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<u>*Proprietary Information Notice*</u>
This letter forwards proprietary information in accordance with 10 CFR 2.390. The balance of this letter may be considered non-proprietary upon the removal of Enclosure 3.

MFN 08-414

Docket No. 52-010

May 12, 2008

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. 97 Related to ESBWR Design Certification Application - Reactor Water Cleanup/Shutdown Cooling System - RAI Number 5.4-59

Enclosure 1 contains the GE Hitachi Nuclear Energy (GEH) response to the subject NRC RAI transmitted via the Reference 1 letter. DCD Markups related to this response are provided in Enclosure 2.

As described in the enclosed RAI response, Enclosures 3 and 4 contain the GEH proprietary version and the non-proprietary version of information supporting the response in Enclosure 1, respectively.

Enclosure 3 contains proprietary information as defined in 10 CFR 2.390. The affidavit contained in Enclosure 5 identifies that the information contained in Enclosure 3 has been handled and classified as proprietary to GEH. GEH hereby requests that the proprietary information in Enclosure 3 be withheld from public disclosure in accordance with the provisions of 10 CFR 2.390. Enclosure 4 is the non-proprietary version of the information contained in Enclosure 3. Therefore, Enclosure 4 is suitable for public disclosure.

If you have any questions or require additional information, please contact me.

Sincerely,

James C. Kinsey

James C. Kinsey
Vice President, ESBWR Licensing

D068
NRO

Reference:

1. MFN 07-292, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 97 Related to ESBWR Design Certification Application*, May 10, 2007

Enclosures:

1. MFN 08-414, Enclosure 1 - Response to Portion of NRC Request for Additional Information Letter No. 97 Related to ESBWR Design Certification Application - Reactor Water Cleanup/Shutdown Cooling System - RAI Number 5.4-59
2. MFN 08-414, Enclosure 2 - Response to Portion of NRC Request for Additional Information Letter No. 97 Related to ESBWR Design Certification Application - Reactor Water Cleanup/Shutdown Cooling System - RAI Number 5.4-59 - DCD Markups
3. MFN 08-414, Enclosure 3 - Response to Portion of NRC Request for Additional Information Letter No. 97 Related to ESBWR Design Certification Application - Reactor Water Cleanup/Shutdown Cooling System - RAI Number 5.4-59 - Supporting Information - GEH Proprietary Information
4. MFN 08-414, Enclosure 4 - Response to Portion of NRC Request for Additional Information Letter No. 97 Related to ESBWR Design Certification Application - Reactor Water Cleanup/Shutdown Cooling System - RAI Number 5.4-59 - Supporting Information - Non-Proprietary Information
5. MFN 08-414, Enclosure 5 - Affidavit - David H. Hinds - dated May 12, 2008

cc:	AE Cubbage	USNRC (with enclosures)
	DH Hinds	GEH/Wilmington (with enclosures)
	GB Stramback	GEH/San Jose (with enclosures)
	RE Brown	GEH/Wilmington (with enclosures)
	eDRF	0000-0082-7706, Rev.1

Enclosure 1

MFN 08-414

Response to Portion of NRC Request for

Additional Information Letter No. 97

Related to ESBWR Design Certification Application

Reactor Water Cleanup/Shutdown Cooling System

RAI Number 5.4-59

NRC RAI 5.4-59:

Provide additional information regarding operation of the reactor water clean up/shutdown cooling (RWCU/SDC) system during Modes 5 and 6 (cold shutdown and refueling).

(A) Provide a drawing of the ESBWR vessel showing the elevations of the feedwater (FW) nozzles and the RWCU/SDC piping penetrations inside and outside the shroud

(B) Include a discussion in the DCD regarding vessel level for normal RWCU/SDC operation in all modes, including Modes 4, 5, and 6.

(C) Perform a calculation demonstrating under what temperatures and levels the RWCU/SDC system can adequately remove decay heat in Modes 4, 5, and 6 (with the RPV head installed) including any minimum and maximum temperatures and levels

(D) Include a discussion in the DCD regarding RWCU/SDC flow and mixing within the vessel and within the shroud

(E) Address thermal-hydraulic uncertainty

(F) Address the impact on the ESBWR shutdown PRA

GEH Response:

Enclosures 3 and 4 provide a GEH proprietary and non-proprietary version, respectively, of supporting information referenced in this response.

(A) Enclosures 3 and 4, Appendix A, each contain GEH Design Control Document Tier 2, Figure 5.3-3 and TABLE A-1 which together show the elevations of the feedwater (FW) nozzles and the reactor water cleanup/shutdown cooling (RWCU/SDC) nozzle penetrations through the RPV outer wall. It should be noted that there are no RWCU/SDC piping and penetrations inside the RPV shroud.

