851P Revision 2 in September 2001. In 2003, Reference 2 closed the USNRC review of NEDC-32851P, Revision 2 pending resolution of concerns stated in the letter. GNF has conducted additional testing to obtain critical power data for GE14 top peaked axial power shape.

Consistent with the USNRC request in Reference 2, the enclosed Supplement 1 presents the re-evaluation of the GEXL14 correlation using the additional data and includes modifications to the report to integrate the information. When Supplement 1 is approved, GNF will integrate the supplement into NEDC-32851P to produce the –A version.

Please note that Enclosure 1 contains proprietary information of the type that GNF maintains in confidence and withholds from public disclosure. The information has been handled and classified as proprietary to GNF-A as indicated in its affidavit, also included in the report. The affidavit contained in Enclosure 3 identifies that the information contained in Enclosure 1 has been handled and classified as proprietary to GNF-A. GNF-A hereby requests that the information in Enclosure 1 be withheld from public disclosure in accordance with the provisions of 10CFR2.390 and 9.17.

Enclosure 1 is the proprietary version of the Supplement 1 to GEXL14 Correlation for GE14 Fuel, NEDC-32851P, Revision 2 and Enclosure 2 is a non-proprietary version. Enclosure 3 contains the affidavit.

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If you have any questions about the information provided here, please contact me at (910) 675-5954 or Jim Harrison at (910) 675-6604.

Sincerely,

R. M. Fawcett

R. M. FAWCETT

FOR Andrew A. Lingenfelter
Manager, Engineering

Global Nuclear Fuel–Americas, LLC
Project No. 712

References

1. Letter GA Watford (GNF) to Document Control Desk (USNRC), Subject: GEXL14 Correlation for GE14 Fuel, NEDC-32851P Revision 2, and GEXL10 Correlation for GE12 Fuel with Inconel Spacer, NEDC-32464P Revision 2, FLN–2001–018, September 25, 2001.
2. Letter AB Wang (USNRC) to JGM Andersen (GNF), Subject: Global Nuclear Fuel (GNF) Topical Reports NEDC-32851, Revision 2, "GEXL14 Correlation For GE14 Fuel" and NEDC-32464P, REVISION 2, "GEXL10 Correlation For GE12 Fuel With Inconel Spacer" (TAC NO. MB3094), July 11, 2003.

Enclosures

1. Supplement 1 to NEDC-32851P, Revision 2 - GNF Proprietary Information
2. Supplement 1 to NEDC-32851P, Revision 2 - Non-Proprietary Information
3. Affidavit for NEDC-32851P, dated April 13, 2007

cc: JGM Andersen, GNF/Wilmington
PL Campbell, GE/Washington
RE Brown, GE/Wilmington
JF Harrison, GE/Wilmington
GB Stramback, GE/San Jose
eDRF Section 0000-0066-9396

ENCLOSURE 1

FLN-2007-016

Supplement 1 to GEXL14 Correlation for GE14 Fuel, NEDC-32851P, Revision 2, September 2001

GNF Proprietary Information

PROPRIETARY INFORMATION NOTICE

This enclosure contains proprietary information of the Global Nuclear Fuel–Americas, L.L.C. (GNF-A) and is furnished in confidence solely for the purpose(s) stated in the transmittal letter. No other use, direct or indirect, of the document or the information it contains is authorized. Furnishing this enclosure does not convey any license, express or implied, to use any patented invention or, except as specified above, any proprietary information of GNF-A disclosed herein or any right to publish or make copies of the enclosure without prior written permission of GNF-A.

The header of each page in this enclosure carries the notation "Global Nuclear Fuel Proprietary Information." The GNF-A proprietary information is identified by [[a dotted underline inside double square brackets$^{\{3\}}$]]. Figures and other large objects are identified with double square brackets before and after the object. In each case, the superscript notation {3} refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination.

ENCLOSURE 2

FLN-2007-016

Supplement 1 to GEXL14 Correlation for GE14 Fuel, NEDC-32851P, Revision 2, September 2001

Non-Proprietary Information

IMPORTANT NOTICE

This is a non-proprietary version of Enclosure 1 to FLN-2007-016, which has the proprietary information removed. Portions of the document that have been removed are indicated by white space with an open and closed bracket as shown here [[ ]].

