



Global Nuclear Fuel

A Joint Venture of GE, Toshiba, & Hitachi

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.

**Andy Lingenfelter
Manager, Engineering**

Global Nuclear Fuel – Americas, LLC
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Andy.Lingenfelter@gnf.com

FLN-2007-021
June 25, 2007

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

Subject: Response to Request for Review of Draft Safety Evaluation For Global Nuclear Fuel (GNF) Topical Report (TR) NEDC-32851P, Revision 2, “GEXL14 Correlation for GE14 Fuel” (TAC No. MD5486)

By Reference 1, the NRC provided GNF with the draft Safety Evaluation (SE) regarding its review of NEDC 32851P, Revision 2, “GEXL14 Correlation for GE14 Fuel,” and requested a review of the SE for proprietary content and to comment on any factual errors or clarity concerns.

GNF has completed the review and documented its comments in the enclosure. Table 1 presents some potential factual errors and clarity concerns. Proprietary information is identified by a single dotted underline inside double square brackets.

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 response and Enclosure 2 is a non-proprietary version. Enclosure 3 contains the affidavit.

DOB

HRK

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,



Andrew A. Lingenfelter
Manager, Engineering

Global Nuclear Fuel–Americas, LLC
Project No. 712

References

1. Letter from S. L. Rosenberg (NRC) to A. A. Lingenfelter (GNF), Draft Safety Evaluation for Global Nuclear Fuel (GNF) Topical Report (TR) NEDC-32851P, Revision 2, “GEXL14 Correlation for GE14 Fuel” (TAC No. MD5486), May 30, 2007.

Enclosures

1. Comments on Draft SE for NEDC-32851P, Revision 2 - GNF Proprietary Information
2. Comments on Draft SE for NEDC-32851P, Revision 2 - Non-Proprietary Information
3. Affidavit, dated June 25, 2007

cc: MC Honcharik, USNRC
JGM Andersen, GNF/Wilmington
PL Campbell, GHNEA, Washington
RE Brown, GHNEA/Wilmington
JF Harrison, GHNEA/Wilmington
eDRF 0000-0069-9522

Table 1 Summary of Potential Factual Errors and Clarity Concerns

Location	Comment
Table 2	The units on the mass flux are shown as 106 lb/hr-ft ² but should be 10 ⁶ lb/hr-ft ² . This may be a Wordperfect-MS Word conversion problem.
Chronology of Events Table September 1999	Based on our records NEDC-32851 Rev 1 was not submitted for review. The date on Rev 1 is September 1999.
Chronology of Events Table February 2002	The commitment to perform additional testing was made at this meeting. (FLN_2002_004 dated February 12, 2002)
Chronology of Events Table May 2003	This letter referenced the February 2002 commitment and suggested that there was no need for an NRC review because GNF would be compliant with GESTAR II when the additional data was acquired.
Chronology of Events Table July 2003	NRC letter rejecting GNF position that correlation issues are addressed by GESTAR, Amendment 22 without review when the additional data was complete.
Chronology of Events Table March 2005	The GESTAR II Amendment 27 does not include information or relationships to the GEXL14 correlation.

ENCLOSURE 3

FLN-2007-021

Affidavit

Global Nuclear Fuel – Americas
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 Enclosure 1 of FLN-2007-021, Andrew A. Lingenfelter (GNF) to Document Control Desk (USNRC), *Response to Request for Review of Draft Safety Evaluation For Global Nuclear Fuel (GNF) Topical Report (TR) NEDC-32851P, Revision 2, “GEXL14 Correlation for GE14 Fuel” (TAC No. MD5486)*, dated June 25, 2007. The proprietary information in Enclosure 1, *Response to Request for Review of Draft Safety Evaluation For Global Nuclear Fuel (GNF) Topical Report (TR) NEDC-32851P, Revision 2, “GEXL14 Correlation for GE14 Fuel” (TAC No. MD5486)*, is identified by a single [[dotted underline inside double square brackets⁽³⁾]]. 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 25th day of June 2007.



