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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 158 Related to ESBWR Design Certification Application - Auxiliary Systems - RAI Number 9.1-15 S02**

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 NRC Letter 158 dated February 29, 2008, Reference 1. The GEH response to RAI Number 9.1-15 S02 is addressed in Enclosure 1. The GEH response to RAI 9.1-15 S01 was submitted via Reference 2 in response to Reference 3. The original response was submitted via Reference 4 in response to Reference 5.

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

Sincerely,

James C. Kinsey

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Vice President, ESBWR Licensing

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NRO

References:

1. MFN 08-209, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 158 Related to the ESBWR Design Certification Application,* February 29, 2008
2. MFN 06-309, Supplement 7, Response to Portion of NRC Request for Additional Information Letter No. 54 – *Auxiliary Systems – RAI Number 9.1-15 S01,* August 13, 2007
3. E-mail dated May 3, 2007 from L. Quinones (NRC).
4. MFN 06-309 – Letter from GE to U.S. Nuclear Regulatory Commission, *Response to Portion of NRC Request for Additional Information Letter No. 54 Related to ESBWR Design Certification Application – Auxiliary Systems,* September 8, 2006
5. MFN 06-302, Letter from U.S. Nuclear Regulatory Commission to David H. Hinds, *Request for Additional Information Letter No. 54 Related to the ESBWR Design Certification Application*, August 23, 2006

Enclosure:

1. Response to Portion of NRC Request for Additional Information Letter No. 158 Related to ESBWR Design Certification Application – Auxiliary Systems - RAI Number 9.1-15 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	0000-0082-7017

Enclosure 1

MFN 08-424

Response to Portion of NRC Request for

Additional Information Letter No. 158

Related to ESBWR Design Certification Application

Auxiliary Systems

RAI Number 9.1-15 S02

For historical purposes, the original text of RAI 9.1-15 and 9.1-15 S01 and the GE responses are included. The historical responses do not include any attachments or DCD mark-ups.

NRC RAI 9.1-15

DCD Tier 2, Section 9.1.2 states that the SFP is a reinforced concrete structure with a stainless steel liner. Operating experience indicates that damage to the liner from light load handling accidents, such as a fuel assembly drop, are credible and can allow leakage at high rates.

Consistent with the guidance of SRP Section 9.1.3, Revision 3,July 1981, Criterion III.1.f, describe how the makeup capacities and the time required to make associated hookups are consistent with expected leakage from structural damage that causes leakage through the liner.

GE Response

SRP 9.1.3, Section III.1.f states:
"A seismic Category I makeup system and an appropriate backup method to add coolant to the spent fuel pool are provided. The backup system need not be a permanently installed system, nor Category I, but must take water from a Category I source. Engineering judgment and comparison with plants of similar design are used to determine that the makeup capacities and the time required to make associated hookups are consistent with heatup times or expected leakage from structural damage."

Reg. Guide 1.13, Section B.1 discusses acceptable solutions for avoiding structural damage resulting from load handling accidents:
"Possible solutions to this potential problem include (1) preventing, preferably by design rather than interlocks, heavy loads from being lifted over the pool; (2) using a highly reliable handling system designed to prevent dropping of heavy loads as a result of any single failure; or (3) designing the pool to withstand dropping of the load without significant leakage from the pool area in which fuel is stored."

The amount of leakage through the liner in the event of a load handling accident is limited by method 3. The SFP liner has been designed to the requirements contained in DCD Tier, Section 9.1.2.4 and as discussed in response to RAI 9.1-6. The ESBWR SFP liner is similar to existing plants such as ABWR. The liner is Seismic 1 and designed to the acceptance criteria of ASME Section III, Division 2, CC-3700.

In addition to the changes described in the response to RAI 9.1-6, the following sentence will be added to DCD section 9.1.2.4:

Pool liners will be evaluated to ensure structural integrity under fuel handling accidents.

NRC RAI 9.1-15 S01

Supplement received via e-mail dated 5/3/07 from Quinones:

The response is insufficient. Provide analyses demonstrating that the pool liner will retain its leak tight integrity after impact by a dropped fuel assembly, describe an alternative method of assuring an adequate pool inventory will be maintained following a fuel handling accident, or provide redundant safety-related makeup capability.

