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Proprietary Notice
This letter forwards proprietary information in accordance with 10CFR2.390. Upon the removal of Enclosure 2, the balance of this letter may be considered nonproprietary.

MFN 06-119
Supplement 2

Docket No. 52-010

September 13, 2007

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. 16 Related to ESBWR Design Certification Application – Piping Design – RAI Numbers 3.12-3 S01, 3.12-3 S02, 3.12-15 S01, 3.12-15 S02, 3.12-21 S01, 3.12-21 S02 and 3.12-21 S03**

Enclosures 1 and 2 contain GEH's response to the subject NRC RAIs initiated during audits conducted in May, 2006 and transmitted via e-mail on February 18, 2007 and May 20, 2007. GEH's original response was provided in the Reference 1 letter.

Enclosure 2 contains GEH proprietary information as defined by 10 CFR 2.390. GEH customarily maintains this information in confidence and withholds it from public disclosure. A non-proprietary version is provided in Enclosure 3.

The affidavit contained in Enclosure 4 identifies that the information contained in Enclosure 2 has been handled and classified as proprietary to GEH. GEH hereby requests that the information of Enclosure 2 be withheld from public disclosure in accordance with the provisions of 10 CFR 2.390 and 9.17.

If you have any questions or require additional information regarding the information provided here, please contact me.

D068
NRO

Sincerely,

James C. Kinsey
Project Manager, ESBWR Licensing

Reference:

1. MFN 06-119, Letter from David Hinds to U.S. Nuclear Regulatory Commission, *Response to NRC Request for Additional Information Letter No. 16 Related to ESBWR Design Certification Application – Piping Design – RAI Numbers 3.12-1 through 3.12-37*, May 3, 2006

Enclosures:

1. MFN 06-119, Supplement 2 – Response to Portion of NRC Request for Additional Information Letter No. 16 Related to ESBWR Design Certification Application – Piping Design – RAI Numbers 3.12-3 S01, 3.12-3 S02, 3.12-15 S01, 3.12-15 S02, 3.12-21 S01, 3.12-21 S02 and 3.12-21 S03
2. MFN 06-119, Supplement 2 – Piping Independent Support Motion Response Spectrum Analysis Justification for SRSS Group Combination – GEH Proprietary Information
3. MFN 06-119, Supplement 2 – Piping Independent Support Motion Response Spectrum Analysis Justification for SRSS Group Combination – Public Version
4. Affidavit – James C. Kinsey – September 13, 2007

cc:	AE Cubbage	USNRC (with enclosures)
	DH Hinds	GEH (with enclosures)
	RE Brown	GEH (w/o enclosures)
	GB Stramback	GEH (with enclosures)
	eDRFs	0000-0070-1781, 0000-0069-6026

Enclosure 1

MFN 06-119

Supplement 2

Response to Portion of NRC Request for

Additional Information Letter No. 16

Related to ESBWR Design Certification Application

Piping Design

RAI Numbers 3.12-3 S01, 3.12-3 S02,

3.12-15 S01, 3.12-15 S02,

3.12-21 S01, 3.12-21 S02 and 3.12-21 S03

For historical purposes, the original text and GE responses to RAIs 3.12-3, 3.12-15 and 3.12-21 are included.

NRC RAI 3.12-3

The current staff position for the ISM method of analysis is presented in Volume 4, Section 2 of NUREG-1061, "Report of the US NRC Piping Review Committee." Some differences were noted between the ISM method of response combinations presented in the DCD Tier 2, Section 3.7.3.9, and the method given in NUREG-1061 (e.g., the SRSS method in the DCD and absolute sum method in NUREG-1061 for combining group responses for a given direction). Indicate whether all of the provisions contained in NUREG-1061 for the ISM method of analysis will be followed or provide the technical justification for any alternatives.

GE Response

NUREG-1503 paragraph 3.9.2.2, page 3-62 provides the guidelines for ISM analysis method.

As an alternative to the enveloped response spectrum method, GE chose to use the multiple-support excitation analysis method. When this method is used, the staff's position is that the response resulting from motions of supports between two or more different support groups may be combined by the SRSS method if a support group is defined by supports that have the same time history input. This usually means all supports located on the same floor or portion of a floor in a structure.

DCD Revision 2 will be revised to incorporate this guideline.

DCD Impact

No changes to the subject LTR will be made in response to this RAI.

NRC RAI 3.12-3 S01

NUREG-1503 refers to ABWR. Why is this being referenced? ESBWR DCD is a stand-alone document.

Original RAI needs to be addressed. Indicate whether all of the provisions contained in NUREG-1061 for the ISM method of analysis will be followed for piping systems supported at different floors and/or different buildings where the time histories are different. Provide the technical justification for any alternatives.

CONCLUSION

The current staff positions on combination methods for groups, modes, directions, and dynamic-static responses for the ISM method of analysis are delineated in NUREG-1061.

During the meeting, GE indicated that the proposed SRSS combination among groups, which is not consistent with the staff's position of absolute sum, has been accepted by the staff for the ABWR design. The NRC indicated that the technical basis for accepting the SRSS method among support groups needs to be established. GE will try to determine the technical justification developed earlier for the ABWR.

Also, GE will revise the RAI response to address the current staff positions on all combination methods presented in NUREG-1061 applicable to the ISM method of analysis. Any deviation from the staff position will be technically justified.

Unresolved, pending GE's revised response to the RAI with technical justifications for those combination methods that deviate from current staff positions.

GEH Response

Please refer to RAI 3.12-3 S02 response.

DCD Impact

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

NRC RAI 3.12-3 S02

GE proposed using SRSS with the ISM method of response spectra analysis. This is not consistent with the staff position provided in NUREG-1061. GE indicated that they will revise the RAI response to present a plan for performing a study for ISM method to show that the SRSS method can be used to combine the responses from different groups rather than the absolute sum method. This item is open pending staff review of GE's revised response.