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

ENCLOSURE 2

FLN-2007-021

Response to Request for Review of Draft Safety Evaluation For Global Nuclear Fuel (GNF) Topical Report (TR) NEDC-32851P, Revision 2, "GEXL14 Correlation for GE14 Fuel" (TAC No. MD5486)

Non-Proprietary Information

IMPORTANT NOTICE

This is a non-proprietary version of Enclosure 1 to FLN-2007-021, 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 [[]].

May 30, 2007

Andrew A. Lingenfelter, Manager
GNF Engineering
Global Nuclear Fuels - Americas, LLC
P.O. Box 780, M/C F12
Wilmington, NC 28402

SUBJECT: DRAFT SAFETY EVALUATION FOR GLOBAL NUCLEAR FUEL (GNF)
TOPICAL REPORT (TR) NEDC-32851P, REVISION 2, "GEXL14
CORRELATION FOR GE14 FUEL" (TAC NO. MD5486)

Dear Mr. Lingenfelter:

By letter dated September 25, 2001, GNF submitted TR NEDC-32851P, Revision 2, "GEXL14 Correlation for GE14 Fuel," to the U.S. Nuclear Regulatory Commission (NRC) staff for review. The NRC staff closed the review in letter dated July 11, 2003, while GNF conducted additional testing. By letter dated April 13, 2007, GNF submitted Supplement 1 to TR NEDC-32851P, Revision 2, "GEXL14 Correlation for GE14 Fuel," which provided the additional data. Enclosed for GNF review and comment is a copy of the NRC staff's draft safety evaluation (SE) for the TR.

Pursuant to Section 2.390 of Title 10 of the *Code of Federal Regulations* (10 CFR), we have determined that the enclosed draft SE does not contain proprietary information. However, we will delay placing the draft SE in the public document room for a period of 10 working days from the date of this letter to provide you with the opportunity to comment on the proprietary aspects. If you believe that any information in the enclosure is proprietary, please identify such information line-by-line and define the basis pursuant to the criteria of 10 CFR 2.390. After 10 working days, the draft SE will be made publicly available, and an additional 10 working days are provided to you to comment on any factual errors or clarity concerns contained in the draft SE. The final SE will be issued after making any necessary changes and will be made publicly available. The NRC staff's disposition of your comments on the draft SE will be discussed in the final SE.

To facilitate the NRC staff's review of your comments, please provide a marked-up copy of the draft SE showing proposed changes and provide a summary table of the proposed changes. If you have any questions, please contact Michelle Honcharik at 301-415-1774.

Sincerely,

/RA/

Stacey L. Rosenberg, Chief
Special Projects Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Project No. 712

Enclosure: Draft SE

cc w/encl: See next page
Andrew A. Lingenfelter, Manager

May 30, 2007

GNF Engineering
Global Nuclear Fuels - Americas, LLC
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Wilmington, NC 28402

**SUBJECT: DRAFT SAFETY EVALUATION FOR GLOBAL NUCLEAR FUEL (GNF)
TOPICAL REPORT (TR) NEDC-32851P, REVISION 2, "GEXL14
CORRELATION FOR GE14 FUEL" (TAC NO. MD5486)**

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Sincerely,

/RA/

Stacey L. Rosenberg, Chief
Special Projects Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Project No. 712
Enclosure: Draft SE
cc w/encl: See next page

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ADAMS ACCESSION NO.: ML071390002

*No major changes to SE input.

