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Subject: **Response to NRC Request for Additional Information Letter Nos. 117 and 130 Related to the ESBWR Design Certification – Radiation Protection – RAI Numbers 2.3-10S02 and 12.2-25**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) responses to the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) sent by NRC letters dated December 6, 2007 and December 27, 2007, respectively. GEH responses to RAI Numbers 2.3-10S02 and 12.2-25 are addressed in Enclosure 1. DCD Markups related to these responses are provided in Enclosure 2.

Verified DCD changes associated with this RAI response are identified in the enclosed DCD markups by enclosing the text within a black box. The marked-up pages may contain unverified changes in addition to the verified changes resulting from this RAI response. Other changes shown in the markup(s) may not be fully developed and approved for inclusion in DCD Revision 5.

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

D068
NRO

Sincerely,

James C. Kinsey

James C. Kinsey
Vice President, ESBWR Licensing

References:

1. MFN 07-656, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, GEH, *Request For Additional Information Letter No. 117 Related To ESBWR Design Certification Application*, dated December 6, 2007.
2. MFN 07-715 Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, GEH, *Request For Additional Information Letter No. 130 Related To ESBWR Design Certification Application*, dated December 27, 2007.

Enclosures:

1. Response to Portion of NRC Request for Additional Information Letter Nos. 117 and 130 Related to ESBWR Design Certification Application – Radiation Protection – RAI Numbers 2.3-10S02 and 12.2-25
2. Response to Portion of NRC Request for Additional Information Letter Nos. 117 and 130 Related to ESBWR Design Certification Application – Radiation Protection – RAI Numbers 2.3-10S02 and 12.2-25 – DCD Markups

cc: AE Cubbage USNRC (with enclosure)
GB Stramback GEH/San Jose (with enclosure)
RE Brown GEH/Wilmington (with enclosure)
eDRF 0000-0083-5521

Enclosure 1

MFN 06-396, Supplement 3

Response to Portion of NRC Request for Additional Information Letter Nos. 117 and 130 Related to ESBWR Design Certification Application

Radiation Protection

RAI Numbers 2.3-10 S02 and 12.2-25

For historical purposes, the original text of RAI 2.3-10 and the GEH response are included.

NRC RAI 2.3-10:

Confirm that the long-term dispersion estimates are reference values only and are not a function of the ESBWR design and list them in DCD Tier 2, Table 2.0-1. The DCD should state that the COL applicant will compare the site-specific X/Q and relative deposition (D/Q) values with the reference X/Q and D/Q values in the DCD and state what the COL applicant should do if the site-specific X/Q or D/Q values exceed the reference X/Q or D/Q values in the DCD.

GE Response:

The long-term dispersion estimates are reference values only and are not a function of the ESBWR design. A discussion of the generation of these values is provided in DCD Tier 2, Subsection 12.2.2.1. The long-term dispersion estimates will be listed in DCD Tier 2, Table 2.0-1. The long-term dispersion estimates are as follows:

X/Q: 2.0E-06 s/m^3

D/Q: 4.0E-09 m^{-2}

With respect to the statement that the DCD should state that the COL applicant will compare the site-specific X/Q and D/Q values with the reference X/Q and D/Q values in the DCD and state what the COL applicant should do if the site-specific X/Q or D/Q values exceed the reference X/Q or D/Q values in the DCD, a revision to the ESBWR DCD will be made. The following statement will be added to Revision 3 of DCD Tier 2, Chapter 2:
"If a selected site has a X/Q value that exceeds the ESBWR reference site value, the release concentrations in Table 12.2-17 would be adjusted proportionate to the change in X/Q. In addition, for a site selected that exceeds the bounding X/Q or D/Q values, the COL applicant will address how the resulting annual average doses (Table 12.2-18b) continue to meet the dose reference values provided in 10 CFR 50 Appendix I using site-specific X/Q and D/Q values."

E-mail from A. Johnson dated April 2, 2007.

