

September 27, 2001

Mr. Glen A. Watford, Manager  
Fuel Engineering Services  
Global Nuclear Fuel  
P.O. Box 780  
Wilmington, NC 28402

SUBJECT: SAFETY EVALUATION FOR TOPICAL REPORT NEDC-32981P, "GEXL96  
CORRELATION FOR ATRIUM-9B FUEL" - GLOBAL NUCLEAR FUEL  
(TAC NO. MB0183)

Dear Mr. Watford:

By letter dated September 26, 2000, Global Nuclear Fuel (GNF), submitted for staff review Topical Report NEDC-32981P, "GEXL96 Correlation for Atrium-9B Fuel." The staff concluded that the proposed approach is acceptable based on the staff findings stated in the enclosed safety evaluation. A Technical Evaluation Report (TER) from our consultant, Pacific Northwest National Laboratory (PNNL), is attached to the safety evaluation.

Pursuant to 10 CFR 2.790, we have determined that the enclosed safety evaluation and TER do not contain proprietary information. However, we will delay placing these documents in the public document room for a period of ten (10) working days from the date of the letter to provide you with the opportunity to comment on the proprietary aspects only. 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 2.790.

We do not intend to repeat our review of the matters described in the subject report, and found acceptable, when the report appears as a reference in license applications, except to ensure that the material presented applies to the specific plant involved. Our acceptance applies only to matters approved in the report.

In accordance with procedures established in NUREG-0390, the NRC requires that GNF publish accepted versions of the submittal, proprietary (-P) and non-proprietary (-NP), within 3 months of receipt of this letter. The accepted versions shall incorporate (1) this letter and the enclosed safety evaluation and its attachment between the title page and the abstract, and (2) all requests for additional information from the staff and all associated responses, and (3) an "-A" (designating "accepted") following the report identification symbol.

Mr. Glen A. Watford

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Should our criteria or regulations change so that our conclusions as to the acceptability of the report are invalidated, GNF and/or the applicants referencing the topical report will be expected to revise and resubmit their respective documentation, or submit justification for the continued applicability of the topical report without revision of their respective documentation.

Sincerely,

**/RA/**

Stuart A. Richards, Director  
Project Directorate IV  
Division of Licensing Project Management  
Office of Nuclear Reactor Regulation

Project No. 711

Enclosure: Safety Evaluation w/attachment

cc w/encl: See next page

Mr. Glen A. Watford

- 2 -

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\* Input received on 8/27/01. No major changes were made.

**ATTACHMENT 2 ACCESSION NO.: ML012490123**

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Global Nuclear Fuel

Project No. 711

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# SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

## GLOBAL NUCLEAR FUEL TOPICAL REPORT NEDC-32981P,

### "GEXL96 CORRELATION FOR ATRIUM-9B FUEL"

#### PROJECT NO. 711

## 1.0 INTRODUCTION

By letter dated September 26, 2000 (FLN-2000-017) (Reference 1), Global Nuclear Fuel (GNF) submitted licensing Topical Report (TR) NEDC-32981P, "GEXL96 Correlation for Atrium-9B Fuel." The submittal describes the process used in the development of the GEXL96 correlation for prediction of critical power for ATRIUM-9B fuel and the determination of the overall uncertainty relative to measurement results. GNF has indirect access to the ANFB correlation for ATRIUM-9B through the 3-D plant simulator code MICROBURN.

The NRC staff was assisted in this review by its consultant, Pacific Northwest National Laboratory (PNNL). The NRC staff's evaluation includes the review of the TR and the responses to the staff's request for additional information (RAI) (References 2 and 3 ). The staff adopted the findings recommended in the attached Technical Evaluation Report (TER) prepared by our consultant PNNL.

## 2.0 EVALUATION

This review includes: (1) adequacy of the hypothetical database generated with MICROBURN for an experimental database; (2) proper determination of the uncertainty in GEXL96 correlation's predictions for ATRIUM-9B fuel, and (3) applicability of the proposed range of GEXL96 correlation to ATRIUM-9B fuel supported by the range of the hypothetical database. The details of the evaluation are provided in the TER.

### 2.1 Validity of Using Hypothetical Data Base

Exelon used the ANFB correlation for ATRIUM-9B fuel (as encoded in the plant simulator program MICROBURN) to generate a hypothetical database of predicted critical power values for a range of operating conditions corresponding to the range of ANFB-9B correlation. This hypothetical database was then treated in the same way as an experimental database, using the approved methodology for GEXL correlation development. Using this approach, GNF produced a new form of GEXL96 correlation intended for application to ATRIUM-9B fuel.

The database generated in this manner is an artificial construct, created with a correlation that can only approximate the actual critical power behavior in the ATRIUM-9B fuel. It can be expected with reasonable engineering certainty that conditions that produce boiling transition in the test assembly would also produce boiling transition in the fuel in a reactor core. Testing the hypothetical databases as if it were real data in the regression analysis, therefore, introduces unavoidable error into the correlation being derived from it. The critical power values in the hypothetical database generated with ANFB-9B correlation have an additional error that is the ANFB-9B correlation's local error at each point.

