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Subject: **Partial Response to Portion of NRC Request for Additional Information Letter No. 304 Related to ESBWR Design Certification Application - Auxiliary Systems - RAI Number 9.1-78 S01**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) partial response to the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) sent by NRC Letter 304, dated March 31, 2009, Reference 1. The original RAI response was submitted to the NRC via Reference 2 in response to Reference 3. GEH partial response to RAI Number 9.1-78 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

References:

1. MFN 09-227, Letter from U.S. Nuclear Regulatory Commission to Jerald G. Head, *Request for Additional Information Letter No. 304 Related to ESBWR Design Certification Application,* March 31, 2009.

2. MFN 08-912, Response to NRC Request for Additional Information Letter No. 217 Related to Licensing Topical Report NEDC-33374P, Revision 0, "Safety Analysis Report for Fuel Storage Racks Criticality Analysis for ESBWR Plants" - RAI Numbers 9.1-77 through 9.1-95, November 24, 2008.

3. MFN 08-551, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 217 Related to ESBWR Design Certification Application,* June 25, 2008.

Enclosures:

1. Partial Response to Portion of NRC Request for Additional Information Letter No. 304 Related to ESBWR Design Certification Application - Auxiliary Systems - RAI Number 9.1-78 S01
2. Partial Response to Portion of NRC Request for Additional Information Letter No. 304 Related to ESBWR Design Certification Application - Auxiliary Systems - RAI Number 9.1-78 S01, DCD Markup

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|---|---|---|
| cc: | AE Cubbage | USNRC (with enclosure) |
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| | eDRF section | 0000-0101-9441 |

**Enclosure 1**

**MFN 09-335**

**Partial Response to Portion of NRC Request for**

**Additional Information Letter No. 304**

**Related to ESBWR Design Certification Application**

**Auxiliary Systems**

**RAI Number 9.1-78 S01**

**For historical purposes, the original text of RAI 9.1-78 and the GEH response is included.**

**NRC RAI 9.1-78**

*NEDC-33374P, Section 1.0 – The scope of the analysis, as described in Section 1.0, may be too restricted. Provide justification for the limited scope of normal and abnormal conditions described and analyzed. Describe the process used to identify the normal and credible abnormal conditions for fresh and spent fuel handling and storage. If bounding configurations are used for the analysis, provide the logic for eliminating the non-bounding configurations.*

**GEH Response**

The scope of the analysis as described in Section 1.0 is based on the guidance provided in ANSI/ANS 57.2 for consideration of normal and credible abnormal fuel handling cases when performing criticality safety analysis calculations for fresh and spent fuel.

For the recommended credible abnormal cases that result in bundle configurations that have the simple addition of an adjacent bundle, such as lateral rack movement, bundle dropped on top of the storage rack, bundle dropped on the side of the storage rack, these are represented by modeling the fuel as an infinite lattice array (i.e., no axial or radial neutron leakage). The infinite lattice representation describes a conservative model configuration that bounds these actual finite cases.

For the credible abnormal cases, which involve manufacturing and material composition uncertainties in both the fuel and storage rack structural components, conservative modeling assumptions are made. These include assuming all the fuel is at its peak in-core (and hence in-rack) reactivity, taking no credit for fission product poisoning and reducing the neutron poison credit for the boron in the steel rack. This modeling approach is justified since it provides a conservative method that adequately addresses these uncertainties, particularly since these are generally treated as worst-case, in accordance with their tolerances. The logic behind this approach is that bounding conditions in poisoned systems are those which minimize the amount of poison and other neutron absorber material in the system.

In the remaining cases in which bounding assumptions for a particular variable cannot be made (these are pool water temperature reduction and moderation inside the new fuel rack), explicit calculations were performed to quantify the reactivity effects of these conditions. In this case, non-bounding configurations are not eliminated.

**DCD Impact**

No changes to the subject LTR will be made in response to this RAI.

**NRC RAI 9.1-78 S01**

The response in MFN 08-912 is not sufficient.

The second paragraph of the response indicates that the [[

]] Please address this inconsistency.

Note: This partial GEH response only addresses NRC questions in the first two paragraphs of RAI 9.1-78 S01. Accordingly, only the first two paragraphs of the question are provided above. The NRC question contained proprietary information, as designated by the [[ ]]. Please refer to MFN 09-227, NRC letter number 304, dated March 31, 2009, for the full RAI 9.1-78 S01 text.