NRC RAI 2.3-10 S01:

Section 12.2.2.1 of DCD Revision 3 states that the Tier 1 and Tier 2 annual average (long term) atmospheric dispersion (X/Q) site design parameter value of 2.0×10^{-6} s/m^3 was derived executing the NRC computer code XOQDOQ for 27 US sites and one fictitious site. Similarly, Section 12.2.2.1 of DCD Revision 3 states that the Tier 1 and Tier 2 annual average atmospheric deposition (D/Q) site design parameter value of 4.0×10^{-9} m^{-2} was taken from a table of annual average meteorological coefficients prepared by the GE REFAE computer code. The annual average X/Q and D/Q site characteristics for the first three docketed early site permits (e.g., North Anna, Clinton, and Grand Gulf) are all larger (e.g., more conservative) than the ESBWR DCD annual average X/Q and D/Q site design parameters.

Consequently, please provide the following:

(a) Describe the input assumptions used in executing the X/Q/D/Q computer code to derive the ESBWR DCD long term X/Q site design parameter value of $2.0X10^{-6}$ s/m^3.

(b) Provide the technical bases for the GE REFAE computer code and the input assumptions used in executing the GE REFAE computer code to derive the ESBWR DCD long term D/Q site design parameter value of $4.0X10^{-9}$ m^{-2}.

GEH Response:

The third paragraph of Tier 2, Subsection 12.2.2.1 (which discussed the derivation of the ESBWR X/Q and D/Q values) has been deleted in DCD Revision 4. The reason that this paragraph has been deleted is the discussion in that paragraph is irrelevant considering that the ESBWR generic X/Q and D/Q values do not exceed several of the X/Q and D/Q values for the first three docketed early site permit (ESP) applications. However, it is not critical that the ESBWR X/Q and D/Q values bound the ESP values, as other parameters are inputs to the dose calculation in demonstrating compliance with 10 CFR 50 Appendix I dose criteria. The ESBWR assumes only one X/Q and D/Q for all pathways of exposure; the ESP applicant X/Qs and D/Qs vary with respect to location (nearest garden, residence, milk cow, etc.) and are bounded by the ESBWR X/Q and D/Q values for a number of pathways and locations.

DCD Tier 2, Table 12.2-18b demonstrates that the ESBWR meets the 10 CFR 50 Appendix I dose criteria assuming the X/Q and D/Q values in DCD Tier 2, Table 12.2-15. Regardless of the ESP applicant X/Q and D/Q values and their relationship relative to the ESBWR values, the applicant must demonstrate compliance to 10 CFR 50 Appendix I as directed in the COL item in DCD Tier 2, Section 12.2.2.2.

DCD Impact

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

NRC RAI 2.3-10 S02:

The October 15, 2007, response to NRC RAI 2.3-10 S01 states that the DCD Tier 2 Subsection 12.2.2.1 discussion regarding the deviation of the annual average (long term) X/Q and D/Q site parameters was deleted in DCD Revision 4 because it is irrelevant that the ESBWR X/Q and D/Q site parameters do not bound the long term X/Q and D/Q site characteristics presented in the first three docketed early site permit applications. The staff finds this response unsatisfactory. The long term X/Q and D/Q values are important inputs for demonstrating that the calculated offsite concentrations and dose consequences of routine airborne releases meet criteria specified in Appendix B to 10 CFR 20 and Appendix I to 10 CFR 50, respectively. Consequently, the bases for these long term X/Q and D/Q site parameters should be provided.