GEH Response

NUREG-1503, Final Safety Evaluation Related to the Certification of the Advanced Boiling Water Design, paragraph 3.9.2.2, page 3-62 provides the guidelines for ISM analysis method as shown below.

"As an alternative to the enveloped response spectrum method, GE chose to use the multiple-support excitation analysis method. When this method is used, the staff's position is that the response resulting from motions of supports between two or more different support groups may be combined by the SRSS method if a support group is defined by supports that have the same time history input. This usually means all supports located on the same floor or portion of a floor in a structure."

During January 9, 2007 audit meeting in GE office at San Jose, NRC indicated that the application of the SRSS method to the ESBWR required GE to show that the time histories from each support group are not correlated. As alternative, performing a dynamic analysis for SSE earthquakes by two different procedures for two typical piping systems for ESBWR inside the containment:

(1) by using Multi-supported Time-History (TH) analysis, and

(2) by Independent Support Motion (ISM) response spectrum analysis using SRSS between support groups.

The results of the analysis are then compared to show that ISM analysis using SRSS between support groups is more conservative than TH analysis.

The Enclosure 2 report presents the detail analysis method and analysis results as proposed by NRC.

Stresses and support loads results from the TH and ISM analyses using SRSS between the support groups showed that the average stress ratios, TH/ISM, for main steam Class 1 pipe is 0.69 and 0.72 for Class 3 pipe. The average ratio for feedwater pipe is 0.92. There are only six points in the feedwater system, that have the TH results slightly higher than the ISM results. The maximum ratio, TH/ISM, is 1.08 at Node 955. (See Appendix C2 for more detailed information).

Therefore, it is confirmed that the guideline in NUREG-1503, Final Safety Evaluation, is also applicable to ESBWR piping analyses. The response resulting from motions of supports between two or more different support groups may be combined by the SRSS method if a support group is defined by supports that have the same time history input.

DCD Impact

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

NRC RAI 3.12-15

DCD Tier 2, Section 3.7.3.17, indicates that where small, Seismic Category II piping is directly attached to Seismic Category I piping, it can be decoupled from Seismic Category I piping. However, the DCD did not describe how the small branch piping will be analyzed in the piping design for both inertial and Seismic Anchor Motion (SAM) responses (e.g., small bore handbook or like other (larger) piping, equivalent static method or dynamic analysis). Describe the seismic analysis methods and procedures, including the input floor response spectrum and input SAM displacements, that apply to the small branch piping design. The description should also describe how any amplification effects and SAM effects, from the main run pipe at the attachment to the small branch pipe, are considered.

GE Response

The non-safety related piping and components whose structural failure due to an SSE could hinder the operation of the safety-related piping components, shall be designed to withstand the SSE without loss of piping integrity. The load combination and acceptance criteria are as follows.

Seismic Category	Description	Load Combination	Acceptance Criteria
II	Sustained Loads	PD + WT	EQ 8 $\leq 1.5\ S_h$
	Occasional Loads	PD + WT+RV2I	EQ 9 $\leq 1.8\ S_h$ or $1.5\ S_y$
	Thermal Range	TE	EQ 13 $\leq S_A + f(S_h\text{-}S_L)$
	Structural Integrity	PD + WT + SSEI PD + WT + $[(CHUGI)^2 + (RV2I)^2]^{1/2}$ PD + WT + $[(CONDI)^2 + (RV2I)^2]^{1/2}$ PT + WT +API	ND 2600 EQ 9 $\leq 3S_h$ and no greater than 2.0 Sy and meet NUREG 1367

For dynamic and SAM analyses,

1. Decouple criteria is 25 to 1 in the ratio of "moment of inertia" of run pipe to branch pipe.
2. Linear spectrum with accelerations from the seismic and dynamic analyses used in the large bore piping analysis (run pipe) are applied to this interface point for the small branch piping design, as well as the seismic and dynamic displacements at the connection point.

Formal analysis methods and procedures similar to the main pipe should be used, or more conservative handbook analysis may also be used.

DCD Impact

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

NRC RAI 3.12-15 S01

The load combination table included in the response corresponds to Class 2 piping components. GE should define the SRV and LOCA loads consistent with the DCD Table 3.9-2.

Follwup RAI: Provide design and analysis criteria for seismic Category I branch piping that decouple from larger piping.

Original RAI not fully addresses.

Explain the term linear spectrum and how amplification of the run pipe is considered.

CONCLUSION

GE states in DCD Section 3.7.3.16 that small branch lines (50 mm and less nominal pipe size) decoupled from larger size piping may be designed using small bore handbooks in lieu of a system flexibility analysis. The criteria presented in this section for the piping handbook are acceptable. However, GE has not developed any such handbook to be used for the design certification and will not have such a document during the second audit sometime next fall. Therefore, this will be a COL action item.

When decoupled piping is not designed using small bore handbooks, GE discussed the use of a linear spectrum for the response spectrum analysis and linear displacements for the SAM analysis in the design of the small branch lines. The linear spectrum or the linear displacement is defined as the interpolated values of the building spectra or SAM displacements on either side of the branch connection. The staff did not accept GE's proposed criteria for cases where the larger size main run piping has some dynamic amplification effects at the attachment to the small branch pipe. GE agreed to develop a criteria for this case and will provide necessary changes to be included in the DCD for staff review.

Note that the decoupling criteria are applicable to both seismic Category I and Category II branch piping.

Unresolved, pending GE's revised response to the RAI and revised DCD.

GEH Response

Instead of the interpolated values of the building spectra or SAM displacements on either side of the branch connection, the proposed method is described in the response to RAI 3.12-15 S02.

DCD Impact

DCD Tier 2 Section 3.7.3.17 will be revised as noted in the attached markup.

NRC RAI 3.12-15 S02

GE should provide the criteria used to evaluate small branch lines that are decoupled from larger piping systems.

