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Proprietary Notice
This letter forwards proprietary information in accordance with 10CFR2.390. Upon the removal of Enclosures 2 and 3, the balance of this letter may be considered non-proprietary.

MFN 06-299

Docket No. 52-010

August 28, 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. 45 Related to ESBWR Design Certification Application – Protection against Dynamic Effects Associated with the Postulated Rupture of Piping - RAI Numbers 3.6-1 through 3.6-10**

Enclosures 1 through 3 contain GE's response to the subject NRC RAIs transmitted via the Reference 1 letter.

Enclosures 2 and 3 contain GE proprietary information as defined by 10 CFR 2.390. GE customarily maintains this information in confidence and withholds it from public disclosure.

The affidavit contained in Enclosure 4 identifies that the information contained in Enclosures 2 and 3 has been handled and classified as proprietary to GE. GE hereby requests that the information of Enclosures 2 and 3 be withheld from public disclosure in accordance with the provisions of 10 CFR 2.390 and 9.17. Enclosures 2 and 3 are entirely proprietary with the exception of their respective Tables of Contents, which are reproduced in the cover pages. This constitutes the extent of available non proprietary information for Enclosures 2 and 3.

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

Sincerely,

Kathy Sedney for

David H. Hinds
Manager, ESBWR

Enclosures:

1. MFN 06-299 - Response to Portion of NRC Request for Additional Information Letter No. 45 Related to ESBWR Design Certification Application – Protection against Dynamic Effects Associated with the Postulated Rupture of Piping - RAI Numbers 3.6-1 through 3.6-10 – Non-Proprietary Information
2. MFN 06-299 - Sample Calculations for Pipe Break Forcing Functions for Main Steam Pipe Break at Terminal Ends, RPV Nozzle and Turbine Stop Valve – GE Proprietary Information
3. MFN 06-299 - Example of Non Linear and Simplified Method of Analysis used in ESBWR Design Demonstrating Compliance with SRP Section 3.6.2 Stress Limit Requirements – GE Proprietary Information
4. Affidavit – George B. Stramback – dated August 28, 2006

Reference:

1. MFN 06-271, Letter from U. S. Nuclear Regulatory Commission to Mr. David H. Hinds, *Request for Additional Information Letter No. 45 Related to ESBWR Design Certification Application,* August 3, 2006

cc:	WD Beckner	USNRC (w/o enclosures)
	AE Cubbage	USNRC (with enclosures)
	LA Dudes	USNRC (w/o enclosures)
	GB Stramback	GE/San Jose (with enclosures)
	eDRF	0000-0057-4234

Enclosure 1

MFN 06-299

Response to Portion of NRC Request for

Additional Information Letter No. 45

Related to ESBWR Design Certification Application

Protection against Dynamic Effects Associated with the

Postulated Rupture of Piping

RAI Numbers 3.6-1 through 3.6-10

NRC RAI 3.6-1

In Section 3.1.1.3 of SECY 93-087, the staff included a Commission-approved staff recommendation to eliminate Operating Basis Earthquake (OBE) from the design of structures, systems, and components (SSCs). Furthermore, the staff concluded that no replacement earthquake loading should be used to establish the postulated pipe ruptures and leakage cracks locations once the OBE is eliminated from the design and that the criteria for postulating pipe ruptures and leakage cracks in high- and moderate-energy piping systems be based on factors attributed only to normal and operational transients. However, for establishing pipe breaks and leakage cracks due to fatigue effects, the staff concluded that calculation of the cumulative usage factor should continue to include seismic cyclic effects. Since ESBWR is not explicitly designed for OBE loads, clarify whether criteria used in determining postulated high- and moderate-energy pipe break and leakage crack locations for ESBWR design are consistent with the above staff position.

GE Response

Acceptance criteria for Stress calculation are modified to account for SRP 3.6.2 MEB 3-1, pipe break requirements at intermediate pipe locations.

DCD Subsection 3.7.3.2 defines the seismic cycle requirements. The fatigue analysis of piping analysis includes two SSE events with 10 peak stress cycles. Alternatively, a number of fractional vibratory cycles equivalent to 20 full SSE vibratory cycles may be used when derived in accordance with Appendix D of IEEE-344. All the cumulative fatigue usage factors should be less than 0.1 to meet no postulated pipe break criteria.

