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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 190 Related to ESBWR Design Certification Application – Radiation Protection – RAI Number 12.5-1 S01**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) supplemental response to a portion of the U.S. Nuclear Regulatory Commission Request for Additional Information (RAI) sent by NRC Letter 190 (Reference 1). The GEH response to RAI Number 12.5-1 S01 is addressed in Enclosure 1.

The initial RAI 12.5-1 was received from the NRC on September 18, 2006 (Reference 2), and the GEH response was transmitted to the NRC on March 28, 2008 (Reference 3).

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

Sincerely,

Charles W. Bagnal
for

Richard E. Kingston
Vice President, ESBWR Licensing

D068
NRO

Reference:

1. MFN 08-476, *Letter from the U.S. Nuclear Regulatory Commission to Robert E. Brown, Request for Additional Information Letter No. 190, Related To ESBWR Design Certification Application*, dated May 14, 2008
2. MFN 06-342, *Letter from the U.S. Nuclear Regulatory Commission to David Hinds, Request for Additional Information Letter No. 60, Related To ESBWR Design Certification Application*, dated September 18, 2006
3. MFN 08-208, *Response to RAI Letter 60 Related to the ESBWR Design Certification – Radiation Protection – RAI Numbers 12.5-1 and 12.5-6*, dated March 28, 2008

Enclosure:

1. Response to Portion of NRC Request for Additional Information Letter No. 190, Related to ESBWR Design Certification Application – Radiation Protection – RAI Number 12.5-1 S01

cc:

AE Cubbage	USNRC (with enclosure)
RE Brown	GEH/Wilmington (with enclosure)
DH Hinds	GEH/Wilmington (with enclosure)
eDRF	0000-0088-9085

Enclosure 1

MFN 08-614

Response to Portion of NRC Request for

Additional Information Letter No. 190

Related to ESBWR Design Certification Application

Radiation Protection

RAI Number 12.5-1 S01

For historical purposes, the original text of RAI 12.5-1 and the GE response is included. This response does not include any attachments or DCD mark-ups.

NRC RAI 12.5-1:

Provide a complete tabulated dose assessment with a scope and detail consistent with the guidance in RG 8.19. Data should be presented in the format provided in RG 8.19 or an acceptable alternative. The analysis should clearly indicate the basis (i.e., based on recent BWR experience or calculated based on similar tasks in other industries) for the staff-hour and dose rate estimates assumed and show how each was adjusted to account ESBWR specific design features. Estimates on work activities similar to the Advanced Boiling Water Reactor (ABWR) design (i.e., control rod drive removal and maintenance) should be based on experience from operating ABWRs.

GEH Response:

DCD Tier 2, Section 12.4 has been rewritten in its entirety to address the requirements of this RAI. The rewritten Section 12.4 is provided in the attachment.

DCD Impact:

DCD Tier 2, Section 12.4 will be revised as noted on the attached markup.

NRC RAI 12.5-1 S01:

1. *In order to ensure that occupational doses are ALARA (in accordance with 10 CFR20.1101), Regulatory Guide 8.19 "Occupational Radiation Dose Assessment in Light-Water Reactor Power Plants Design Stage Man-Rem Estimates" states, in part, that the basis for entries in the dose assessment tables should be explained in the text of the report (e.g., expected (reduced) values due to design and engineering improvements). The staff requests that GEH modify the proposed It'Section 12.4 to reinsert the following sections (which were included in the Revision 4 version of Section 12.4 but were deleted in the proposed version) which provide specific examples of improvements in equipment design, maintenance/surveillance requirements, or building layout to reduce personnel doses:*

   a) *Insert the sentences beginning with "The Nuclear Boiler System..." and "The MSIVs require periodic..."on page 12.4-13 into the section on special maintenance in the drywell on page 12.4-7.*

   b) *Insert the first two sentences in the fifth paragraph on page 12.4-13 (beginning with "Early studies on") into the first paragraph on page 12.4-8.*

   c) *Insert the second, third, and seventh bulleted items on page 12.4-14 into the second paragraph in section 12.4.5 on page 12.4-6.*

   d) *Insert the first 6 lines of the paragraph beginning with "Simplified systems..."on page 12.4-14 into the 2nd paragraph in section 12.4.2 on page 12.4-3.*

   e) *Insert the five lines starting with "It has been arranged..." in the first paragraph in Section 12.4.2 on page 12.4-15 into the second paragraph in Section 12.4.2 on page 12.4-3.*

   f) *Insert the first three sentences in the sixth paragraph on page 12.4-17 (beginning with "The condensate system") into the section on special maintenance in the turbine building on page12.4-10.*

   g) *Insert the sentence beginning with "More of the radwaste operations..." in the first paragraph on page 12.4-18 into the third paragraph in Section 12.4.3 on page 12.4-4.*

