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MFN 05-097

Project 717

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

Subject: **Response to NRC Request for Additional Information Related to NEDE-33083P, "TRACG Application for ESBWR Stability Analysis"**

This letter provides GE responses to NRC action items and Requests for Additional Information (RAIs) regarding the subject GE LTR. Enclosure 1 to this letter contains:

- GE response to action items identified in the Reference 1 NRC meeting summary regarding application of the TRACG code to ESBWR stability analysis, and
- GE response to RAI No. 9 regarding NEDE-33083P, Supplement 1 (Reference 2)

Enclosure 1 contains GE proprietary information as defined by 10 CFR 2.390. GE customarily maintains this information in confidence and withholds it from public disclosure. Enclosure 1 also includes non-proprietary information to form a complete package. A non-proprietary version of the action items and RAI responses is provided in Enclosure 2.

The affidavit contained in Enclosure 3 identifies that the information contained in Enclosure 1 has been handled and classified as proprietary to GE. GE hereby requests that the information of Enclosure 1 be withheld from public disclosure in accordance with the provisions of 10 CFR 2.390 and 9.17.

If you have any questions about the information provided here, please let me know.

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Sincerely,

David H. Hinds
Manager, ESBWR

References:

1. MFN 05-085, U. S. Nuclear Regulatory Commission Meeting Summary, *Summary of Meeting held on July 12, 2005, to Discuss Preapplication Review Submittal Regarding the Application of the TRACG Code to ESBWR Stability (NEDC-33083P),* August 10, 2005

2. MFN 05-086, Letter from U. S. Nuclear Regulatory Commission to Robert E. Gamble (GE), *Request for Additional Information Letter No. 2 Related to NEDE-33083P, Supplement 1, TRACG Application for ESBWR Stability Analysis,* August 15, 2005

Enclosures:

1. MFN 05-097 – Response to Action Items and RAIs Related to NEDE-33083P, *TRACG Application for ESBWR Stability Analysis* – GE Proprietary Information
2. MFN 05-097 – Response to Action Items and RAIs Related to NEDE-33083P, *TRACG Application for ESBWR Stability Analysis* – Non Proprietary Version
3. Affidavit, George B. Stramback, dated September 22, 2005

cc: WD Beckner USNRC (w/o enclosures)
AE Cubbage USNRC (with enclosures)
LA Dudes USNRC (w/o enclosures)
GB Stramback GE (with enclosures)
eDRF 0000-0030-1246

ENCLOSURE 2

MFN 05-097

Response to Action Items and RAIs Related to NEDE-33083P, *TRACG Application for ESBWR Stability Analysis*

Non-Proprietary Notice

IMPORTANT NOTICE

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

Response to Action Items identified in an NRC meeting

Responses to the two GE action items resulting from the Reference 1 meeting are as follows:

1. Clarify information provided on core inlet loss coefficients provided in MFN-04-77 dated August 2004.

GE Response:
The relevant paragraph from MFN-04-77 is modified for clarification as follows:

Orifice Loss Coefficient for Peripheral and Central Locations

Consistent with previous GE BWR plant designs, the loss coefficients are different between the peripheral and central locations. Based on most recent estimates, the peripheral loss coefficient was chosen to be [[ ]] and the central loss coefficient was chosen to be [[ ]].
It is clarified that these numbers are based on the total bundle inlet flow and that they do not include the loss coefficient at the lower tieplate of the bundles. The corresponding numbers based on only the active flow (excluding the leakage flow) and including the lower tieplate loss at the rated core power of 4500 MW would be [[ ]] for the peripheral bundles and [[ ]] for the central bundles. All of these losses are based on a reference flow area of 10 in^2.

2. GE will re-run the 5400 MW case with the correction in the steady state case and submit revised response to RAI # 3.

GE Response:
Revised Response to RAI 3. TRACG Calculation of Instability Threshold

Perform a series of TRACG steady-state calculations at BOC conditions with increasing powers until unstable power oscillations develop to demonstrate the power-margin to instability.

RAI 3 Response:

Starting with the rated core design at 4500 MWt at BOC conditions, control rods were withdrawn to increase the core power level. The inserted rods were pulled out uniformly in steps to increase the core power to 5000, 5200 and 5400 MWt. The last power level is higher than the thermal scram point. At each power level, a steady state was established. Channel and core wide stability was evaluated at each state by observing the response to a perturbation from the steady state. These calculations were made using the same process followed for the calculations shown in the Licensing Topical Report. Even at 5400 MWt, TRACG calculated a substantial margin to instability. Regional stability evaluations were also made at an elevated power of 5200 MWt, slightly below the scram power level. The regional decay ratio was found to be well below 1.0 at this power level.