NRR-043

OFFICE	PSPB/PM	PSPB/LA	SNPB/BC*	PSPB/BC
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01/25/07

DRAFT SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

TOPICAL REPORT NEDC-32851P, REVISION 2

"GEXL14 CORRELATION FOR GE14 FUEL"

GLOBAL NUCLEAR FUEL

PROJECT NO. 712

1.0 INTRODUCTION AND BACKGROUND

By letter dated September 25, 2001 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML012760506), Reference 1, Global Nuclear Fuel - Americas, LLC, hereafter referred to as GNF, submitted a request to the U. S. Nuclear Regulatory Commission (NRC) to review topical report (TR) NEDC-32851P, Revision 2, "GEXL14 Correlation for GE14 Fuel." This revision includes changes to the correlation statistics for the GNF 10x10 fuel design based entirely on experimental data and additional testing of the GE14 fuel. The review of NEDC-32851P, Revision 2 was closed by the NRC staff in letter dated July 11, 2003, while GNF conducted additional testing to obtain critical power data for GE14 top peaked axial power shape. Supplement 1 to NEDC-32851P, Revision 2, was provided by letter dated April 13, 2007 (ADAMS Accession No. ML071080327) and proprietary enclosure (ADAMS Accession No. ML071080333), Reference 2, which includes the additional test data.

The TR presents the GEXL14 correlation development for determination of the minimum critical power ratio (MCPR) during normal operation and postulated transient events for the General Electric Corporation (GE) boiling water reactor (BWR). The GEXL14 correlation is a critical quality and boiling length correlation used to predict the occurrence of boiling transition in BWR fuel designs. The test data used to support the development of the correlation include full-scale simulations of 7x7, 8x8, 9x9, and 10x10 fuel assemblies that were obtained at the GE ATLAS test facility in San Jose, California. The database supporting the basic GEXL correlation includes over 20,000 full-scale boiling transition data points and encompasses all of the fuel assembly designs and operating regions for BWRs. Testing has been performed in the ATLAS facility to demonstrate that the GEXL correlation can be used to predict the onset of boiling transition during postulated transient conditions that are analyzed in the safety analysis process.

The specific GEXL14 correlation developed for use in the core design and safety analysis process is intended to accurately predict the expected critical power performance of the fuel assembly design. In the core design process, the GEXL14 correlation is used to determine the expected thermal margin for the operating cycle. In the safety analysis process, the GEXL14 correlation is used in the determination of the change in critical power transients and in the determination of an acceptable MCPR safety limit. Based on the supporting test database, the TR concludes that the safety related conditions have been satisfied with respect to the development of an acceptable critical power correlation.

Revision 1 of TR NEDC-32851P, which describes the GEXL14 critical power correlation for GE14 fuel, was transmitted to the NRC by letter dated August 8, 2000. The lead plant application for GE14 fuel was the Duane Arnold Energy Center (DAEC) Extended Power Uprate (EPU). The DAEC Technical Specification Change Request for EPU, Reference 4, referred to TR NEDC-32851P, Revision 1, for critical power determination for the new fuel. As part of the DAEC EPU review, the NRC staff evaluated Revision 1 of the TR, including the experimental database used for the development of the GEXL14 critical power ratio (CPR) correlation for the GE14 (10x10) fuel lattice design. Several issues were identified by the NRC staff. The summary of the NRC staff's findings and GNF's corrective actions to resolve the issues are discussed below.

During the week of March 26, 2001, four members of the NRC staff visited the GNF engineering and manufacturing facility in Wilmington, North Carolina. The purpose of the visit was to perform an onsite review of the safety analyses and system and component performance evaluations used to support the proposed EPU. The areas covered by the review included:

1. Fuel performance of the 10x10 GE14 fuel lattice design used for DAEC, including available post-irradiation examination data;
2. Review of the GEXL14 correlation database for GE14 fuel;
3. Verification that the experimental database range covered DAEC's expected operating ranges or state points (i.e., pressures, mass fluxes, inlet subcooling) for all three axial profiles (cosine, inlet-peaked, and outlet-peaked); and
4. Review of the GE14 fuel design compliance with the NRC-approved methodology.