ENCLOSURE 3

FLN-2007-016

Affidavit

Global Nuclear Fuel – Americas

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 FLN-2007-016, Andrew A. Lingenfelter (GNF) to Document Control Desk (USNRC), *Supplement 1 to GEXL14 Correlation for GE14 Fuel, NEDC-32851P, Revision 2, September 2001,* dated April 13, 2007. The proprietary information in Enclosure 1, *Supplement 1 to GEXL14 Correlation for GE14 Fuel, NEDC-32851P, Revision 2, September 2001,* is identified by [[a dotted underline inside double square brackets$^{\{3\}}$]]. Figures and other large objects are identified with double square brackets before and after the object. 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" (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, resulting in potential products 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 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. 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. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.

(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 information 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.

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 on this 13th day of April 2007.

Jens G. M. Andersen
Consulting Engineer, Thermal Hydraulic Methods
Global Nuclear Fuel – Americas, L.L.C.

ENCLOSURE 2

FLN-2007-016

Supplement 1 to GEXL14 Correlation for GE14 Fuel, NEDC-32851P, Revision 2, September 2001

Non-Proprietary Information

IMPORTANT NOTICE

This is a non-proprietary version of Enclosure 1 to FLN-2007-016, which has the proprietary information removed. Portions of the document that have been removed are indicated by white space with an open and closed bracket as shown here [[ ]].

The following information will be added to end of Section 3.

Additional test data were subsequently obtained from the Stern Laboratory. [[

]] The database for the Stern Laboratory GE14 tests [[
]] is summarized in Tables 3-6 and 3-7. The Stern Laboratory GE14 test assembly characteristics are provided in Table 3-8 and Figures 3-4 and 3-5.

Table 3-6. Additional Stern Laboratory Inlet Peaked Database for GE14 Fuel with Zircaloy Spacers

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Table 3-7. Additional Stern Laboratory Outlet Peaked Database for GE14 Fuel with Zircaloy Spacers

[[

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Table 3-8. Stern Laboratory GE14 Test Assembly Characteristics for Additional GE14 Data

Characteristic	Test Assembly
Test Assembly	Bottom and Top Peaked APS
Lattice	10x10
Nominal Inside Width of Channel	[[
Corner Radius of Channel	
Channel Wall Feature	
Rod Pitch	
Diameter of All Heated Rods	
Axial Heat Flux Profiles (2) of All Full Length Rods	]]
Number of Full Length Heated Rods	78
Heated Length of Full Length Rods	[[ ]]
Number of Heated Part Length Rods	14
Length of Part Length Rods (Heated plus Unheated)	[[
Heated Region of Part Length Rods	]]
Number of Water Rods	2
Diameter of Large Water Rods	[[ ]]
Number of Spacers on the Heated Length	8
Spacer Type	Zircaloy ferrule
Nominal Elevations of Spacer Leading Edge Relative to the Full Length Rod Beginning of the Heated Length:	
8	[[
7	
6	
5	
4	
3	
2	
1	]]
Hydraulic Parameters Used in GEXL Correlation:	
Flow Area	[[
Hydraulic Diameter	
Thermal Diameter	]]

[[

]]

Figure 3-4. Typical Rod Axial Heat Shape – Stern Laboratory Critical Power Tests

[[

]]

Figure 3-5. Typical Bundle Axial Heat Shape – Stern Laboratory Critical Power Tests

The following information will be added to Section 4.2. The previous paragraph "3)" will become paragraph "4)".

3) [[

]] The Stern laboratory test matrix is outlined in Table 4-2A. [[

]]

Table 4-2A. GE14 Stern laboratory Test Matrix for Additional Data Collection (Steady-state)

Test Type: Number of peaking patterns: Axial Heat Flux Shape: R-factor: Pressure: Mass flux: Inlet subcooling:	[[
Test Type: Number of peaking patterns: Axial Heat Flux Shape: R-factor: Pressure: Mass flux: Inlet subcooling:	
Test Type: Number of peaking patterns: Axial Heat Flux Shape: R-factor: Pressure: Mass flux: Inlet subcooling:	
Test Type: Number of peaking patterns: Axial Heat Flux Shape: R-factor: Pressure: Mass flux: Inlet subcooling:	]]

