Omaha Public Power District
444 South 16th Street Mall
Omaha, Nebraska 68102-2247

September 28, 2000
LIC-00-0084

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Station P1-137
Washington, DC 20555

References:
1. Docket No. 50-285
2. LIC-00-0069, Letter from S. K. Gambhir to NRC Document Control Desk, Application for Amendment of Facility Operating License No. DPR-40, September 5, 2000 (TAC Number MB0083)

SUBJECT: Transmittal of Siemens Fuel Assembly Growth Model

Omaha Public Power District (OPPD) submitted an "Application for Amendment of Facility Operating License" (Reference 2) to permit the use of nuclear fuel fabricated by Siemens Power Corporation at Fort Calhoun Station (FCS). In conjunction with that application, attached is the justification for the Fuel Assembly Growth Model used by Siemens Power Corporation (SPC) for Fort Calhoun Station. This information was discussed during the May 31, 2000 NRC/OPPD meeting on fuel and referenced in Slide 41 of the FCS presentation.

Pursuant to 10 CFR 2.790, OPPD requests that the proprietary information enclosed be withheld from public disclosure. Siemens Power Corporation considers this information to be proprietary as justified in the supporting affidavit (Enclosure 1). Enclosure 2 is the OPPD/Siemens presentation with the proprietary information enclosed in brackets. Enclosure 3 is the non-proprietary version of Enclosure 2 with the bracketed information deleted.

Please contact me if you have any questions.

Sincerely,

S. K. Gambhir
Division Manager
Nuclear Operations

SKG/RLJ/ASH

Attachments
c: E. W. Merschoff, NRC Regional Administrator, Region IV
L. R. Wharton, NRC Project Manager
W. C. Walker, NRC Senior Resident Inspector
Winston & Strawn (w/o Attachment)

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Enclosure 1

Affidavit from Siemens Power Corporation Supporting
Proprietary Nature of Portions of OPPD/Siemens Fuel Assembly Growth Model

AFFIDAVIT

STATE OF WASHINGTON)
) ss.
COUNTY OF BENTON)

1. My name is Jerald S. Holm. I am Manager, Product Licensing, for Siemens Power Corporation ("SPC"), and as such I am authorized to execute this Affidavit.

2. I am familiar with the criteria applied by SPC to determine whether certain SPC information is proprietary. I am familiar with the policies established by SPC to ensure the proper application of these criteria.

3. I am familiar with the SPC information included in the letter LIC-00-0084 from S. K. Gambhir of Omaha Public Power District to the U.S. Nuclear Regulatory Commission, subject: Transmittal of Siemens Fuel Assembly Growth Model, which is referred to herein as "Document." Information contained in this Document has been classified by SPC as proprietary in accordance with the policies established by SPC for the control and protection of proprietary and confidential information.

4. This Document contains information of a proprietary and confidential nature and is of the type customarily held in confidence by SPC and not made available to the public. Based on my experience, I am aware that other companies regard information of the kind contained in this Document as proprietary and confidential.

5. This Document has been made available to the U.S. Nuclear Regulatory Commission in confidence with the request that the information contained in the Document be withheld from public disclosure.

6. The following criteria are customarily applied by SPC to determine whether information should be classified as proprietary:

(a) The information reveals details of SPC's research and development plans and programs or their results.

(b) Use of the information by a competitor would permit the competitor to significantly reduce its expenditures, in time or resources, to design, produce, or market a similar product or service.

(c) The information includes test data or analytical techniques concerning a process, methodology, or component, the application of which results in a competitive advantage for SPC.

(d) The information reveals certain distinguishing aspects of a process, methodology, or component, the exclusive use of which provides a competitive advantage for SPC in product optimization or marketability.

(e) The information is vital to a competitive advantage held by SPC, would be helpful to competitors to SPC, and would likely cause substantial harm to the competitive position of SPC.

7. In accordance with SPC's policies governing the protection and control of information, proprietary information contained in this Document has been made available, on a limited basis, to others outside SPC only as required and under suitable agreement providing for nondisclosure and limited use of the information.

8. SPC policy requires that proprietary information be kept in a secured file or area and distributed on a need-to-know basis.

9. The foregoing statements are true and correct to the best of my knowledge, information, and belief.

Gerald S. Holm

SUBSCRIBED before me this 21st day of September, 2000.

