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MFN 06-305
Supplement 3

Docket No. 52-010

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U.S. Nuclear Regulatory Commission
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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 233 Related to ESBWR Design Certification Application – Radiation Protection – RAI Number 12.2-15 S03**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) response to a portion of the U.S. Nuclear Regulatory Commission Request for Additional Information (RAI) sent by NRC Letter 233 (Reference 1). The GEH response to RAI Number 12.2-15 S03 is addressed in Enclosure 1. The DCD markup pages related to this response are provided in Enclosure 2.

The initial RAI 12.2-15 and supplements were received via References 2 and 5.

A supplemental RAI was received from the NRC, Reference 5.

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

Sincerely,

Richard E. Kingston

Richard E. Kingston
Vice President, ESBWR Licensing

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References:

1. MFN 08-648, *Letter from the U.S. Nuclear Regulatory Commission to Robert E. Brown, Request for Additional Information Letter No. 233, Related To ESBWR Design Certification Application*, dated August 15, 2008
2. MFN 06-302, *Letter from the U.S. Nuclear Regulatory Commission to David Hinds, Request for Additional Information Letter No. 54, Related To ESBWR Design Certification Application*, dated August 23, 2006
3. MFN 06-305, *Response to Portion of NRC Request for Additional Information Letter No. 54 Related to ESBWR Design Certification Application – Radioactive Waste Management/Radiation Protection – RAI Numbers 11.2-9, 11.2-10, 11.4-12 through 11.4-14 and 12.2-11 through 12.2-15,* dated September 1, 2006
4. MFN 06-305 Supplement 1, *Response to Portion of NRC Request for Additional Information Letter No. 54 Related to E5BWR Design Certification Application - Radiation Protection - RAI Number 12.2-15 S01*, dated December 11, 2007
5. MFN 08-117, *Letter from the U.S. Nuclear Regulatory Commission to Robert E. Brown, Request for Additional Information Letter No. 150, Related To ESBWR Design Certification Application*, dated February 7, 2008
6. MFN 06-305 Supplement 2, *Response to Portion of NRC Request for Additional Information Letter Nos. 54 and 150 Related to E5BWR Design Certification Application - Radiation Protection - RAI Number 12.2-15 S02*, dated May 16, 2008

Enclosures:

1. Response to Portion of NRC Request for Additional Information Letter No. 233, Related to ESBWR Design Certification Application – Radiation Protection – RAI Number 12.2-15 S03
2. Response to Portion of NRC Request for Additional Information Letter No. 233, Related to ESBWR Design Certification Application – Radiation Protection – RAI Number 12.2-15 S03 - DCD Markup

cc: AE Cubbage	USNRC (with enclosures)
RE Brown	GEH/Wilmington (with enclosures)
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Enclosure 1

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Response to Portion of NRC Request for

Additional Information Letter No. 233

Related to ESBWR Design Certification Application

Radiation Protection

RAI Number 12.2-15 S03

For historical purposes, the original text of RAIs 12.2-15, 12.2-15 S01, 12.2-15 S02 and the GE responses are included. These responses do not include any attachments or DCD mark-ups.

NRC RAI 12.2-15

The dose model parameter describing the transit time of effluents from the point of discharge to the location of exposure (maximum exposed individual) is not listed in DCD Tier 2, Table 12.2-20a. Update Table 12.2-20a to include this model parameter and its assumed value used in the analysis.

GEH Response

Liquid dose parameters used in LADTAPII are the ones included in Regulatory Guide 1.109 for maximum exposure and included as default values in LADTAPII. Transit times from discharge to the receiving water body to exposure location:

- for all pathways except drinking water: instantaneous
- for drinking water: 12 hr
- for irrigated foods: instantaneous

DCD Impact

DCD Table 12.2-20a will be revised in the next update as noted in the markup (see response to RAI 12.2-13).

