HITACHI

GE Hitachi Nuclear Energy

James C. Kinsey
Vice President, ESBWR Licensing

PO Box 780 M/C A-55
Wilmington, NC 28402-0780
USA

T 910 675 5057
F 910 362 5057
jim.kinsey@ge.com

MFN 08-006

Docket No. 52-010

January 7, 2008

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

Subject: **Response to Portion of NRC Request for Additional Information Letter No. 60 Related to ESBWR Design Certification Application – Radiation Protection – RAI Numbers 12.3-8S01, 12.3-9S01, 12.4-6S02 and 12.6-2**

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 dated September 18, 2006. GEH responses to RAI Numbes 12.3-8S01, 12.3-9S01, 12.4-6S02 and 12.6-2 are addressed in Enclosure 1. Enclosure 2 contains the associated DCD Markups reflected in the RAI responses.

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

Sincerely,

James C. Kinsey

James C. Kinsey
Vice President, ESBWR Licensing

DCD
NRO

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 06-389, Letter from David H. Hinds to U.S. Nuclear Regulatory Commission, *Response to Portion of the NRC Request for Additional Information Letter No. 60 - Radiation Protection Systems - RAI Numbers 12.3-2, 12.3-3, 12.3-9, and 12.4-3*, dated October 18, 2006.
3. MFN 07-220, Letter from James C. Kinsey to U.S. Nuclear Regulatory Commission, *Response to Portion of NRC Request for Additional Information Letter No. 60 - Radiation Protection - RAI Number 12.3-8,* dated April 20, 2007.
4. MFN 06-512, Supplement 1, Letter from James C. Kinsey to U.S. Nuclear Regulatory Commission, *Response to Portion of NRC Request for Additional Information Letter No. 60 - Radiation Protection - RAI Numbers 12.4-4S01 through 12.4-6S01*, dated June 7, 2007.

Enclosures:

1. Response to Portion of NRC Request for Additional Information Letter No. 60 Related to ESBWR Design Certification Application – Radiation Protection – RAI Numbers 12.3-8S01, 12.3-9S01, 12.4-6S02 and 12.6-2
2. MFN 08-006 DCD Markups

cc: AE Cubbage USNRC (with enclosure)
GB Stramback GEH/San Jose (with enclosure)
RE Brown GEH/Wilmington (with enclosure)
eDRF 0000-0076-9453

Enclosure 1

MFN 08-006

Response to Portion of NRC Request for Additional Information Letter No. 60 Related to ESBWR Design Certification Application

Radiation Protection

RAI Numbers 12.3-8 S01, 12.3-9 S01, 12.4-6 S02, and 12.6-2

NRC RAI 12.3-8 S01:

Reference: GE Response Letter MFN-07-220, dated April 20, 2007, which addressed NRC RAI Letter No. 60, dated September 18, 2006.

In GE's April 20, 2007, response to RAI 12.3-8, GE included Table 12.2-5, Radioactive Sources in the Control Rod Drive System. The estimated gamma dose rate for the Rotating Ball Spindle before cleaning of 0.0E+00 mSv/hr appears to be in error. It would appear that the before cleaning dose rate value for this component would be larger than the after cleaning dose rate value listed at 3.0E-01 mSv/hr. Please correct this apparent discrepancy.

GEH Response:

The data provided in DCD Tier 2, Table 12.2-5 are based on survey measurements taken for the Fine Motion Control Rod Drive (FMCRD) disassembly at a nuclear plant in 1988. The zero (0.00E+00) values in the table indicated that no measurements were taken of that component. DCD Tier 2, Table 12.2-5 will be revised to reflect this.

DCD Impact:

DCD Tier 2, Table 12.2-5 will be revised as noted on the attached markup.

NRC RAI 12.3-9 S01:

Reference: GE Response Letter MFN-06-389, dated October 18, 2006, which addressed NRC RAI Letter No. 60, dated September 18, 2006.

RAI 12.3-9 asked the applicant to provide a description of any sources (such as calibration sources) needed to construct and operate an ESBWR plant or provide justification why this should be left to the COL applicant. To the extent that radiation protection features for these sources are provided for in the design (shielding, separate source rooms, etc.), they need to be addressed in the DCD. To the extent that these design features are to be provided in a COL, please identify them as COL action items.