1. *Please identify all the release pathways to the atmosphere for each of the annual airborne release source terms provided in DCD Tier 2 Table 12.2-16. For each release point, provide the following information:*

- *Height of release point and inside dimensions of release point exit*
- *Effluent temperature, flow rate, and exit velocity*
- *Size and shape of flow orifices*

2. *If any of the release points identified in Item 1 are not part of the standard plant design (such as the plant vent stack), please list the release points as interfaces with the standard plant design in DCD Tier 2 Subsection 1.8.*

3. *Please provide the basis for selecting the long term X/Q and D/Q site parameter values of 2.0x10E-6 s/mE+3 and 4.0x10E-9 mE-2 for modeling each of the release pathways identified in Item 1.*

GEH Response:

1. The ESBWR standard design employs three ventilation stacks (airborne release points). Individual stacks will service the ventilation flows from the Reactor/Fuel Buildings (RB/FB), the Turbine Building (TB) and the Radwaste Building (RWB). The requested design data associated with the subject release points is shown in the table below.

Building Stack (Release Point)	Release Height Above Grade m (ft)	Vent Inside (Exit) Diameter m (ft)	Effluent Temperature deg. F	Flow rate m^3/hr (cfm)	Average Exit Velocity m/s (ft/min)	Shape of Flow Orifice (Vent)
Reactor/ Fuel Building Stack	54.0* (177.3)*	2.4 (7.9)	min. = 73 max = 78	292,826 (172,350)	17.8 (3,500)	Cylindrical
Turbine Building Stack	71.3 (234)	2.0 (6.4)	min. = 59 max = 120	190,290 (112,000)	17.8 (3,500)	Cylindrical
Radwaste Building Stack	18* (59.1)*	1.3 (4.4)	min. = 50 max = 122	90,048 (53,000)	17.8 (3,500)	Cylindrical

*Note: Calculated X/Q and D/Q values for this release point are conservatively based on an assumed ground level release.

2. The ESBWR stack design described in Item 1 is a standard ESBWR design feature and therefore is not referenced in DCD Subsection 1.8.

3. The offsite airborne release analysis of the ESBWR ventilation stack design described in Item 1 employs separate long term atmospheric dispersion (X/Q) and deposition (D/Q) parameter values for each release location. The values for these parameters are shown in the table below.

Ventilation Stack Release Point	X/Q (s/m^3)	D/Q (m^{-2})
Reactor/Fuel Building	2.0E-06	2.0E-08
Turbine Building	2.0E-07	6.0E-09
Radwaste Building	3.0E-06	3.0E-08

The specific values for these parameters were determined by performing an analysis of available meteorological data for 25 sites originally evaluated for the ABWR program and two existing nuclear power plant sites. The meteorological data were used to generate X/Q and D/Q parameters for the each of the release points described in item 1 using the XOQDOQ computer code (NUREG/CR-2919, "XOQDOQ: Computer Program for the

Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations," September 1982). The atmospheric dispersion X/Q and D/Q parameters were generated for each of the 27 sites assuming an 800 meter exclusion area boundary (site boundary). The values shown in the table were then selected to bound (i.e. were greater than) at least 97% of the maximum generated X/Q and D/Q parameters for all the evaluated sites. The X/Q and D/Q values identified in the above table will be shown in DCD Tier 2, Table 12.2-15, "Airborne Sources Calculation" and described in DCD Tier 2, Section 12.2.2.1, "Airborne Releases Offsite".

DCD Impact:

DCD Tier 2, Table 12.2-15 and DCD Tier 2, Section 12.2.2.1 will be revised as noted on the attached markup. Reference 12.2-5, "XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations," NUREG/CR-2919, September 1982, will be added to DCD Tier 2, 12.2.5 References.

NRC RAI 12.2-25:

DCD Tier 2, Revision 4, Section 12.2.2.1 does not present the basis or appropriate references for the atmospheric dispersion and deposition parameter values used in calculating offsite doses from gaseous effluents. The staff noted that this information had been previously included in Revision 3, but has now been removed in Revision 4. Accordingly, revise DCD Tier 2, Section 12.2.2.1 to include this information either in this section of the DCD or in DCD Tier 2, Table 12.2-15 where the values are given for the atmospheric dispersion and deposition parameters.