GEH Response

For dynamic and Seismic Anchor Motion analyses,

1. Decouple criteria is 25 to 1 in the ratio of "moment of inertia" of run pipe to branch pipe.
2. Amplified response spectra from the seismic and dynamic analyses used in the large bore piping analysis (run pipe) are applied to the small branch piping interfaces. The seismic and dynamic displacements at the connection point use the run pipe displacements.
3. Formal analysis methods and procedures similar to the main pipe should be used, or more conservative handbook analysis may also be used.
4. Branch pipe decoupling using response spectrum analysis can use one of the following options.
    a. Place the branch line close (4 pipe diameters or less) to large bore pipe supports.
    b. Demonstrate that the applicable pipe segment is "dynamically rigid"
    c. Overlapping analysis. (a) Include the small bore pipe up to two supports in all three directions to the large bore pipe., (2) analyze the small bore pipe again.
    d. The dynamic analysis obtains the accelerations at the supports on both sides of the run pipe side (Aa), and side (Ab), and at the small branch at (Ac). Envelope the adjusted amplified response spectra (ARS) from both sides of the run pipe supports, (Ac/Aa) and (Ac/Ab) in all three directions and apply to the branch pipe analysis,
    e. From large bore piping analysis, obtains the ARS at the branch location to apply to the branch pipe analysis. (A referenced program is ERSIN01 user's manual)

DCD Impact

DCD Tier 2 Section 3.7.3.17 will be revised as noted in the attached markup.

NRC RAI 3.12-21

For the analyses of vibratory loads (other than seismic) with significant high-frequency input (e.g., above 33 Hz), describe: (a) the modal combination method to be used for the high frequency modes above the cutoff frequency for vibratory loads.(b) the nonlinear analysis method to be used to account for large gaps between the pipe and its supports.

GE Response

(a) The modal combination to be used for the high frequency modes above the cutoff frequency for vibratory loads is performed according to Appendix A of SRP Section 3.7.2.

(b) In general, the clearance of the supports considered in the piping analysis is sufficiently small so that a non-linear analysis is not needed. If this case should happen, a detailed analysis would be carried out with finite elements using the appropriate evaluation tools.

DCD Impact

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

NRC RAI 3.12-21 S01

(a) Resolved pending resolution of RAI 3.12-20.

(b) Unresolved

Clarify the second sentence whether it meant to say "If this is not the case, a detailed..." Is this a COL action item or provide a description of the "appropriate evaluation" methods.

COL action item or provide a description of the "appropriate evaluation" methods.

CONCLUSION

GE is not sure if nonlinear analysis will ever be performed in the ESBWR piping design. GE will confirm if this will be considered as a COL action item; otherwise, GE will provide appropriate method of nonlinear analysis to be included in the ESBWR piping design.

Unresolved, pending revised response to the RAI.

GEH Response

Please see response to RAI 3.12-21 S02.

DCD Impact

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

NRC RAI 3.12-21 S02

We identified the following issue with the response to part (a) of RAI 3.12-21, involving an inconsistency between two DCD commitments, after our piping audit and public meeting in January 2007:

DCD Revision 2 changed the commitment to meet Regulatory Guide (RG) 1.92, Revision 2, July 2006. However, DCD, Tier 2, Revision 2, Section 3.7.2.7 is not consistent with RG 1.92 Revision 2. In particular, Step 2 of the criteria in Section 3.7.2.7 does not satisfy the criteria on Appendix A of RG 1.92 Revision 2. Please correct this inconsistency.

GEH Response

GE has updated the PISYS program to comply with RG 1.92, Revision 2, 2006.

DCD Impact

DCD Tier 2 Section 3.7.2.7 will be revised as noted in the attached markup.

NRC RAI 3.12-21 S03

GE committed to meet the criteria specified in RG 1.92, Revision 2. However, the criteria specified DCD Section 3.7.2.7 is not entirely consistent with the Regulatory Position provided in RG 1.92, Revision 2. GE should revise DCD Section 3.7.2.7 to be consistent with RG 1.92, Revision 2.

GEH Response

GE has updated PISYS program to comply with RG 1.92, Revision 2, 2006. Detail description of RG1.92, Revision 2, 2006 equations and the analysis are shown in the response to RAI 3.12-11 S01.

DCD Impact

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

(2) For small bore piping defined as piping 50 mm (2 in.) and less nominal pipe size, and small branch lines 50 mm (2 in.) and less nominal pipe size, as defined in (1) above, it is acceptable to use small bore piping handbooks in lieu of performing a system flexibility analysis, using static and dynamic mathematical models, to obtain loads on the piping elements and using these loads to calculate stresses per equations in NB, NC, and ND-3600 in ASME Code Section III and ASME B31.1 Code, whenever the following are met:

a. When the small bore piping handbook is serving the purpose of the Design Report it meets all of the ASME requirements for a piping design report. This includes the piping and its supports.

b. Formal documentation exists showing piping designed and installed to the small bore piping handbook (1) is conservative in comparison to results from a detail stress analysis for all applied loads and load combinations using static and dynamic analysis methods defined in Subsection 3.7.3, (2) does not result in piping that is less reliable because of loss of flexibility or because of excessive number of supports, (3) satisfies required clearances around sensitive components.

The small bore piping handbook methodology is not applied when specific information is needed on (a) magnitude of pipe and fittings stresses, (b) pipe and fitting cumulative usage factors, (c) accelerations of pipe-mounted equipment, or locations of postulated breaks and leaks.

The small bore piping handbook methodology is not applied to piping systems that are fully engineered and installed in accordance with the engineering drawings.

3.7.3.17 Interaction of Other Piping with Seismic Category I Piping

In certain instances, Seismic Category II piping may be connected to Seismic Category I piping at locations other than a piece of equipment which, for purposes of analysis, could be represented as an anchor. The transition points typically occur at Seismic Category I valves, which may or may not be physically anchored. Because a dynamic analysis must be modeled from pipe anchor point to anchor point, two options exist:

(1) Specify and design a structural anchor at the Seismic Category I valve and analyze the Seismic Category I subsystem.