GEH Response:

Calibration of operational instrumentation is carried out using calibration standards consisting of sealed source containers of precisely determined amounts of radioisotope activities of gamma, beta, alpha, or neutron source emitters. Some calibration sources consist of low specific activity "check" sources used for process and in-line instrumentation calibration. Other calibration gamma sources (Cs-137, Co-60 or Am-241) are contained in lead or tungsten shielded calibration irradiators. These irradiators open under controlled conditions to emit a collimated beam of gamma radiation and are used to calibrate survey instruments, personnel dosimeters, and other health physics instrumentation. External shielding for these irradiators is determined during installation activities and is based on the desired location in the facility.

Special lock-out or alert features are provided during periods of gamma calibration source exposure. Some calibration irradiators are self-contained and require no external shielding to permit operation. Alpha and beta check sources (typically Tl-204, Sr-90/Y-90) are shielded with thin metal enclosures. Neutron calibration sources (Am-241 or Cf-252), if used, can be shielded in portable boron impregnated polyethylene contained in steel housings. In general, calibration sources are selected based on the specific type and manufacture of instrumentation chosen for use in the installation. As such, specification of specific calibration sources and any associated shielding is not performed until the instrumentation suite has been selected by the cognizant plant organization.

Radiography sources may be used by the maintenance organization for nondestructive (NDT) weld testing procedures. The type and number of these sources would be determined by that organization. Radiography sources are generally gamma emitters wholly self-contained in shielded containers. Control of the radiography sources would be overseen by the health physics organization.

Radiation protection measures and any shielding associated with calibration, radiography, or other sources will be a function of the type of instrumentation the health physics, radiochemistry and/or maintenance organizations select for implementation. Personnel doses resulting from the use or handling of the above sources are regulated by 10 CFR 20, and are the responsibility of the plant operator and its radiation

protection organization, and any required shielding will meet these limits upon installation. The COL applicants will provide the level of detail for this shielding information as indicated on the markup to DCD Tier 2, Subsection 12.5.4.

DCD Impact:

DCD Tier 2, Subsection 12.2.1.5 will be added as noted on the attached markup. DCD Tier 2, Subsections 12.2.4-A, 12.5.3 and 12.5.3-A will be revised as noted on the attached markup.

NRC RAI 12.4-6 S02:

Reference: GE Response Letter MFN-06-512, Supplement 1, and MFN-06-528, Supplement 1, dated June 7, 2007, which addressed NRC RAI Letter No. 60, dated September 18, 2006.

In the applicant's June 7, 2007, response to RAI 12.4-6 S01, GE stated that, if required, special shielding features using other materials such as lead blankets, lead curtains, etc., will be defined later by the COL holder. To the extent that these design features are to be provided in a COL, they should be identified as COL Action Items in the DCD.

GEH Response:

Temporary shielding such as lead blankets, lead curtains, lead bricks, etc., are normally provided for activities such as plant modifications or inspections. Use of these temporary shielding materials would be the responsibility of the plant radiation protection organization and will be required to meet the requirements of USNRC Regulatory Guides 1.8, "Qualification and Training of Personnel for Nuclear Power Plants," and 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as Is Reasonably Achievable," as well as Section C.2 of Regulatory Guide 8.8. As stated in DCD Tier 2, Subsection 12.5.4, the COL applicants will provide the level of detail for this information.

DCD Impact:

DCD Tier 2, Subsection 12.5.4 will be revised as noted on the attached markup.

NRC RAI 12.6-2:

DCD Tier 2, Section 12.5.2 states that shielded rooms are provided for radioactivity analysis and instrument calibration. Describe the radiation sources that these facilities are designed to contain, shielding provided and any other protective considerations in the design. Does the ESBWR design provide a low background facility for personnel bioassay? If so include a description with the above.

GEH Response:

Instrument calibration is carried out using calibration standards consisting of sealed source containers of precisely determined amounts of radioisotope activities of gamma, beta, alpha, or neutron source emitters. Some calibration sources consist of low specific activity "check" sources used for process and in-line instrumentation calibration. Other calibration gamma sources (Cs-137, Co-60 or Am-241) are contained in lead or tungsten shielded calibration irradiators. These irradiators open under controlled conditions to emit a collimated beam of gamma radiation and are used to calibrate survey instruments, personnel dosimeters, and other health physics instrumentation. External shielding for these irradiators is determined during installation activities and is based on the desired location in the facility.

Special lock-out or alert features are provided during periods of gamma calibration source exposure. Some calibration irradiators are self-contained and require no external shielding to permit operation. Alpha and beta check sources (typically Tl-204, Sr-90/Y-90) are shielded with thin metal enclosures. Neutron calibration sources (Am-241 or Cf-252), if used, can be shielded in portable boron impregnated polyethylene contained in steel housings. In general, calibration sources are selected based on the specific type and manufacture of instrumentation chosen for use in the installation. As such, specification of specific calibration sources and any associated shielding is not performed until the instrumentation suite has been selected by the cognizant plant organization.