(B) As discussed in DCD Tier 2, Subsection 5.4.8.2.2, the RPV water level during normal shutdown operation is maintained above the first stage spillover of the steam separators. This is to ensure natural circulation through the reactor core. The spilled water from the separators mixes with the incoming colder shutdown water (through the FW nozzle) in the upper downcomer and flows down. Hotter shutdown water (through the RWCU/SDC nozzle) returns to the non-regenerative heat exchanger (NRHX) in order to remove the decay heat.

(C) An analytical calculation has been performed for Modes 4 and 5. Mode 6 is not analyzed because the RPV has been cooled for this mode. The starting point for this calculation is 0.5 hour after control rod (CR) insertion when the RPV is at the rated temperature. The fluid flow within the RPV is assumed to be single liquid phase flow. The heat rejection (loss) through the RPV outer wall to the drywell is not considered. It is noted that these two assumptions are conservative for the current application. The RPV is modeled as two nodes: the core region and the downcomer region, as shown in Figure 5.4-59-1. The core region node includes the fuel, vessel metal mass, and water inside the shroud. The downcomer region includes the water outside of the shroud and the water in the lower plenum. As mentioned in the response to Item B, the RPV water level is higher than the first stage steam separator drain when the RWCU/SDC System starts operating. The calculation is based on the water level that is equal to the first stage of steam separator drain. Any level higher than this level would not have an impact on the natural circulation core flow rate, and thus would not affect the RWCU/SDC characteristics. The schematic of the flow path for the current calculation is shown in Figure 5.4-59-1. The following equations are solved together to obtain the RPV temperature response: 1) energy balance equations for the core node; 2) energy balance equations for the downcomer node; 3) flow mixing in the mid-vessel region; 4) heat transfer equation in the NRHX; and 5) the momentum conservation equation in the downcomer and core nodes to solve the core flow rate.