The details of the calculations are provided below. The results of the calculations are summarized in Table 3-2.

The initial conditions for the three elevated power levels are shown in Table 3-1. The corresponding axial power shapes for the average and peak power bundle are shown in Figures 3-1 to 3-3. Stability analysis was performed at the higher power levels using the same techniques employed in the report NEDE-33083 Supplement 1. Channel decay ratios were evaluated by perturbing instantaneously the velocities in the inlet single-phase region of the bundle. Core decay ratios were evaluated by perturbing the steamline pressure and observing the core power response. For regional stability, channels on either side of the axis of symmetry of the harmonic flux shape were perturbed in opposite directions and the channel power responses were evaluated.

The channel stability results are shown in Figures 3-4 through 3-6. The decay ratio increased from [[

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The core wide power responses to pressure perturbations are shown in Figures 3-7 through 3-9. The core decay ratio was of the order of [[
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For the regional analysis, calculations were made at 5200 MW to see of instability in the regional mode would occur at a lower power than the scram power level. The harmonic flux shape for the core at 5200 MW is shown in Figure 3-10. The products of the fundamental and harmonic flux shapes are shown in Figure 3-11. Based on these, the channel grouping shown in Figure 3-12 was developed. This is slightly different from the one used at 4500 MW in the report because of differences in the rod pattern harmonic flux shape. Regional stability was then evaluated by perturbing the inlet velocities to the channel groups in opposite directions on the two sides of the line of harmonic symmetry. Figure 3-13 shows the power response for two channel groups on opposite sides of the line of symmetry, confirming the regional mode of the perturbation. Figure 3-14 shows the response of several channel groups on the same side of the line of symmetry. The maximum decay ratio is [[ ]].

Table 3-1: Initial Conditions at Higher Power Levels

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Table 3-2: Stability Results at Higher Powers

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Figure 3-1 Axial Power Profiles for Average and Peak Bundles at 5000 MW

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Figure 3-2 Axial Power Profiles for Average and Peak Bundles at 5200 MW

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Figure 3-3 Axial Power Profiles for Average and Peak Bundles at 5400 MW

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Figure 3-4 Channel Flow Response to Inlet Velocity Perturbation (5000 MW)

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Figure 3-5 Channel Flow Response to Inlet Velocity Perturbation (5200 MW)

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Figure 3-6 Channel Flow Response to Inlet Velocity Perturbation (5400 MW)

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Figure 3-7 Core Power Response to Pressure Perturbation (5000 MW)

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Figure 3-8 Core Power Response to Pressure Perturbation (5200 MW)

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Figure 3-9 Core Power Response to Pressure Perturbation (5400 MW)

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Figure 3-10 First Harmonic Flux Shape at 5200 MW

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Figure 3-11 Product of the Fundamental and First Harmonics (5200MW)

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Figure 3-12 Channel Grouping for Regional Analysis at 5200 MW

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Figure 3-13 Channel Power Response –Channels on Opposite Sides of Line of Symmetry

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Figure 3-14 Channel Power Response – Channels on Same Side of Line of Symmetry

Request for Additional Information (RAI)
NEDE-33083P, Supplement 1, "TRACG Application for ESBWR Stability Analysis"

RAI No. 9

TRACG calculations indicate that the Regional instability mode dominates the stability response of the reference ESBWR core. Staff confirmatory calculations with the LAPUR code exhibit a similar relation between the relative stability of the core-wide and regional modes in the reference ESBWR design. Thus, the margin to instability of the regional mode is a key design parameter for ESBWR. Stability margins for core-wide and channel instability, while relevant, are not as limiting for the reference ESBWR design, and they are not expected to be limiting for future design changes.

During the development of the Boiling Water Reactor Owners' Group (BWROG) Long Term Stability Solutions (LTS) in the early 1980's, a correlation was developed that attempted to bound all regional instability events observed to date within a region defined in the core-wide vs channel decay ratio. This correlation is sometimes called the "dog bite" correlation. With this methodology, the BWROG was able to circumvent a deficiency in their calculation methodology. At the time, no code was able to calculate the regional DR directly, so an approximate correlation was used.

