GE Energy

Proprietary Information Notice
This letter forwards proprietary information in accordance with 10CFR2.390. The balance of this letter may be considered non-proprietary upon the removal of Enclosure 1.

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MFN 06-506

Docket No. 52-010

December 8, 2006

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

Subject: **Response to Portion of NRC Request for Additional Information Letter No. 66 Related to ESBWR Design Certification Application – TRACG Application for Pressurization Events – RAI Numbers 21.6-56, 21.6-58 and 21.6-59**

Enclosure 1 contains GE's response to the subject NRC RAIs transmitted via the Reference 1 letter.

Enclosure 1 contains proprietary information attachments as defined in 10CFR2.390. 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 proprietary information in Enclosure 1 be withheld from public disclosure in accordance with the provisions of 10 CFR 2.390 and 9.17. The RAI response contained in Enclosure 2 is a non-proprietary version.

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

Sincerely,

David H. Hinds
Manager, ESBWR

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References:

1. MFN 06-377, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 66 Related to ESBWR Design Certification Application*, October 10, 2006

Enclosures:

1. MFN 06-506 – Partial Response to Portion of NRC Request for Additional Information Letter No. 66 Related to ESBWR Design Certification Application – TRACG Application for Pressurization Events – RAI Numbers 21.6-56, 21.6-58 and 21.6-59 – GE Proprietary Information
2. MFN 06-506 – Partial Response to Portion of NRC Request for Additional Information Letter No. 66 Related to ESBWR Design Certification Application – TRACG Application for Pressurization Events – RAI Numbers 21.6-56, 21.6-58 and 21.6-59 – Non-Proprietary Version
3. Affidavit – David H. Hinds – dated December 8, 2006

cc: AE Cubbage USNRC (with enclosures)
GB Stramback GE/San Jose (with enclosures)
eDRFs 0058-8597

Enclosure 2

MFN 06-506

Response to Portion of NRC Request for Additional Information Letter No. 66 Related to ESBWR Design Certification Application

TRACG Application for Pressurization Events

RAI Numbers 21.6-56, 21.6-58, 21.6-59

Non-Proprietary Version

NRC RAI 21.6-56:

GEXL is a quasi-steady-state boiling length correlation, which is used in TRACG to predict the critical power ratio (CPR). Provide the basis for using a boiling length quasi-steady-state correlation for rapid pressurization transients,such as load rejection with no bypass (LRNB).

GE Response:

The use of GEXL for calculating CPR margins for rapid pressurization transients has been accepted by the NRC for over 30 years [1,2,3]. The basis for acceptance is on empirical rather than physical grounds.

Following the development of the GEXL correlation in the mid-seventies, GE experimented with various approaches for its application to transients. Among the approaches tried were: the use of 'particle' boiling length in a Lagrangian framework, the use of inlet, local and average mass fluxes, etc. The approach that performed the best relative to experimental data was the use of the correlation with the [[ ]]. This approach has been successfully used for over three decades with a number of GE transient analysis computer codes.

Specific comparisons with TRACG and GEXL for rapid pressurization transients are discussed below. Tests were performed in the ATLAS test facility simulating the pressure, inlet flow and heat flux for typical pressurization transients. Figure 21.6-56-1 shows the transient parameters for a typical test. Tests were performed by increasing the initial power in small increments until a boiling transition occurred during a test. This implies that the minimum CPR in the transient was 1.0. The experimental ΔCPR for the test can then be determined based on the initial CPR at the start of the transient. The experimental ΔCPR is then compared with the ΔCPR calculated for the transient with TRACG and the GEXL correlation. Figure 21.6-56-2 shows a comparison for five pressurization transient tests performed with rod bundles simulating GE-9, GE-11 and GE-14 fuel types. It is evident that the agreement between data and calculations is excellent.

DCD Impact:

There is no DCD change related to this RAI.

References:

1.GETAB, NEDO-10958-A, 1977.