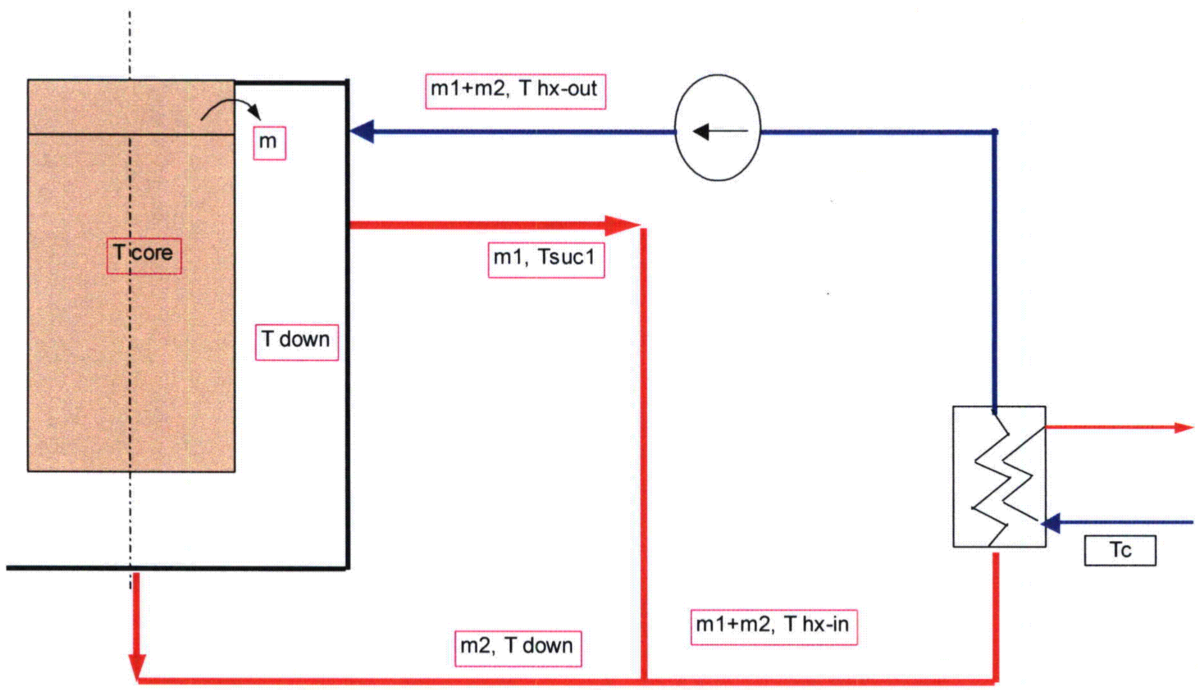

Figure 5.4-59-1. Schematic of RWCU/SDC System Flowpath

Enclosures 3 and 4, Appendix B, Figure 5.4-59-B1, shows that under various temperatures from Mode 4 to Mode 5, the RWCU/SDC System is able to adequately remove the decay heat, and cool down the RPV. It is also noted that it takes about 5.4 hours to cool the reactor from Mode 4 to Mode 5. As mentioned in DCD Tier 2, Subsection 5.4.8.2, during the early phase of shutdown cooling, the RWCU/SDC pumps operate at reduced speeds. The heat removal maximum capability can be maintained by gradually increasing the RWCU/SDC flow rate. As the shutdown proceeds and the reactor temperature is reduced, the RWCU/SDC pump speeds are increased until the flow rate limit is reached. After the RWCU/SDC pump flow reaches its maximum, the heat removal rate becomes slower because of the lower NRHX inlet temperature. The service water temperature is 38.3°C (101°F) for this calculation. Enclosures 2 and 3, Appendix B, Figure 5.4-59-B2, shows the RWCU/SDC flow rate variations.

(D) See response to Item B.

(E) Thermal hydraulic uncertainties are considered as follows:

1. Flow mixing uncertainty in Mode 5. The heat exchanger heat removal capacity depends on the flow mixing between the core natural circulation flow and the cold RWCU/SDC injection flow. The base calculation (base case) shown in Enclosures 3 and 4, Appendix B, Figure 5.4-59-B1 and Figure 5.4-59-B2, assumes that the hot core flow and the cold RWCU/SDC injection flow are completely mixed before it returns back to the inlet of the heat exchanger. The mixture temperature is defined as T_{mean} in Enclosures 3 and 4, Appendix B, Figure 5.4-59-B3. However, considering that the physical geometry in the mixing zone might have effect on the flow pattern of the cold and hot streams, thus affecting the mixing efficiency between the flow streams, it is postulated that the temperature of the heat exchanger inlet liquid might be higher or lower than the T_{mean}. Higher suction liquid temperature would result in higher RPV cooldown rate, or vice-versa. By varying the mid-vessel suction temperatures (Tsuc1) by 5% higher or lower than the T_{mean}, two sensitivity study cases are investigated in this application. The results show that the core temperature will increase by 3~4°C when Tsuc1 is 5% lower than T_{mean}, and will decrease by 3~4°C when Tsuc1 is 5% higher than T_{mean}. The temperature history results are shown in Enclosures 3 and 4, Appendix B, Figure 5.4-59-B3.

2. Flow resistance uncertainty. It has been found that the cooldown rate is also affected by the core circulation flow rate, whose uncertainty is mainly caused by the uncertainties in the pressure drop calculations in different flow paths in the calculation. As shown in Table 5-1 of NEDE-33083P, Supplement 3, "TRACG Application for ESBWR Transient Analysis," December 2007, the RPV pressure drop uncertainty is bounded by ±25%. Therefore, a sensitivity study was performed in this application by increasing the irreversible losses by 50%. The results in Enclosures 3 and 4, Appendix B, Figure 5.4-59-B4 and Figure 5.4-59-B5, show that the core circulation flow rate would be reduced by 12.5% and the RPV temperature is increased by 0.8°C, compared to the base case. The RPV cooldown rate is found to be insensitive to flow resistance uncertainties.

(F) The ESBWR Shutdown Probabilistic Reliability Analysis (PRA) covers Mode 5 (Cold Shutdown) and Mode 6 (Refueling). Mode 4 (Stable Shutdown) cooling is bounded by the Full Power PRA. Entry into Mode 5 from Mode 4 requires that the RWCU/SDC be successful (i.e., the decay heat is successfully transferred to the RWCU/SDC System). The ESBWR Shutdown PRA assumes the loss of SDC function as an initiating event. The modeling of this event includes the recovery of the SDC function at a later time. The Loss of SDC initiating event causes <1% of the Shutdown Core Damage Frequency (CDF).

In the ESBWR Shutdown PRA, the RWCU/SDC System is not credited for mitigating loss-of-coolant accident (LOCA) events. If the water level for a LOCA event were above the reactor water Level 3, the SDC function would not be affected. If during a LOCA event water level is below the reactor water Level 3, no credit is assumed for the RWCU/SDC System.

DCD Impact:

DCD Tier 2, Subsection 5.4.8.2.2, will be revised as shown in the attached markup.