Amy R. Nixon

Amy R. Nixon
NOTARY PUBLIC, STATE OF WASHINGTON
MY COMMISSION EXPIRES: 12/06/03

AMY R. NIXON
COMMISSION EXPIRES
NOTARY PUBLIC
DECEMBER 6, 2003
STATE OF WASHINGTON

LIC-00-0084

Enclosure 3

Non-Proprietary Version of OPPD/Siemens Fuel Growth Model

Introduction

The fuel assembly irradiation growth models used by Siemens Power Corporation (SPC) are specific for each type fuel design. For PWRs, there are four different growth models:

5. Westinghouse type assemblies with small diameter, thin-wall guide tubes and leaf hold-down springs.
6. Combustion Engineering (CE) 14x14/16x16 type assemblies with large diameter, thick wall guide tubes, and coil hold-down springs.
7. Combustion Engineering 15x15 type assemblies with rolled plate guide bars and no hold-down springs.
8. Kraftwerk Union (KWU) type assemblies with small diameter, thick wall guide tubes and coil hold-down springs.

The growth models are based on irradiation data, and the data show different populations for these different designs.

The Ft. Calhoun fuel design is a CE 14x14 type assembly. However, the design does not use hold-down springs. Therefore, there is a potential that use of the approved growth model for this type of assembly design will result in an underprediction of the end-of-life (EOL) assembly growth. Therefore, SPC will use the CE 15x15 assembly irradiation growth model for the Ft. Calhoun EOL assembly growth evaluation. The CE 15x15 design uses guide bars and does not have hold-down springs. This CE 15x15 model predicts a much larger growth and is expected to bound any effect of not having hold-down springs in the Ft. Calhoun fuel design.

Summary

The CE 15x15 type assembly irradiation growth correlation is expected to provide a conservative overprediction of the EOL irradiation growth of the Ft. Calhoun fuel assemblies. This overprediction results from the higher growth of the CE 15x15 type assembly when compared with the CE 14x14/16x16 type assembly and from the conservatism in the SPC growth model formulation. This conservatism is demonstrated by the comparison of the two growth models and by comparing the model's predictions with irradiation data.

Assembly Irradiation Growth Model Description

The SPC assembly irradiation growth models are described in the correspondence supporting the NRC approval of the PWR generic mechanical design criteria (Reference 1). The form of this model is two lines, intersecting at a fast fluence (>1Mev) of $8x10^{21}$ n/cm^2. A growth model with a higher growth rate at higher fluences is needed because the data indicate that the growth rate of recrystallized zircaloy increases toward the growth rate of cold worked stress-relieved (CWSR)

zircaloy (Reference 2) at higher fluences. The guide tubes are fabricated from recrystallized zircaloy. Fuel cladding is fabricated with CWSR zircaloy.

The lower curve is a correlation based on assembly irradiation growth data. A linear correlation of the growth as a function of the fast fluence is determined from the data for the different assembly types. A conservative, upper prediction (one-sided 95% upper confidence limit) of the growth curve is established. This line provides the growth prediction for fast fluences of less than or equal to $8x10^{21}$ n/cm^2.

The predicted growth above $8x10^{21}$ n/cm^2 is established by the assembly growth at $8x10^{21}$ n/cm^2 plus the growth projected by a second line with the slope of the fuel rod cladding growth. The fuel rod cladding is CWSR material that grows at a much faster rate than the fully recrystallized guide tube material. This slope is used because some recrystallized material irradiation data indicate that the growth rate of recrystallized material increases at high exposure. The increase in growth rate is conservatively assumed to reach the growth rate of CWSR material.

The slope transition exposure of $8x10^{21}$ n/cm^2 was selected to bound the exposure at which the data indicated a growth rate change. This curve bounds the growth of the recrystallized guide tube material.

Figures 1 and 2 present the fuel assembly irradiation growth models for the CE 14x14/16x16 type assembly and the CE 15x15 type assembly, respectively. These figures illustrate the model configuration described above.