2. *(page 12.4-1) Describe to what extent data from the BWR and ABWR product lines were used in developing the dose estimates in Section 12.4 and provide references to historical data used.*

3. *(page 12.4-3) The second paragraph on page 12.4-3 states that "Additional shielding is provided to reduce radiation levels in routinely occupied areas during power operation from N-16 sources." State where the use of additional shielding for N-16 is described in the DCD.*

4. *(page 12.4-3) The second paragraph on page 12.4-3 states that the ESBWR is expected to have reduced general radiation levels during operation compared to the typical BWR due to "two percent reactor water clean up capacity" (among other things). Describe the dose benefits of having a 2% RWCU cleanup capacity and compare the RWCU cleanup capacity of the ESBWR design with that of a standard BWR design.*

5. *(page 12.4-7) Describe the purpose of using of main steam line plugs (mentioned in Section 12.4.6) and how their use reduces overall maintenance requirements.*

6. *(page 12.4-8) The last paragraph on page 12.4-8 states that the LRPM/AFIP (Local Power Range Monitors with fixed in-core detectors) assemblies are removed remotely from beneath the reactor vessel, cut up, and placed in a shielded cask for disposal. Describe the dose benefits of using this method of removing and disposing of the LRPM/AFIP assemblies.*

7. *(page 12.4-9) Provide the basis for the person-hours estimates for special maintenance on valves (1500 hours) and on instrumentation (1000 hours) in the drywell.*

8. *(page 12.4.8) The first paragraph on page 12.4-8 states that the effective dose rate in the drywell/steam tunnel is 18 μSv/hr. Figure 12.3-10 shows this area to be a zone E area (<100 μSv/hr). Explain this apparent discrepancy in dose rates.*

9. *(page 12.4-9) The first paragraph on page 12.4-9 states that the average dose rate for special maintenance on miscellaneous drywell valves is estimated to be 40 μSv/hr and 50 μSv/hr for the maintenance on miscellaneous drywell instrumentation. Explain the reasoning for the difference in effective dose rates for these two jobs.*

10. (pages 12.4-21, 22, and 26) Table 12.4-2 states that the dose rate associated with CRD/HCU surveillance is 150 μSv/hr while Tables 12.4-3 and 12.4-7 state that the dose rate associated with CRD HCU maintenance is only 30 μSv/hr. Explain the difference in dose rates for these jobs that apparently will be performed in the same area.

11. (Tables 12.4-2 through 12.4-7) Add a footnote to these tables stating that the person-hours for those jobs that can only be performed during refueling outages (once every 24 months) are twice the annual person-hours shown on these tables.

12. (page 12.4-5) The first paragraph on page 12.4-5 states that operation of the Radwaste Building Control Room is assumed to occur in a dose rate of 10 μSv/hr. Table 12.4-4 states that the estimated average dose rate for this control room is 8 μSv/hr. Explain this apparent discrepancy.

13. (page 12.4-5) The first paragraph on page 12.4-5 states that miscellaneous activities in high dose rate areas will be require the expenditure of 208 person-hrs/yr (4 hrs/wk times 52 weeks per year). Table 12.4-4 states that these activities will require the expenditure of 200 person-hours/yr. Correct this apparent discrepancy.

14. *(page 12.4-7) The first paragraph on page 12.4-7 states that in-service inspection work will require 750 person-hours/yr. Table 12.4-6 shows that ISI work will require 766 person-hours/yr. Correct this apparent discrepancy.*

15. *(page 12.4-10) The third paragraph on page 12.4-10 states that reactor building instrumentation work that cannot be performed during normal operation is assumed to require 600 person-hours/yr. Verify that this work will be done during the 24 month refueling outage for a total of 1200 person-hours per outage.*

16. *(page 12.4-10) The fourth paragraph on page 12.4-10 states that additional reactor building outage maintenance items will involve 3400 person-hours/yr. Specify whether this work be done on a continuing basis, or only during outages (in which it would require 6800 person-hours per outage).*

17. *(page 12.4-5) The first paragraph on page 12.4-5 states that shipments of concentrated wet solid wastes in HICs will require 1664 person-hours (8 hours/week x 52 weeks/yr x 4 workers/job). Table 12.4-4 shows that this activity will require the expenditure of only 832 person-hours/yr. Explain this apparent discrepancy.*

Editorial corrections

E1. *(page 12.4-5) Insert the word "access" after the word "drywell" in the last sentence in the second paragraph in Section 12.4.4.*

E2. *The third paragraph in Section 12.4.4 contains some superfluous sentences that make the dose assessment hard to follow. This section can be clarified by making the following modifications:*

(page 12.4-5) Delete the sentence beginning with "This reduces the operator effective dose rate...".

