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

MFN 08-878

Docket No. 52-010

November 6, 2008

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

Subject: **Response to Portion of NRC RAI Letter No. 220 Related to ESBWR Design Certification Application - DCD Tier 2 Section 3.9 – Mechanical Systems and Components; RAI Numbers 3.9-221, 3.9-222, 3.9-224, 3.9-225, 3.9-226, 3.9-227, 3.9-228, 3.9-229, 3.9-230, 3.9-231, & 3.9-232**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) response to the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) letter number 220 sent by NRC letter dated July 29, 2008 (Reference 1). RAI Numbers 3.9-221, 3.9-222, 3.9-224, 3.9-225, 3.9-226, 3.9-227, 3.9-228, 3.9-229, 3.9-230, 3.9-231, & 3.9-232 are addressed in Enclosure 1.

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

Sincerely,

Richard E. Kingston

Richard E. Kingston
Vice President, ESBWR Licensing

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NRO

Reference:

1. MFN 08-609 Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, GEH, *Request For Additional Information Letter No. 220 Related to NEDE-33312P, "ESBWR Steam Dryer Acoustic Load Definition," NEDE-33313P, "Steam Dryer Structural Evaluation," NEDC-33408P, "ESBWR Steam Dryer-Plant Based Load Evaluation Methodology," NEDE-33259P, "Reactor Internals Flow Induced Vibration Program," and ESBWR Design Control Document, Revision 5*, dated July 29, 2008

Enclosures:

1. Response to Portion of NRC RAI Letter No. 220 Related to ESBWR Design Certification Application - DCD Tier 2 Section 3.9 – Mechanical Systems and Components; RAI Numbers 3.9-221, 3.9-222, 3.9-224, 3.9-225, 3.9-226, 3.9-227, 3.9-228, 3.9-229, 3.9-230, 3.9-231, & 3.9-232 - Proprietary Version
2. Response to Portion of NRC RAI Letter No. 220 Related to ESBWR Design Certification Application - DCD Tier 2 Section 3.9 – Mechanical Systems and Components; RAI Numbers 3.9-221, 3.9-222, 3.9-224, 3.9-225, 3.9-226, 3.9-227, 3.9-228, 3.9-229, 3.9-230, 3.9-231, & 3.9-232 - Public Version
3. Affidavit

Attachment:

1. "Finite Element Method for Acoustics"

cc:		
	AE Cubbage	USNRC (with enclosures)
	RE Brown	GEH/Wilmington (with enclosures)
	DH Hinds	GEH/Wilmington (with enclosures)
	eDRF	0000-0092-7051 (RAI 3.9-221, 222 & 224-232)

Enclosure 2

MFN 08-878

Response to Portion of NRC Request for

Additional Information Letter No. 220

Related to ESBWR Design Certification Application

Mechanical Systems and Components

RAI Numbers 3.9-221, 3.9-222, 3.9-224, 3.9-225, 3.9-226, 3.9-227, 3.9-228, 3.9-229, 3.9-230, 3.9-231, & 3.9-232

Public Version

NRC RAI 3.9-221

Summary: Provide experimental validation of equations 13 &14

The speed of sound (a) and the absorption coefficient (a) used in the acoustic finite element model are based on the steam wetness fraction and the water droplet size, according to Eqs. 13 and 14 in report NEDC-33408P. Since no experimental validation of these equations is included in the report, GEH is requested to provide experimental validation of Eqs. 13 and 14.

GEH Response

The speed of sound and absorption are determined by Equations 13 and 14 are based on Reference 7 of NEDC-33408P. GEH believes this correlation appropriately represents the gas-moisture relaxation phenomena. [[

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By adopting the model of Reference 7, GEH is complying with Regulatory Guide 1.20 that requires that the load prediction methodology should be based as much as possible on physical properties and should not include any plant specific tuning. In this context the model in Reference 7 was considered the most suitable for acoustic simulations in the RPV. Confidence in the model is further increased by the good agreement between measurements and predictions as presented in Section 3 and Appendices A and B of NEDC-33408P.

DCD Impact

No change will be made to NEDC-33408P in response to this RAI.

NRC RAI 3.9-222

Summary: Clarify why the acoustic model is insensitive to an order of magnitude change in the steam properties

In the acoustic finite element model, different values of steam wetness and droplet size are used for the regions upstream and downstream of the dryer. This results in different sound speed and attenuation in these regions. [[

]] *GEH is requested to clarify why the acoustic model is insensitive to almost an order of magnitude change in the steam properties in the dryer banks.*

GEH Response

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DCD Impact

No change will be made to NEDC-33408P in response to this RAI.

NRC RAI 3.9-224

Summary: Explain the effect of wetness fraction and droplet size on the resonance frequencies

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]] *Explain and illustrate the effect of wetness fraction and droplet size on the acoustic resonance frequencies.*

GEH Response

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DCD Impact

No change will be made to NEDC-33408P in response to this RAI.

