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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 176 Related to ESBWR Design Certification Application – Design of Structures, Components, Equipment, and Systems - RAI Number 3.9-143 S02**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) response to a portion of the U.S. Nuclear Regulatory Commission Request for Additional Information (RAI) sent by NRC Letter 176 (Reference 1). The GEH response to RAI Number 3.9-143 S02 is addressed in Enclosure 1.

The GEH response to RAI 3.9-143 S01 was submitted via Reference 2 in response to a Reference 3. The original RAI 3.9-143 response (Reference 4) was submitted in response to Email from Chandu Patel (NRC) (Reference 5).

Should you have any questions about the information provided here, please contact me.

Sincerely,

James C. Kinsey

James C. Kinsey
Vice President, ESBWR Licensing

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References:

1. MFN 08-375, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 176 Related to the ESBWR Design Certification Application,* dated April 10, 2008

2. MFN 07-308, *Response to Portion of NRC Request for Additional Information Letter No. 67 Related to ESBWR Design Certification Application – Mechanical Systems and Components – RAI Numbers 3.9-89 and 3.9- 143* dated June 6, 2007

3. MFN 06-378, Letter from U.S. Nuclear Regulatory Commission to David H. Hinds, *Request for Additional Information Letter No. 67 Related to ESBWR Design Certification Application dated October 10, 2006*

4. MFN 07-308, Supplement 1, *Response to Portion of NRC Request for Additional Information Letter No. 67 Related to ESBWR Design Certification Application – Mechanical Systems and Components Qualification – RAI Number 3.9-143 S01*, dated November 29, 2007

5. Email from the NRC (Chandu Patel) dated July 10, 2007

Enclosure:

1. Response to Portion of NRC Request for Additional Information Letter No. 176 Related to ESBWR Design Certification Application – Design of Structures, Components, Equipment, and Systems - RAI Number 3.9-143 S02

cc:		
	AE Cubbage	USNRC (with enclosure)
	RE Brown	GEH/Wilmington (with enclosure)
	DH Hinds	GEH/Wilmington (with enclosure)
	GB Stramback	GEH/San Jose (with enclosure)
	eDRF	0000-0076-5644, Revision 0

Enclosure 1

MFN 08-425

Response to Portion of NRC Request for

Additional Information Letter No. 176

Related to ESBWR Design Certification Application

Design of Structures, Components, Equipment, and Systems

RAI Number 3.9-143 S02

For historical purposes, the original text of RAI 3.9-143 and 3.9-143 S01 and the GE responses are included. These responses do not include any attachments or DCD mark-ups.

NRC RAI 3.9-143

In Section 4.1.2.2 of the DCD Tier 2, GE stated that individual fuel assemblies in groups of four rest on orificed fuel supports that are mounted on top of the control rod guide tubes (CRGT). Each guide tube, with its orificed fuel support, bears the weight of four fuel assemblies and is supported on a CRD Housing (CRDH) penetration nozzle in the bottom of the reactor vessel. It appears that the weld at the nozzle is subjected to the weight of four fuel assemblies, orificed fuel support, CRGT and CRDH, and other vertical and horizontal loads. GE is requested to clarify the load path and ensure the weld at the nozzle is adequate to accommodate these loads. In the event of weld failure, GE is requested to assess the adequacy of the CRGT and the CRDH subjected to flow-induced vibrations, and the ability to insert the control rod, considering the boundary conditions at the top of the CRGT and failed weld, and the CRGT base coupling connection with the CRDH.

GEH Response

The CRD housing - to - CRD Stub Tube weld in the bottom head of the reactor pressure vessel carries the deadweight of four fuel assemblies, the orificed fuel support and the CRD guide tube. In addition, the weld carries the loads due to seismic and hydrodynamic accelerations as well as scram reaction loads, spring loads and vibratory loads. The load path is identical to that of earlier BWRs including the ABWR. A sketch of the CRD penetration was included in GE's response to RAI 4.5-19. The weld is analyzed, designed, manufactured and examined to be in full compliance with the requirements for ASME Code, Section III, Division 1, Class 1 pressure retaining components considering all the loads mentioned in the foregoing.