It is correct that equations 9, 10, 11 do not consider OBE because SSE is the only design earthquake considered for ESBWR Standard Plant.

No DCD change is required in response to this RAI because DCD Subsection 3.7.3.2 has included all the items.

NRC RAI 3.6-2

In DCD Tier 2, Rev.1, Tables 3.6-3 and 3.6-4, General Electric (GE) identified high-energy piping systems inside and outside the containment that are subject to postulated pipe breaks. However, GE did not identify the moderate-energy systems for both inside and outside the containment applicable to an ESBWR plant. Identify moderate-energy systems that will be subject to postulated leakage cracks in accordance with Standard Review Plan (SRP) Section 3.6.1, Branch Technical position (BTP) SPLB 3-1 and will be used by the COL applicant, or provide reasons for not including them in the DCD for design certification.

GE Response

Moderate energy systems meet both of the following requirements:

(1) Maximum operating temperature is 93 ° C or less.
(2) Maximum operating pressure is 1902.5 kPaG or less

Therefore, moderate-energy crack leakage does not have energy to produce dynamic effects - like missiles, pipe whipping, jet impingement or compartment pressurization, and causes only wetting, water spray and flooding.

Flooding, including water spray effects, inside and outside the containment is discussed in DCD Section 3.4.

The moderate-energy piping systems inside the containment are the following:

- Gravity Driven Cooling System
- Passive Containment Cooling System
- Fuel and Auxiliary Pools Cooling System
- Chilled Water System
- High Pressure Nitrogen Supply System
- Service Air System
- Equipment and Floor Drain System

The moderate –energy piping systems outside the containment are the following:

- Containment Inerting System
- Fuel and Auxiliary Pools Cooling System
- Chilled Water System
- Control Rod Drive System (pump suction line only)
- Makeup Water System
- Fire protection System

- Service Air System
- High Pressure Nitrogen Supply System
- Instrument Air System
- Equipment and Floor Drain System
- Passive Containment Cooling System

DCD Subsection 3.6.1.2, Table 3.6-3 and Table 3.6-4 will be revised in the next update as noted in the attached markups.

NRC RAI 3.6-3

In BTP EMEB-3-1, Item B.1.c(5), it is stated that safety-related equipment must be environmentally qualified in accordance with SRP Section 3.11. Required pipe breaks and leakage cracks must be included in the design bases for defining the qualifying environment for these components both inside and outside the containment. Clarify if the design bases for environmental qualification (EQ) of safety-related equipment include the consideration of the environment resulting from pipe breaks or leakage cracks.

GE Response

The design bases for environmental qualification (EQ) of safety-related equipment includes the consideration of the environment resulting from pipe breaks or leakage cracks.

Please see Subsection 3.11 introductory text (last sentence of first paragraph):

"EQ documentation must describe methods and procedures used to demonstrate the capabilities of equipment to perform their required safety-related functions when exposed to the environmental conditions in their respective locations as discussed in SRP 3.11 Draft 3 (Reference 3.11-1)."

Please see also Subsection 3.11.2.1, the second paragraph states the following:

"Environmental parameters include thermodynamic parameters (temperature, pressure and relative humidity), radiation parameters (dose rates and integrated doses of neutron, gamma and beta exposure)."

There are no chemical sprays in ESBWR; therefore, DCD Subsection 3.11.2.1 will be revised as noted in the attached markup.

NRC RAI 3.6-4

In BTP EMEB-3-1 Section B.1.d, it is stated that in complex systems such as those containing arrangements of headers and parallel piping running between headers, the designer should identify and include all such piping within the designated run in order to postulate the number of breaks required by the criteria in item B.1.c. Clarify if this criterion is applicable to ESBWR for identifying pipe break locations.

GE Response

Criterion BTP EMEB –3-1, B.1.c applies to the ESBWR for identification of pipe breaks. These criteria are summarized in the DCD Subsection 3.6.2.1.1

No DCD change will be made in response to this RAI.

NRC RAI 3.6-5

In DCD Tier 2, Rev.1, Section 3.6.2.1.3, GE discusses the reasons why the 1.25-inch hydraulic control unit (HCU) fast scram lines do not require protection against pipe breaks. The second reason states that the total amount of energy contained in the 1.25-inch piping between the normally closed scram insert valve on the HCU module and the ball-check valve in the control rod housing is small. Provide the actual amount of energy contained in this line and demonstrate how its small value prevents any pipe ruptures in HCU fast scram lines.