(2) Analyze the subsystem from the anchor point in the Seismic Category I subsystem through the valve to either the first anchor point in the Seismic Category II subsystem; or for a distance such that there are at least two seismic restraints in each of the three orthogonal directions.

(3) The interface anchor between the seismic and non-seismic category piping shall be designed for the maximum load using piping reactions from both sides.

Where small, Seismic Category II piping is directly attached to Seismic Category I piping, it can be decoupled from Seismic Category I piping.

For dynamic and Seismic Anchor Motion analyses,

(1) Decouple criteria is 25 to 1 in the ratio of "moment of inertia" of run pipe to branch pipe.

(2) Amplified response spectra from the seismic and dynamic analyses used in the large bore piping analysis (run pipe) are applied to the small branch piping interfaces. The seismic and dynamic displacements at the connection point use the run pipe displacements.

(3) Formal analysis methods and procedures similar to the main pipe should be used, or more conservative handbook analysis may also be used.

(4) Branch pipe decoupling using response spectrum analysis can use one of the following options.

a. Place the branch line close (4 pipe diameter, for example) to large bore pipe supports.

b. Demonstrate that the applicable pipe segment is "dynamically rigid".

c. Overlapping analysis. (1) Include the small bore pipe up to two supports in all three directions to the large bore pipe, (2) analyze the small bore pipe again.

d. The dynamic analysis obtains the accelerations at the supports on both sides of the run pipe side (Aa), and side (Ab), and at the small branch at (Ac). Envelope the adjusted amplified response spectra (ARS) from both sides of the run pipe supports, (Ac/Aa) and (Ac/Ab), in all three directions and apply to the branch pipe analysis.

e. From large bore piping analysis, obtains the ARS at the branch location to apply to the branch pipe analysis. (A referenced program is ERSIN01 user's manual.)

3.7.4 Seismic Instrumentation

In accordance with SRP 3.7.4, the seismic instrumentation system meets the relevant requirements of GDC 2, 10 CFR 50, Appendix S, and 10 CFR 50.55a "Codes and Standards" as they relate to the capabilities and performance of the instruments to adequately measure the effects of earthquakes. Any other seismic instrumentation program, which is justified to have equivalent capabilities, may also be used. The instrumentation used for the measurements is capable of recording the effects produced by the most severe earthquakes that have been historically reported for the unique site considered and surrounding area, with sufficient margin for the limited accuracy, quantity and period of time in which historical data has been accumulated. As required in 10 CFR 50, Appendix S, instrumentation is provided so that the seismic response of nuclear plant features important to safety can be evaluated promptly after an earthquake.

3.7.4.1 Comparison with Regulatory Guide 1.12

The seismic instrumentation program described in the following subsections is consistent with Regulatory Guide 1.12. The procedures for plant response to earthquakes follow the guidelines of Electric Power Research Institute (EPRI) reports NP-6695 (Reference 3.7-10), NP-5930 (Reference 3.7-11) and TR-100082 (Reference 3.7-12), as permitted by Regulatory Guide 1.166 and Regulatory Guide 1.167.

3.7.4.2 Location and Description of Instrumentation

The following instrumentation and associated equipment of a solid-state digital type are used to measure plant response to earthquake motion:

DCD markup for RAI 3.12-21 S02

3.7.2.7 Combination of Modal Responses

This section addresses the applicable methods for the combination of modal responses and the missing mass, when the response spectrum method is used for response analysis.

The analysis methods will meet the requirements in Regulatory Guide 1.92 Revision 2, 2006 for combining the modal responses and the missing masses. The detail of the equations from the Regulatory Guide are shown below..

Closely spaced modes:

The periodic modal responses and the periodic components of modal responses are combined using the following double sum "complete quadratic combination" (CQC equations:

$$R_{pI} = \left[\sum_{i=1}^{n} \sum_{j=1}^{n} \varepsilon_{ij} R_{p_i} R_{p_j} \right]^{1/2} \qquad (1)$$

where R_{pI} = combined periodic response for the I^{th} component of seismic input motion (I = 1, 2, 3, for one vertical and two horizontal components), ϵ_{ij} = the modal correlation coefficient for modes i and j, R_{pi} = periodic response or periodic component of a response of mode i, R_{pj} = periodic response or periodic component of a response of mode j, and n = number of modes considered in the combination of modal responses.

For completely correlated modes i and j, $\epsilon_{ij} = 1$; for partially correlated modes i and j, $0 < \epsilon_{ij} < 1$; for uncorrelated modes i and j, $\epsilon_{ij} = 0$.

The modal correlation coefficients are uniquely defined, depending on the method chosen for evaluating the correlation coefficient, as follows.

calculation of the coefficient ϵ_{ij} as a function of modal frequencies (f_i, f_j), modal damping ratios (λ_i, λ_j), and the time duration of strong earthquake motion (t_D) was derived as follows:

$$\varepsilon_{ij} = \left[1 + \left(\frac{f'_i - f'_j}{\lambda'_i f_i + \lambda'_j f_j} \right)^2 \right]^{-1} \qquad (3)$$

where

$$f'_i = f_i \left[1 - \lambda_i^2 \right]^{1/2}$$

$$\lambda_i' = \lambda_i + \frac{1}{\pi t_D f_i}$$

and f_j' , λ_j' are similarly defined.