Sections 4.7 and 4.8 will be replaced by

4.7 POWER SHAPE SENSITIVITY COMPARISON

[[

]]

The statistics for the validation of the GEXL14 correlation against the Stern Laboratory data is given in the Table 4-10:

Table 4-10. GEXL14 Compared to Stern Laboratory Data

	Bottom Peaked Axial Power Shape	Top Peaked Axial Power Shape	All Data
Number of Data Points	[[		
Mean ECPR, μ			
Standard Deviation			]]

[[

]]

[[

]]

Figure 4-1. Power Shape Sensitivity Comparison for 9x9 and 10x10 Fuel Designs

[[

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4.8 HIGH R-FACTOR

[[

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4.9 PRESSURE RANGE

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4.10 CONCLUSION

[[

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The GEXL14 Application range in Section 5.2 will be replaced by:

5.2 GEXL14 APPLICATION RANGE

The GEXL14 correlation for GE14 fuel is valid over the range stated below:

Pressure: [[
Mass Flux:
Inlet Subcooling:
R-factor:
*exception

]]

The Table 5-1 in Section 5.4.5 will be replaced by:

Table 5-1. GEXL14 Additive Constants for GE14 with Ferrule Spacer

Fuel Rod Lattice Position	Fuel Rod Additive Constant
(1,1)	[[
(1,2)	
(1,3)	
(1,4)	
(1, 5)	
(2, 2)*	
(2, 3)	
(2, 4)*	
(2, 5)	
(3, 3)**	
(3, 4)**	
(3, 5)**	
(3, 3A)***	
(3, 4A)***	
(3, 5A)***	
(4, 4)	
(4, 5)	
(5, 5)*	]]

*Part length fuel rods

**For rods not adjacent to a water rod

***For rods adjacent to a water rod (refer to Figure 8-3 in Section 8)

Section 5.4.6 will be replaced by:

5.4.6 Annular Flow Length

Annular flow length, L_A, is defined as the distance from the slug/annular flow transition point to the point of boiling transition. Investigation into two-phase flow and heat transfer mechanisms in a BWR fuel bundle has shown that boiling transition depends on the annular flow phenomenon. This conclusion was reached based on an improved understanding of the boiling transition phenomena for BWRs supported by the experience gained during ATLAS testing.

Annular flow is the two-phase flow condition where the vapor medium (with entrained liquid droplets) flows in the less obstructed higher velocity regions of the BWR fuel subchannel, while a continuous liquid film flows along the fuel rod, water rod, and channel surfaces. Boiling transition occurs in the annular flow regime when the thin liquid film covering the fuel rod ruptures. Use of the annular flow length parameter improved the accuracy of the critical quality-boiling length correlation, by providing a parameter that can more directly characterize the complex liquid vaporization, film entrainment, and droplet deposition mechanisms. [[

]]

Figure 5-2 provides a representation of two-phase flow regimes in a heated cylindrical tube. Boiling transition occurs at the point of disruption or complete depletion of the liquid film layer on a heated fuel rod surface. The slug to annular flow transition point is characterized by the transition from the state of vapor entrainment in a continuous liquid phase flow medium to a state of liquid entrainment in a continuous vapor phase flow medium. The location of transition to annular flow, $Z_{TR} = Z(X=X_{TR})$, is determined from the [[ ]] given by Equation 5-4:

[[ ]] (5-4)

where j_g^* and j_f^* are the dimensionless vapor and liquid velocities and are defined by:

$$j_g^* = G_g \, (\rho_g)^{-1/2} \, [(gD_H) \, (\rho_f - \rho_g)]^{-1/2} \quad (5\text{-}5)$$

$$j_f^* = G_f\ (\rho_f)^{-1/2}\ [(gD_H)\ (\rho_f - \rho_g)]^{-1/2} \quad (5\text{-}6)$$

and where D_H is the hydraulic diameter of the fully rodded region,

$$G_g = XG \quad (5\text{-}7)$$

$$G_f = (1 - X)\ G \quad (5\text{-}8)$$

Combining these expressions gives the annular flow transition quality

[[ ]] (5-9)

Thus the annular flow length is given by

[[ ]] (5-10)

where

$Z_{TR} = Z$ when $X = X_{TR}$. (5-11)