The clearance between the CRD housing is controlled and kept as small as practicable for installation purposes. Thus, in the unlikely event of a complete weld failure, the transversal movement of the CRD Housing and the CRD Guide Tube is limited. Flow induced vibration during this hypothetical condition would produce stresses in the CRD Guide Tube that are within the endurance limit as defined using the fatigue curve for austenitic stainless steel, Figure I-9.2.1 of the ASME Code, Section III.

A complete failure of the CRD housing - to - CRD Stub Tube is very unlikely. The existence of weld cracks in some older plant were discovered by leakage through the weld. The leakage started long in advance of any possibility of a complete weld failure. Also, the use of Columbium stabilized Alloy 82 weld material and Ni-Cr-Fe Alloy 600 stub tube material per ASME Code Case N-580-1 in the ESBWR has widely eliminated the concern for stress corrosion cracking in the weld and adjacent material.

As mentioned in the foregoing, in the case of a complete weld failure, the transverse movement of the CRD Guide Tube is limited. The control rods and the control drive are designed to accommodate this misalignment during insertion of the control rods.

DCD Impact

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

NRC RAI 3.9-143 S01

The following Supplementary RFI was received from the NRC (Chandu Patel) on July 10, 2007, via e-mail to Jim Rogers.

Comment on response to RAI 3.9-143-S01 (MFN 07-308, June 6, 2007):

In RAI 3.9-143, the staff requested GE to assess, in the event of weld failure at the penetration nozzle in the bottom of the reactor vessel, the adequacy of the control rod guide tubes (CRGT) and the control rod drive housing (CRDH) subjected to flow-induced vibrations, and the ability to insert the control rod, considering the boundary conditions at the top of the CRGT and failed weld, and the CRGT base coupling connection with the CRDH.

In its response to RAI 3.9-143 (MFN 07-308), dated June 6, 2007, GHNEA stated that, in the unlikely event of a complete weld failure, the transversal movement of the CRD Housing and the CRD Guide Tube is limited. Flow induced vibration during this hypothetical condition would produce stresses in the CRD Guide Tube that are within the endurance limit as defined using the fatigue curve for austenitic stainless steel, Figure I-9.2.1 of the ASME Code, Section III.

It is not clear how GHNEA reached the conclusion described above. GHNEA is requested to provide the following information to justify its conclusion:

(1) What is the maximum transversal movement of the CRD Housing and the CRD Guide Tube; (a) during normal operation, and (b) under the condition with weld failure?

(2) The natural frequency of the worst system configuration with boundary conditions at the top of the CRGT, the CRGT base coupling connection with the CRDH, and the failed weld at the bottom of the reactor vessel.

(3) The maximum cross flow and longitudinal flow velocities along the system configuration identified in (2) above, and those at the CRGT-CRDH coupling location.

(4) The results of the calculations for vortex shedding frequencies of the system configuration identified in (2) above, and the resulting maximum stress in the CRD.

GEH Response

The reactor pressure vessel tube stub/CRD housing weld is part of the reactor coolant pressure boundary as such it is designed, analyzed, fabricated, examined, and tested to ASME Section III Subsection NB class 1 requirements and is assigned the highest quality group classification A. This safety-related weld is designed and analyzed using seismic category I loads and load combinations as shown in Table 3.9.1 and 3.9.2 of the DCD Tier 2. This ensures the structural and functional integrity of the RPV and FMCRD. The capability to insert the control rods is maintained under all plant operating events and dynamic loading events and load combinations as discussed in response to RAI 3.9-43. The material selection and fabrication process provide an extremely high probability of weld integrity as discussed in DCD Tier 2, Section 4.5. In conclusion there is an extremely low probability of leakage, of a rapidly propagating failure, and of gross rupture. If this weld were to fail (leak), it would be detected by the safety-related leak detection system as discussed in DCD Tier 2, Subsection 5.2.5. The safety-related leak detection system indicates unidentified leakage through sump activity and sump level changes. The technical specifications specify limiting conditions of operation, required actions, surveillance requirements, and completion times to control the response as discussed in DCD Tier 2, Chapter 16, Subsections 3.4.2 and 3.3.4.1. In the unlikely event of a gross weld rupture the radial clearance between the RPV tube stub and the CRD housing is very small (nominally 1/8 mm) which would minimize any transverse movement of a CRD housing. Frequency induced vibrations, stress, and flow are discussed in ESBWR Licensing Topical Report NEDE-33259.