~~If the modes are not closely spaced (two consecutive modes are defined as closely spaced if their frequencies differ from each other by 10% or less of the lower frequency), the total response is obtained by combining the peak modal responses by the SRSS method as:~~

$$R = \left(\sum_{k=1}^{n} R_k^2 \right)^{1/2} \qquad (3.7\text{-}10)$$

~~where~~

~~R = total response~~

~~R_k = peak response of kth mode~~

~~n = number of modes considered in the analysis~~

~~If some or all of the modes are closely spaced, any one of the three methods (grouping method, 10% method, and double sum method) presented in Regulatory Guide 1.92 is applicable for the combination of modal responses.~~

For modal combination involving high-frequency modes, the following procedure applies:

Step 1 — Determine the modal responses only for those modes that have natural frequencies less than that at which the spectral acceleration approximately returns to the ZPA of the input response spectrum. Combine such modes in accordance with the methods described above.

Step 2 — For each degree of freedom (DOF) included in the dynamic analysis, determine the fraction of DOF mass included in the summation of all of the modes included in Step 1. This fraction d_i for each DOFi is given by:

$$d_i = \sum_{n=1}^{N} \Gamma_n \times \phi_{n,i} \qquad (3.7\text{-}11)$$

where

n = order of the mode under consideration

N = number of modes included in Step 1

$\phi_{n,i}$ = mass-normalized mode shape for mode n and DOFi

Γ_n = participation factor for mode n (see Equation 3.7-3 for expression).

Next, determine the fraction of DOF mass not included in the summation of these modes (e_i):

$$e_i = |d_i - \delta_{ij}| \quad (3.7\text{-}12)$$

where δ_{ij} is the Kronecker delta, which is one if DOFi is in the direction of the input motion and zero if DOFi is a rotation or not in the direction of the input motion. If, for any DOFi, the absolute value of this fraction e_i exceeds 0.1, one should include the response from higher modes with those included in Step 1.

Step 3 — Higher modes can be assumed to respond in phase with the ZPA and, thus, with each other; hence, these modes are combined algebraically, which is equivalent to pseudo-static response to the inertial forces from these higher modes excited at the ZPA. The pseudo-static inertial forces associated with the summation of all higher modes for each DOFi are given by:

$$P_i = ZPA \times M_i \times e_i \quad (3.7\text{-}13)$$

where P_i is the force or moment to be applied at DOFi, and M_i is the mass or mass moment of inertia associated with DOFi. The system is then statically analyzed for this set of pseudo-static inertial forces applied to all of the degrees of freedom to determine the maximum responses associated with high-frequency modes not included in Step 1.

Step 4 — The total combined response to high-frequency modes (Step 3) is combined by the SRSS method with the total combined response from lower-frequency modes (Step 1) to determine the overall peak responses.

This procedure requires the computation of individual modal responses only for lower-frequency modes (below the ZPA). Thus, the more difficult higher-frequency modes need not be determined. The procedure ensures inclusion of all modes of the structural model and proper representation of DOF masses.

In lieu of the above procedure, an alternative method is as follows. Modal responses are computed for enough modes to ensure that the inclusion of additional modes does not increase the total response by more than 10%. Modes that have natural frequencies less than that at which the spectral acceleration approximately returns to the ZPA are combined in accordance with Regulatory Guide 1.92. Higher-mode responses are combined algebraically (i.e., retain sign) with each other. The absolute value of the combined higher modes is then added directly to the total response from the combined lower modes.

Enclosure 3

MFN 06-119

Supplement 2

Piping Independent Support Motion Response Spectrum Analysis Justification for SRSS Group Combination

Public Version

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

1.1 Description

As a result of the certification process of the ESBWR and as part of the auditing process underway by the NRC (Nuclear Regulatory Commission), there arose a request for additional information (RAI 3.12-3) as follows:

The current staff position for the ISM method of analysis is presented in Volume 4, Section 2 of NUREG-1061, "Report of the USNRC Piping Review Committee." Some differences were noted between the ISM method of response combinations presented in the DCD Tier 2, Section 3.7.3.9, and the method given in NUREG-1061 (e.g., the SRSS method in the DCD and absolute sum method in NUREG-1061 for combining group responses for a given direction). Indicate whether all of the provisions contained in NUREG-1061 for the ISM method of analysis will be followed or provide the technical justification for any alternatives.

GE provided response to NRC RAI as follows:

NUREG-1503, Final Safety Evaluation Related to the Certification of the Advanced Boiling Water Design, paragraph 3.9.2.2, page 3-62 provides the guidelines for ISM analysis method as shown below.

"As an alternative to the enveloped response spectrum method, GE chose to use the multiple-support excitation analysis method. When this method is used, the staff's position is that the response resulting from motions of supports between two or more different support groups may be combined by the SRSS method if a support group is defined by supports that have the same time history input. This usually means all supports located on the same floor or portion of a floor in a structure."

During January 9, 2007 audit meeting in GE office at San Jose, NRC indicated that the [[

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This report presents analysis models and the methodologies used to perform the analyses. The analysis results of this report are from Reference 9. GH (GE-Hitachi Nuclear Energy) has also performed independent analysis to confirm the results. Brief descriptions of the sections are as follows.

Section 2 provides summaries and conclusions.

Section 3 listed the pipe sizes and the materials.

Section 4 provides the analysis parameters for both of the TH and ISM to produce all the comparisons.

Section 5 provides the dynamic analysis methods. [[

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Section 6 provides the TH and ISM stress results tables, support loads and nozzle loads comparisons.

2. SUMMARY AND CONCLUSION

2.1 RESULTS

2.1.1 Main Steam Lines (MS)

2.1.1.1 Stresses Summary:

ESBWR Class1 Lines					
NO. NODE	SIZE O.D. (mm)	COMP TYPE	ISM, SRSS Mpa (ISM)	Time History Mpa (TH)	TH/ISM
			(B)	(A)	(A)/(B)
[[					]]

ESBWR Class 3 Lines					
NO. NODE	SIZE O.D.(mm>)	COMP TYPE	ISM, SRSS Mpa (ISM)	Time History Mpa (TH)	TH/ISM
			(B)	(A)	(A)/(B)
[[					
					]]

The Average Ratio TH/ISM for main steam system is [[ ]] for Class 1 piping and [[ ]] for Class 3 piping. The maximum ratio is [[ ]] for Class 1 piping and [[ ]] for Class 3 piping.

