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Security Notice
This letter forwards Security-Related information in accordance with 10CFR2.390. Upon removal of Enclosure 2, the balance of this letter may be considered non-Security-Related.

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MFN 06-499, Supplement 1
and 06-512, Supplement 2

Docket No. 52-010

April 15, 2008

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555-0001

Subject: **Response to RAI Letter Nos. 60 and 112 Related to the ESBWR Design Certification – Radiation Protection – RAI Numbers 12.4-4S02, 12.4-19S01 and 12.4-19S02**

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 letters dated September 18, 2006 (Reference 1), and October 17, 2007 (Reference 2), respectively. GEH responses to RAI Numbers 12.4-4S02, 12.4-19S01 and 12.4-19S02 are addressed in Enclosure 1.

Enclosure 2 contains Security-Related DCD Figures identified by the designation "{{{Security-Related Information - Withhold Under 10 CFR 2.390}}}." GEH hereby requests this information be withheld from public disclosure in accordance with the provisions of 10 CFR 2.390. No public version of these security-related DCD Markups are provided in these RAI responses since they would be blank pages with only figure titles and figure numbers; however, DCD Tier 2, Revision 5, will contain public versions of these figures.

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NRO

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

Sincerely,

James C. Kinsey

James C. Kinsey
Vice President, ESBWR Licensing

References:

1. MFN 06-342, Letter from U.S. Nuclear Regulatory Commission to David H. Hinds, GEH, *Request For Additional Information Letter No. 60 Related To ESBWR Design Certification Application*, dated September 18, 2006.
2. MFN 07-588, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, GEH, *Request For Additional Information Letter No. 112 Related To ESBWR Design Certification Application*, dated October 17, 2007.

Enclosures:

1. Response to Portion of NRC Request for Additional Information Letter Nos. 60 and 112 Related to ESBWR Design Certification Application – Radiation Protection – RAI Numbers 12.4-4S02, 12.4-19S01 and 12.4-19S02
2. Response to Portion of NRC Request for Additional Information Letter Nos. 60 and 112 Related to ESBWR Design Certification Application – Radiation Protection – RAI Numbers 12.4-4S02, 12.4-19S01 and 12.4-19S02 – DCD Markups – Security-Related Information - Withhold Under 10 CFR 2.390

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eDRF 0000-0083-7357 – RAI 12.4-4S02
0000-0082-9538 – RAIs 12.4-19S01 and 12.4-19S02

Enclosure 1

MFN 06-499, Supplement 1
and 06-512, Supplement 2

Response to Portion of NRC Request for Additional Information Letter Nos. 60 and 112 Related to ESBWR Design Certification Application

Radiation Protection

RAI Numbers 12.4-4S02, 12.4-19S01 and 12.4-19S02

NRC RAI 12.4-4 S02:

In GE's June 7, 2007, response to RAI 12.4-4 S01, GE revised the estimated radiation zone designations for several rooms depicted in Figure 12.3-19. The revised radiation zone designations for three of these rooms are still inconsistent with the zone designations listed in GE's initial response to RAI 12.4-4.

In GE's initial response to RAI 12.4-4, the following rooms are listed as having anticipated dose rates of >100 rads/hr (zone I) during normal operations: 6106, 6107, and 6161. In GE's response to RAI 12.4-4 S01, these rooms are designated as having the following dose rates: Room 6106 (< 10 R/hr, zone G), 6107 and 6161(<100 rads/hr, Zone H). Please clarify these apparent zone designation inconsistencies.

GEH Response:

DCD Tier 2, Figure 12.3-19 was revised in DCD Revision 4 to include the revised radiation zone designations as described in the response to RAI 12.4-4 Supplement 1 (MFN 06-512 Supplement 1, dated June 7, 2007).

The following Rooms are anticipated to have dose rates >100 rads/hr (Zone I) during normal operations and anticipated operational occurrences:

1170	Lower Drywell
1570	Upper Drywell
1251	Reactor Water Cleanup/Shutdown Cooling Filter/Demineralizer Vault A1
1252	Reactor Water Cleanup/Shutdown Cooling Filter/Demineralizer Vault A2
1261	Reactor Water Cleanup/Shutdown Cooling Filter/Demineralizer Vault B1
1262	Reactor Water Cleanup/Shutdown Cooling Filter/Demineralizer Vault B2
1702	Incline Fuel Transfer Tube Room (during transfer of spent fuel)
17P3	Buffer Pool (during transfer of spent fuel)
18P1	Reactor Well (during transfer of spent fuel)
18P2	Incline Fuel Transfer Tube Pool (during transfer of spent fuel)
21P0	Fuel Storage Pool
21P1	Incline Fuel Transfer Tube Pit (during transfer of spent fuel)
6108	High Activity Resin Holdup Tank Room