**GEH Response**

This partial GEH response only addresses NRC questions in the first two paragraphs of RAI 9.1-78 S01. The remainder of RAI 9.1-78 S01, question 1, parts a through t, will be addressed in a separate letter.

The RAI identified inconsistencies between NEDC-33374P, Rev. 1 and the DCD Rev. 5. DCD Tier 2 subsections 9.1.1.1, 9.1.2.2, and 9.1.2.8 are being revised in DCD Tier 2 Revision 6 to address the inconsistency between NEDC-33374P, Rev. 1 and the DCD.

**DCD Impact**

DCD Tier 2 subsections 9.1.1.1, 9.1.2.2, and 9.1.2.8 are being revised in Revision 6 as noted in the attached markup.

**Enclosure 2**

**MFN 09-335**

**Partial Response to Portion of NRC Request for**

**Additional Information Letter No. 304**

**Related to ESBWR Design Certification Application**

**Auxiliary Systems**

**RAI Number 9.1-78 S01**

**DCD Markup**

Monte Carlo techniques are employed in the calculations performed to assure that $k_{eff}$ does not exceed 0.95 under all normal and abnormal conditions.

~~The assumption is made that the storage array is infinite in all directions. Because no credit is taken for neutron leakage, the values reported as effective neutron multiplication factors are, in reality, infinite neutron multiplication factors.~~

The biases between the calculated results, experimental results, and the uncertainty in the calculation, are taken into account as part of the calculation procedure to assure that the specific $k_{eff}$ limit is met.

### *9.1.1.2 Storage Design*

The new fuel storage racks in the buffer pool can store a minimum of 476 new fuel assemblies.

The new fuel storage rack design complies with the requirements of General Design Criteria (GDC) 2 by meeting the guidance of Regulatory Guides (RGs) 1.13, 1.29, and 1.117. The new fuel storage racks are located within a Seismic Category I structure that is designed to withstand the effects of extreme wind and tornado missiles. In addition, the racks conform to the applicable provisions of industry standards ANSI/ANS 57.1 and RG 1.13 and therefore, meet the requirements of GDC 61 and GDC 62.

### *9.1.1.3 Mechanical and Structural Design*

The new fuel storage racks contain storage space in the Reactor Building buffer pool for a minimum of 476 new fuel assemblies. They are designed to withstand all credible static and dynamic loadings.

The racks are designed to protect the fuel assemblies and fuel bundles from excessive physical damage under normal and abnormal conditions caused by being struck by fuel assemblies, fuel bundles or other equipment.

The racks are constructed in accordance with the Quality Assurance Requirements of 10 CFR 50, Appendix B.

The racks are classified as nonsafety-related and Seismic Category I

### *9.1.1.4 Material Considerations*

Material used in the fabrication of the new fuel storage racks is limited to the use of stainless steel in accordance with the latest issue of the applicable ASTM specifications at the time of equipment order. The new fuel racks are fabricated from Type 304L stainless steel, which conforms to ASTM A240/A240M. The appropriate weld wire for the Type 304L components (E308L or ER308L) is utilized in the fabrication process. Materials are chosen for their corrosion resistance and their ability to be formed and welded with consistent quality.

### *9.1.1.5 Dynamic and Impact Analysis*

A standard dynamic analysis, using the appropriate response spectra, is performed to demonstrate compliance to design requirements. The input excitation for these analyses utilizes the horizontal and vertical response spectra provided in Section 3.7.

**GDC 62**

Criticality in the spent fuel storage pool is prevented by the presence of fixed neutron absorbing material to assure $k_{eff}$ does not exceed 0.95 under all normal and abnormal conditions which include earthquake and load drop. The spent fuel storage system is designed to the applicable provisions of ANSI/ANS 57.1, which specify criteria for compliance with GDC 62. Individual fuel racks are spaced less than one fuel assembly apart so that a fuel assembly cannot be inserted between racks. The spent fuel storage system conforms to the applicable provisions of RG 1.13 and ANSI/ANS 57.1 and complies with GDC 62 requirements.

**GDC 63**

The fuel storage monitoring section of GDC 63 applies to Sections 9.4.2 and 11.5. Instrumentation associated with spent fuel storage conforms to the guidance of RG 1.13 and complies with GDC 63 requirements.