2.1.1.2 Support Reactions:

SSE (SRSS)						
REST TYPE	**TH FORCE kN**	**RS FORCE kN**	**Ratio TH/ISM**	**TH MOMENT kNxm**	**RS MOMENT kNxm**	**Ratio TH/ISM**
[[						
				]]		

All Average Ratio TH/ISM for pipe support is [[ ]].

2.1.2 Feedwater Lines

2.1.2.1 Stresses Summary:

ESBWR Feedwater Class1 Lines					
NO. NODE	SIZE O.D. (mm)	COMP TYPE	ISM, SRSS Mpa (ISM)	Time History Mpa (TH)	TH/ISM
			(B)	**(A)**	**(A)/(B)**
[[					
					]]

All Average Ratio TH/ISM are less than [[ ]]

2.1.2.2 Support Reactions:

SSE (SRSS)						
REST TYPE	**TH FORCE kN**	**RS FORCE kN**	**Ratio TH/ISM**	**TH MOMENT kNxm**	**RS MOMENT kNxm**	**Ratio TH/ISM**
ANCHOR						
Average Ratio:	[[					
GLOBAL GUIDES						
Average Ratio:						
SNUBBERS						
Average Ratio:				]]		

All Average Ratio TH/ISM are far below 1.0

2.2 CONCLUSION

Stresses and support loads results from the TH and ISM analyses using SRSS between the support groups, showed that the average stress ratios, TH/ISM, for [[

]] (See Appendix C2 for more detailed information).

Therefore, it is confirmed that the guideline in NUREG-1503, Final Safety Evaluation, is also applicable to ESBWR piping analyses. The response resulting from motions of supports between two or more different support groups may be combined by the SRSS method if a support group is defined by supports that have the same time history input.

3. INPUT DATA

3.1 MAIN STEAM LINES CONFIGURATION

3.1.1 System Geometry

Data needed for modeling the MS piping were obtained per Reference 3 and 4. Figures are shown in Appendix A-1 and A-2.

3.1.2 Mechanical Properties

3.1.2.1 Class 1 Piping Material Properties

The material properties and ASME III allowable stress used are shown in Table 3-1 and the dimensional properties of the piping are shown in Table 3-3.

Table 3-1 Material Properties (Class 1 piping)

[[

1. Design Temperature
2. Operating Temperature
3. Sm = Stress Intensity at Design Temperature
4. Sy = Yield Strength at Operating Temperature
5. Ec = Modulus of elasticity at 21.1 °C
6. Eh = Modulus of Elasticity at Operating Temperature
7. α = Mean Coefficient of Expansion at Operating Temperature

]]

3.1.2.2 Class 3 Piping Material Properties

The material properties and ASME III allowable stress used are shown in Table 3-2 and the dimensional properties of the piping are shown in Table 3-3.

Table 3-2 Material Properties (Class 3 piping)

[[

1. Design Temperature
2. Operating Temperature
3. Sh = Allowable Stress at Design Temperature
4. Sc = Allowable Stress at 21.1 °C
5. Sy = Yield Strength at Operating Temperature
6. Ec = Modulus of Elasticity at 21.1 °C
7. Eh = Modulus of Elasticity at Operating Temperature
8. α = Mean Coefficient of Expansion at Operating Temperature

]]

3.1.2.3 Dimensional Properties and Design Conditions

Table 3-3 Piping Dimensional Properties and Design Conditions

[[

Notes:
1) Weight without water
2) Weight with water

]]

3.1.3 Model

Isometric joint diagrams, a list of the joint coordinates of the complete piping mathematical model, and a table summarizing the locations of anchor points are shown in Appendix A.

3.2 MAIN STEAM LINES 2 AND 3 SUPPORT STIFFNESS

Class 1 piping:

- Anchor at the Reactor Pressure Vessel nozzles and the penetration. Stiffnesses considered are:
  - [[ ]]
- Seismic guide in MS line. Estimative stiffnesses considered are:
  - [[ ]]

Class 3 piping:

- Guides stiffnesses considered are:
  - [[ ]]
- Snubber stiffnesses considered are:
  - [[ ]]

3.3 FEEDWATER LINES CONFIGURATION

3.3.1 System Geometry

The isometric drawing (see Reference 4) for the current analysis is shown in Appendix A-2

The materials considered in the analysis are those shown in Table 3-4.

3.3.2 Mechanical Properties

The material properties and ASME III allowable used are shown in Table 3-4 and the dimensional properties of the piping are shown in Table 3-5.

Table 3-4 Material Properties

[[

1. T_D = Design Temperature
2. T_O = Operating Temperature]]
3. Sm= Stress Intensity at Design Temperature
4. Sy= Yield Strength at Operating Temperature
5. Ec= Modulus of Elasticity at 21 °C
6. Eh=Modulus of Elasticity at Operating Temperature
7. α=Means Coefficient of Expansion at Operating Temperature

Table 3-5 Piping Dimensional Properties and Design Conditions

[[

]]

3.4 FEEDWATER SUPPORT STIFFNESS

- Anchor at the Reactor Pressure Vessel nozzles.
  - [[ ]]
- Anchor at the penetration.
  - [[ ]]
  - [[ ]]
- Guides stiffnesses considered are:
  - [[ ]]
- Snubber stiffnesses considered are:
  - [[ ]]

3.5 REFERENCES

1) PISYS07D, User's Manual, NEDE-32836, July 2002.

2) ANSI713D, User's Manual, NEDE-23518, October 2000.

3) 092-134-F-A-00008B Issue 3, Main Steam Lines 2 and 3 Piping Stress Analysis Report.

4) 092-134-F-A-00009 Issue 2, Feedwater Lines Piping Stress Analysis Report.

5) E-mail from GE (Henry Hwang) dated 02-27-2007 with the Response Spectra to be considered.