2. GESTAR-II, Rev. 5, NEDE-24011-P-A-13, 1995.

3. NRC SER on Amendment 2 to GESTAR II, MFN-32-88, 1988.

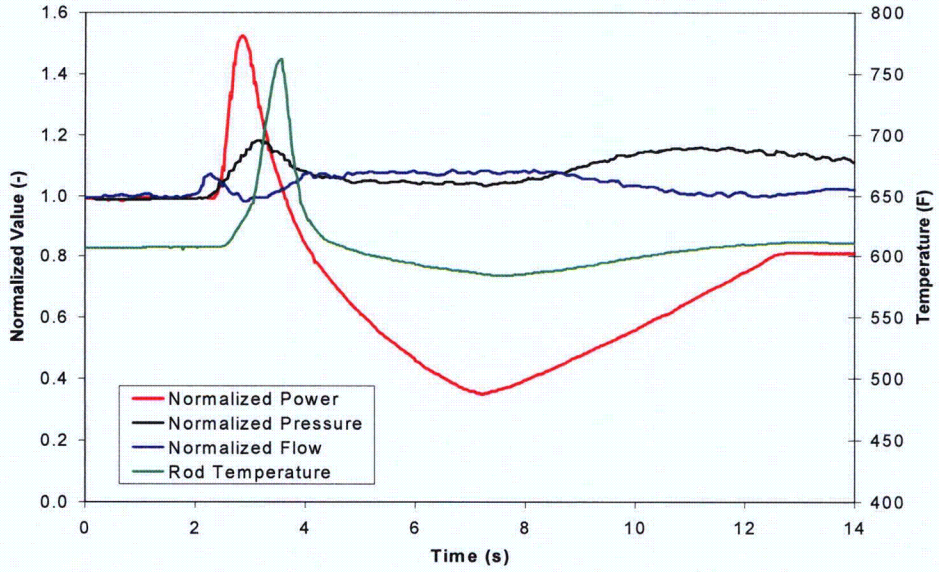

Figure 21.6-56-1. GE14 Pressurization Event without Recirculation Pump Trip (Run 1412)

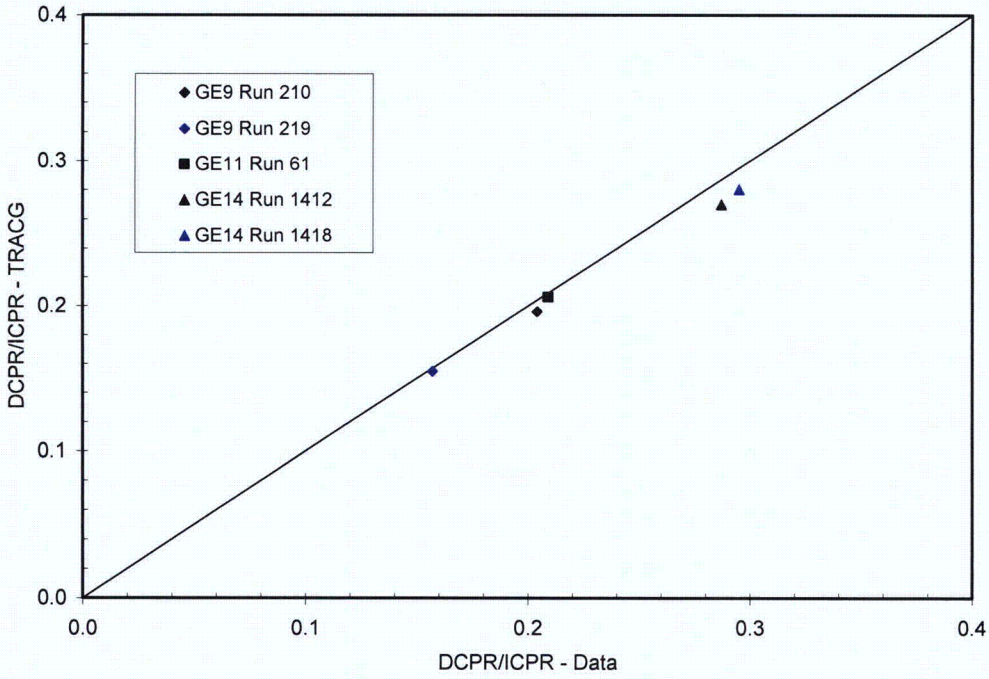

Figure 21.6-56-2. Comparison of ΔCPR/ICPR for Five Pressurization Event Tests

NRC RAI 21.6-58:

A two-fluid finite difference donor cell model with a relatively coarse noding such as that implemented in the TRACG methodology tends to smear out or diffuse pressure waves. Explain how this numerical diffusion of the pressure wave has been quantified and factored into the TRACG uncertainty analysis for the rapid pressurization events.