GE Response

Using previous analysis methodology as guide, an analysis of the pool liners was performed for the ESBWR. The resulting conclusion demonstrated that a liner thickness of 10.80 mm or greater is sufficient to resist damage from a dropped fuel bundle. This is well within the16 mm thickness of the liner.

DCD Impact

DCD Tier #2, Section 9.1.2 will be revised as noted in the attached markup.

NRC RAI 9.1-15 S02

The response to RAI 9.1-15S01 states that an analysis of the pool liner was performed for the ESBWR and the resulting conclusion demonstrated that a liner thickness of 10.80 mm or greater is sufficient to resist damage from a dropped fuel bundle. During an audit performed on January 30, 2008, the staff reviewed the applicant's drop analysis on the spent fuel pool (and reactor buffer pool) liner. The staff requests that the applicant responds to the following:

1) What is the basis for the equation used to calculate the required liner thickness?

2) Describe how the material properties of the liner were considered.

3) Describe the type of impact model is assumed (e.g., is all the energy absorbed by the liner)?

4) How is the liner assumed to fail (i.e., fracture, plastic deformation, etc.)?

5) How was operational experience considered during the evaluation? (See INPO Significant Event Report (SER) 15-95, "Spent Fuel Pool Liner Punctured by Dropped Equipment")

GEH Response

1) The equation used to calculate the required liner thickness for ESBWR is the same equation used in the analysis performed for the Lungmen ABWR, "Fuel Assembly Drop Evaluation" (proprietary report) (31113-0U71-1129-0012, 8/2000):

$T = [(M*V_s^2)/2]^{2/3}/(672*D)$

The reference for the equation used in the Lungmen analysis is a "First of a Kind Engineering (FOAKE)" report for ABWR prepared by Bechtel, "Reactor Building Fuel Pool Liner" (22362-MLC-1060-001, Rev. 1, 2/1996). The Bechtel report references a topical report, also prepared by Bechtel, "Design of Structures for Missile Impact (BC-TOP-9A, 9/1974), which points to three Ballistic Research Laboratory references for inputs to development of the equation:

a) Russell, C.R., Reactor Safeguards, MacMillan, New York, 1962,

b) Fundamentals of Protective Design, TM 5-855-1, Headquarters, Department of the Army, Washington, D.C., July 1965,

c) Gwaltney, R.C., Missile Generation and Protection in Light-Water-Cooled Power Reactor Plants, ORNL NSIC-22, Oak Ridge National Laboratory, Oak Ridge, Tennessee, for the U.S. Atomic Energy Commission, September 1968.

The Bechtel topical report was submitted to the Atomic Energy Commission and approved in November, 1974. The equation was used based on the Regulatory staff approval of this document.

To validate the original analysis, an alternative analysis has been completed. This analysis is available for review at the GEH Washington, D. C. office and used very conservative assumptions to determine that a 304L stainless steel liner of 16 mm thickness has sufficient capability to absorb the impact energy from a dropped fuel assembly. The results provide a margin that is consistent with the result obtained in the original analysis (40% vs. 48%).

2) For the original calculation method, the reference assumed the material to be steel, without any further definition. For the alternate analysis, 304L stainless steel was used for the pool liner material based on its corrosion resistance properties.

3) The fuel assembly impact with the pool liner is assumed to occur at the location of a leak channel, such that the liner absorbs the total energy.

4) Based on analysis results, the liner is not assumed to fail. The alternate analysis considered plastic deformation of the liner.

5) SER 15-95 was reviewed for consideration in the analyses. Both events documented in the SER occurred due to workers using unapproved equipment in and around their respective spent fuel pools.

   A dropped fuel assembly is considered the bounding case for the following reasons: 1) analysis was performed with the expectation that work will be performed within analyzed boundaries and according to applicable procedures, 2) the assumptions used in the analyses were conservative and results identified 40-48% margins in relation to the 16 mm pool liner thickness, 3) the fuel assembly geometry and weight is bounding relative to servicing tools that are provided to the plant.

DCD Impact

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