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Subject: Response to Portion of NRC Request for Additional Information Letter No. 229 - Related To Design Control Document (DCD) Revision 5 – RAI Number 4.2-2 Supplement 4

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) sent by the Reference 1 NRC letter. GEH response to RAI Number 4.2-2 Supplement 4 is addressed in Enclosure 1. DCD markups associated with this response are provided in Enclosure 2.

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

Sincerely,

Lee F. Dougherty for

Richard E. Kingston
Vice President, ESBWR Licensing

DO68
NRO

Reference:

1. MFN 08-611, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request For Additional Information Letter No. 229 Related To Design Control Document (DCD) Revision 5*, dated July 30, 2008.

Enclosure:

1. MFN 08-789 – Response to Portion of NRC Request for Additional Information Letter No. 229 - Related To Design Control Document (DCD) Revision 5 – RAI Number 4.2-2 S04
2. MFN 08-789 – Response to Portion of NRC Request for Additional Information Letter No. 229 - Related To Design Control Document (DCD) Revision 5 – RAI Number 4.2-2 S04 – DCD Markup Page

cc:	AE Cubbage	USNRC (with enclosures)
	RE Brown	GEH/Wilmington (with enclosures)
	DH Hinds	GEH/Wilmington (with enclosures)
	eDRF	0000-0091-6173

Enclosure 1

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Response to Portion of NRC Request for

Additional Information Letter No. 229

Related to ESBWR Design Certification Application

RAI Number 4.2-2S04

NRC RAI 4.2-2S04

Clarify statement on hydrogen content limit in Section 4.2.1.1.5.

In response to RAI 4.2-2 and 4.2-4, ESBWR DCD Revision 5, Tier 2, Section 4.2.1.1.5 was revised to capture the effects of cladding corrosion. The following text in DCD, Tier 2, Section 4.2.1.1.5 (Revision 5) is in contradiction. In the first part it states that hydrogen has negligible effect, whereas the second part specifies a limit. Please disposition these items or revise text to remove contradictory statements.

"Mechanical properties testing demonstrates that the cladding mechanical properties are negligibly affected by hydrogen contents far in excess of that experienced during normal operation. Based on available mechanical properties test data of the irradiated cladding, a design basis hydrogen limit is specified in Reference 4.2-5."

GEH Response

DCD Revision 5, Tier 2, Subsection 4.2.1.1.5 will be revised to clarify the text.

DCD Impact

The ESBWR DCD, Tier 2, Subsection 4.2.1.1.5 will be revised as shown in the DCD markup in Enclosure 2.

Enclosure 2

MFN 08-789

Response to Portion of NRC Request for

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Related to ESBWR Design Certification Application

RAI Number 4.2-2S04

DCD Markup Page

4.2.1.1.5 Fuel Rod Hydrogen Absorption

There are two considerations relative to fuel rod hydrogen absorption. The first consideration involves the potential for hydrogenous impurity evolution, historically from the fuel pellets, resulting in primary hydriding and fuel rod failure. This consideration is addressed by the application of a specification limit on the as-fabricated fuel pellets. The absence of primary-hydriding induced fuel rod failures demonstrates the effectiveness of this limit since its first application in 1972. The second consideration is the partial absorption by the fuel rod cladding of hydrogen liberated by the cladding waterside corrosion reaction. Mechanical properties testing demonstrates that the cladding mechanical properties ~~are negligibly~~can be affected by ~~hydrogen contents far in excess of that experienced during normal operation~~significant presence of hydrides. The effect of hydrogen on cladding ductility is taken into account in the fuel cladding strain limit. Based on available mechanical properties test data of the irradiated cladding, a design basis hydrogen limit is specified in Reference 4.2-5.

4.2.1.1.6 Cladding Creep Collapse

The fuel rod is evaluated to ensure that fuel rod failure due to cladding collapse into a fuel column axial gap does not occur. This criterion is discussed in detail in Reference 4.2-3.

4.2.1.1.7 Fuel Rod Stresses

Based upon the limits specified in ANSI/ANS 57.5-1981, the fuel rod is evaluated to ensure that the fuel does not fail due to cladding stresses or strains exceeding the cladding ultimate stress or strain capability. The figure of merit employed is termed the Design Ratio, where:

$$\text{Design Ratio} = \frac{\text{Effective Stress}}{\text{Stress Limit}} \text{ or } \frac{\text{Effective Strain}}{\text{Strain Limit}}$$

The effective stress or strain is determined by applying the distortion energy theory. The limit is the material ultimate stress or strain. To be within the limit, the Design Ratio must be less than or equal to 1.0.

4.2.1.1.8 Dynamic Loads / Cladding Fatigue

The fuel rod is evaluated to ensure that cladding strains due to cyclic loadings do not exceed the cladding material fatigue capability. The design limit for fatigue cycling is determined from Zircaloy fatigue experiments and is conservatively specified to ensure with high confidence that failure by cladding fatigue does not occur. Based on the LWR cyclic design basis presented in Reference 4.2-5, the cladding fatigue life usage is calculated and maintained below the cladding material fatigue limit.

As noted in Subsection 4.2.1.1, for each fuel design, steady-state operating limits are established to ensure that actual fuel operation, including AOOs, complies with the fuel rod thermal-mechanical design and safety analysis bases above. These operating limits define the maximum allowable fuel operating power level as a function of fuel exposure. Lattice local power and exposure peaking factors may be applied to transform the maximum allowable fuel power level into maximum linear heat generation rate (MLHGR) limits for individual fuel bundle designs.