Routine radiochemical analyses conducted include the analysis of samples collected from various process stream locations for the purpose of determining the status of the nuclear fuel cladding, corrosion of reactor structural components/surfaces, and buildup of activation and fission products affecting the radiation fields in various plant areas. In addition, analyses of contamination swipes (in addition to radiation field surveys) are performed to determine the general radiological cleanliness of the various rooms of the facility, and to determine the location, type and source of possible contamination. Non-routine radiochemical analyses may include a requirement to analyze post accident samples taken from the containment atmosphere or reactor coolant. Generally these analyses result in radiation sources that consist of activation isotopes of reactor structural materials, fission products and actinides. Shielding for radiochemical analyses can range from minimal shielding in the case of routine samples to lead, steel, or tungsten shield bricks to attenuate gamma sources to thin steel or aluminum plates for beta or alpha shielding. The level of activity found in routine sample analysis is quite small and large amounts of shielding are not required. Special shielding casks, carriers or "pigs" are used in the transportation and handling of post-accident samples. As

stated above, the specific shielding configurations selected will be a function of the exact type of instrumentation installed by the plant operator.

Personnel bioassay equipment will vary based on the requirements of the radiation protection organization. Off-site facilities or commercial vendors may provide this service. In the event that the health physics organization chooses to implement personnel bioassay facility on-site, the shielding requirements would be dependent on the particular requirements of the design of the instrumentation selected and the location of the facility in the plant.

Radiography sources may be used by the maintenance organization for nondestructive (NDT) weld testing procedures. The type and number of these sources would be determined by that organization. Radiography sources are generally gamma emitters wholly self-contained in shielded containers. Control of the radiography sources would be overseen by the health physics organization.

In summary, shielding associated with calibration, radiography, and/or radiochemical analyses will be a function or the type of instrumentation the health physics, radiochemistry and/or maintenance organizations select for implementation. Personnel doses resulting from the use or handling of the above sources are regulated by 10 CFR 20, and are the responsibility of the plant operator and its radiation protection organization, and any required shielding will be designed to meet these limits upon installation. The COL applicants will provide the level of detail for this shielding information as provided in the markup to DCD Tier 2, Subsection 12.5.4.

DCD Impact:

DCD Tier 2, Subsection 12.2.1.5 will be added as noted on the attached markup. DCD Tier 2, Subsections 12.2.4, 12.5.3 and 12.5.4 will be revised as noted on the attached markup.

Enclosure 2

MFN 08-006

DCD Markups

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.

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.

Annual Releases

Based upon the above criteria, the normal operating source terms are given in Table 12.2-16 and a comparison to 10 CFR 20 criteria is given in Table 12.2-17.

12.2.2.2 Airborne Dose Evaluation Offsite

Airborne doses were calculated based upon the criteria specified in Subsection 12.2.2.1 for compliance with 10 CFR 50, Appendix I. Doses were calculated using methodologies and conversion factors consistent with Regulatory Guides 1.109 (Reference 12.2-7) and 1.111 (Reference 12.2-8) as implemented in References 12.2-1 and 12.2-2. The airborne offsite dose calculation bases are provided in Table 12.2-18a. Default parameters of Regulatory Guide 1.109 were used in determining the offsite dose, with the exception of the explicitly stated values in Table 12.2-18a. The results of the dose analysis are given in Table 12.2-18b. 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

The assumptions and parameters used to determine the airborne activity levels in the Turbine Building are listed in Table 12.2-23a. The airborne concentrations are provided in Table 12.2-23d. 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.

12.2.3.5 Radwaste Building

The Radwaste Building HVAC system is discussed in Subsection 9.4.3. Subsection 12.3.3.2.4 discusses the radiation control aspects of the HVAC system.

Corridors and routine access operating areas within the Radwaste Building are not expected to have significant airborne radioactivity levels. Equipment cubicles are infrequently accessed and may contain low levels of airborne radioactivity, but design provisions are provided to minimize the release of radioactivity.

Radwaste Building tanks are filled from the top and as the water splashes into the tanks, dissolved and entrained radioactivity may become airborne. This activity is not released into the atmosphere in the rooms because the tank vents are connected directly to the building ventilation system. Pumps and valves for radioactive systems in the Radwaste Building are located in separate compartments that are not normally occupied. The Radwaste Building ventilation design provides airflow from areas of low potential for airborne contamination to areas of increasing potential. This insures that any leakage from radwaste pumps and valves is not directed into normally occupied areas of the building, but is exhausted from the building.