6) SZGE-SR3-2007-0010, Transmittal of RBFB Acceleration Time History Data for EA Piping Analysis.

7) 26A6647 Rev. 3, Seismic Analysis of Reactor/Fuel Building Complex.

8) E-mail from GE (Henry Hwang) dated 05-18-2007 with the new PISYS Program "pisys08pc version.

9) Impresarios Agrupados Document No. 092-134-F-A-00100, ISM and TH Analysis Report.

10) EPRI Research Project, RP-964-10 by Westinghouse, "Seismic Analysis of Multiple Multipled Piping System".

4. DYNAMIC ANALYSIS CRITERIA

4.1 LOADS

The loads acting on the piping within the scope of this report are defined in Table 4-1.

The time histories analyses (TH) and the ISM response spectra analyses used consistent input parameters as described below.

- Multiple support time histories analyses (TH) used modal damping ratio of [[ ]]. The time step is [[ ]] steps are used. The time histories broading has been included peak shifting of [[ ]] in accordance with [[ ]] requirements.
- The ISM response spectra analyses use same damping ration, 2% and 15% peak broading. The response combinations for the support groups are carried out by the square root of the sums of the squares (SRSS).

This report thus presents the analysis results from TH and ISM using the piping analysis models developed for the ESBWR as shown below.

(1) [[ ]]

(2) [[ ]]

Comparing the results from TH and ISM to show that the results [[ ]]

Table 4-1 Definition of Loads

Load Type	Ident	Direction(1)	Description
[[			
			]]

1. X,Y,Z directions correspond to the global X,Y,Z directions shown in figure 1
2. Two different cases are considered: Time-History Modal Analysis and Response Spectra Analysis

Table 4-2 Dynamic analysis criteria

Item	Criteria
[[	
	]]

5. DYNAMIC ANALYSES

5.1 PIPING ANALYSIS MODELS

5.1.1 Main Steam

There are 4 main steam lines. Lines 2 and 3 are the inside loop and are connected together by crossover piping. [[

]] The isometric plots of the piping system are shown in Appendix A-1.

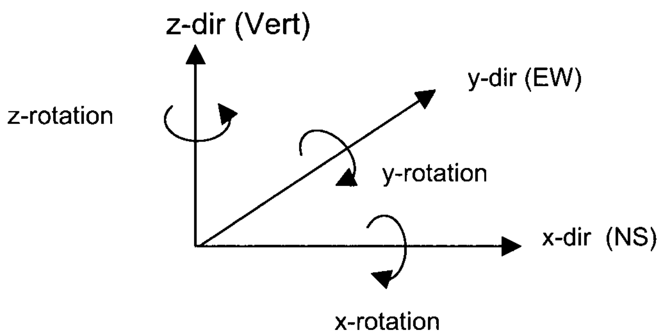
5.1.2 Feedwater Piping

There are two feedwater piping systems. Both systems are symmetrical. [[

]] The isometric drawing of the system is shown in Appendix A-2.

5.2 INPUT TIME HISTORIES AND AMPLIFIED RESPONSE SPECTRA

The coordinate system from Reference 6 (Structural) is as follow.



	Piping coord	Structural (Ref. 6)
N-S (horizontal)	X	X
Vertical	Y	Z
E-W (horizontal)	Z	Y

The seismic analysis of reactor and fuel building complex is shown in Reference 7. [[

]]

Table 5-1 Model Seismic Nodes

Node	Building Structure	Elevation (m)	Direction
[[			
			]]

Note.-X,Y are Horizontal and Z axis is Vertical

Appendix B-1 shows the time histories.

Appendix B-2 shows the response spectra used in the analyses.

5.3 SUPPORT GROUPS

[[
]]

5.3.1 Main Steam Analyses

Main steam analyses in the horizontal direction used two groups. Node 701, Node 206 and Node 9064 have the same time histories, therefore, they are in the same group. Node 807 is in the other group.

In the vertical direction, [[ ]] are used as summarized in Table 5-2.

5.3.2 Feedwater Piping

Feedwater piping analyses used [[ ]], RPV nozzles are in [[ ]] and all the other [[ ]] as summarized in Table 5-2.

Table 5-2 Support Groups

[[

]]

5.4 DISCUSSION OF TIME HISTORIES CORRELATION

[[

]]

Appendix B-3 plots the detail of the following time history correlations.

Figure B-3-1 shows the [[

]] of the time history. The detail acceleration time histories between this duration are plotted together to show whether or not they are correlated.

Figure B-3-2 [[
]]

Figure B-3-3 [[
]]

Figure B-4-4 [[
]]

From these figures it can be seen that the [[

]]

The peaks and the maximum accelerations of each ARS are in Table 5-3.

Table 5-3 Response Spectrum Peak Accelerations and Frequencies

Node	Direction	ARS peak frequency (Hz)	ARS maximum g
[[			
			]]

From the table, it can be seen that [[ ]] It is used as two groups in this analysis because one extra group in y direction is included. The ISM analysis results using [[ ]] will be slightly lower than [[ ]] in the vertical direction. For these analysis comparisons, [[ ]]

[[ ]]

5.5 COMPUTER PROGRAMS

The computer programs used in the piping stress analysis are described below. All of these programs meet the GE Quality Control Standards. All programs have been approved for production use after independent review and verification. Any changes to these programs require verification and approval in accordance with GE Quality Assurance Program.

5.5.1 PISYS08PC

[[ ]]

5.5.2 ANSI713D

[[ ]]

6. EVALUATION OF RESULTS

No load combinations have been considered. Only stresses resulting from time history analysis and stresses from response spectra analysis are considered for the comparison purpose.

6.1 PIPE STRESS

The piping components were analyzed in accordance with the requirements of ASME III, Subarticles NB-3650 for Class 1 piping by the ANSI7 computer program. The detail comparisons are tabulated in Appendix C.

