HITACHI

GE Hitachi Nuclear Energy

James C. Kinsey
Vice President, ESBWR Licensing

PO Box 780 M/C A-55
Wilmington, NC 28402-0780
USA

T 910 675 5057
F 910 362 5057
jim.kinsey@ge.com

MFN 07-225, Supplement 1

Docket No. 52-010

January 25, 2008

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

Subject: **Response to Portion of NRC Request for Additional Information Letter Number 67 Related to ESBWR Design Certification Application - Special Topics for Mechanical Components - RAI Numbers 3.9-13 S01**

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) originally transmitted via the Reference 1 letter and supplemented by an NRC request for clarification in Reference 2. The GEH response to RAI Number 3.9-13 S01 is addressed in Enclosure 1.

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

Sincerely,

James C. Kinsey

James C. Kinsey
Vice President, ESBWR Licensing

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NRO

References:

1. MFN 06-378, Letter from U.S. Nuclear Regulatory Commission to Mr. David H. Hinds, Manager, ESBWR, General Electric Company, *Request For Additional Information Letter No. 67 Related To ESBWR Design Certification Application*, dated October 10, 2006

2. E-Mail from Chandu Patel, U.S. Nuclear Regulatory Commission, to John Leatherman, GE, dated May 7, 2007 (ADAMS Accession Numbers ML071620006 and ML071620013)

Enclosure:

1. Response to Portion of NRC Request for Additional Information Letter Number 67 Related to ESBWR Design Certification Application - Special Topics for Mechanical Components - RAI Numbers 3.9-13 S01

cc:	AE Cubbage	USNRC (with enclosure)
	DH Hinds	GEH/Wilmington (with enclosure)
	GB Stramback	GEH/San Jose (with enclosure)
	RE Brown	GEH/Wilmington (with enclosure)
	eDRF	0000-0073-2314

Enclosure 1

MFN 07-225, Supplement 1

Response to Portion of NRC Request for

Additional Information Letter No. 67

Related to ESBWR Design Certification Application

Special Topics for Mechanical Components

RAI Number 3.9-13 S01

For historical purposes, the original text of RAI 3.9-13 and the GEH response is included, except for any attachments or DCD mark-ups.

NRC RAI 3.9-13

In DCD Tier 2, Appendix 3D verify that all computer programs used for calculating stresses and cumulative usage factors for Class 1, 2, and 3 components include staff endorsed environmental effects on the fatigue curves.

GE Response

The following DCD Tier 2 Appendix 3D computer programs are used for calculating stresses and cumulative usage factors for class 1, 2 and 3 components.

- ANSYS. When used in this capacity, environmental effects on fatigue curves are accounted for outside of the program.
- EVAST. Environmental effects are not included when using fatigue curves from ASME Code Section III Appendix I. Prior to use of the program results, the environmental effects will be factored into the final output.
- ANSI7. Includes environmental effects on the fatigue curves according to DG1144 and NUREG/CR-6909.

DCD Impact

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

NRC RAI 3.9-13 S01

RAI 3.9-13 S01 Comments on response to RAI 3.9-13 from MFN 07-225:

1. The GE response to NRC RAI 3.9-13 indicates that for the computer program ANSYS, environmental effects on fatigue curves are accounted for outside of the program.

A. State whether the environmental effects correspond to those endorsed by the staff in DG-1144 and NUREG/CR-6909.

B. Provide a description of how the environmental effects are accounted for in the calculation of the cumulative usage factor.

2. The GE response to NRC RAI 3.9-13 indicates that for the computer program EVAST, environmental effects are not included when using fatigue curves from ASME Section III Appendix I, and that environmental effects will be factored into the final output prior to use of the program results.

A. Provide clarification and a description of how the environmental effects are accounted for in the calculation of the cumulative usage factor.

B. State whether the environmental effects correspond to those endorsed by the staff in DG-1144 and NUREG/CR-6909.

GEH Response

When using computer programs to calculate stresses and cumulative usage factors for Class 1, 2, and 3 components, environmental effects on fatigue curves will be considered. The environmental effects will correspond to those endorsed by the staff in DG-1144 and NUREG/CR-6909, and the method used will be in accordance with Regulatory Guide 1.207 (draft issued as DG-1144) and Appendix A of NUREG/CR-6909. In the case of ANSYS and EVAST, these computer programs do not specifically address environmental effects on fatigue curves; therefore, the calculations are performed outside the program; however, the calculations will be in accordance with DG-1144 and NUREG/CR-6909.