Enclosure 2

MFN 08-414

Response to Portion of NRC Request for Additional Information Letter No. 97 Related to ESBWR Design Certification Application Reactor Water Cleanup/Shutdown Cooling System RAI Number 5.4-59 DCD Markups

CRD System flow is maintained to provide makeup water for the reactor coolant volume contraction that occurs as the reactor is cooled down. The RPV water level during normal shutdown operation is maintained above the first stage water spill of the steam separators. This is to ensure natural circulation through the reactor core. The spilled water from the separators mixes with the incoming colder shutdown water (through the Feedwater nozzle) in the upper downcomer, and the mixture flows down. Hotter shutdown water (through the RWCU/SDC nozzle) returns to the NRHX in order to remove the decay heat.

The RWCU/SDC system overboarding line is used for fine level control of the RPV water level as needed.

Hot Standby — During hot standby the RWCU/SDC system may be used as required in conjunction with the main or isolation condenser to maintain a nearly constant reactor temperature by processing reactor coolant from the reactor bottom head and the mid-vessel region of the reactor vessel and transferring the decay heat to the RCCWS by operating both RWCU/SDC trains and returning the purified water to the reactor via the feedwater lines.

The pumps and the instrumentation necessary to maintain hot standby conditions are connectable to the Standby AC Power supply during any loss of preferred power.

Refueling — The RWCU/SDC system can be used to provide additional cooling of the reactor well water when the RPV head is off in preparation for removing spent fuel from the core.

Operation Following Transients— In conjunction with the isolation condensers, one-half hour after control rod insertion, the RWCU/SDC system has the capability of removing core decay heat and overboarding excess makeup due to the CRD purge flow.

If the reactor is in the "run" mode of operation, a shutdown caused by an isolation event causes the Isolation Condensers (ICS) to activate. Assuming the most restrictive single active failure, any number of the Isolation Condensers can be valved-out by the operator in order to provide easier pressure and water regulation of the RWCU/SDC system.

5.4.8.2.3 Safety Evaluation

The RWCU/SDC system does not perform or ensure any system level safety-related function, and thus, is classified as nonsafety-related.

Refer to Subsection 5.4.8.1.3 for an evaluation of the safety-related containment isolation, and instrumentation for pipe break detection outside the containment functions of the RWCU/SDC system.

5.4.8.2.4 Testing and Inspection Requirements

Refer to Subsection 5.4.8.1.4 for the testing and inspection requirements for the RWCU/SDC system.

5.4.8.2.5 Instrumentation

RWCU/SDC system instrumentation is described in Subsection 7.4.3. The shutdown cooling mode of the RWCU/SDC has an automatic temperature control function that controls the speed of the ASDs to control the coolant temperature as measured by the core inlet thermocouples during the shutdown operation.