(page 12.4-6) Delete the first portion ("This is accomplished using the automated refueling machine and") of the first full sentence on page 12.4-6 and begin the sentence with "It is estimated...".

E3. *(page 12.4-8) Insert a space between the words "titanium" and "or" in the 9th line on page 12.4-8.*

E4. *(page 12.4-8) Delete one of the words (either "assumed" or "required") in the 5th line in the third paragraph on page 12.4-8.*

E5. *(page 12.4-10) The last paragraph on page 12.4-10 states that the Turbine Building valve and pump maintenance requirements will require 2000 person-hours per outage (1000 person-hours per year). Table 12.4-7 indicates that this work will require 910 person-hours per year. Explain this apparent discrepancy.*

GEH Response:

1a) The sentences were added into the second and sixth paragraphs of DCD Revision 5, Tier 2, Subsection 12.4.6.

1b) The sentences were added into the sixth paragraph of DCD Revision 5, Tier 2, Subsection 12.4.6.

1c) The bulleted items were added into the second paragraph of DCD Revision 5, Tier 2, Subsection 12.4.5.

1d) The lines were added into the second paragraph of DCD Revision 5, Tier 2, Subsection 12.4.2.

1e) The lines were added into the second paragraph of DCD Revision 5, Tier 2, Subsection 12.4.2.

1f) Because the ESBWR design does not use hollow fiber filled filters, the first sentence was not inserted in the subject section. The remaining two sentences were added into the twenty-third paragraph of DCD Revision 5, Tier 2, Subsection 12.4.6.

1g) The sentence was added into the third paragraph of DCD Revision 5, Tier 2, Subsection 12.4.2.

2. GEH design documentation was used in the preparation of this section. The following references were used and were added as References 12.4-3 through 12.4-8 to DCD Revision 5, Tier 2, Subsection 12.4.9:

Knecht, P.D., "BWR/6 Drywell and Containment Maintenance and Testing Access Time Estimates", GE Report NEDE-23819, May 1978.

Knecht, P.D., "Maintenance Access Time Estimates, BWR/6 Radwaste Building", GE Report NEDE-23996-2, May 1979.

Knecht, P.D., "Maintenance Access Time Estimates, BWR/6 Auxiliary and Fuel Buildings", GE Report NEDE-23996-1, May 1979.

"Study of Advanced BWR Features, Plant Definition/Feasibility Results", Volume III, Appendix Part G, GE Report NEDE-24679, October 1979.

Knecht, P.D., "Work at Power Access Time Estimates BWR/6 Containment, Auxiliary, Fuel, Radwaste and Turbine Buildings", GE Report NEDE-23996-3, May 1979.

"GE Advanced Boiling Water Reactor (ABWR) First of a Kind Engineering Program - ABWR FOAKE Occupational Exposure", Advanced Reactor Corporation Report 24156-1A23-6440-0001 Revision 1, August 1996.

In addition to the design information cited above, operational information from the NUREG-0713, "Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities" series of reports was reviewed as a possible source of man-hour and collective dose information. Prior to 1997, NUREG-0713 reports were formatted with occupational exposure information in a format similar to that required by Regulatory Guide 8.19. However, it was found that after 1997 the NUREG-0713 reports were reformatted to not include these data. In addition, collective dose information prior to 1997 was considered out-dated to reflect the current downward trend in collective occupational exposure, and as a result, was not used in the analyses supporting the development of the DCD Revision 5, Tier 2, Section 12.4. In addition, the International Atomic Energy Agency (IAEA) "Information System on Occupational Exposure" (ISOE) reports were also reviewed and were also found to not contain information in a format which would support the analyses required for the revised section.

3. The N-16 shielding source term and its use in the design of ESBWR shielding is described in DCD Revision 5, Tier 2, Subsection 11.1.2.