Comparison of the CE Type Growth Models

Figure 1 presents the growth model that would normally be used for the CE 14x14/16x16 type fuel. Figure 2 presents the CE 15x15 type fuel. Table 1 provides a comparison of the best estimate and 95/95 upper bound growth predictions at $8x10^{21}$ n/cm^2. These comparisons show that the CE 15x15 model prediction is about [ ] times higher than the CE 14x14/16x16 model prediction. The CE 15x15 model is based on a design with fully recrystallized guide bars instead of recrystallized guide tubes. The guide bar growth is thought to be higher primarily due to the texture that results from the forming. The guide bar design also does not have any holddown, and, therefore, is an unrestrained growth.

Because the high fluence line starts from the intersection point, for a given fluence greater than $8x10^{21}$ n/cm^2, the predicted growth continues to be higher. For PWRs, typically the exposure at $8x10^{21}$ n/cm^2 (>1Mev) is about 45 to 50 MWd/kgU. Therefore, the EOL fast fluence is around 10^{22} n/cm^2.

Conservatism of the CE 15x15 Model for Ft. Calhoun

The conservatism of the CE 15x15 type assembly growth model for Ft. Calhoun results from:

- The large predicted growth of the CE 15x15 model
- The conservatism in the formulation of the growth model.

This conservatism is illustrated by comparisons with high fluence growth measurements. As discussed in the model comparison, at the transition fluence, the CE 15x15 model yields a maximum growth that is almost [ ] higher than the CE 14x14/16x16 model [ ] respectively). The uncertainty in the applicability of the CE 14x14/16x16 model for Ft. Calhoun is due to the lack of hold-down springs. Although not directly comparable, an assessment of the impact of the loading state can be made using BWR CWSR fuel rod information. The normal BWR fuel rods are in compression and the tie rods are in tension. Comparison of the BWR fuel rod and tie rod data indicates a difference of about [ ] in the growth at EOL. Because the springs relax, the growth rate difference between the rod types diminishes with exposure. However, the BWR difference is [ ] the difference between the CE 15x15 growth model and the CE 14x14/16x16 growth model.

As indicated above, the formulation of the SPC assembly growth model is conservative. There are two main sources of the conservatism. The first source is the use of a 95% upper confidence limit prediction of the data. The second source is the selection of the transition fluence. In Reference 2, the transition to the higher growth rate was at about 10^{22} n/cm^2, E>0.82 Mev (an approximate conversion to >1 Mev from >0.82 Mev is to divide the 0.82 fast fluence by 0.85). Therefore, the selection of $8x10^{21}$ n/cm^2 as the transition point is very conservative. The use of the steeper fuel cladding growth curve at this point further increases the conservatism. This conservatism can be seen by comparing the growth data in the Reference 2 report to the CE 15x15 and CE 14x14/16x16 design curves. The Reference 2 data are for fully recrystallized zircaloy in the unrestrained condition. This comparison is shown in Table 2. At the transition fluence, the measured growth is slightly above the CE 14x14/16x16 growth prediction but well under the CE 15x15 model prediction. At a fluence of 10^{22} n/cm^2, E>1Mev, both of the growth models substantially overpredict the measured growth.

A second comparison of irradiation growth data to the transition point is provided in the Westinghouse type assembly growth model. This growth model and the data are shown in Figure 3. The data support the faster growth rate at higher fluences. The transition appears to be between $8x10^{21}$ n/cm^2 and 10^{22} n/cm^2. Again, the data show the overprediction of the model at the higher fluences.

Therefore, the use of the CE 15x15 assembly type growth model for the Ft. Calhoun assembly growth calculations is conservative.

References

1. EMF-92-116(P)(A) Revision 0, *Generic Mechanical Design Criteria for PWR Fuel Designs*, Siemens Power Corporation, February 1999.

2. F. Garzarolli, etal., "Effects of High Neutron Fluences on Microstructure and Growth of Zircaloy 4," *Zirconium in the Nuclear Industry: Eight International Symposium, ASTM STP 1023*, L. F. P. Van Swam and C. M. Eucken, Eds., American Society for Testing and Materials, Philadelphia, 1989, pp. 641-657.

Table 1 Predicted Assembly Growth

Table 2 Growth Model Comparisons

Figure 1 CE 14x14/16x16 Type Assembly Growth versus Fast Fluence (SPC Data)

Figure 2 CE 15x15 Type Assembly Growth versus Fast Fluence (SPC Data)

Figure 3 Westinghouse Type Assembly Growth versus Fast Fluence (SPC Data)