Enclosure 4

MFN 08-414

Response to Portion of NRC Request for

Additional Information Letter No. 97

Related to ESBWR Design Certification Application

Reactor Water Cleanup/Shutdown Cooling System

RAI Number 5.4-59

Supporting Information

Non-Proprietary Information

Appendix A. Reactor Vessel Drawing

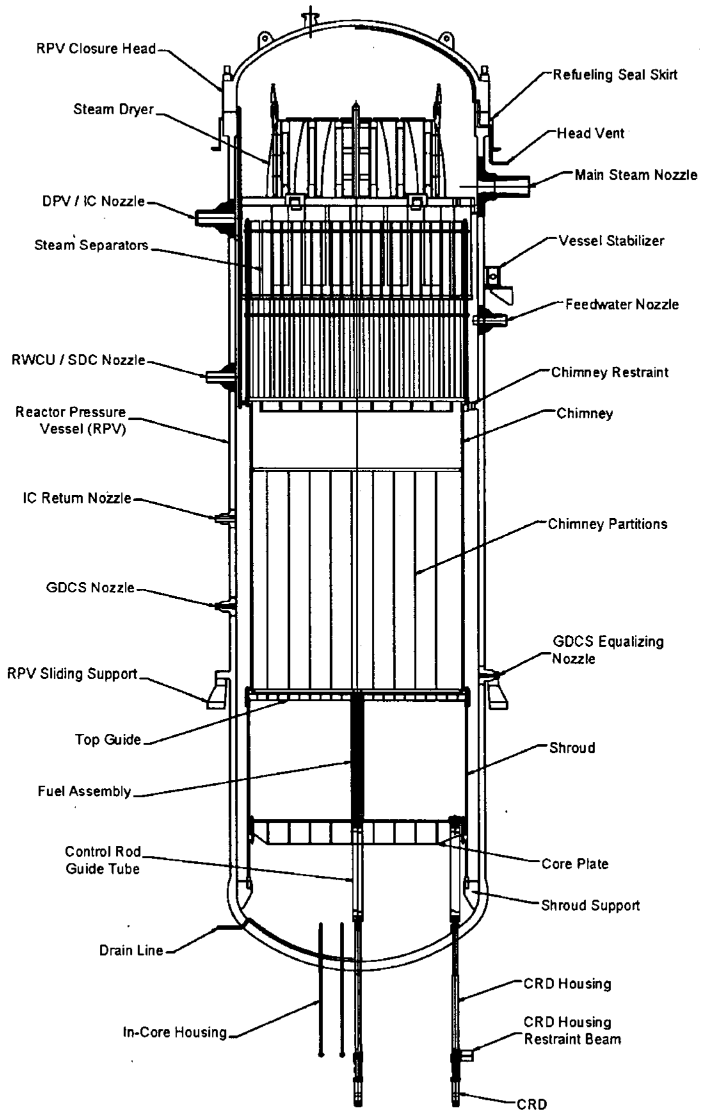

Figure 5.3-3. Reactor Pressure Vessel System Key Features

Table A-1 Feedwater and RWCU/SDC Nozzle Arrangement

Item	Function Description	QTY	Elevation (m) --Based on RPV bottom	Azimuth of Nozzle Center Line (Degree)
1	FEEDWATER Nozzle	6	18.915	30, 90, 150, 210, 270, 330
2	RWCU/SDC Nozzle	2	17.215	90, 270

Appendix B. Shutdown Cooling Analysis Results

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{3}]]

Figure 5.4-59-B1. Temperature Histories During Shutdown Process (Base Case)
(See Figure 1 in the RAI Response for Nomenclature)

[[

{3}]]

Figure 5.4-59-B2. Flow Rates During Shutdown Process (Base Case)

[[

{3}]]

Figure 5.4-59-B3. Mid-Vessel Suction Temperature Sensitivity Study Results

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{3}]]

Figure 5.4-59-B4. Flow Resistance Impact on Core Flow Rates.

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{3}]]

Figure 5.4-59-B5. Flow Resistance Impact on the Core Temperature

Enclosure 5

MFN 08-414

Affidavit

GE Hitachi Nuclear Energy

AFFIDAVIT

I, David H. Hinds, state as follows:

(1) I am the General Manager, New Units Engineering, GE Hitachi Nuclear Energy ("GEH") 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 3 of GEH letter MFN 08-414, Mr. James C. Kinsey to U.S. Nuclear Regulatory Commission, *Response to Portion of NRC Request for Additional Information Letter No. 97 Related to ESBWR Design Certification Application - Reactor Water Cleanup/Shutdown Cooling System - RAI Number 5.4-59,* dated May 12, 2008. GEH proprietary information is identified in Enclosure 3, *MFN 08-414 - Response to Portion of NRC Request for Additional Information Letter No. 97 Related to ESBWR Design Certification Application - Reactor Water Cleanup/Shutdown Cooling System - RAI Number 5.4-59 - Supporting Information - GEH Proprietary Information,* by a dotted underline inside double square brackets. The electronic version includes a dark red font inside the brackets. For black-grayscale printed copies, the red font and dotted underline appears similar to normal text. [[This sentence is an example. {3}]] 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 of the proprietary determination. Specific information that is not so marked is not GEH proprietary. A non-proprietary version of this information is provided in Enclosure 4, *MFN 08-414 - Response to Portion of NRC Request for Additional Information Letter No. 97 Related to ESBWR Design Certification Application - Reactor Water Cleanup/Shutdown Cooling System - RAI Number 5.4-59 - Supporting Information - Non-Proprietary Information.*

(3) In making this application for withholding of proprietary information of which it is the owner, GEH 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 GEH's competitors without license from GEH 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 GEH customer-funded development plans and programs, resulting in potential products to GEH;

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 GEH, 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 GEH, 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, or subject to the terms under which it was licensed to GEH. Access to such documents within GEH 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 GEH 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 GEH and its partners performed significant research and evaluation to

develop a basis for the methodologies to be used in evaluating the ESBWR over a period of several years at a cost of over one 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 GEH asset.

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

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.

GEH's competitive advantage will be lost if its competitors are able to use the results of the GEH 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 GEH 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 GEH 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 12th day of May 2008.

David H. Hinds
GE Hitachi Nuclear Energy