6.2 PIPE SUPPORT LOADS

Load combinations 'ANC', 'STR', 'HAN', 'SNB', 'GUD', and 'GGD', are used by the ANSI7 computer program for computing the pipe support loads as applicable. A summary of forces, moments and deflections for each support analyzed is provided in Appendix D.

6.3 EIGENVALUES

A summary of Eigenvalues is shown in Appendix E.

APPENDIX A

Isometric Diagrams, Joint Coordinates and Anchor Locations

APPENDIX A-1 Main Steam Lines 2 And 3

[[

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Figure A-1-1 Lines 2 and 3 PYSIS Model

(Complete Model including SRV Discharge Lines)

[[

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Figure A-1-2 Lines 2 and 3 PYSIS Model (Class 1 Lines)

[[

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Figure A-1-3 Lines 2 and 3 PYSIS Model (SRV Discharge Lines)

[[

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Figure A-1-4 SRV H-J-K-L Discharge Line

[[

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Figure A-1-5 SRV F Discharge Line

[[

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Figure A-1-6 SRV G Discharge Line

[[

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Figure A-1-7 SRV M Discharge Line

[[

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Figure A-1-8 SRV N Discharge Line

APPENDIX A-2 Feedwater Piping System Configuration

[[

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Figure A-2-1 Feedwater Piping

APPENDIX B
Input Time Histories and Response Spectra

APPENDIX B-1 Input time histories

[[

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Figure B-1-1 Node 206 (Containment Penetration) Acceleration Time History

[[

]]

Figure B-1-2 Node 701 (Vent Wall) Acceleration Time History

[[

]]

Figure B-1-3 Node 807 (Reactor Pressure Vessel) Acceleration Time History

[[

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Figure B-1- 4 Node 9064 (Diaphragm Floor) Acceleration Time History

Note. Horizontal Time History is the same as Vent Wall and Containment Penetration

APPENDIX B-2 Amplified Response Spectra (ARS)

Note- X and Y axis are Horizontal and Z axis is Vertical.

[[

]]

Figure B-2-1 Node 701X (Containment Penetration) X-Horiz. ARS

(Same for nodes 206, 9064)

[[

]]

Figure B-2-2 Node 206 (Containment Penetration) Y-Horiz. ARS

(Same for node 9064)

[[

]]

Figure B-2-3 Node 206 (Containment Penetration) Z-Vert. ARS

[[

]]

Figure B-2-4 Node 701 (Vent Wall) Z-Vert. ARS

[[

]]

Figure B-2-5 Node 807 (RPV) X-Horiz. ARS

[[

]]

Figure B-2-6 Node 807 (RPV) Y-Horiz. ARS

[[

]]

Figure B-2-7 Node 807 (RPV) Z-Vert. ARS

[[

]]

Note.-Horizontal Spectra is the same for 206 and 701 Nodes

Figure B-2-8 Node 9064Z (Diagraphm) Z-Vert. ARS

APPENDIX B-3 TIME HISTORY CORRELATION

[[

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Figure B-3-1 Acceleration Time History for Building Node 206 X (containment in horizontal)

[[

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Figure B-3-2 Acceleration Time Histories for Containment Node 206 X and RPV Nozzle 807X from time 7.5 sec. to 8.0 sec.

[[

]]

Figure B-3-3 Acceleration Time Histories for Containment Node 206 X and RPV Nozzle 807X from Time 9.5 sec. to 10.5 sec.

[[

]]

Figure B-3-4 Acceleration Time Histories for Building Node 206, RPV Nozzle 807 and Diaphragm Floor 9064 in Vertical Direction from Time 7.5 sec to 8.0 sec.

[[

]]

Figure B-3-5 Acceleration Time Histories for Vent Wall 701, RPV Nozzle in Vertical Direction from Time 7.5 sec. to 8.0 sec. (Correlated)

APPENDIX C

Piping Stress Analysis Comparison

Units: Stresses in MPa.

APPENDIX C-1 Main Steam Lines
Piping Stress Analysis Comparison

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[[

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APPENDIX C-2 Feedwater Lines

Piping Stress Analysis Comparison

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[[

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[[

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[[

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[[

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APPENDIX D
Piping Support Comparison

Units: Stresses in kN, kNm

APPENDIX D-1 Main Steam Lines

Piping Support Comparison

[[

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[[

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[[

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APPENDIX D-2 Feedwater Lines

Piping Support Comparison

[[

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APPENDIX E
System Eigenvalue Summary

APPENDIX E-1 Main Steam Lines

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APPENDIX E-2 Feedwater Lines

[[

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Enclosure 4

MFN 06-119

Supplement 2

Affidavit

GE-Hitachi Nuclear Energy Americas LLC

AFFIDAVIT

I, James C. Kinsey, state as follows:

(1) I am Project Manager, ESBWR Licensing, GE-Hitachi Nuclear Energy Americas LLC ("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 2 of GEH's letter, MFN 06-119, Supplement 2, Mr. James C. Kinsey to U.S. Nuclear Energy Commission, entitled "*Response to Portion of NRC Request for Additional Information Letter No. 16 Related to ESBWR Design Certification Application – Piping Design – RAI Numbers 3.12-3 S01, 3.12-3 S02, 3.12-15 S01, 3.12-15 S02, 3.12-21 S01, 3.12-21 S02 and 3.12-21 S03*", dated September 13, 2007. The proprietary information in Enclosure 2, which is entitled "*Piping Independent Support Motion Response Spectrum Analysis Justification for SRSS Group Combination – GEH Proprietary Information*", is delineated by a [[dotted underline inside double square brackets.{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 for the proprietary determination.

(3) In making this application for withholding of proprietary information of which it is the owner or licensee, 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 2.390(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 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 it contains details of GEH's evaluation methodology.

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 and obtaining 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 13th day of September 2007.

James C. Kinsey

James C. Kinsey
GE-Hitachi Nuclear Energy Americas LLC