GEH Response:

Per the response to RAI 2.3-10 S02 and this RAI, the atmospheric dispersion (X/Q) and deposition (D/Q) parameter values identified in the response to RAI 2.3-10 S02 will be shown in DCD Tier 2, Table 12.2-15,"Airborne Sources Calculation" and described in DCD Tier 2 Section 12.2.2.1, "Airborne Releases Offsite".

DCD Impact:

DCD Tier 2, Table 12.2-15 and DCD Tier 2, Section 12.2.2.1 will be revised as noted on the attached markup. Reference 12.2-5, "XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations," NUREG/CR-2919, September 1982, will be added to DCD Tier 2, 12.2.5 References.

Enclosure 2

MFN 06-396, Supplement 3

Response to Portion of NRC Request for Additional Information Letter Nos. 117 and 130 Related to ESBWR Design Certification Application

Radiation Protection

RAI Numbers 2.3-10 S02 and 12.2-25

DCD Markups

Verified DCD changes associated with this RAI response are identified in the enclosed DCD markups by enclosing the text within a black box. The marked-up pages may contain unverified changes in addition to the verified changes resulting from this RAI response. Other changes shown in the markup(s) may not be fully developed and approved for inclusion in DCD Revision 5.

a sealant and a steel liner, as described in Subsection 15.3.16.1, to prevent any potential water releases from high activity areas.

12.2.1.5 Other Contained Sources

The COL applicant will address any additional contained radiation sources (including sources for instrumentation and radiography) not identified in Subsection 12.2.1. (COL 12.2-4-A)

12.2.2 Airborne and Liquid Sources for Environmental Consideration

This subsection deals with the models, parameters, and sources required to evaluate the airborne concentration of radionuclides during plant operations in various plant radiation areas where personnel occupancy is expected. This subsection also deals with the sources and parameters required to evaluate airborne and liquid releases during normal plant operation for compliance with 10 CFR 20 and 10 CFR 50, Appendix I criteria.

12.2.2.1 Airborne Releases Offsite

Airborne sources are calculated using the source terms given in Section 11.1. A ratio to an expected release rate is shown in Table 12.2-15 for average annual releases and subject to the criteria of Reference 12.2-1.

The bases for these calculations are shown in Table 12.2-15.

~~Since the ESBWR is designed for a generic site, the X/Q and D/Q values in Table 12.2-15 are the generic parameters used in the calculation of the gaseous effluent normal operation doses in Table 12.2-18b. Calculation of site-specific doses is discussed in Subsection 12.2.2.2.~~

The ESBWR standard design employs three ventilation stacks (airborne release points). Individual stacks will service the ventilation flows from the Reactor/Fuel Buildings (RB/FB), the Turbine Building (TB) and the Radwaste Building (RWB). The offsite airborne release analysis of the ESBWR ventilation stack design employs separate long term atmospheric dispersion (X/Q) and deposition (D/Q) parameter values for each release location. The specific values for these parameters are shown in Table 12.2-15 and were determined by performing an analysis of available meteorological data for 25 sites evaluated for the ABWR program and two existing nuclear power plant sites. The meteorological data were used to generate X/Q and D/Q parameters for the each of the described release points using the XOQDOQ computer code (NUREG/CR-2919 – Reference 12.2-5). The atmospheric dispersion X/Q and D/Q parameters were generated for each of the 27 sites assuming an 800 meter exclusion area boundary (site boundary). The values shown in Table 12.2-5 were then selected to bound (i.e. were greater than) at least 97% of the maximum generated X/Q and D/Q parameters for all the evaluated sites.

The subject X/Q and D/Q values in Table 12.2-15 are used in the calculation of the gaseous effluent normal operation doses in Table 12.2-18b. Calculation of site-specific doses is discussed in Subsection 12.2.2.2.

Table 12.2-15 contains values used in calculating the annual airborne release source term provided in Table 12.2-16. Design basis noble gas, iodine, and other fission product concentrations are taken from the tables in Chapter 11. The methodology of NUREG-0016 was used in determining the annual airborne release values in Table 12.2-16. Specific details and information on the derivation of the airborne source terms are provided in Appendix 12B.