During the audit, the NRC staff evaluated the thermal-hydraulic compatibility of the DAEC resident fuel types in the low-flow/high power conditions with off-normal void distribution.

A formal Request for Additional Information letter summarizing the audit issues was issued in June 2001. A chronology of events related to the TR review is attached to this safety evaluation.

2.0 REGULATORY EVALUATION

The regulation at Title 10 of the Code of Federal Regulations (10 CFR), Section 50.34, "Contents of applications; technical information," requires that Safety Analysis Reports be submitted that analyze the design and performance of structures, systems, and components provided for the prevention of accidents and the mitigation of the consequences of accidents. As part of the core reload design process, licensees (or vendors) perform reload safety evaluations to ensure that their safety analyses remain bounding for the design cycle. To confirm that the analyses remain bounding, licensees confirm that key inputs to the safety analyses, such as the CPR are conservative with respect to the current design cycle. If key safety analysis parameters are not bounded, a re-analysis or re-evaluation of the affected transients or accidents is performed to ensure that the applicable acceptance criteria are satisfied.

The NRC staff review was based on the evaluation of the technical merit and compliance with any applicable regulations associated with reviews of TRs.

General Design Criterion (GDC)-10, "Reactor design," of Appendix A to 10 CFR Part 50 is intended to ensure that reactor cores are designed with appropriate margin such that specified acceptable fuel design limits are not exceeded during normal operation or anticipated operational occurrences (AOOs).

To ensure compliance with GDC-10, the NRC staff confirms that the thermal and hydraulic design of the core and the reactor coolant system has been accomplished using acceptable analytical methods, is equivalent to or is a justified extrapolation from proven designs, provides acceptable margins of safety from conditions which would lead to fuel damage during normal reactor operation and AOOs, and is not susceptible to thermal-hydraulic instability.

Reference 5, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," Section 4.4, "Thermal and Hydraulic Design," describes the normal review of thermal and hydraulic design and requires that additional independent audit analyses be performed for new CPR correlations.

3.0 TECHNICAL EVALUATION

The GE critical quality - boiling length critical power correlation (GEXL) was developed to accurately predict the onset of boiling transition in BWR fuel assemblies during both steady-state and reactor transient conditions. The use of the GEXL correlation is necessary for determining the MCPR operating limits resulting from transient analysis, the MCPR safety limit analysis, and the core operating performance and design. The GEXL correlation is an integral part of the transient analysis methodology used by GNF. It is used to confirm the adequacy of the MCPR operating limit, and it can be used to determine the time of onset of boiling transition in the analysis of other events.

The GEXL correlation has been used in the safety analysis process for GE fueled BWRs since 1974. The GEXL correlation is based on the relationship of critical quality with boiling length. It expresses bundle average critical quality as a function of boiling length, thermal diameter, system pressure, lattice geometry, local rod peaking pattern (R-factor), mass flux, and annular flow length.

During the DAEC EPU audit, the NRC staff reviewed GE's experimental database used to develop the GEXL14 CPR correlation for the GE14 (10x10) fuel lattice design. The EPU onsite audit findings and the resolutions to identified open items are discussed below:

- (1) The NRC staff found that in its CPR correlation methodology, GNF was using the COBRAG computer code (with the GEXL correlation built in) to generate data instead of using experimental data obtained from their critical heat flux test facility in San Jose, California. The use of artificial data instead of raw data affects the validity of the statistical results obtained from this methodology. The statistical results are important because they are used in the calculation of the safety limit MCPR (SLMCPR) for all BWRs that use GE14 fuel. The correlation uncertainty associated with the data points

affects the uncertainty of the safety limit calculations, as well as the degree of conservatism that is used to establish the reactor operating limits.

The NRC staff is aware of the difficulty in predicting critical power phenomena in the upper portion of the core because of the active multiple phase transitions and the part-length rods present in GE14 fuels. The COBRAG code has never been reviewed by the NRC staff for this purpose. Consequently, GNF agreed to remove the COBRAG-generated data from the development of the GEXL correlation for the GE14 fuel design.

