September 1, 2005

Mr. George B. Stramback
Regulatory Services Project Manager
GE Nuclear Energy
175 Curtner Avenue
San Jose, CA 95125

SUBJECT: DRAFT SAFETY EVALUATION REGARDING REMOVAL OF METHODOLOGY LIMITATIONS FOR NEDC-32983P-A, "GENERAL ELECTRIC METHODOLOGY FOR REACTOR PRESSURE VESSEL FAST NEUTRON FLUX EVALUATION" (TAC NO. MC3788)

Dear Mr. Stramback:

By letters dated January 29, 2003, July 14, September 10, and December 2, 2004, and May 20, 2005, General Electric Nuclear Energy (GENE) submitted information to justify removing methodology limitations associated with NEDC-32983P-A, "General Electric Methodology for Reactor Pressure Vessel Fast Neutron Flux Evaluation." This letter transmits the Nuclear Regulatory Commission (NRC) staff's draft safety evaluation (SE) regarding removing these limitations for GENE's review and comment.

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 Mel Fields at (301) 415-3062.

Sincerely,

/RA/
Robert A. Gramm, Chief, Section 2
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Project No. 710

Enclosure: Draft SE

cc w/encl: See next page

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DRAFT SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REGARDING REMOVAL OF METHODOLOGY LIMITATIONS FOR NEDC-32983P-A,

"GENERAL ELECTRIC METHODOLOGY FOR REACTOR PRESSURE VESSEL FAST

NEUTRON FLUX EVALUATION"

GENERAL ELECTRIC NUCLEAR ENERGY

PROJECT NO. 710

1.0 INTRODUCTION

On September 14, 2001 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML012400381), the Nuclear Regulatory Commission (NRC) approved the General Electric Nuclear Energy (GENE) boiling-water reactor (BWR) methodology for pressure vessel and core shroud fast neutron flux (E > 1.0 MeV) evaluation (Reference 1). However, the approval was subject to the following limitations:

(1) Within three years from the day of the approval of this methodology, GENE will perform predictive calculations of at least four additional BWR surveillance capsule dosimetry measurements which will be submitted to the NRC staff before initiation of the measurements.

(2) Comparisons of the measurements and calculations will also be submitted to the NRC.

(3) Shroud fluence estimates will be limited to the beltline region, without bias adjustment.

(4) GENE will perform dosimetry analysis to confirm and remove the conservatism in the shroud fluence calculations.

(5) Revisions to the fluence methodology and supporting uncertainty analysis will be provided, if the calculated/measured (C/M) comparisons (for the additional analysis of the vessel and the shroud) are not consistent with the NEDC-32983P fluence methodology.

In the process of removing the limitations, GENE submitted additional information in letters dated January 29, 2003, July 14, September 10, and December 2, 2004, and May 20, 2005 (References 2 to 6, respectively). Information was also exchanged in telephone conferences between the NRC staff and GENE personnel in order to clarify the information submitted in these letters.

2.0 REGULATORY BASIS

Specific fracture toughness requirements for normal operation and for anticipated operational occurrences for power reactors are set forth in Appendix G, "Fracture Toughness

Requirements," of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities." The requirements of Appendix G are imposed by 10 CFR 50.60. Additionally, in response to concerns over potential pressurized thermal shock events in pressurized-water reactors, the NRC issued 10 CFR 50.61, "Fracture toughness requirements for protection against pressurized thermal shock events."

To satisfy the requirements of both Appendix G and 10 CFR 50.61, methods for determining the fast neutron fluence (E > 1.0 MeV) are necessary to estimate the fracture toughness of the pressure vessel materials.

Regulatory Guide (RG) 1.190, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence," describes methods and assumptions acceptable to the NRC staff for determining pressure vessel fluence. This RG is intended to ensure the accuracy and reliability of the fluence determination required by General Design Criteria 14, 30, and 31 of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50. The NRC staff's review of the NEDC-32983P methodology used the guidance contained in RG 1.190 to determine the acceptability of the proposed changes.

3.0 TECHNICAL EVALUATION

The following is a discussion and justification for the removal of those limitations.

Limitation (1):

> Within three years from the day of the approval of this methodology, GENE will perform predictive calculations of at least four additional BWR surveillance capsule dosimetry measurements which will be submitted to the NRC staff before initiation of the measurements.

GENE stated that there were no surveillance capsules in the pipeline for them to fulfill the condition of four surveillance capsules. Instead, General Electric (GE) proposed a one capsule blind test (from the River Bend plant) and three existing (but not calculated) surveillance capsules. The alternative, i.e., the four GE surveillance capsules for a blind test, would cause an unpredictable delay in removing the limitations. The NRC staff agreed to this arrangement and the River Bend surveillance capsule at 183E azimuth calculated value was submitted on January 29, 2003 (Reference 2). The measured value of the same capsule was published by the Electrical Power Research Institute in June 2003 in BWRVIP-113 (Reference 7). The difference between the pre-calculated and measured values is about 4.5 percent. This is well within the 20 percent (1σ) guidance in RG 1.190 (Reference 8) and, therefore, it is acceptable. In addition, GE submitted the calculated values for the three existing surveillance capsules (one by GE; two by other vendors) for which GE performed the calculations. The C/M ratios range between -16.5 percent to 6.3 percent, again within the provisions of RG 1.190 and, therefore, are acceptable.

GE incorporated the additional four data points into its data base. The bias and the associated uncertainty changed to 6.4 percent ± 3.4 percent (1σ). However, GE stated that the practice of

applying the 7.0 percent (1σ) bias will continue. This is acceptable and the requirement to perform additional confirmatory calculations has been fulfilled and therefore, this limitation is being removed.