GE Response:

Effects of numerical diffusion of the pressure wave are not directly factored into TRACG uncertainty analysis. Rather, in keeping with the TRACG application philosophy, the effects of nodalization and time step size are resolved through sensitivity studies and comparisons with data. The nodalization and time steps determined to be appropriate through these studies are then used in the application.

The TRACG steamline nodalization for the ESBWR follows the standard nodalization scheme that has been used for BWRs (TRACG Qualification Report NEDE-32177, Rev. 2, Figure 6.5-1). The steamlines (including the manifold and turbine inlet sections) typically have about [[ ]]cells. A sensitivity study was performed by doubling the number of nodes in the steamline (TRACG Qualification Report NEDE-32177, Rev. 2, Figure 6.9-2). The impact on ΔCPR/ICPR for pressurization transients was of the order of 0.001. The adequacy of this nodalization for analysis of pressure waves has also been demonstrated in comparisons with the Peach Bottom Turbine Trip tests discussed in the response to RAI 21.6-59.

The ESBWR steamlines are modeled with [[ ]] cells, and the cell lengths typically range from [[ ]] m with an average of around [[ ]] m. The calculations were made using the implicit numerical scheme and a time step size that varied from 0.001 to 0.01 s. For an acoustic velocity in saturated steam of 480 m/s at 80 bar, the transit time for the acoustic wave through an average cell is of the order of [[ ]] s. A time step in the range of 0.001 to 0.003 s should be adequate to resolve acoustic wave propagation. It should be noted that the "explicit" numerical integration option in TRACG is explicit with respect to the treatment of the convective terms, but implicit with respect to pressure coupling. Hence, this scheme will be limited in time step size by the material velocities and not the acoustic velocities. There is no advantage to using the explicit scheme relative to numerical dissipation of acoustic waves.

Sensitivity studies were made for the Turbine Trip without Bypass case, as this is the most severe case for acoustic effects in the steamline. The base case in the DCD uses a DTMAX (maximum time step) of 0.001 s for the first 0.5 s and 0.1 s thereafter. Three sensitivity studies were performed:

4) DTMAX of 0.001 s for 1 s and 0.1 s thereafter
5) DTMAX of 0.0025 s for 1 s and 0.1 s thereafter
6) DTMAX of 0.0005 s for 1 s and 0.1 s thereafter

The results are shown in Figures 21.6-58-1 and 21.6-58-2 for the pressure and power response, respectively. There is almost no effect of time step size in the range of sensitivity studies. The time step and nodalization used in the base case in the DCD are adequate

DCD Impact:

There is no DCD change related to this RAI.