- (2) The NRC staff was concerned that GNF had not conducted sufficient testing of the new GE14 fuel to adequately evaluate the GEXL14 correlation. The NRC staff discovered that the experimental data collected to develop and validate the GEXL14 correlation did not include inlet and outlet power shapes. GNF pointed out to the NRC staff that there are similarities between the GE11 (9x9) fuel lattice design and the GE14 (10x10) fuel lattice designs, namely the presence of part-length rods. However, the NRC staff believes that there are also significant differences, such as the locations of the part-length rods relative to the water holes in the GE14 fuel design. To resolve the issue, GNF proposed to obtain additional critical heat flux (CHF) data to validate the GEXL14 correlation. In the interim, GNF proposed a self imposed "additional correlation uncertainty" while they obtained the additional data.

3.1 Supplemental Data and Power Shape Sensitivity Comparison

Subsequent to the NRC staff's finding during the DAEC EPU audit, GNF obtained (inlet/bottom peaked) data from its ATLAS facility. GNF also obtained (outlet/top peaked) data from Stern Laboratory in Ontario, Canada. This additional data was used to validate the GE14 correlation uncertainty and CHF behavior for inlet and outlet peaked power profiles.

The ATLAS critical power data used to develop the GEXL14 correlation contained bottom peaked and cosine axial power shape data, but no top peaked axial power shape data. Additional critical power data have subsequently been collected from the Stern Laboratory test facility. A total of [[]] critical power data points were collected to verify the axial power shape sensitivity. These data points were not used in the development of the GEXL14 correlation, but were used to validate the capability of the GEXL14 correlation to predict the trend with axial power shape. The GEXL14 correlation coefficients were not adjusted in this process, only the additive constants were determined for the rod-to-rod peakings used in the Stern Laboratory tests.

The statistics for the validation of the GEXL14 correlation against the Stern Laboratory data is given in the Table 4-10 of TR NEDC-32851P, Supplement 1. Analysis of the ATLAS and Stern Laboratory data show that the numbers compare very well to the GEXL14 correlation statistics for the ATLAS data used to develop the correlation, as shown in Table 1 below. The correlation statistics for the ATLAS data had a mean ratio of calculated to measured critical power (ECPR) of [[]] and a standard deviation of [[]] percent. The General Electric Thermal Analysis Basis method was used to account for the absence of inlet/outlet peaked experimental data resulting in an increase in the licensing basis uncertainty to [[]] percent. It is seen from the

close agreement between these data that the GEXL14 correlation predicts the trend with axial power shape very well.

The interim additional correlation uncertainty was calculated using a conservative estimate of the outlet peaked standard deviation. A correlation uncertainty of [[]] percent has been used for outlet peaked power shapes in all GEXL14 applications. This has resulted in as much as a [[]] percent increase in the SLMCPR for operating plants with GE14 fuel. When additional data was obtained and the correlation statistics were determined, the correlation upskew and downskew CPR uncertainties were found to be within the original correlation total uncertainty. Therefore, the original correlation uncertainty of [[]] percent can be reinstated.

Using the actual calculated standard deviation and considering the data in Table 1, the overall uncertainty is calculated to be [[]] percent. This is within the original licensing basis uncertainty of [[]] percent.

Table 1. GEXL14 Statistics versus Experimental Data

	Bottom Peaked Axial Power Shape (Stern)	Top Peaked Axial Power Shape (Stern)	Cosine Power Shape (ATLAS)
Number of Data Points	[[
Mean ECPR, μ			
Standard Deviation]]

Table 1 demonstrates that these uncertainties are within the original licensing basis correlation uncertainty of [[]] percent for various axial power shapes.

