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Supplement 1

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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 71 – Radiation Protection – RAI Number 12.2-10 – Supplement 1**

Enclosure 1 contains GE's response to the subject NRC RAIs transmitted via the Reference 1 letter.

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

Sincerely,

Kathy Sedney for

David H. Hinds
Manager, ESBWR

D068

Reference:

1. MFN 06-383, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 71 Related to ESBWR Design Certification Application*, October 11, 2006

Enclosure:

1. MFN 06-212, Supplement 1 – Response to Portion of NRC Request for Additional Information Letter No. 71 – Radiation Protection – RAI Number 12.2-10

cc: AE Cubbage USNRC (with enclosures)
GB Stramback GE/San Jose (with enclosures)
eDRF 0061-7302

Enclosure 1

MFN 06-212, Supplement 1

Partial Response to RAI Letter No. 71 Related to ESBWR Design Certification Application.

Radiation Protection

RAI Number 12.2-10

RAI 12.2-10 Supplement 1:

The estimates of total annual liquid effluent releases presented in DCD Tier 2, Revision 1, Table 12.2-19b could not be duplicated using the information contained GE responses to RAI No. 12.2-10 (MFN-06-212 dated July 21, 2006) and RAIs No. 11.1-1 and 11.1-2 (MFN-06-219 dated July 19, 2006) and the BWR-GALE Code (NUREG-0016) and the BWRGALE Code (NUREG-0016). For example, the staff's analyses show results that are inconsistent even after making specific adjustments to results, such as for the assumed primary coolant radionuclide concentrations and plant capacity factor. Please address the following:

a. *Since the BWR-GALE code was not used by GE in deriving total annual effluent releases, provide a description of the alternate method used, including adjustments made to address specific plant processes and/or radionuclides.*

b. *Provide technical discussions describing differences between the method used by GE and NUREG-0016. Include sufficient details in the response to facilitate the staff's review in comparing sources of differences.*

GE Response:

The BWR-GALE code has been used to calculate annual liquid effluent releases (NUREG-0016). It was not used directly to calculate annual gaseous effluent releases.

The attached revised Table 12.2-19a includes data used to calculate liquid effluent releases, structured in BWR-GALE input format.

Inputs to estimate the total annual liquid effluent releases with the BWR-GALE code have been revised, resulting in recalculated liquid releases and doses.

DCD Impact:

Changes to the BWR-GALE code input data parameters are reflected in DCD Table 12.2-19a, and the resulting Average Annual Liquid Releases (revised Table 12.2-19b) and Liquid Pathway Dose Results (revised Table 12.2-20b) will be provided in DCD Tier 2, Revision 3, as shown on the attached mark-up.

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

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.

12.2.2.3 Liquid Sources

The ESBWR Radwaste System as described in Section 11.2 is designed to monitor and process all radioactive liquid streams in the ESBWR and to provide water management for those streams. Under normal conditions, the water management is not expected to result in any routine release of radioactive effluents in the liquid discharges. However, under some conditions such as high water inventory, some processed radioactive liquid effluents may be released. By administrative control, the discharge of these effluents through the discharge line is adjusted so that it can be shown that the discharge meets the requirements of 10 CFR 20 on isotopic concentration limits and Appendix I of 10 CFR 50 on annualized dose requirements.

The bounding annualized release is shown in Table 12.2-19b. Decontamination factors listed in Table 11.2-3 were used in determining the annual liquid release to the environment. The decontamination factors used were based on two in-series ion exchangers and weighted by liquid waste volume and activity for obtaining primary coolant activity values, which were used as input to the BWR-GALE computer code calculation (Reference 12.2-1). The BWR-GALE code input parameters for determining the Table 12.2-19b annual liquid release values are provided in Table 12.2-19a. These parameters are listed by cards, following the BWR-GALE format.

12.2.2.4 Liquid Doses

Liquid pathway doses were calculated based upon the criteria specified in Subsection 12.2.2.3 for compliance with 10 CFR 50, Appendix I. Dose conversion factors and methodologies consistent with Regulatory Guides 1.109 and 1.113 were used as described in References 12.2-7 and 12.2-4. The liquid effluent pathway offsite dose calculation bases are provided in Table 12.2-20a. It is assumed that an additional dilution factor of ten exists between the discharge canal and the subsequent consumption or recreational activity involving liquid effluents. This assumption is expected to bound conditions found at actual sites. LADTAPII code is used to perform the liquid dose analysis (Reference 12.2-3). The results of the dose calculation are given in Table 12.2-20b.

12.2.3 COL Information

None.