The following areas meet the definition of 10 CFR 20 Very High Radiation Area (VHRA) during normal operations and anticipated operational occurrences, and are classified as Radiation Zone J (> 500 rads/hr):

1170	Lower Drywell
1570	Upper Drywell
1702	Incline Fuel Transfer Tube Room (during transfer of spent fuel)
17P3	Buffer Pool (during transfer of spent fuel)
18P1	Reactor Well (during transfer of spent fuel)

18P2 Incline Fuel Transfer Tube Pool (during transfer of spent fuel)
21P0 Fuel Storage Pool (at the fuel racks elevation)
21P1 Incline Fuel Transfer Tube Pit (during transfer of spent fuel)

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

NRC RAI 12.4-19S01:

In its February 21, 2007, memo, the staff issued Supplement 1 to RAI 12.2-19 concerning the core burn-up values used for the fuel with respect to GE's shielding analysis. This supplemental RAI also applies to RAI 12.4-19. Upon further review of GE's response to RAI 12.4-19, the staff finds that it needs the following additional information regarding the IFTT:

a. *In your response to RAI 12.4-19, verify that all of the dose rate measurements are correct in light of the fact that some of the dose rates are given in units of mrem/h and some in mSv/h.*

b. *In Figure 9.1-2 there appears to be two areas where the embedded IFTT comes very close to potentially accessible areas. One of these areas is in Room 2400 (rail car bay) near the rail supports of the main crane in the fuel building (roughly at level +13570). The other is in Room 2400 near the lower part of the fuel handling machine opposite the trapezoidal room at elevation +4650.*
   - *Describe what features (both physical and administrative) are in place to restrict personnel access to these two areas during fuel transfer operations.*
   - *Provide the thickness of the concrete at the narrowest point between the IFTT and each of these two areas and provide the corresponding maximum dose rate at these points from a spent fuel assembly in the adjacent portion of the IFTT.*

c. *On Elevation 13570 mm (Figure 12.3-6) there appears to be a hallway between quadrants of General Area 1600 in the reactor building which passes by the IFTT which is embedded in the concrete wall to the south of this hallway. The note on Figure 12.3-6 states that this hallway is listed as radiation zone I (<500 rem/hr) during spent fuel transfer.*
   - *Provide the minimum concrete thickness between the IFTT and this hallway.*
   - *Provide the maximum dose rate at this point from a spent fuel assembly in the adjacent portion of the IFTT.*
   - *Describe what features (both physical and administrative) are in place to restrict personnel access to this hallway when fuel is being transferred in the IFTT.*
   - *Indicate where this hallway is located on Figure 9.1-2.*

d. *In your response to RAI 12.4-19, you mention access stairs to the crane in the fuel building.*
   - *Describe where these stairs are located (list appropriate figure(s) showing location of the access stairs) with respect to the IFTT .*

e. *Figure 9.1-2 indicates that there is an access plug (elevation +4650 mm) to access the portion of the IFTT, which runs through the trapezoidal room.*
   - *State what plant layout figure shows this access plug entrance to the trapezoidal room (it does not seem to be shown on Figure 12.3-4) and describe the access route to reach this access plug.*

NRC RAI 12.4-19S02:

The applicant used an incorrect input parameter to the shielding code, which resulted in an estimated dose rate smaller than the one calculated by the staff's contractor. The applicant should correct the erroneous input parameter(s), address the effects of the revised dose rates, and describe the verification process used.

The applicant's reply to RAI 12.4-19 provides the estimated maximum dose rates (from a fuel assembly in the inclined fuel transfer system tube (IFTT)) for several areas in the Fuel Building and Reactor Building, which are adjacent to the IFTT. In evaluating the estimated dose rates provided in the applicant's response to this RAI, the staff noted a discrepancy between the estimated dose rate calculated by the applicant and the estimated dose rate for the same location calculated by staff's contractor (who used the same shielding software in their analysis). It appears that the applicant used an incorrect input parameter (use of a diameter value instead of a radius value for the cross section of the IFTT transfer tube and first gap) to the shielding code which resulted in an estimated dose rate which was considerably less (by a factor of approximately 10) than the dose rate calculated by the staff's contractor. Since the applicant used a single shielding code run (with different concrete wall thicknesses) to calculate all of the dose rate values given in the applicant's response to RAI 12.4-19, all of the dose rate values which appear in the response to RAI 12.4-19 appear to be in error.