NRC RAI 3.9-225

Summary: Provide more information to support the PBLE uncertainties assessment

GEH analyzed a refined mesh of the acoustic finite element model to assess the effect of mesh size on PBLE uncertainties. [[

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GEH Response

In Figure 2 NEDC-33408P, [[

]] As shown in Figure 3 of NEDC 33408P, having a detailed model in this area [[

]] Figure 2 of NEDC 33408P shows that the [[
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[[

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As described in Supplement 1 to NEDC-33408P, [[

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DCD Impact

No change will be made to NEDC-33408P in response to this RAI.

NRC RAI 3.9-226

Summary: Explain discrepancies [[
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]] *Explain this discrepancy.*

GEH Response

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Supplement 1 to NEDC-33408P provides additional benchmark evaluations [[

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DCD Impact

No change will be made to NEDC-33408P in response to this RAI.

NRC RAI 3.9-227

Summary: Specify the bias error and uncertainty applied to dryer loads estimated in the design

GEH should specify what final bias error and uncertainty GEH will apply to dryer loads estimated for the ESBWR design. Are they based on QC benchmark data? The Design of Experiments data? Both? Are any conservative bias errors credited?

GEH Response

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DCD Impact

No change will be made to NEDC-33408P in response to this RAI.

NRC RAI 3.9-228

Summary: Explain whether singularities in the acoustic FRF matrices lead to non-conservative errors

GEH should explain whether singularities in the acoustic FRF matrices lead to non-conservative errors in the computed loading, such as sharp dips at certain frequencies. If so, how will GEH account for the errors?

GEH Response

From benchmarking results provided in both *NEDC-33408P* and *NEDC-33408P* Supplement 1, GEH found that loads were generally [[ ]] GEH has performed benchmarking that included multiple frequency bands that included bands that coincide [[ ]] The range in PBLE (Plant Based Load Evaluation) error from narrow frequency bands is summarized in section 4.5.3 of NEDC-33408P Supplement 1. [[

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DCD Impact

No change will be made to NEDC-33408P in response to this RAI.

NRC RAI 3.9-229

Summary: Describe the options of SYSNOISE used in the analysis

Section 2.1 of NEDC-33408P:
(a) Provide a description of the options of SYSNOISE used in the analysis.
(b) Provide a description of the interface between SYSNOISE and MATLAB.

GEH Response

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DCD Impact

No change will be made to NEDC-33408P in response to this RAI.

NRC RAI 3.9-230

Summary: Provide detail description of analysis procedure

Section 2.2.1, NEDC-33408P:

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(b) Show how the Helmholtz form of the wave equation that includes the frequency dependent damping was obtained, or provide a reference where this may be obtained.
(c) Provide the detailed formulation of the finite element implementation of the Helmholtz form of the wave equation leading to Equation 1 on page 4, or provide a reference in the literature where this implementation may be found.
(d) State the method for determining the coefficients in the damping matrix of Equation 1.
(e) Show the formulation for obtaining the velocity field by differentiation of the pressure field.

GEH Response

(a) [[

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(b) The Helmholtz equation that is the basis for Acoustic FE is described in Reference 1. The Helmholtz equation in Section 2.2 of Reference 1 is sufficiently general and applies also for complex and frequency dependent fluid properties.

(c) The acoustic finite element method is described in Section 2.3 of Reference 1.

(d) The coefficients for the damping matrix are calculated as a function of the impedance boundary conditions as described in Section 2.3.3.4 of Reference 1.

(e) The velocity vector $\vec{v}$ at any point *(x,y,z)* in the model can be determined by the gradient of the acoustic pressure *p*:

$$\vec{\nabla} p(x,y,z) = -j\omega\rho\,\vec{v}(x,y,z)$$

where ω equals the circular frequency (=$2\pi f$ with f equal to the frequency) and ρ is the fluid density. The pressure gradient can be expressed in terms of shape functions as given by Equation (2.14) of Reference 1 and provided as Attachment 1 to MFN 08-878.

Reference:

1. W. Desmet, D. Vandepitte, 'Finite Element Method in Acoustics' in ISAAC13- International Seminar on Applied Acoustics, Leuven, 2002, ISBN 90-73802-73-3

DCD Impact

No change will be made to NEDC-33408P in response to this RAI.

NRC RAI 3.9-231

Summary: Provide basis for the requirement selected

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GEH Response

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DCD Impact

No change will be made to NEDC-33408P in response to this RAI.

NRC RAI 3.9-232

Summary: Provide further details about the analysis method

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GEH Response

(a) [[

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(b) The relation between the [[

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(c) The SYSNOISE® analysis steps include setting up the acoustic finite element mesh by [[

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(d) [[

]]This method is implemented as a standard function in MATLAB® and is based on the work [[

References:

1. [[
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2. [[
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DCD Impact

No change will be made to NEDC-33408P in response to this RAI.