HITACHI

GE Hitachi Nuclear Energy

Richard E. Kingston
Vice President, ESBWR Licensing

P.O. Box 780
3901 Castle Hayne Road, M/C A-65
Wilmington, NC 28402 USA

T 910.819.6192
F 910.362.6192
rick.kingston@ge.com

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Subject: **Response to Portion of NRC RAI Letter No. 339 Related to ESBWR Design Certification Application – DCD Tier 2 Section 3.9 – Mechanical Systems and Components; RAI Number 3.9-245 S01**

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 (NRC) Request for Additional Information (RAI) letter number 339 sent by NRC letter dated May 26, 2009 (Reference 1). RAI Number 3.9-245 S01 is addressed in Enclosure 1.

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

Sincerely,

Richard E. Kingston

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Vice President, ESBWR Licensing

Reference:

1. MFN 09-365 Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, GEH, *Request For Additional Information Letter No. 339 Related to ESBWR Design Certification* dated May 26, 2009

Enclosure:

1. Response to a Portion of NRC RAI Letter No. 339 Related to ESBWR Design Certification Application - DCD Tier 2 Section 3.9 – Mechanical Systems and Components; RAI Number 3.9-245 S01

cc:	AE Cubbage	USNRC (with enclosures)
	JG Head	GEH/Wilmington (with enclosures)
	DH Hinds	GEH/Wilmington (with enclosures)
	eDRF Section	0000-0091-9192 (RAI 3.9-245 S01)

Enclosure 1

MFN 09-438

Response to Portion of NRC Request for

Additional Information Letter No. 339

Related to ESBWR Design Certification Application

DCD Tier 2 Section 3.9 – Mechanical Systems and Components

RAI Number 3.9-245 S01

NRC RAI 3.9-245 S01

RAI Summary

Explain whether the radiation-induced loss of fracture toughness of the internals materials and stress-relaxation of the bolts would challenge the integrity of ESBWR reactor internals during the design life of 60 years.

RAI Text

The staff agrees with GEH that the susceptibility of the reactor internal components to IGSCC, IASCC and thermal aging would be low during the ESBWR design life of 60 years because of the proposed water chemistry control. specified chemical composition of the structural materials. and the proposed fabrication processes. However, in Sections 4.5.2 and 5.2.3.2 of the DCD, GEH does not address the issue of radiation-induced loss of fracture toughness of the internals materials. e.g. austenitic stainless steels and nickel-based alloys, and stress-relaxation of the bolts used to fasten the reactor internal components. GEH is requested to explain whether the radiation-induced loss of fracture toughness of the internals materials and stress-relaxation of the bolts would challenge the integrity of ESBWR reactor internals during the design fife of 60-years.

GEH Response

The response is divided into two parts. The first addresses the concern for stress relaxation in threaded fasteners and the second addresses the concern for loss of toughness in reactor core internal components.

Threaded Fasteners

Radiation effects for threaded fasteners have been addressed in Section 3.9.3.9 of the DCD. In addition, the design process for the reactor internal components includes the effects of stress relaxation from irradiation on bolting.

Core Internals

The effects of irradiation on the core internals in the ESBWR is well understood based on the current experience with operating BWRs. These effects do not challenge the integrity of the ESBWR core internals. The basis for this assessment follows. Austenitic stainless steel and nickel-base alloys are very ductile materials. The elongation and reduction in area values for these materials in the un-irradiated condition are very high. There is no concern for brittle fracture at room temperature up to the operating temperature of 288°C in the un-irradiated condition. It is understood that irradiation will lead to changes in the material's strength and ductility. However, experience and investigative studies have shown that only above fluence levels of 3×10^{20} n/cm^2 do these changes start to produce a reduction in the inherent ductility of the materials. In the ESBWR, there are no nickel base materials that reach this fluence level in 60 years of operation. Therefore the only materials that need to be addressed are the austenitic stainless steel materials and their welds that will exceed this critical fluence level over the life of the plant.

The internal components being used are bounded by the experience and levels of irradiation for current operating BWRs. As discussed in DCD Sections 4.5.2 and 5.2.3.2.2, efforts are made to prevent cracking initiation during operation through material selection, fabrication controls and water chemistry. Additionally, efforts are made to minimize welds and to locate necessary welds away from high fluence locations. Components such as the top guide are designed to also reduce the end of life fluence as compared to earlier BWRs. The BWRVIP has also developed supporting toughness data (References 1, 2 and 3) that cover the range of fluences that these components will experience in the ESBWR design.

In summary, the design of the ESBWR internal components is similar to those in operating BWRs. As stated in DCD Section 4.5.2 and 5.2.3.2.2, the ESBWR design incorporates materials and fabrication processes as well as design features to minimize welds and the potential for cracking. Additionally, the fluence levels at the end of life are bounded by current operating experience. Therefore, radiation-induced loss of fracture toughness of the core internal materials and the stress relaxation of the bolts will not challenge the structural integrity of ESBWR reactor internals during its design life.

References

1. "BWR Vessel and Internals Project, Review of Test Data for Irradiated Stainless Steel Components (BWRVIP-66)," EPRI Report TR-112611, March 1999.
2. "BWRVIP-99: BWR Vessel and Internals Project, Crack Growth Rates in Irradiated Stainless Steels in BWR Internal Components," EPRI Technical Report 1003018, December 2001. *Errata issued August 2002, BWRVIP letter 2002-219.*

3. “BWRVIP-100-A: BWR Vessel and Internals Project, Updated Assessment of the Fracture Toughness of Irradiated Stainless Steel for BWR Core Shrouds,” EPRI Technical Report 1013396, August 2006.

DCD Impact

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