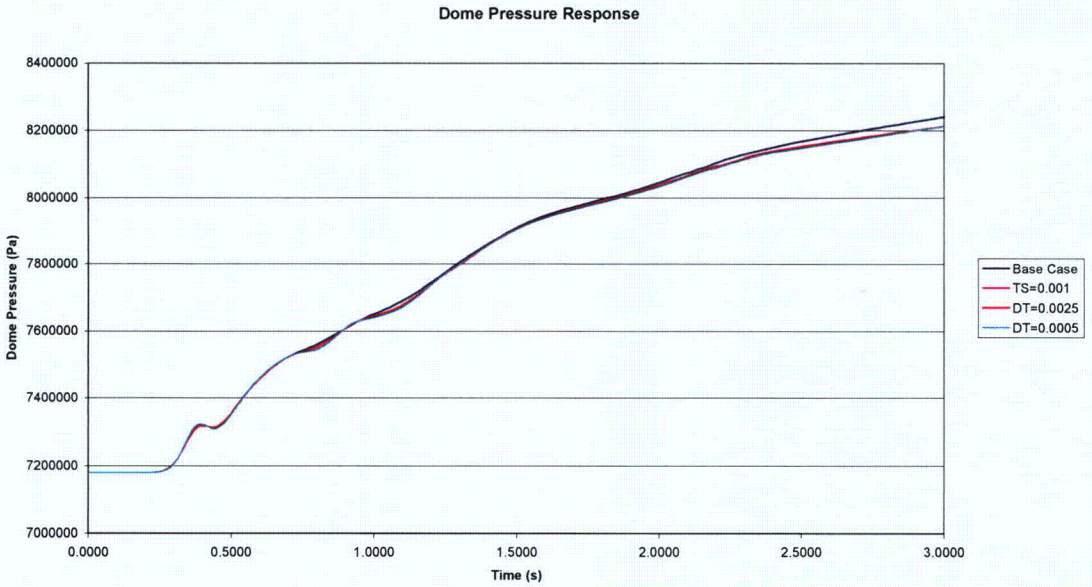

Figure 21.6-58-1: Effect of Time Step Size on Steam Dome Pressure Response for Pressurization Transient

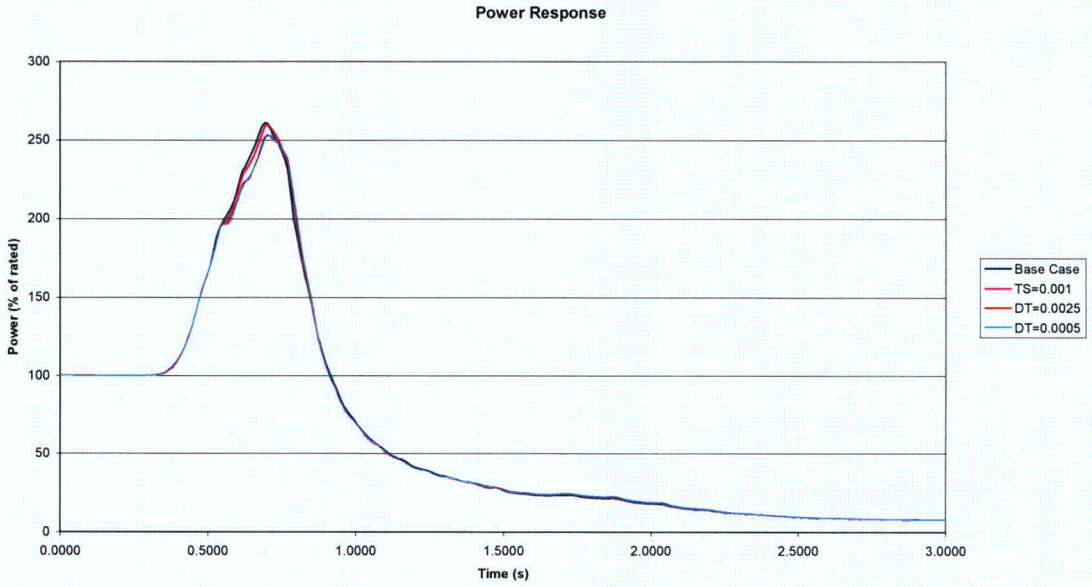

Figure 21.6-58-2: Effect of Time Step Size on Power Response for Pressurization Transient

NRC RAI 21.6-59:

Provide additional information demonstrating that TRACG is capable of calculating the propagation of a pressure wave through a two-phase mixture. Identify the assessment calculations in which this is demonstrated.

GE Response:

Three specially instrumented turbine trip with bypass tests at a reduced power level were carried out at the Peach Bottom Atomic Power Station, Unit 2. These tests were performed during April 1977. The test conditions were specifically selected to assure that the fuel would be within acceptable design values while obtaining the maximum amount of model qualification data. These tests were sponsored by the Electric Power Research Institute and performed by GE and Philadelphia Electric Company. The tests were designed to obtain qualification data for transient analysis codes. More specifically, GE proposed these tests and participated in their design and performance to obtain meaningful and high quality test data on the steam line dynamics effects that occur during rapid pressurization events. These tests were conducted with the direct scram (initiated by the turbine stop valve position switches) disabled so that the scram would initiate on high neutron flux. This departure from the normal reactor operation was required to obtain a sufficiently large neutron flux increase to give a meaningful model–to–test comparison.