a. *The applicant should correct the erroneous input parameter(s) to the shielding code and resubmit the response to RAI 12.4-19 with the corrected dose rates. (In this revised response, the applicant should also address the staff's additional concerns contained in Supplement No. 1 to RAI 12.4-19.)*
b. *Address what effects the revised dose rates (assumed to be greater than the estimated dose rates in the original response to RAI 12.4-19) in the vicinity of the IFTT will have on local radiation zoning designations, shielding, and access controls.*
c. *Part b) of Supplement 1 to RAI 12.4-19 describes two areas in the Fuel Building where the staff asked the applicant to provide the estimated maximum dose rates from a spent fuel assembly in the adjacent portion of the IFTT. During a September 18, 2007, conference call with GEH, the applicant verbally stated that both of these areas are inaccessible. If both of these areas are considered inaccessible, describe the physical and/or administrative controls that will be in place to ensure that personnel cannot access these areas of the Fuel Building. Using the revised dose rate calculations described above, provide the*

estimated maximum dose rates at each of these two areas from a fuel assembly in the IFTT.

d. *Describe the verification process used (e.g., evaluation of the input parameters for shielding calculations performed to determine dose rates in other parts of the plant) to ensure that the errors made in calculating the dose rates for the response to RAI 12.4-19 were not repeated for shielding calculations performed for other parts of the plant.*

GEH Response:

Response to RAI 12.4-19 Supplement 1

a: All dose rates included in the response to Supplement 1 and 2 to RAI 12.4-19 are given in units of mSv/hr.

b: See the response to part (c) of Supplement 2 to RAI 12.4-19

c: The minimum concrete thickness between the IFTT and this hallway is 200 cm. The maximum dose rate at this point from one spent fuel assembly in the adjacent portion of the IFTT is 3.04E-04 mSv/hr.

This hallway is classified as radiation zone B during operation (as Room 1600). The dose rate at this hallway during spent fuel transfer does not imply a higher dose rate (see response to part (b) of Supplement 2, Table 2), as a result, the radiation zone classification at shutdown is kept as "B." The note on Figure 12.3-6 will be deleted in the next revision of the DCD Tier 2 Chapter 12, as shown on the attached markup.

No personnel access restriction to this hallway is required when fuel is being transferred in the IFTT.

d: See response to part (c) of Supplement 2 to RAI 12.4-19.

e: Access plug entrance to the trapezoidal room is shown in the revised DCD Tier 2 Figures 12.3-6 and 12.3-10.

Response to RAI 12.4-19 Supplement 2

a: The incorrect input data to the QAD-CGGP shielding code were corrected and new calculations have been performed.

The new calculations have been performed using the following assumptions:

- The intensity of gamma radiation source for a GE14 fuel element in an ESBWR reactor, with a burn-up of 35 GWd/MTU, and after one day of decay following shutdown, is indicated in the following Table 1.

Table 1
Spent Fuel Element Radiation Source Intensity

Energy, MeV	MeV/s
0.8	6.02E+16
1.3	3.99E+15
1.7	1.14E+16
2.5	1.19E+15
4.0	5.37E+12
5.0	4.08E+10
6.4	1.02E+10

- The simultaneous presence of two fuel elements side-by-side has been considered.
- A radial peaking factor of 2 has also been considered.
- A parallel-piped shaped radiation source with dimensions 13.8 cm x 13.8 cm x 424.5 cm has been considered representing the spent fuel element.
- The density of the fuel element homogenized in water is 4.26 g/cm^3, and the percent composition is: UO_2-59.9%, Steel-1.9%, Zircalloy-2-25%, and water-13.2%.
- The spent fuel element is located inside a steel tube with an outer radius of 30.5 cm (12") representing the transfer tube. The thickness of transfer tube is 1.27 cm (0.5"). The space between the fuel element and the transfer tube is considered to be full of water, with density 1 g/cm^3.
- A guard tube with outer radius of 45.70 (18") cm and a conservative thickness of 1.27 cm (0.5") is considered to surround the transfer tube when the IFTT is embedded. The space between the transfer tube and the guard tube is considered to be full of air.
- Whenever the transfer tube runs through the inside of a room, the guard tube is not considered in the model. A minimum distance (air) of 15.24 cm (6.0") from the tube guard to the wall is taken into account.
- The geometry of the shielding model is surrounded by normal reinforced concrete thicknesses with a density of 2.35 g/cm^3 of up to 200 cm having arranged detectors at 50 cm, 100 cm, 150 cm, and 200 cm to assess the various thicknesses of concrete bordering on accessible areas.

b: The concrete shielding between rooms surrounding the IFTT, the dose rates and radiation zoning designations during the IFTT operation (assuming transfer of two fuel elements simultaneously) are shown in the following Table 2. DCD Tier 2 Figures 12.3-1 through 12.3-11 will be updated accordingly in the next revision of the DCD.