GE Response

The 1.25-inch hydraulic control unit (HCU) fast scram lines are at ambient temperature and an operating pressure of approximately 7200 kPaA.

Because the working fluid is cold and it is confined between two points (closed scram insert valve on the HCU module and the ball-check valve in the control rod housing) without a pressure supply source after the line breaks, the line will depressurize rapidly. The quantity of energy in the line will be the mass of water in the line multiplied by the water enthalpy in stagnation conditions.

Enthalpy (P = 7200 kPaA, Temperature = 20 °C) = 90.61 kJ/kg,

Entropy = 0.29477 kJ/kg/K

Assuming isentropic expansion to atmospheric pressure.

Enthalpy (P = 100 kPaA, Entropy = 0.29477 kJ/kg/K) = 83.513 kJ/kg

Total energy per meter of 1.25 inch line = (90.61 - 83.513) * 0.0008 m^2 * 1 m* 1000 kg/m^3 = 5.67 kJ, which is a small amount of energy.

DCD Subsection 3.6.2.1.3 will be revised in the next update as shown in the attached markup.

<u>NRC RAI 3.6-6</u>

In DCD Tier 2, Rev. 1, Section 3.6.2.2, GE states that blowdown forcing functions are determined by the method specified in Appendix B of ANSI/ANS-58.2. However, GE did not provide any details as to how the blowdown forces are calculated for the ESBWR design, and also did not provide any sample calculation to illustrate the adequacy of any analytical method. Also, there does not appear to be any consideration of how potential feedback between the jet and any nearby reflecting surface(s), which can increase substantially the dynamic jet forces impinging on the nearby target component and the dynamic thrust blowdown forces on the ruptured pipe through resonance, is considered. Provide details (including the methods and computer programs, if any), with examples, for calculating the blowdown forcing functions at break locations that will be used by COL applicant. Also, include a description of how feedback amplification of dynamic blowdown forces will be considered in the calculation.

<u>GE Response</u>

Enclosure 2 provides sample calculations prepared for a typical ABWR Plant for the pipe break forcing functions for main steam pipe break at terminal ends, RPV nozzle and Turbine Stop Valve which is a representative method to be used for ESBWR Plant.

No DCD change will be made in response to this RAI.

NRC RAI 3.6-7

In DCD Section 3.6.2.2 and Appendix 3J, GE provides details regarding assumptions in the piping dynamic analysis. The staff notes that SRP Section 3.6.2, item III.2.a, provided dynamic analysis criteria and discusses material capacity limitations for a crushable material type of whip restraint, while SRP Section 3.6.2, item III.2.b discusses various methods of analyses. Also, ANSI/ANS-58.2-1988, Paragraph 6.3 presents several different types of dynamic analysis methods. Provide answers to the following:

(a) In SRP Section 3.6.2, item III.2.a, it is stated that for piping pressurized during normal operation at power, the initial condition should be the greater of the contained energy at hot standby or at 102% power. Clarify if this is applicable to all approaches used for the ESBWR. If not, then provide technical justification for the alternate initial conditions assumed in the analyses.

(b) Acceptable dynamic models suggested in the SRP include lumped parameter analysis models, energy balance analysis models, and static analysis models. Also, alternate analytical approaches are discussed in ANS standard Paragraphs 6.3.1 through 6.3.5. DCD Appendix 3J presents only two specific approaches: dynamic time-history analysis with simplified models and dynamic time-history analysis with detailed piping models. Clarify if any other analytical (nonlinear) methods and modeling techniques (discussed in SRP and ANS standard) will be used for ESBWR plants.

(c) Discuss acceptable procedures and computer programs to be used to calculate the pipe whip dynamic responses for all those methods not discussed in DCD Appendix 3J.

(d) Provide examples illustrating nonlinear and simplified methods of analysis that will be used in the ESBWR design, demonstrating compliance with SRP Section 3.6.2 stress limit requirements. Also, describe the computer programs for selecting the size and different types of whip restraints (i.e., crushable or rigid, if any)

(e) Discuss the validation of the computer programs which the NRC staff has not yet approved.