NRC RAI 12.2-15 S01

In RAIs 11.2.2-8, 12.2-10 (and its followup), and 12.2-15, the staff had requested the applicant to provide discussions and assumptions describing offsite dose receptor locations, rationale for the exposure pathways listed in DCD Tier 2, Rev. 1, Table 12.2-20b, and a listing of all model parameters used in calculating doses using the methodology of the BWR-GALE Code (NUREG-0016) and NUREG/CR- 4013. Based on the information presented in DCD Tier 2, Rev. 1, Tables 12.2-19a, 12.2-20a, 11.2-3, 11.2-4, 11.1-3, and 9.3-2, the staff could not duplicate, using the BWR-GALE Code, the average annual liquid effluent concentrations and releases listed in Table 12.2-19b. The following observations were noted:

a. *Using the updated information, the staff's evaluation confirmed the estimates of annual radioactivity releases for all but 13 of the 46 radionuclide listed in Table 12.2-19b. The applicant's results were found to be higher than the staff's analysis for Np-239, Sr-90, Te-132, and CS-137, with factors ranging from about 1.1 to 4.0. For nine radionuclide, the applicant's results were found to be lower than the staff's analysis for Br-83, Ru-103, 1-131, 1-132, 1-133, 1-134, 1-135, Cs-136, and H-3 with factors ranging from about 0.2 to 0.09.*

Accordingly, provide supplemental information with which to resolve these differences and update the DCD.

GEH Response

GEH calculated liquid effluent releases using the Radiation Safety Information Computational Center (RSICC) computer code GALE86 (CCC-506) instead of the RSICC code BWR-GALE (CCC-335) that the staff used to calculate the ESBWR liquid effluents. The GALE86 code abstract reference section on the RSICC website indicates that this code is associated with NUREG-0016, Revision 1, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors (BWR-GALE Code)."

In order to determine if the differences between the staff's radioactive liquid releases and GEH's releases are a function of the computer code used, GEH took the sample input file in Chapter 3 of NUREG-0016, Revision 1, and used GALE86 to calculate the liquid releases. The attached table provides a comparison of the GALE86 output results and the output values provided in Chapter 3 of NUREG- 0016, Revision 1.

As can be seen by the results provided in the attached table, there are significant differences between the GALE86 and NUREG-0016 R1 results for all the isotopes. Of the 13 radionuclides cited in the RAI, differences range from a minimum of 0.44 (Cs-136) to a maximum of 1.50 (Cs-137). This confirms that there are fundamental differences between the GALE86 and BWR-GALE computer codes.

DCD Tier 2, Subsections 12.2.2.3 and 12.2.5 will be changed in DCD Revision 5 to reference the GALE86 code instead of the BWR-GALE code, as GALE86 was used by GEH to determine the liquid effluent releases.

DCD Impact

DCD Tier 2, Subsections 12.2.2.3 and 12.2.5 will be revised as noted on the attached markup.

NRC RAI 12.2-15 S02

An evaluation of the response to NRC RAI 12.2-15 S01, contained in MFN 06-0305 Supp. 1 (Dec. 11, 2007), indicates that the staff could not independently confirm the estimated annual amounts of radioactivity released in liquid effluents. In its evaluation, the staff used the 1986 version of the BWR-GALE code (aka GALE86), given that GE had used that version of the code in its analysis in estimating yearly releases of radioactivity in liquid effluents. In comparing both sets of results, please note the following:

1. *The staff's analysis used the input described in DCD Table 12.2-19a and plant design capacity factor (0.92) listed in DCD Table 12.2-15.*
2. *The results from the GALE86 code analysis were adjusted (1.15) to address the difference in plant capacity factors: 0.92 as the stated design capacity factor vs the default value of 0.80 hardwired in the GALE86 code.*
3. *For the analysis ran with no adjustment factor for the difference in capacity factors, the staff's results matches that presented in DCD Table 12.2-19b.*
4. *For the analysis ran with an adjustment factor of 1.15 (0.92/0.8) for the difference in capacity factors, the staff's results do not match that presented in DCD Table 12.2-19b.*
5. *It is concluded that the results presented in DCD Table 12.2-19b do not account for the DCD stated plant capacity factor of 0.92. Note that the corresponding analyses used in estimating gaseous effluent source terms did make adjustments for the stated design capacity factor of 0.92.*