Limitation (2):

> Comparisons of the measurements and calculations will also be submitted to the NRC.

As indicated in the discussion of Limitation (1) above, this requirement has been satisfied and therefore, this limitation is being removed.

Limitations (3) and (4):

> Shroud fluence estimates will be limited to the beltline region, without bias adjustment.
>
> GENE will perform dosimetry analysis to confirm and remove the conservatism in the shroud fluence calculations.

Reference 4 documented GE's efforts regarding shroud fluence recalculation and benchmarking. GE identified two shroud samples taken from BWR-4 plants, one from the middle-plane at a 100E azimuth and the other 36 inches below the top guide ring weld at the 316E azimuth. A total of seven samples were created, measured, and calculated. The mean value of C/M ratios for E > 1.0 MeV flux and the associated uncertainty is 1.10 ± 0.11 (1σ). These values are conservative and GE suggested that this was sufficient to satisfy the requirement for additional work.

The NRC staff expected that GE would present measurements to quantify axial shroud bias. This is important because fluence is used in estimating shroud crack growth rates due to irradiation assisted stress corrosion cracking. Such cracks populate mostly at the beltline region. In the December 2, 2004, submittal (Reference 5), GE stated that it does not possess any additional data to establish the shroud axial dependance of the flux. However, GE presented arguments based on the In-Reactor Irradiation Monitoring (IRIM) experimental data from 36 near-shroud measurements in response to question 8 during the original review. These data show that there is no axial bias although the uncertainty appears to be higher with elevation. In addition, GE presented arguments that material properties, for example yield strength versus fluence and intergranular chromium precipitation versus fluence, demonstrate very wide variations for a given fluence value, thus accurate knowledge of the fluence does not add to the accuracy of the knowledge of the material properties. The NRC staff considered in total: the IRIM data not being actual plant data, the existence of two actual plant data points showing good C/M agreement, theoretical arguments advanced by GE that there does not exist a particular cause for such axial bias dependence, the behavior of irradiated material versus fluence and the lower fluence accuracy requirements (compared to vessel) regarding crack propagation rate and decided that the GE fluence methodology is acceptable for shroud fluence calculations. Therefore, Limitations (3) and (4) are being removed.

There is another emerging issue regarding fluence calculations for the shroud and for reactor internals, i.e., that of helium production that affects their weldability. Helium calculations involve both fast and thermal fluence. GE stated (Reference 6) that because its methodology does not calculate thermal flux, it will not be applied to helium calculation problems.

Limitation (5):

> Revisions to the fluence methodology and supporting uncertainty analysis will be provided if the C/M comparisons (for the additional analysis of the vessel and the shroud) are not consistent with the NEDC-32983P fluence methodology.

This limitation is a generic condition that remains unchanged.

4.0 CONCLUSIONS

GENE provided information to justify removing methodology Limitations (1) through (4), listed above, associated with NEDC-32983P-A, "General Electric Methodology for Reactor Pressure Vessel Fast Neutron Flux Evaluation." The NRC staff has reviewed the information submitted by GENE using the regulatory basis described in Section 2.0 above and concludes that sufficient justification has been provided to remove Limitations (1) through (4). This safety evaluation does not alter any of the other conclusions and applicability statements made in the NRC staff's September 14, 2001, letter approving the use of NEDC-32983P-A. In particular, Limitation (5) remains as a condition of applicability of the methodology.

5.0 REFERENCES

1. NEDC-32983P-A, Licensing Topical Report, "General Electric Methodology for Reactor Pressure Vessel Fast Neutron Flux Evaluations," by S. Sitaraman, et. al., General Electric Nuclear Energy, December 2001 (proprietary submittal - not publicly available in ADAMS).

2. Letter from G. Stramback, GE Nuclear Energy to U.S. Nuclear Regulatory Commission, "GE Flux Calculation Methodology Confirmation Results Part I - Surveillance Capsule Flux at River Bend Station," January 29, 2003 (ADAMS Accession No. ML030310134).

3. Letter from G. Stramback, GE Nuclear Energy to U.S. Nuclear Regulatory Commission, "Confirmatory Information on GE Methodology for RPV Flux Calculation" (Re: NEDC-32983P-A), July 14, 2004 (ADAMS Accession No. ML042020102).

4. Letter from G. Stramback, GE Nuclear Energy to U.S. Nuclear Regulatory Commission, "Confirmatory Information on GE Methodology for Shroud Flux Calculation" (Re: NEDC-32983P-A), September 10, 2004 (ADAMS Accession No. ML042610137).

5. Letter from G. Stramback, GE Nuclear Energy to U.S. Nuclear Regulatory Commission, "Response to Request for Additional Information - GE Nuclear Energy Licensing Topical Report NEDC-32983P-A" (TAC No. MC37388), December 2, 2004 (ADAMS Accession No. ML043480399).

6. Letter from G. Stramback, GE Nuclear Energy to U.S. Nuclear Regulatory Commission, "Response to Request for Additional Information - GE Nuclear Energy Licensing Topical Report NEDC-32983P-A" (TAC No. MC37388), May 20, 2005 (ADAMS Accession No. ML051600469).

7. BWRVIP-113, "BWR Vessel and Internals Project River Bend 183 Degree Surveillance Capsule Report," by R. Carter, June 2003 (proprietary submittal - not publicly available in ADAMS).

8. Regulatory Guide 1.190, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence," U.S. Nuclear Regulatory Commission, March 2001.

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Date: September 1, 2005

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