GE Response

The ESBWR Plant design does not utilize "crushable" material type of whip restraint as allowed by SRP Section 3.6.2.

(a) The criterion of energy at hot standby or 102 % power is applicable to ESBWR. DCD Subsection 3.6.2.3.1 will be updated as noted in the attached markup.

(b) Enclosure 4 provides sample calculations prepared for a typical ABWR Plant for the pipe break nonlinear method and modeling technique for main steam pipe break at terminal end RPV nozzles, which is a representative method to be used for ESBWR Plant.

(c) GEs computer program Pipe Dynamic Analysis (PDA) is used. ANSYS computer program can also be used.

(d) Response to this question is included in attached Enclosure 3.

(e) The analytical approach for (1) a complete system dynamic analysis as defined in Paragraph 6.3.1 of ANS 58.2 using ANSYS computer program, and (2) a simplified dynamic analysis as defined in Paragraph 6.3.2 of ANS 58.2 using the PDA computer program.

NRC RAI 3.6-8

In DCD Section 3.6.2.3.2, GE states that for components on the ruptured piping required for safe shutdown or that serve to protect the structural integrity of a safety-related component, limits to meet the ASME Code requirements for faulted conditions and limits to ensure required operability are met. The staff needs further clarification on what this particular criterion means. If it means that meeting the ASME Code requirements for faulted conditions ensures meeting the required operability of these components, provide technical justification for the criterion. Otherwise, describe the limits to ensure the operability of these components.

GE Response

The paragraph that reads: "If these components are required for safe shutdown or serve to protect the structural integrity of a safety-related component, limits to meet the ASME Code requirements for faulted conditions and limits to ensure required operability are met" establishes the acceptance criterion for pipe whip restraint design.

Components in the same pipe run that protect the structural integrity of a safety-related component but that do not have to maintain their operability to fulfill that function are designed to meet the ASME code requirements for faulted conditions. This would be the case, for instance, in pipe runs close to the break whose displacements are limited by pipe whip restraints to avoid damaging the safety-related components located in the vicinity. This criterion is applied in Subsection 3.6.2.2, second part of the fifth bullet under Pipe Whip Dynamic Response Analysis: "Piping systems are designed so that plastic instability does not occur in the pipe at the design dynamic and static loads unless damage studies are performed which show the consequences do not result in direct damage to any safety-related system or component".

On the other hand, the required operability has to be assured in components in the same pipe run that are required for safe shutdown and that have to operate to fulfill their safety function. This would be the case, for instance, of ruptures in pipes connected to containment isolation valves. Further clarifications are included in Appendix 3J.

Jet map and jet impingement analysis on safety components will be analyzed to insure safety equipments remains functional considering jet impingement.

For a ruptured pipe, such as main steam pipe break at the RPV nozzle as an example, the pipe stresses within the containment penetration region are required to be less than 2.25 Sm in accordance with BTP EMEB 3-1 criteria. This will ensure the operability of the MSIV installed within the containment penetration.

No DCD change will be made in response to this RAI.

NRC RAI 3.6-9

In DCD Section 3.6.2.3.3, GE provides design criteria for one type of whip restraint design (i.e., U-Bar type). Describe the design criteria, including load combination methods, for other types of whip restraints if they will be used in the design of ESBWR piping systems.

GE Response

In ESBWR, no other types of whip restraints will be used.

No DCD changes will be made in response to this RAI.

NRC RAI 3.6-10

BTP EMEB 3-1, item B.1.b (6) contains design, testing, and examination guidelines for guard pipes in the containment penetration areas. DCD Tier 2, Rev.1, Section 3.6.2.4 states that the ESBWR primary containment does not require guard pipes. However, GE identifies these guard pipes as sleeves in the DCD Tier 2, Rev. 1, Section 3.6.2.1.1 and the design, testing, and examination requirements for these sleeves are consistent with the SRP requirements for guard pipes. Clarify this discrepancy.

GE Response

ESBWR does not use guard pipes similar to the ABWR as discussed in ABWR Final Safety Evaluation Report, NUREG-1503, July 1994, Subsection 3.6.2 (2).

The following paragraph included in the ABWR FSER Subsection 3.6.2 (2) clarifies the NRC Staff approval for the ABWR project.