The local critical power values predicted with the approved ANFB-9B correlation can be predicted to vary over the range of the hypothetical database. Since the GEXL96 correlation is fitted to this hypothetical database, the error in the critical power prediction of the GEXL96 correlation for a given set of conditions will have some additional error relative to the real critical power value for those conditions, over and above the uncertainty of the correlation's fit to the hypothetical database. Therefore, the approach of the correlation procedure can be valid only if overall uncertainty in the new GEXL96 correlation is appropriately characterized in terms of the uncertainty in its fit to the hypothetical database and the uncertainty of the critical power values in the hypothetical database itself.

## 2.2 Appropriate Treatment of Uncertainties

The treatment of the overall uncertainty of the GEXL96 correlation for ATRIUM-9B fuel, as originally presented in the submittal, is not complete in that it does not appropriately combine the uncertainty of the fit of GEXL96 correlation to the hypothetical database and the uncertainty of the database itself, which is a function of the uncertainty of ANFB-9B correlation.

GNF has conceded in its response to the staff's RAI (Reference 2) that their arguments (i.e., the lack of trend errors in the prediction of the GEXL96 correlation) do not prove the assumed statistical independence of the two correlations, and accepts the assumption that the uncertainty of the GEXL96 correlation should be calculated with a covariance of 1.0.

## 2.3 Range of Application of GEXL96

Extrapolation of any correlation beyond its database is generally an ill-advised procedure and cannot be permitted without some reasonable attempt to quantify the uncertainty of the correlation's predictions in the extrapolated region.

The range of application for the GEXL96 correlation as stated in the submittal is larger than the range of the hypothetical database over which the correlation is derived. Specifically, the ranges on mass flux and R-factor exceed the ranges of the hypothetical database for these parameters. In addition, the range on inlet subcooling is extrapolated back to zero, even though the database does not include any point with zero inlet subcooling. Such extrapolation on inlet subcooling is standard practice, however, and is justified by the fact that critical power is essentially linear with inlet subcooling in this very low subcooling range.

With respect to the ranges on mass flux and R-factor, GNF presents the results of the analysis of the reference loading pattern for Dresden-2 Cycle 18 (Reference 2), which will be the first GE14 reload in Exelon's BWR-3s, and has core characteristics that are representative of the mixed cores that will be encountered at each of Exelon's BWR-3s. The critical power ratio (CPR) was extracted for all ATRIUM-9B fuel throughout the entire cycle at nominal extended power uprate (EPU) condition (115 percent power and 95 percent - 100 percent rated flow). This analysis shows that: (1) the CPR increases rapidly as a function of mass flux above a value of 1.2 Mlbm/hr-ft<sup>2</sup>; (2) bundles with very low R-factors correspond to high exposure fuel that will operate at low power and have high margin to boiling transition (CPR>2.0); (3) the higher R-factors correspond to fuel with various control fractions and high margin (CPR>2); and (4) the majority of ATRIUM-9B fuel in the analysis of Cycle 18 exhibited R-factors within the range of the database and corresponding to uncontrolled fuel assemblies.

Based on the justification provided by GNF, the staff has found that the extrapolation to high R-factors is acceptable because only fully controlled bundles will have R-factors in this range, and they will be operating at very low power and will not be limiting.

### 3.0 CONCLUSION

Based on the staff's review of NEDC-32981P, "GEXL96 Correlation for ATRIUM-9B Fuel," the staff concludes that the proposed approach is acceptable based on the following findings:

1. The total uncertainty in the correlation's critical power predictions appropriately takes into account the fact that the uncertainty in the new correlation's fit to the hypothetical database and the uncertainty in the hypothetical database with respect to the underlying experimental data are not independent;
2. Generating the hypothetical databases using the ANFB-9B correlation in MICROBURN code is a reasonable engineering approach to dealing with mixed core fuel in this case, where the experimental database and critical power correlation for the previous vendor's fuel is not available to the new vendor;
3. GNF has demonstrated that small extrapolations of the GEXL96 correlation's range of application do not involve any significant increase in the risk of boiling transition occurring for conditions in the extrapolated regions; and
4. The total uncertainty in the GEXL96 correlation predictions of critical power in ATRIUM-9B fuel is 1.39 times the proposed value specified in NEDC-32981-P, Revision 0, as agreed by GNF in its letter of April 27, 2001.

### 4.0 REFERENCES

1. Letter dated September 26, 2000 (FLN-2000-017), from Glen A. Watford, GNF to USNRC transmitting Topical Report NEDC-32981P, Revision 0, "GEXL96 Correlation for ATRIUM-9B Fuel," September 2000.
2. Letter dated April 27, 2001 (FLN-2001-006) from Glen A. Watford, GNF to USNRC transmitting responses to NRC "Request for Additional Information for Topical Report NEDC-32981-P, GEXL96 Correlation for ATRIUM-9B Fuel," March 7, 2001.
3. Letter dated May 11, 2001 (FLN-2001-011), from Glen A. Watford, GNF to USNRC transmitting May 8, 2001 letter from Anthony Giancattarino to Tammy Orr with attachment "Statement on Use of ANFB to Support GEXL96 Development," Exelon Corporation, NFM:MV:01-141.

Attachment: Technical Evaluation Report

Principal Contributor: T. Huang

Date: September 27, 2001