Details of the TRACG qualification studies for these tests can be found in the TRACG Qualification Report [NEDE-32177, Rev. 2 or Rev. 3]. The key comparisons are shown in the attached figures. Figure 21.6-59-1 shows the short-term pressure response. The effects of the steamline dynamics are evident in the pressure response. The turbine stop valves close at time zero on the plot. The pressure wave reaches the steam dome at approximately 0.35 s, when it starts to pressurize. The pressure trace reflects the effects of acoustic wave reflections from the steam dome and the stop valve. TRACG predicts the start of pressurization and the pressure rate accurately. The timings of the inflection points indicating acoustic wave reflections are also predicted accurately. This confirms the adequacy of the TRACG model and nodalization to capture the acoustic wave phenomena in the steamlines.

The most important and demanding test for the code predictions is the neutron flux response, because it is a primary parameter in the determination of the transient critical power ratio, and its prediction requires not only good core pressure calculations, but accurate representation of Doppler, scram and void reactivity feedback phenomena. The total flux results are compared in Figure 21.6-59-2 for the three turbine trip tests and demonstrate excellent agreement (slightly on the conservative side). This confirms that acoustic propagation effects in the steamlines as well as within the reactor pressure vessel are well captured by TRACG.

A schematic of the steamline nodalization used to simulate the Peach Bottom tests with TRACG is shown in Figure 21.6-59-3. The steamline to the manifold is represented by [[ ]] cells, with an additional [[ ]] cells to the center of the manifold and [[ ]] more cells to the turbine inlet. The smallest cell in the steamline was [[ ]]m and the longest cell in the turbine inlet region was [[ ]]m. The default implicit numerical scheme was used. The time step used for the calculation was 0.002 s. Assuming an acoustic velocity in saturated steam of 480 m/s at a pressure of 80 bar, the transit time for the acoustic wave ranges from [[ ]] s. The time steps used in the calculation provide adequate resolution of the propagation of the acoustic

wave. The results show that the nodalization and time step are adequate for an accurate representation of the phenomena.

DCD Impact:

There is no DCD change related to this RAI.