........the ABWR design does not contain guard pipes as defined in Section 3.6.2.4 of RG 1.70, "Standard Format and Content of Safety Analysis Report for Nuclear Power Plants," Revision 3: " a guard pipe is a device to limit pressurization of the space between dual barriers of certain containments to acceptable levels." The Staff notes that SRP 3.6.2 uses the term "guard pipe" in a broader context than that in RG 1.70 to include all applicable sleeves in the containment penetration area. Section 3.6.2.1.4.2(6) in the SSAR provides design, testing, and examination requirements for such sleeves. These requirements are consistent with the guidelines in SRP 3.6.2 and are acceptable.

DCD Subsection 3.6.2.4 heading is "Guard Pipe Assembly Design". Since guard pipe is not used in ESBWR plant design, no DCD change will be made in response to this RAI.

- The fluid internal energy associated with the pipe break reaction can take into account any line restrictions (e.g., flow limiter) between the pressure source and break location and absence of energy reservoirs, as applicable.
- All walls, doors and penetrations, which serve as divisional boundaries, are designed to withstand the worst case pressurizations associated with the postulated pipe failures inside primary containment. All structural divisional separations walls are designed to maintain their structural integrity after a postulated failure outside containment and within reactor building. Divisional separation doors, penetration and floors are not required to maintain their structural integrity. Justification for divisional separation integrity is addressed in Subsections 3.4.1, 6.2.3 and 9.5.1.

Approach

To comply with the objectives previously described, the safety-related systems, components, and equipment are identified. The safety-related systems, components, and equipment, or portions thereof, are identified in Table 3.6-1 for piping failures postulated inside the containment and in Table 3.6-2 for outside the containment.

3.6.1.2 Description

The lines identified as high and moderate-energy per Subsection 3.6.2.1 are listed in Table 3.6-3 for inside the containment and in Table 3.6-4 for outside the containment. Pressure response analyses are performed for the subcompartments containing high-energy piping. A detailed discussion of the line breaks selected, vent paths, room volumes, analytical methods, pressure results, etc., is provided in Section 6.2.

The effects of pipe whip, jet impingement, spraying, and flooding on required function of safety-related systems, components, and equipment, or portions thereof, inside and outside the containment, are considered.

In particular, there are no high-energy lines near the control room. As such, there are no effects upon the habitability of the control room by a piping failure in the control room or elsewhere either from pipe whip, jet impingement, or transport of steam. Further discussion on control room habitability systems is provided in Section 6.4.

3.6.1.3 Design Evaluation

General

An analysis of pipe break events is performed to identify those safety-related systems, components, and equipment that provide protective actions required to mitigate, to acceptable limits, the consequences of the pipe break event.

Pipe break events involving high-energy fluid systems are evaluated for the effects of pipe whip, jet impingement, flooding, room pressurization, and other environmental effects such as temperature. Pipe break events involving moderate-energy fluid systems are evaluated for wetting from spray, flooding, and other environmental effects.

By means of the design features such as separation, barriers, and pipe whip restraints, a discussion of which follows, adequate protection is provided against the effects of pipe break nominal pipe size or cause a throughwall crack in the same nominal pipe size but with thinner wall thickness.

- The total amount of energy contained in the 32-mm (1.25-in) piping between the normally closed scram insert valve on the HCU module and the ball-check valve in the control rod housing is smaller than 6 kJ per meter of 1.25 inch line. In the event of a rupture of this line, the ball-check valve would close to prevent reactor vessel flow out of the break.
- Even if a number of the HCU lines ruptured, the control rod insertion function would not be impaired, because the electrical motor of the fine motion control drive would drive in the control rods.