DCD Impact

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

NRC RAI 3.9-143 S02

NRC Summary:

If GEH continues to assume the complete failure of the penetration nozzle weld, provide the detailed response to the four questions raised in the RAI 3.9-143 S01.

NRC Full Text:

GEH's response to RAI 3.9-143 S01, dated December 7, 2007, is not acceptable. It did not address specifically the four questions raised in the RAI. In GEH's response to RAI 3.9-143 S01, GEH stated that:

... In the unlikely event of a gross weld rupture the radial clearance between the RPV tube stub and the CRD housing is very small (nominally 1/8 mm) which would minimize any transverse movement of a CRD housing. "Frequency" (should be "flow") induced vibrations, stress, and flow are discussed in ESBWR Licensing Topical Report NEDE-33259P, "Reactor Internals Flow Induced Vibration Program - Part I," (transmitted via MFN 06-012).

The adequacy of CR Guide Tube, CR Housing, and natural frequency and stress of the system configuration discussed in NEDE-33259P was based on the fixed end boundary condition at the penetration nozzle weld, not based on the assumed complete weld failure. Therefore, if GEH continue to conclude that the flow induced vibration during this hypothetical condition would produce stress in the CRD Guide Tube that are within the endurance limit as defined using the fatigue curve for austenitic steel, Figure I-9.2.1 of ASME Code, Section III, GEH is requested to provide detailed response to the four questions raised in the RAI 3.9-143 S01.

GEH Response

GEH no longer assumes the complete failure of the penetration nozzle weld. To ensure the structural integrity of the nozzle weld, it is analyzed, designed, fabricated, examined, and tested with the requirements of the ASME Code, Section III, Division 1, Class 1 pressure retaining components considering all the required loads mentioned in DCD Tier 2 Tables 3.9-1 and 3.9-2.

For early BWR operating plants (BWR/2 plants and one BWR/3 overseas plant), stress corrosion cracking of furnace sensitized stainless steel CRD stub tubes that occurred were detected by leakage through the narrow annulus gap at the penetration. Subsequent plants used Ni-Cr-Fe Alloy 600 material, which has proven through many years of service to be crack resistant. For ESBWR, Columbium stabilized alloy 82 weld material and Ni-Cr-Fe Alloy 600 stub tube material per ASME Code Case N-580-1 has been selected to provide long term resistance to stress corrosion cracking. In the cases where leakage occurred, it was demonstrated, unlike typical nozzle designs where pipe separation can occur, the inherent features of the stub tube design provides a means to detect relatively small amounts of leakage that is readily detected, and significant structural margin remains such that there is no impact on the performance of the CRD. Therefore, the complete failure of the CRD penetration connection is not credible for design purposes, and does not need to be evaluated from a flow induced vibration perspective.

Additionally, to ensure the ability to insert the control rod, the Fine Motion Control Rod Drive is designed, fabricated, and tested:

1) To quality standards commensurate with the importance of the safety-related functions to be performed in accordance with GDC 1 and 10 CFR 50.55a.
2) To withstand the effects of a safe shutdown earthquake without loss of capability to perform its safety-related functions in accordance with GDC 2.
3) To assure the extremely low probability of leakage or gross rupture in accordance with GDC 14.
4) With appropriate margin to assure its reactivity control function under conditions of normal operation including anticipated operational occurrences in accordance with GDC 26.
5) With appropriate margin, and in conjunction with the emergency core cooling system, to be capable of controlling reactivity and cooling the core under postulated accident conditions in accordance with GDC 27.
6) To assure an extremely high probability of accomplishing its safety-related functions in the event of anticipated operational occurrences in accordance with GDC 29.

DCD Impact

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