4. Standard BWR design reactors are designed with a 1% RWCU cleanup capacity. A 2% RWCU cleanup flow will further reduce the concentrations of activation and fission products in the reactor vessel. With a lower amount of radioactive species, fewer radionuclides will carry over into the steam as radioactive gases (and in some cases particulates), reducing the amount of radioactive contamination that will occur downstream of the reactor vessel, and thereby reducing the source terms for occupational doses.

5. The use of "plug" devices keeps water out of lines downstream of the plug while flooding the reactor vessel during refueling operations . These plugs preclude the necessity to provide other methods and additional procedures (such as freeze plugging) to seal lines that have valves requiring maintenance. With the plugs in place in the vessel, maintenance time is reduced by not having to perform an alternate plugging operation.

6. The response to RAI 12.3-11 in letter MFN 07-222 (dated May 4, 2007) indicates that the Local Power Range Monitor (LPRM)/Automated Fixed In-Core Probe (AFIP) assemblies are removed from the vessel when it is open and placed in the spent fuel pool. After decay, the assemblies are cut up into smaller segments and disposed based on the specific activity associated with the segments. As such, the subject statement was removed from the ninth paragraph of DCD Revision 5, Tier 2, Subsection 12.4.6 and replaced by the correct description. No reduction in the collective dose associated with the operation is assumed.

7. The estimates were derived from a review of available (published and unpublished) design information and previous estimates for these activities for the SBWR and ESBWR product lines and were selected to represent person-hour estimate values for this type of work.

8. Effective dose rates are defined in DCD Revision 5, Tier 2, Section 12.4 and do not correspond with the maximum allowable radiation zone value. The 18 μSv/hr dose rate value was obtained from a study conducted on the occupational exposure associated with the projected maintenance activities in the ABWR. This study is shown as DCD Revision 5, Tier 2, Reference 12.4-8.

9. Different types of components can have different dose rates associated with their location throughout the drywell. It was estimated that miscellaneous instrumentation is located in a slightly higher average effective radiation field than miscellaneous valves.

10. Surveillances are assumed to occur while the plant is in operation. Maintenance in this area is assumed to occur when the plant is shut down and the dose rates would be lower.

11. The subject footnotes have been incorporated in DCD Revision 5, Tier 2, Tables 12.4-2 through 12.4-7.

12. DCD Revision 5, Tier 2, Subsection 12.4.3 states that 10 μSv/hr is a maximum dose rate. An estimated average effective dose rate of 8 μSv/hr was used to determine the collective dose.

13. Due to the approximate nature of the estimates used to calculate collective dose in this analysis, a rounded value of 200 person-hours/yr was used to determine the collective dose in this case.

14. Due to the approximate nature of the estimates used to calculate collective dose in this analysis, rounded values were used to state the approximate person-hours/year expended in this case. The text indicates this by use of the word 'approximately'. The value in the table represents the sum of all the estimates of person-hours/year for the In-Service Inspection ISI category.

15. GEH confirms that 1200 person-hours per outage allocated to the estimate of reactor building instrumentation work are correct. This translates to 600 person-hours/yr on an annual basis.

16. This work is assumed to be performed during an outage and is estimated to take 6800 person-hours, translating to an annual estimate of 3400 person/hrs-yr.

17. The processing of wet solid wastes is assumed to take 4 hours/week but this statement of time expenditure was originally omitted in the text in Subsection 12.4.3. This statement of time expenditure was added to the fourth paragraph of DCD Revision 5, Tier 2, Subsection 12.4.3.

E1. This change was incorporated into the second paragraph of DCD Revision 5, Tier 2, Subsection 12.4.4.

E2. This change was incorporated into the third paragraph of DCD Revision 5, Tier 2, Subsection 12.4.4.

E3. This change was incorporated into the sixth paragraph of DCD Revision 5, Tier 2, Subsection 12.4.6.

E4. The word "required" was deleted. This change was incorporated into the eighth paragraph of DCD Revision 5, Tier 2, Subsection 12.4.6.

E5. Due to the approximate estimates used to calculate collective dose in this analysis, rounded values were used to state the approximate person-hours expended in this case. Added emphasis of the approximate nature of this estimate is therefore indicated by the addition of the word "approximately" to the subject sentence in Subsection 12.4.6. The value in the table represents a more realistic person-hour estimate used for this case. This change was incorporated into the twenty-second paragraph of DCD Revision 5, Tier 2, Subsection 12.4.6.

DCD Impact:

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