- Longitudinal breaks are postulated only in piping having a nominal diameter equal to or greater than 102 mm (4 inches).
- Circumferential breaks are only assumed at all terminal ends.
- At each of the intermediate postulated break locations identified to exceed the stress and usage factor limits of the criteria in Subsection 3.6.2.1.1, consideration is given to the occurrence of either a longitudinal or circumferential break. Examination of the state of stress in the vicinity of the postulated break location is used to identify the most probable type of break. If the maximum stress range in the longitudinal direction is greater than 1.5 times the maximum stress range in the circumferential direction, only the circumferential break is postulated. Conversely, if the maximum stress range in the circumferential direction is greater than 1.5 times the stress range in the longitudinal direction, only the longitudinal break is postulated. If no significant difference between the circumferential and longitudinal stresses is determined, then both types of breaks are considered.
- Where breaks are postulated to occur at each intermediate pipe fitting, weld attachment, or valve without the benefit of stress calculations, only circumferential breaks are postulated.
- For both longitudinal and circumferential breaks, after assessing the contribution of upstream piping flexibility, pipe whip is assumed to occur in the plane defined by the piping geometry and configuration for circumferential breaks and out of plane for longitudinal breaks and to cause piping movement in the direction of the jet reactions. Structural members, piping restraints, or piping stiffness as demonstrated by inelastic limit analysis are considered in determining the piping movement limit (alternatively, circumferential breaks are assumed to result in pipe severance and separation amounting to at least a one-diameter lateral displacement of the ruptured piping sections).
- For a circumferential break, the dynamic force of the jet discharged at the break location is based upon the effective cross-sectional flow area of the pipe and on a calculated fluid pressure as modified by an analytically or experimentally determined thrust coefficient. Limited pipe displacement at the break location, line restrictions, flow limiters, positive pump-controlled flow, and the absence of energy reservoirs are used, as applicable, in the reduction of the jet discharge.

An analysis for pipe whip restraint selection using the piping design analysis (PDA) computer program and a pipe break modeling program (ANSYS) are performed as described in Appendix 3D, which predicts the response of a pipe subjected to the thrust force occurring after a pipe break. The program treats the situation in terms of generic pipe break configuration, which involves a straight, uniform pipe fixed at one end and subjected to a time-dependent thrust force at the other end. A typical restraint used to reduce the resulting deformation is also included at a location between the two ends. Nonlinear and time-independent stress strain relationships are used to model the pipe and the restraint. Using a plastic-hinge concept, bending of the pipe is assumed to occur only at the fixed end and at the location supported by the restraint.

Effects of pipe shear deflection are considered negligible. The pipe-bending moment-deflection (or rotation) relation used for these locations is obtained from a static nonlinear cantilever-beam analysis. Using the moment-rotation relation, nonlinear equations of motion of the pipe are formulated using energy considerations and the equations are numerically integrated in small time steps to yield time-history of the pipe motion.

The piping stresses in the containment penetration areas are calculated by the ANSYS computer program, a program as described in Appendix 3D. The program is used to perform the non-linear analysis of a piping system for time varying displacements and forces due to postulated pipe breaks.

3.6.2.3 Dynamic Analysis Methods to Verify Integrity and Operability

3.6.2.3.1 Jet Impingement Analyses and Effects on Safety-Related Components

The methods used to evaluate the jet effects resulting from the postulated breaks of high-energy piping are described in Appendices C and D of ANSI/ANS 58.2 and presented in this subsection.

The criteria used for evaluating the effects of fluid jets on safety-related structures, systems, and components are as follows:

- Safety-related structures, systems, and components are not impaired so as to preclude safety-related functions. For any given postulated pipe break and consequent jet, those safety-related structures, systems, and components needed to safely shut down the plant are identified.
- Safety-related structures, systems and components, which are not necessary to safely shut down the plant for a given break are not protected from the consequences of the fluid jet.
- Safe shutdown of the plant caused by postulated pipe ruptures within the RCPB is not aggravated by sequential failures of safety-related piping and the required emergency cooling system performance is maintained.
- Off-site dose comply with 10 CFR 50.34(a) or 10 CFR 100.
- Postulated breaks resulting in jet impingement loads are assumed to occur in high-energy lines at 102% power operation or hot Standby of the plant.
- Throughwall leakage cracks are postulated in moderate-energy lines and are assumed to result in wetting and spraying of safety-related structures, systems, and components.