The TRACG LTR submittal recognizes that at least one ESBWR parameter is sufficiently different from operating reactors to require a modification of the dog-bite correlation. This parameter is the core diameter, which will result is a smaller eigenvalue separation for the first subcritical neutronic mode. Thus, the LTR methodology proposes to modify in a conservative manner the dog-bite correlation to account for this difference. Other ESBWR design parameters may have similar effects, but we may not have sufficient operating/calculations experience to judge a priori what their effect on the ESBWR-specific dog-bite correlation may be.

Since TRACG is capable of directly calculating the limiting event (i.e., the regional DR), the staff believes that the TRACG ESBWR stability criteria should be based on calculated results, rather than an approximation that was developed based on operating-reactor experience. Please provide the rationale for GE's proposed approach regarding regional instability.

GE Response:

GE has adopted the core decay ratio vs. channel decay ratio stability map for the ESBWR to maintain consistency with the accepted practice for operating BWRs. GE recognizes that the regional boundary ("dog-bite correlation") could be different for the ESBWR and has accounted for the differences, primarily core size, through differences in the magnitude of the core subcriticality. Taken together with the large margins to the dog-bite correlation, GE believes adequate margins to regional stability can be maintained.
However, GE agrees that the capability in TRACG to directly calculate the regional decay ratio provides a technically superior basis for evaluating margins for regional stability. GE agrees to modify the approach used for analysis as follows:

The stability design criteria will be modified to be:

- Limiting channel decay ratio < 0.8
- Core decay ratio < 0.8;
- Regional decay ratio < 0.8.

All these evaluations will be made at 95% content and 95% confidence.
The design goal will be to maintain the nominal values of the channel, core and regional decay ratios less than 0.4.

The Licensing Topical Report NEDE-33083P, Supplement 1, "TRACG Application for ESBWR Stability Analysis" will be revised to reflect these changes. A Monte Carlo analysis for regional stability will be added to Section 8 of the report. It is not possible to vary the harmonic shape and subcriticality during Monte Carlo trials. The Monte Carlo analysis will be performed at the limiting point in the cycle (BOC, MOC or EOC). This will cover the range of harmonic subcriticalities and neutronic parameters over the cycle.

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ENCLOSURE 3

MFN 05-097

Affidavit

General Electric Company

AFFIDAVIT

I, George B. Stramback, state as follows:

(1) I am Manager, Regulatory Services, General Electric Company ("GE") 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 GE letter MFN 05-097, David H. Hinds to Amy E. Cubbage (NRC), *Response to NRC Request for Additional Information Related to NEDE-33083P, "TRACG Application for ESBWR Stability Analysis,"* dated September 28, 2005. The proprietary information in Enclosure 1, *Response to Action Items and RAIs Related to NEDE-33083P, TRACG Application for ESBWR Stability Analysis*, is identified by a dark red font with double underlines inside double square brackets. Figures and large equation 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, GE 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 2.790(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 General Electric's competitors without license from General Electric 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 General Electric customer-funded development plans and programs, resulting in potential products to General Electric;

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 GE, 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 GE, 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. Access to such documents within GE 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 GE 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), above, is classified as proprietary because it contains the results of analytical models, methods and processes, including computer codes, which GE has developed, and applied to perform stability evaluations using the TRACG code for the ESBWR. GE has developed this TRACG code for over fifteen years, at a total cost in excess of three million dollars.

The development of the evaluation process along with the interpretation and application of the analytical results is derived from the extensive experience database that constitutes a major GE asset.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GE's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GE'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 GE.

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.

GE's competitive advantage will be lost if its competitors are able to use the results of the GE 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 GE 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 GE of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing 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 22nd day of September 2005

George B. Stramback
General Electric Company

ENCLOSURE 1

MFN 05-097

Response to Action Items and RAIs Related to NEDE-33083P, *TRACG Application for ESBWR Stability Analysis*

Contains GE Proprietary Information

PROPRIETARY INFORMATION NOTICE

This enclosure contains proprietary information of the General Electric Company (GE) 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 GE disclosed herein or any right to publish or make copies of the enclosure without prior written permission of GE. The header of each page in this enclosure carries the notation "GE Proprietary Information."

GE proprietary information is identified by a double underline inside double square brackets. In each case, the superscript notation{3} refers to Paragraph (3) of the affidavit provided in the previously provided affidavits, which documents the basis for the proprietary determination. [[This sentence is an example.{3}]] Specific information that is not so marked is not GE proprietary.