Figure 4-1 of TR NEDC-32851P, Supplement 1, compares the power shape sensitivity between inlet/outlet peak power shapes and cosine for GE14 (GEXL14), GE12 (GEXL10), GE11 (GEXL07), and GE13 (GEXL09). The latter two are correlations for 9x9 bundles for which ATLAS tests for all three power shapes were performed. The comparison shows that the outlet peak relative performance for GEXL14 is very consistent with the outlet peak relative performance for previous 9X9 fuel. This shows that additional spacers at varying locations within the bundle do not introduce any new sensitivities into the axial power shape effects. The agreement of the GEXL14 correlation predictions with the Stern Laboratory data for inlet and outlet peaked axial power shapes confirms this observation and demonstrates that the GEXL correlation accurately predicts the sensitivity with axial power shape.

3.2 High R-factor

The data collected in the ATLAS facility and the standard critical power database from the Stern laboratory tests had R-factors up to [[]]. This R-factor range had previously been judged to be sufficient to cover fully controlled bundles. [[

]], MFN-05-095, J. S. Post to NRC, "Part 21 Notification Completion, Critical

Power Determination for GE14 and GE12 with Zircaloy Spacers”, September 20, 2005 (Reference 6), and FLN-2005-034, A. A. Lingenfelter to NRC, “Recent Experimental Thermal Hydraulics and GNF2 Licensing Meeting, October 26-27, 2005”, December 15, 2005 (Reference 7). [[

]] However, GNF conducted an additional test at the Stern Laboratory test facility simulating a fully controlled bundle and having a very high R-factor of 1.26. Comparison of the ECPR results from the Stern Laboratory test with those of the GEXL14 correlation prediction of an ECPR of [[]] and a standard deviation of [[]] demonstrates that the extension of the upper R-factor application range to 1.25 is justified.

The pressure range was also adjusted. The previous ATLAS testing covered the pressure range from 800 to 1300 psia. The Stern Laboratory testing extended this range from 700 to 1400 psia.

The GEXL14 correlation for GE14 fuel is valid over the range stated in Table 2 below.

Table 2. GEXL14 Applicability Range

Pressure	4.8 to 9.7 MPa (700 to 1400 psia)
Mass Flux	*136 to 2448 kg/sec-m ² (0.1 x 10 ⁶ to 1.8 x 10 ⁶ lb/hr-ft ²)
Inlet Subcooling	0 to 233 kJ/kg (0 to 100 Btu/lb)
R-factor	*0.9 - 1.25

*exception in R-factor and Mass flux plane, the parameters should also satisfy:

$$(1.2-R)/0.05 \geq (G-1.5)/0.3 \text{ for } 1.15 < R < 1.20$$

$$(1.25-R)/0.05 \geq (G-1.3)/0.2 \text{ for } 1.20 < R < 1.25$$

The upper mass flux range for R < 1.15 is 2448 kg/sec-m²

4.0 CONCLUSION

The GEXL14 correlation has been validated against ATLAS data for cosine and inlet peaked axial power shapes and against Stern Laboratory data for inlet and outlet peaked axial power shapes. These comparisons show that the axial power shape sensitivity is well predicted by the GEXL correlation. The power shape sensitivity has been shown to be very similar for the different 9X9 and 10x10 fuel product lines.

The TR NEDC-32851P was reviewed as part of the DAEC EPU submittal. The technical issues which were discovered during the DAEC EPU review were resolved in the EPU audit and supplemental documentation (Reference 8). On the basis of these prior reviews and the NRC staff review of Supplement 1 to TR NEDC-32851P, Revision 2, the NRC staff considers the methodology described in TR NEDC-32851P, Revision 2, acceptable. GNF satisfactorily

responded to the issues with timely and appropriate corrective actions, explanations, and additional test data. Therefore, on the basis of the above review and justification, the NRC staff concludes that the proposed GEXL14 critical power correlation is acceptable.