Table 3.6-3

High Energy Piping Inside Containment

1.	Nuclear Boiler System
2.	Control Rod Drive System (to and from HCU)
3.	Reactor Water Cleanup and Shutdown Cooling System (suction and RPV drain lines)
4.	Isolation Condenser System
5.	Gravity-Driven Cooling System Injection Lines (from RPV to isolation valves)
6.	Standby Liquid Control System Lines

Moderate Energy Piping Inside Containment

1.	Gravity Driven Cooling System
2.	Passive Containment Cooling System
3.	Fuel and Auxiliary Pools Cooling System
4.	Chilled Water System
5.	High Pressure Nitrogen Supply System
6.	Service Air System
7.	Equipment and Floor Drain System

Table 3.6-4

High Energy Piping Outside Containment

1.	Reactor Water Cleanup and Shutdown Cooling System
2.	Nuclear Boiler System Lines in Steam Tunnel
3.	Control Rod Drive System (from CRD pumps to HCU and to FW lines and from HCU to containment penetrations)
4.	Standby Liquid Control Lines
5.	Isolation Condenser System Lines

Moderate Energy Piping Outside Containment

1.	Containment Inerting System
2.	Fuel and Auxiliary Pools Cooling System
3.	Chilled Water System
4.	Control Rod Drive System (pump suction line only)
5.	Makeup Water System
6.	Fire Protection System
7.	Service Air System
8.	High Pressure Nitrogen Supply System
9.	Instrument air System
10	Equipment and Floor Drain System
11.	Passive Containment Cooling System

arrangements. Typical equipment in the noted zones is shown in the referenced system design schematics.

Environmental parameters include thermodynamic parameters (temperature, pressure and relative humidity), radiation parameters (dose rates and integrated doses of neutron, gamma and beta exposure). Subsection 3.11.4 describes further the chemical and radiation environments.

The magnitude and 60-year frequency of occurrence of significant deviations from normal plant environments in the zones have insignificant effects on equipment total thermal normal aging or accident aging. Abnormal and test condition environments are bounded by the normal or accident conditions according to the Appendix 3H tables.

Margin is defined as the difference between the most severe specified service conditions of the plant and the conditions used for qualification. Margins shall be included in the qualification parameters to account for normal variations in commercial production of equipment and reasonable errors in defining satisfactory performance. The environmental conditions shown in the Appendix 3H tables do not include margins.

Some mechanical and electrical equipment may be required to perform an intended function between minutes of the occurrence of the event but less than 10 hours into the event. Such equipment shall be shown to remain functional in the accident environment for period of at least 1-hour in excess of the time assumed in the accident analysis unless a time margin of less than one hour can be justified. Such justification shall include for each piece of equipment:

(1) consideration of a spectrum of breaks;

(2) the potential need for the equipment later in the event or during recovery operations;

(3) a determination that failure of the equipment after performance of its safety function is not detrimental to plant safety or does not mislead the operator; and

(4) determination that the margin applied to the minimum operability time, when combined with other test margins, accounts for the uncertainties associated with the use of analytical techniques in the derivation of environmental parameters, the number of units tested, production tolerances, and test equipment inaccuracies.

For equipment with required time of operation during accident of more than 10 hours, it shall be demonstrated that they remain functional under accident conditions for a period of time at least 10% longer than the required time of operation.

The environmental conditions shown in the Appendix 3H tables are upper-bound envelopes used to establish the environmental design and qualification bases for equipment. The upper bound envelopes indicate that the zone data reflects the worse case expected environment produced by a compendium of accident conditions. Estimated chemical environmental conditions are also reported in Appendix 3H.

Accident environmental profiles (i.e. Pressure, Temperature, Radiation) and operating service conditions shall be provided in Environmental Data Sheets per Appendix J, in Reference 3.11-4.

ENCLOSURE 4

MFN 06-299

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 Enclosures 2 and 3 of GE letter MFN 06-299, David H. Hinds to USNRC, *Response to Portion of NRC Request for Additional Information Letter No. 45 Related to ESBWR Design Certification Application – Protection against Dynamic Effects Associated with the Postulated Rupture of Piping - RAI Numbers 3.6-1 through 3.6-10,* dated August 28, 2006. The proprietary information in Enclosure 2, *Sample Calculations for Pipe Break Forcing Functions for Main Steam Pipe Break at Terminal Ends, RPV Nozzle and Turbine Stop Valve,* and the proprietary information in Enclosure 3, *Example of Non Linear and Simplified Method of Analysis used in ESBWR Design Demonstrating Compliance with SRP Section 3.6.2 Stress Limit Requirements,* is identified by the designation "GE Proprietary Information {3}" on each page.

(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 detailed ESBWR dynamic pipe rupture analysis design information developed by GE and/or its partners over a period of more than ten years at a cost of several million dollars. This information, 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.

(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 28th day of August 2006

George B. Stramback
General Electric Company