DCD Impact

DCD Tier #2, Appendix 3D will be revised in Revision 5 as noted in the attached markup.

provided by ANSYS, Inc. are extracted from textbooks in which classical or theoretical solutions are published or can readily be obtained by simple hand calculations.

3D.3.1.3 Extent of Application

This program is used for the elastic and inelastic stress analysis and vibration analysis of the reactor pressure vessel and internals. The extent and limitation are determined by verification cases performed to qualify ANSYS as an Approved Production Program that is verified and documented for design applications or for all technical activities used in developing design-related information. The program calculates elastic and inelastic stresses for level D, faulted limits, but the ASME Code Section III Appendix F limits are not within the program. The computer program may be used for calculating stress and Cumulative Usage Factors (CUF) for Class 1, 2, or 3 components, but the environmental effects are addressed outside ANSYS in accordance with DG-1144 and NUREG/CR-6909.

3D.3.2 Dynamic Stress Analysis of Axisymmetric Structures Under Arbitrary Loading - ASHSD2

3D.3.2.1 Description

This FORTRAN program was created at the Earthquake Engineering Research Center, University of California, Berkeley. A finite element method is presented for the dynamic analysis of complex axisymmetric structures subjected to any arbitrary static or dynamic loading or base acceleration. The three-dimensional axisymmetric continuum is represented either as an axisymmetric thin shell or as a solid of revolution or as a combination of both. The axisymmetric shell is discretized as a series of frustrums of cones, and the solid of revolution as triangular or quadrilateral "toroids" connected at their nodal point circles. Hamilton's variational principle is used to derive the equations of motion for this discrete structure. This leads to a mass matrix, stiffness matrix, and load vectors that are all consistent with the assumed displacement field. But to minimize computer storage and execution time, a diagonal mass matrix has been assumed in writing the computer program (with the input diagonalized accordingly by coordinate system transform). These equations of motion are solved numerically through the time domain either by direct integration or by modal superposition. In both cases, a step-by-step integration procedure was used.

3D.3.2.2 Validation

Hand calculations using theoretical equations published in literature are performed to demonstrate the program's applicability and validity.

3D.3.2.3 Extent of Application

This program is used to calculate elastic stresses in the reactor pressure vessel and shroud support, using axisymmetric shell and solid elements for axisymmetric and non-axisymmetric static loading. The program calculates stresses for level D, faulted limits, but only for ASME Code Section III elastic analysis as defined in F1321.3 requirements.

3D.3.3 EVAST

3D.3.3.1 Description

This FORTRAN program was created by Babcock-Hitachi K.K. to calculate stress intensities, perform fatigue evaluation, and evaluate thermal ratcheting.

3D.3.3.2 Validation

Hand calculations are performed to demonstrate the program's applicability and validity.

3D.3.3.3 Extent of Application

This program is used to evaluate the primary stress intensities and fatigue and thermal ratcheting of the shroud support. Where fatigue curves are used, environmental effects are addressed outside EVAST in accordance with DG-1144 and NUREG/CR-6909~~not considered~~.

3D.3.4 TACF

3D.3.4.1 Description

This FORTRAN program was created by Babcock-Hitachi K.K. to evaluate temperature distribution.

3D.3.4.2 Validation

Hand calculations using theoretical equations published in literature are performed to demonstrate the program's applicability and validity.

3D.3.4.3 Extent of Application

This program is used to evaluate the steady and non-steady state axisymmetric thermal conduction of the reactor pressure vessel and shroud support.

3D.3.5 ABAQUS

3D.3.5.1 Description

This PC-based program was created by ABAQUS, Inc. ABAQUS solves traditional implicit finite element analyses, such as static, dynamics, and thermal, all powered with a wide range of contact and nonlinear material options. ABAQUS also has optional add-on and interface products that address design sensitivity analysis. ABAQUS enables a wide range of linear and nonlinear engineering simulations.

3D.3.5.2 Validation

Hand calculations using theoretical equations published in literature are performed to demonstrate the program's applicability and validity.