The assumptions and parameters used to determine the airborne activity levels in the Radwaste Building are listed in Table 12.2-23a. The airborne concentrations are provided in 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

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.

12.2-8 USNRC, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Regulatory Guide 1.111, Revision 1, July 1977.

12.2-9 Sources of Radioiodine at Boiler Water Reactors, EPRI NP-495, Research Project 274-1, Final Report, February 1978.

Table 12.2-5

Radioactive Sources in the Control Rod Drive System

Control Rod Drive Radiation Survey Data		
	Gamma Dose Measured at Contact, mSv/hr**	
Upper Component	**Before Cleaning**	**After Cleaning**
Rotating Ball Spindle	~~0.0E+00~~Not measured	3.0E-01
Hollow Piston	7.5E-01	3.8E-01
Labyrinth Seal	6.0E-01	6.0E-01
Guide Tube	4.5E-01	3.0E-01
Outer Tube/Flange	3.3E+00	3.0E-01

** The gamma doses listed in this table are based on survey measurements taken for the FMCRD disassembly at a nuclear plant in 1988. No measurements were taken for the rotating ball spindle before cleaning.

Control Blade Principal Isotopes	
Isotope	**MBq/Blade**
Cr-51	5.2E+09
Mn-54	3.4E+08
Fe-55	5.9E+09
Co-58m	3.3E+08
Co-60	4.1E+09
Ni-63	1.9E+08
Total	1.6E+10

12.5 OPERATIONAL RADIATION PROTECTION PROGRAM

12.5.1 Objectives

The ESBWR design includes health physics facilities and features providing capabilities for administrative control of:

- The activities of plant personnel to limit personnel exposure to radiation and radioactive materials as low as reasonably achievable (ALARA) and within the guidelines of 10 CFR 20.
- Effluent releases from the plant to maintain the releases ALARA and within the limits of 10 CFR 20 and the plant Technical Specifications.
- Waste shipments from the plant to meet applicable requirements for the shipment and receipt of the material at the storage or burial site.

12.5.2 Equipment, Instrumentation, and Facilities

The health physics facilities are located in the Service building. Access to the radiologically controlled areas of the Reactor, Fuel, Turbine, and Radwaste buildings is normally through the entry/exit area of the health physics facilities of the Service building. Exit from the radiologically controlled areas is at the same location.

The health physics area contains the personnel contamination monitoring equipment, decontamination shower facilities, changing rooms and first-aid equipment. The changing rooms are provided with lockers, wash sinks, showers and toilet facilities.

Portable radiation survey instrumentation is stored at the access control and health physics room and at in-plant control points. This instrumentation allows plant personnel to perform radiation, contamination and neutron surveys, as needed, as well as to collect samples for airborne analysis. Shielded rooms are provided in the health physics area for radioactivity analysis and for calibration of survey instruments.

The non-portable airborne radiation monitoring equipment is described in Subsection 12.3.4. The COL applicant will provide a description of plant health physics equipment, instrumentation, and facilities (COL 12.5-1-A). The COL applicant will provide a description of the portable instruments that accurately measure radio-iodine concentrations in plant areas under accident conditions and of the training and procedures on the use of these instruments in compliance with Paragraph 50.34 (f) (xxvii) of 10 CFR 50 and NUREG-0737 Item III.D.3.3. (COL 12.5-2-A).

12.5.3 Operational Considerations

The COL applicant will provide a description of the operational radiation protection program utilizing the guidance provided in Regulatory Guide 1.206. The radiation protection program will consider special shielding features such as lead blankets, lead curtains, etc. (COL 12.5-3-A).

12.5.4 COL Information

12.5-1-A Equipment, Instrumentation, and Facilities

The COL applicant will provide a description of plant health physics equipment, instrumentation, and facilities (Subsection 12.5.2).

12.5-2-A Compliance with Paragraph 50.34 (f) (xxvii) of 10 CFR 50 and NUREG-0737 Item III.D.3.3

The COL applicant will provide a description of the portable instruments that accurately measure radio-iodine concentrations in plant areas under accident conditions and of the training and procedures on the use of these instruments (Subsection 12.5.2).

12.5-3-A Radiation Protection Program

The COL applicant will provide a description of the operational radiation protection program utilizing the guidance provided in Regulatory Guide 1.206. The radiation protection program will consider special shielding features such as lead blankets, lead curtains, etc. (Subsection 12.5.3).

12.5.5 References

12.5-1 USNRC, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)," Regulatory Guide 1.70, Revision 3, November 1978.