5.0 REFERENCES

1. G. A. Watford to NRC, "GEXL14 Correlation for GE14 Fuel, NEDC-32851P Revision 2 and GEXL10 Correlation for GE12 Fuel with Inconel Spacers, NEDC-32464P Revision 2," September 25, 2001 (ADAMS Accession No. ML012760506).
2. A. A. Lingenfelter to NRC, "Supplement 1 to GEXL14 Correlation for GE14 Fuel, NEDC-32851P, Revision 2, September 2001," April 13, 2007 (ADAMS Accession No. ML071080327) and proprietary enclosure (ADAMS Accession No. ML071080333).
3. NEDE-24011-P-A-14, General Electric Standard Application for Reactor Fuel (GESTAR II), June 2000 (ADAMS Accession No. ML011230173).
4. Nuclear Management Company to the NRC, "Duane Arnold Energy Center, Docket No. 331, Op. License No. DPR-49, Technical Specification Change Request (TSCR-042): 'Extended Power Uprate,'" November 16, 2000, and attachments (ADAMS Accession No. ML003771301).
5. NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," April 1996.
6. J. S. Post to NRC, "Part 21 Notification Completion, Critical Power Determination for GE14 and GE12 Fuel with Zircaloy Spacers," September 20, 2005 (ADAMS Accession No. ML052690084).
7. A. A. Lingenfelter to NRC, "Recent Experimental Thermal Hydraulics and GNF2 Licensing Meeting, October 26-27, 2005," December 15, 2005 (ADAMS Accession No. ML060050548).
8. Duane Arnold Energy Center, NRC Staff Safety Evaluation for Amendment No. 243, Extended Power Uprate, November 6, 2001 (ADAMS Accession No. ML013050342).

Attachment: Chronology of Events for Approval of GEXL14 Correlation TR NEDC-32851P

Principle Contributors: J. Gilmer
A. Attard

Date: May 20, 2007

CHRONOLOGY OF EVENTS FOR APPROVAL OF GEXL14
CORRELATION TOPICAL REPORT (TR) NEDC-32851P

<u>Date</u>	<u>Description</u>	{See Comments Summary Table}
September 1999	Requests for additional information (RAIs) on Revision 1 of TR NEDC-32851P sent to Global Nuclear Fuel (GNF).	
March 26, 2001	Duane Arnold Energy Center (DAEC) extended power uprate (EPU) audit conducted at GNF (identified same issues as those encountered in review of NEDC-32851P, Revision 1).	
March 27, 2001	GNF letter and attached responses to RAIs regarding GE14 review.	
June 2001	Presentation to the U.S. Nuclear Regulatory Commission (NRC) staff on axial power shape sensitivity (echoed GNF's position provided in responses to Revision 1 in March 2001).	
September 2001	GNF submitted TR NEDC-32851P, Revision 2, to the NRC staff for review.	
November 2001	Safety Evaluation (SE) for DAEC EPU (Agencywide Documents Access and Management System Accession No. ML013050342) - lead plant for GE14 fuel; accepted by NRC staff.	
February 2002	NRC staff meeting with GNF to discuss TR NEDC-32851P, Revision 2 (corrective actions, proposed testing program, preventative actions, double hump considerations).	{See Comments Summary Table}
April 2002	GNF letter describing proposed interim evaluation process.	
May 2003	GNF letter committing to additional testing.	{See Comments Summary Table}
July 2003	NRC letter rejecting GNF position that correlation issues are addressed by GESTAR, Amendment 22.	{See Comments Summary Table}
January/February 2005	GNF conducts additional tests at Stern Laboratory to obtain additional data for the GEXL14 correlation.	
March 2005	Final SE on GESTAR, Amendment 27 (this SE did address the additional CHF data for the GEXL14 correlation).	
October 2005	GNF presentation to the NRC staff on testing results to resolve test data deficiency for the GE14 fuel.	
April 2007	GNF letter provided Supplement 1 to NEDC-32851P, Revision 2.	

{See Comments Summary Table}