### *9.1.2.2 Nuclear Design*

A full array in the loaded spent fuel rack is designed to be subcritical by at least 5% Δk/k. Neutron-absorbing material (borated stainless steel in accordance with ASTM A887), as an integral part of the design, is employed to assure that the calculated $k_{eff}$, including biases and uncertainties, does not exceed 0.95 under all normal and abnormal conditions.

Monte Carlo techniques are employed in the calculations performed to assure that $k_{eff}$ does not exceed 0.95 under all normal and abnormal conditions (see Reference 9.1-2).

~~The storage array is assumed to be infinite in all directions. No credit is taken for neutron leakage, therefore, the values reported as effective neutron multiplication factors are, in reality, infinite neutron multiplication factors.~~

The biases between the calculated results and experimental results, as well as the uncertainty involved in the calculations, are taken into account as part of the calculative procedure to assure that the specific $k_{eff}$ limit is met.

### *9.1.2.3 Storage Design*

The fuel storage racks provided in the Spent Fuel Pool in the Fuel Building provide for storage of 3504 ~~3600~~ irradiated fuel assemblies, which provides enough storage capacity for 10 calendar years of plant operation. ~~accommodates the spent fuel resulting from 10 calendar years of plant operation plus one full core off load.~~ The fuel storage racks in the Reactor Building buffer pool deep pit can hold a maximum of 154 spent fuel assemblies. Together, the spent fuel storage racks provided in the spent fuel pool and buffer pool deep pit, accommodate the spent fuel resulting from 10 calendar years of plant operation plus one full core off load.

### *9.1.2.4 Mechanical and Structural Design*

The spent fuel storage racks in the Reactor Building buffer pool and in the Spent Fuel Pool in the Fuel Building contain storage space for fuel assemblies. A standard dynamic analysis using the appropriate response spectra is performed to demonstrate compliance to design requirements. They are designed to withstand all credible static and dynamic loadings. The racks are designed to protect the fuel assemblies from excessive physical damage which may cause the release of

Spent fuel storage racks in the buffer pool area provide storage in the Reactor Building for spent fuel received from the reactor vessel during the refueling operation. These racks can store a maximum of 154 spent fuel assemblies. The deep pit for the storage of spent fuel in the rack is designed such that the depth of the cavity allows the fuel to be placed in the rack with sufficient margin below the rack for natural convection cooling to occur and that the top of the active fuel remains below the top of the cavity. The spent fuel storage racks are top entry racks designed to preclude the possibility of criticality under normal and abnormal conditions.

Together, the ~~S~~spent fuel storage racks in the Spent Fuel Pool ~~area~~ and the buffer pool deep pit provide storage ~~in the Fuel Building~~ for spent fuel received from the reactor vessel resulting from ten calendar years of operation plus one full core offload of fuel. The cavity for the storage of spent fuel in the rack is designed such that the depth of the cavity allows the fuel to be placed in the rack with sufficient margin below the rack for natural convection cooling to occur and that the top of the active fuel remains below the top of the cavity. The spent fuel storage racks are top entry racks designed to preclude the possibility of criticality under normal and abnormal conditions.

On a complete loss of the FAPCS active cooling capability and under the condition of maximum heat load associated with 20 years of fuel storage and a full core off load, sufficient quantity of water is available in the Spent Fuel Pool above the top of active fuel (TAF) level to allow boiling for 72 hours and still have the TAF submerged under water.

### *9.1.2.8 Safety Evaluation*

**Criticality Control**

The spent fuel storage racks are designed to assure that the fully loaded array is sub critical by at least 5% $\Delta k/k$.

Monte Carlo techniques are employed in the calculations performed to assure that $k_{eff}$ does not exceed 0.95 under all normal and abnormal conditions.

~~The assumption is made that the storage array is infinite in all directions. Because no credit is taken for neutron leakage, the values reported as effective neutron multiplication factors are, in reality, infinite neutron multiplication factors.~~

The biases between the calculated results, experimental results, and the uncertainty in the calculation, are taken into account as part of the calculative procedure to assure that the specific $k_{eff}$ limit is met. Criticality analysis is documented in Reference 9.1-2.

**Structural Design and Material Compatibility Requirements:**

- The support structure allows sufficient pool water flow for natural convection cooling of the stored fuel and allows the rack material temperatures to stay within limits.
- The racks include individual solid tube storage compartments, which provide lateral restraints over the entire length of the fuel assembly or bundle.
- The racks are fabricated from materials specified in accordance with the latest issue of applicable ASTM specifications at the time of equipment order.