Confirm whether the staff interpretation's of the analytical approach presented in GE MFN 06-305 Supp. 1 and liquid effluent source term results listed in DCD Table 12.2-19b is correct, revise the liquid effluent source terms listed in DCD Table 12.2-19b, revise the estimated liquid effluent concentrations listed in Table 12.2-19b, and revise the associated dose results shown in Table 12.2-20b.

GEH Response

There is no input card for the capacity factor in the GALE-86 code. A capacity factor of 0.8 is an internal default value.

In the liquid effluent releases in the BWR GALE-86 code, a capacity factor of 0.8 is only used for the tritium calculations; specifically, to calculate the tritium discharges via the "processed liquid regenerant wastes" stream. It is not used for other streams. If a capacity factor of 0.92 is applied using the GALE-86 Code instructions, the tritium discharges would change from 14.47 Ci/yr to 14.65 Ci/yr (note: the GALE-86 Code presents the results rounded to the whole number). This change would mean an increase in a negligible dose for a maximum increase of 1.1% for infant, total body and 1.2% for infant, lung organ. Considering that all the Tier 2, Table 12.2-20b doses are well under the 3.0E-02 mSv (3 mrem) total body and 1.0E-01 mSv (10 mrem) maximum organ dose criteria established in 10 CFR 50 Appendix I, Section II.A, this slight increase still maintains the doses due to liquid effluents well below the dose limits.

The capacity factor applies to the GALE-86 gaseous releases code module, where the default capacity factor of 0.8 is applied. Due to the fact that the use of a higher capacity factor is more conservative in calculating gaseous release (Offgas operation is one leading contribution to gaseous releases), a capacity factor of 0.92 has been used in the ESBWR gaseous release calculations.

DCD Impact

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

NRC RAI 12.2-15 S03

A review of MFN 06-305 S02 and DCD Tier 2, Revision 5, DCD Table 12.2-19b indicates that the annual liquid effluent source term was not adjusted for the ratio of the plant rated capacity factor (0.92/0.8). The applicant is requested to either revise the liquid source term and doses by a ratio of 1.15, or introduce a properly qualified footnote in DCD Tier 2, Tables 12.2-19a and 12.2-20a (bases of source term and dose calculations) explaining the departure from the plant's rated design and significance of impact on dose results

GEH Response

A properly qualified footnote will be introduced in DCD Tier 2, Tables 12.2-19a and 12.2-20a which explains the departure and significance of impact on the dose results.

DCD Impact

DCD Tier 2, Tables 12.2-19a and 12.2-20a will be revised as noted in the markup in Enclosure 2.

Enclosure 2

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Response to Portion of NRC Request for