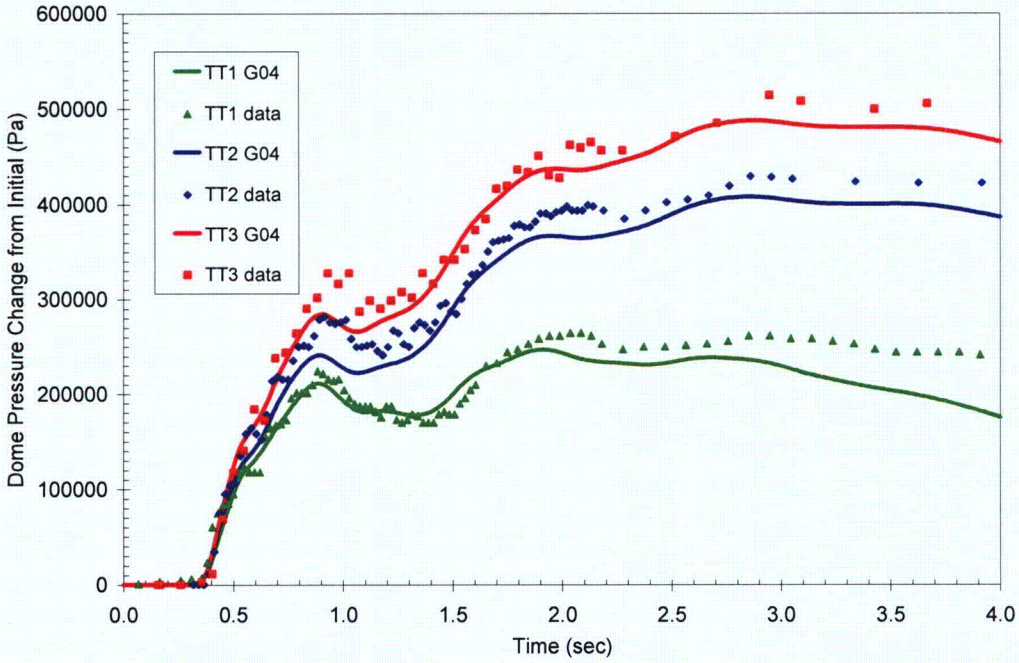

Figure 21.6-59-1: Pressure Response for Peach Bottom Turbine Trip Tests

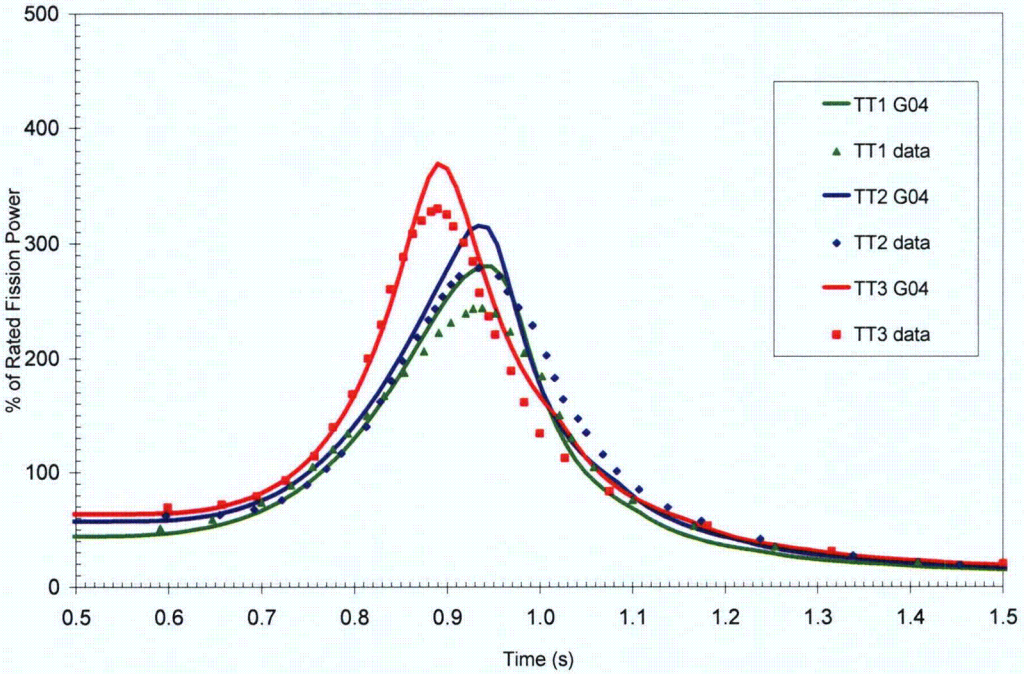

Figure 21.6-59-2: Peach Bottom Turbine Trip Fission Power Response

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Figure 21.6-59-3: TRACG Steam line Nodalization for Peach Bottom Turbine Trip Tests

Enclosure 3

MFN 06-506

Affidavit

General Electric Company

AFFIDAVIT

I, David H. Hinds, state as follows:

(1) I am Manager, ESBWR, 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 06-506, David H. Hinds to NRC, *Partial Response to Portion of NRC Request for Additional Information Letter No. 66 Related to ESBWR Design Certification Application – TRACG Application for Pressurization Events – RAI Numbers 21.6-56, 21.6-58 and 21.6-59* dated December 8, 2006. The proprietary information in Enclosure 1, *Partial Response to Portion of NRC Request for Additional Information Letter No. 66 Related to ESBWR Design Certification Application – TRACG Application for Pressurization Events – RAI Numbers 21.6-56, 21.6-58 and 21.6-59, – Contains GE Proprietary Information* is delineated by a double underline 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 TRACG analytical models, methods and processes, including computer codes, which GE has developed, and applied to perform pressurization event evaluations for the ESBWR. GE has developed this TRACG code for over fifteen years, at a total cost in excess of three million dollars. The reporting, evaluation and interpretations of the results, as they relate to pressurization evaluations for the ESBWR was achieved at a significant cost, in excess of one quarter million dollars, to GE.

The development of the testing and 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 8th day of December 2006.

David H. Hinds
General Electric Company