Table 12.2-23e. Even though the values presented were obtained in a very conservative manner, they are below the limits established in 10 CFR 20 Appendix B table 1 column 3.

12.2.4 COL Information

12.2-1-H Reactor Startup Source (Deleted)

12.2-2-A Airborne Effluents and Doses

The COL applicant is responsible for ensuring that offsite dose (using site-specific parameters) due to radioactive airborne effluents complies with the regulatory dose limits in Sections II.B and II.C of 10 CFR 50, Appendix I. In addition, the COL applicant is responsible for compliance with Section II.D of 10 CFR 50, Appendix I; airborne effluent concentration limits of 10 CFR 20 Appendix B (Table 2, Column 1); and dose limits of 10 CFR Parts 20.1301 and 20.1302 to members of the public (Subsection 12.2.2.2).

12.2-3-A Liquid Effluents and Doses

The COL applicant is responsible for ensuring that offsite dose (using site-specific parameters) due to radioactive liquid effluents complies with the regulatory dose limits in Section II.A of 10 CFR 50, Appendix I. In addition, the COL applicant is responsible for compliance with Section II.D of 10 CFR 50, Appendix I; liquid effluent concentration limits of 10 CFR 20 Appendix B (Table 2, Column 2); and dose limits of 10 CFR Parts 20.1301 and 20.1302 to members of the public (Subsection 12.2.2.4).

12.2-4-A Other Contained Sources

The COL applicant will address any additional contained radiation sources (including sources for instrumentation and radiography) not identified in Subsection 12.2.1.

12.2.5 References

12.2-1 USNRC, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors," NUREG-0016, Revision 1, January 1979.

12.2-2 USNRC, "GASPAR II Technical Reference and User Guide" NUREG/CR-4653, March 1987.

12.2-3 USNRC, "LADTAP II Technical Reference and User Guide" NUREG/CR-4013, April 1986.

12.2-4 USNRC, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," Regulatory Guide 1.113, Revision 1, April 1977.

12.2-5 ~~Deleted~~"XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations," NUREG/CR-2919, September 1982.

12.2-6 Deleted.

12.2-7 USNRC, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Regulatory Guide 1.109, Revision 1, October 1977.

Table 12.2-15

Airborne Sources Calculation

Calculation Bases	
Methodology	Appendix 12B
Noble Gas Source at t=30 min	740 MBq/sec (20,000 μCi/sec)
I^{131} Release Rate	3.7 MBq/sec (100 μCi/sec)
Meteorology Boundary	800 Meters
Meteorology χ/Q	~~2.0E-06 s/m^3~~
RB/FB Ventilation Stack	2.0E-06 s/m^3
TB Ventilation Stack	2.0E-07 s/m^3
RWB Ventilation Stack	3.0E-06 s/m^3
Meteorology D/Q	~~4.0E-09 m^{-2}~~
RB/FB Ventilation Stack	2.0E-08 m^{-2}
TB Ventilation Stack	6.0E-09 m^{-2}
RWB Ventilation Stack	3.0E-08 m^{-2}
~~Meteorology Boundary~~	~~800 m~~
Plant Availability Factor	0.92
Offgas System:	
Offgas stream temperature	100°F
Flow rate at 100°F	54 m^3/hr
K_d (Kr)	~~19~~ 18.5 cm^3/g
K_d (Xe)	330 cm^3/g
K_d (Ar)	6.4 cm^3/g
Guard tank charcoal mass	7,500 kg (single tank)
Adsorber tank charcoal mass	27,750 kg (each)
Adsorber tank arrangement	2 parallel trains of 4 tanks each
Turbine Gland Sealing System Exhaust:	
I-131 release	0.81 Ci/yr per μCi/g of I-131 in coolant
I-133 release	0.22 Ci/yr per μCi/g of I-~~131~~ 133 in coolant