Additional Information Letter No. 233

Related to ESBWR Design Certification Application

Radiation Protection

RAI Number 12.2-15 S03

DCD Markups

Table 12.2-19a

Average Annual Liquid Release Calculation Parameters**

BWR-GALE Card Number	Parameter	Data
1	Name of reactor	GE-ESBWR
	Type	BWR
2	Thermal power level	4500 MWth
3	Total steam flow	1.93E+07 lb/hr
4	Mass of water in reactor vessel	6.74E+05 lb
5	Clean-up demineralizer flow	1.93E+05 lb/hr
6	Condensate demineralizer regenerative time	0 days
7	Cooper tubing for condenser	0 (no)
8	Fraction feed water through condensate demineralizer	1.0
9	High purity waste input	17,173 gal/day
	High purity: Fraction of reactor coolant activity	0.268
10	High purity: Decontamination factor for iodine	1000
	High purity: Decontamination factor for Cs and Rb	100
	High purity: Decontamination factor for others	1000
11	High purity: Collection time	2.958 days
	High purity: Process and discharge time	0.233 days
	High purity: Fraction discharged	0.01
12	Low purity waste input	6,750 gal/day
	Low purity: Fraction of reactor coolant activity	0.001
13	Low purity: Decontamination factor for iodine	10,000
	Low purity: Decontamination factor for Cs and Rb	200
	Low purity: Decontamination factor for others	10,000
14	Low purity: Collection time	9.455 days
	Low purity: Process and discharge time	0.289 days
	Low purity: Fraction discharged	0.1
15	Chemical waste input	793 gal/day
	Chemical: Fraction of reactor coolant activity	0.02
16	Chemical: Decontamination factor for iodine	10,000
	Chemical: Decontamination factor for Cs and Rb	200
	Chemical: Decontamination factor for others	10,000
17	Chemical: Collection time	1.255 days
	Chemical: Process and discharge time	0.289 days
	Chemical: Fraction discharged	0.1
18	Detergent waste input	1,057 gal/day

Table 12.2-19a

Average Annual Liquid Release Calculation Parameters**

BWR-GALE Card Number	Parameter	Data
19	Detergent: Decontamination factor for iodine	1
	Detergent: Decontamination factor for Cs and Rb	1
	Detergent: Decontamination factor for others	1
20	Detergent: Collection time	3.0 days
	Detergent: Process and discharge time	0.25 days
	Detergent: Fraction discharged	0.100
21 to 33	Data only of gaseous releases	0
34	Detergent waste decontamination factor - Laundry	0

** There is no capacity factor input card in the GALE-86 code. A capacity factor of 0.8 is an internal default value. In the liquid effluent release module of the GALE-86 code, a capacity factor of 0.8 is only used for the tritium calculations; specifically, to calculate the tritium discharges via the "processed liquid regenerant waste" stream (and not for other streams). If an ESBWR capacity factor of 0.92 is applied to the GALE-86 code, the tritium discharges would change from 14.47 Ci/yr to 14.65 Ci/yr (note: the GALE-86 code presents the results rounded to the whole number). This change would mean a negligible dose increase for a maximum increase of 1.1% for infant, total body, and 1.2% for infant, lung. This slight increase still maintains the doses due to liquid effluents well below the 10 CFR 50 Appendix I limits.

Table 12.2-20a

Liquid Pathway Offsite Dose Calculation Bases**

Calculation Methodology	Regulatory Guide 1.109
Computer Code Utilized	LADTAP II (NUREG/CR-4013)
Individual Consumption/Exposure Rates	Table E-5 of Reg. Guide 1.109
Site Water Type	Freshwater
Discharge Canal Flow Rate	2.0E+04 liters/min
Shore-Width Factor	0.2
Dilution Factor	10
Transit times from discharge to the receiving water body to exposure location	- All pathways except drinking water: instantaneous - Drinking water: 12 hours - Irrigated foods: instantaneous
Irrigation rate	0.001 m^3/m^2-day
Fraction of year that leafy vegetables are grown	0.75
Fraction of year that animals graze on pasture	0.5
Fraction of daily feed that is pasture grass when the animal grazes on pasture	0.75
Animal milk considered for milk pathway	Cow
Liquid Pathway Offsite Annual Doses	Table 12.2-20b

** There is no capacity factor input card in the GALE-86 code. A capacity factor of 0.8 is an internal default value. In the liquid effluent release module of the GALE-86 code, a capacity factor of 0.8 is only used for the tritium calculations; specifically, to calculate the tritium discharges via the "processed liquid regenerant waste" stream (and not for other streams). If an ESBWR capacity factor of 0.92 is applied to the GALE-86 code, the tritium discharges would change from 14.47 Ci/yr to 14.65 Ci/yr (note: the GALE-86 code presents the results rounded to the whole number). This change would mean a negligible dose increase for a maximum increase of 1.1% for infant, total body, and 1.2% for infant, lung. This slight increase still maintains the doses due to liquid effluents well below the 10 CFR 50 Appendix I limits.