Table 2
Dose rate and Radiation Zoning Designations During IFTT Operation

Room		Concrete shielding cm.	mSv/hr	Radiation Zone
1401	RB CRD B Panel Room.	200 (1)	9.52E-04	A
1501	Reactor Building. Electrical Equipment Room B	200	6.84E-04	A
1600	Wetwell access / Fan room. Hallway between quadrants.	200	6.84E-04	A (2)
1703	Standby Liquid control Pump room.	200	9.52E-04	A (2)
1702	Incline fuel transfer tube room.	N/A: Inside	8.16E+06	J
-	Trapezoidal room.	N/A: Inside	8.16E+06	J
2IP1	Incline fuel transfer pit.	N/A: Inside	8.16E+06	J
2190	FB Commodity chase.	200	9.52E-04	A (3)
2400	FB Rail car bay (at Elevations 4650, and 13570)	125 (4)	1.86E+00	F

Note 1. The wall of the Trapezoidal Room to room 1401 to room is designed up to a minimum 200 cm concrete shielding equivalent, allowing the room 1401 to remain as a radiation zone "A" during IFTT operation.

Note 2. The normal Operation Radiation Zone Classification is "B".

Note 3. The normal Operation Radiation Zone Classification is "D".

Note 4. The wall of the trapezoidal room to room 2400, at Elevation 4650, is designed up to a minimum 125 cm concrete shielding equivalent, allowing the room 2400 at this area to remain as a radiation zone "F" or lower during IFTT operation.

Access to any area adjacent to the transfer tube, with a high radiation zone classification is controlled, in accordance with 10 CFR 20.1601 and 10 CFR 20.1902, through a system of physical controls, interlocks and annunciators (see response to Supplement 2 part (c)).

c: Access to the crane and the rail car bay will be performed via stairs or a ladder (the exact location will be defined at a further stage of the project, but in any case closest to the area of the trapezoidal room).

Personnel access into the rail car bay is required only for maintenance of the Fuel Building Crane, which is not allowed during refuelling operations. Access stairs/ladders to the rail car bay are locked by chains and posted during IFTT operation.

Access to any area adjacent to the transfer tube, with radiation zone classification higher than "A", is controlled through a system of physical controls, interlocks and an annunciator. Specifically:

- Controls prevent personnel from inadvertently or unintentionally being left in the IFTT areas at the time the access doors are closed;
- A key-lock system of key-locks in both the IFTT main operation panel and in the control room is provided to prevent access to any IFTT maintenance area during IFTT operation;
- During IFTT operation or shutdown, personnel are prevented from (a) either reactivating the IFTT while personnel are in a controlled maintenance area, or (b) entering a controlled IFTS maintenance area while irradiated fuel or components are in any part of the IFTT;
- Chains, locked doors, annunciators and posted signals are located at areas close to IFTT rooms where high radiation dose could be expected. Both an audible alarm and flashing red lights are provided both inside and outside any these room, or area, to indicate IFTT operation; and
- Radiation monitors with alarms are provided both inside and outside any maintenance area.

The maximum dose rate during the transfer of one fuel element in the Room 2400 at the "rail car bay" near the rail supports of the main crane in the fuel building (roughly at level +13570) and the at elevation +4650 (near the operating platform of the fuel handling machine opposite the trapezoidal room) is 0.93E+00 mSv/h (see response to Supplement 2 part (b), Table 2).

d: The input data of all other Nuclear Island shielding calculations performed with the QAD-CGGP code have been rechecked and found correct. It has been determined that the incorrect use has been an isolated incident with no additional impact.

The project engineering staff is being retrained on the input data use and its verification process that is already established to maintain records on the computer codes input data checking and verification.

DCD Impact:

DCD Tier 2, Figures 12.3-1 through 12.3-11 will be revised in DCD Revision 5, as shown on the attached mark-ups.