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

Table 12.2-19a

Average Annual Liquid Release Calculation Parameters

BWR-GALE Card Number	Parameter	Data
18	Detergent waste input	1,057 gal/day
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

Table 12.2-19b

Average Annual Liquid Releases

Isotope	Annual Release (MBq/yr)	Concentration (Bq/ml)	10CFR20 (Bq/ml)
I-131	1.55E+02	1.48E-05	3.70E-02
I-132	3.03E+01	2.88E-06	3.70E+00
I-133	7.77E+02	7.39E-05	2.59E-01
I-134	1.48E+00	1.41E-07	1.48E+01
I-135	2.00E+02	1.90E-05	1.11E+00
H-3	5.18E+05	4.92E-02	3.70E+01
Na-24	1.89E+02	1.79E-05	1.85E+00
P-32	1.55E+01	1.48E-06	3.33E-01
Cr-51	4.81E+02	4.57E-05	1.85E+01
Mn-54	5.92E+00	5.63E-07	1.11E+00
Mn-56	4.81E+01	4.57E-06	2.59E+00
Fe-55	8.51E+01	8.09E-06	3.70E+00
Fe-59	2.59E+00	2.46E-07	3.70E-01
Co-58	1.63E+01	1.55E-06	7.40E-01
Co-60	3.33E+01	3.17E-06	1.11E-01
Cu-64	4.81E+02	4.57E-05	7.40E+00
Zn-65	1.67E+01	1.58E-06	1.85E-01
Zn-69m	3.40E+01	3.24E-06	2.22E+00
Br-83	3.33E+00	3.17E-07	3.33E+01
Sr-89	8.14E+00	7.74E-07	2.96E-01
Sr-90	7.40E-01	7.03E-08	1.85E-02
Sr-91	4.44E+01	4.22E-06	7.40E-01
Y-91	5.18E+00	4.92E-07	2.96E-01
Sr-92	1.07E+01	1.02E-06	1.48E+00
Y-92	4.07E+01	3.87E-06	1.48E+00
Y-93	4.44E+01	4.22E-06	7.40E-01
Zr-95	7.40E-01	7.03E-08	7.40E-01
Nb-95	7.40E-01	7.03E-08	1.11E+00
Mo-99	1.11E+02	1.06E-05	7.40E-01
Tc-99m	2.04E+02	1.93E-05	3.70E+01
Ru-103	1.48E+00	1.41E-07	1.11E+00
Ru-105	6.29E+00	5.98E-07	2.59E+00
Te-129m	3.33E+00	3.17E-07	2.59E-01
Te-131m	3.70E+00	3.52E-07	2.96E-01

Table 12.2-19b

Average Annual Liquid Releases

Isotope	Annual Release (MBq/yr)	Concentration (Bq/ml)	10CFR20 (Bq/ml)
Te-132	7.40E-01	7.03E-08	3.33E-01
Cs-134	2.52E+01	2.39E-06	3.33E-02
Cs-136	1.52E+01	1.44E-06	2.22E-01
Cs-137	6.66E+01	6.33E-06	3.70E-02
Ba-139	1.48E+00	1.41E-07	7.40E+00
Ba-140	3.03E+01	2.88E-06	2.96E-01
Ce-141	2.59E+00	2.46E-07	1.11E+00
La-142	1.11E+00	1.06E-07	3.70E+00
Ce-143	1.11E+00	1.06E-07	7.40E-01
Pr-143	3.33E+00	3.17E-07	7.40E-01
W-187	8.88E+00	8.44E-07	1.11E+00
Np-239	4.07E+02	3.87E-05	7.40E-01

Table 12.2-20b

Liquid Pathway Dose Results in mSv/year

PATHWAY	Annual Doses (mSv/yr)							
	SKIN	BONE	LIVER	T. BODY	THYROID	KIDNEY	LUNG	GI-LLI
Drinking								
Adult	0.00E+00	3.93E-05	8.50E-05	7.64E-05	8.20E-04	7.36E-05	6.09E-05	9.06E-05
Teenager	0.00E+00	3.66E-05	6.65E-05	5.18E-05	7.08E-04	5.57E-05	4.39E-05	6.58E-05
Child	0.00E+00	1.03E-04	1.31E-04	9.35E-05	1.78E-03	1.08E-04	8.43E-05	1.05E-04
Infant	0.00E+00	1.09E-04	1.46E-04	9.02E-05	2.75E-03	1.09E-04	8.36E-05	9.58E-05
Fish								
Adult	0.00E+00	1.62E-02	2.22E-03	1.48E-03	3.31E-04	4.46E-04	1.37E-04	1.87E-03
Teenager	0.00E+00	1.76E-02	2.34E-03	1.17E-03	3.16E-04	4.56E-04	1.63E-04	1.52E-03
Child	0.00E+00	2.27E-02	2.15E-03	1.05E-03	3.46E-04	3.87E-04	1.29E-04	6.46E-04
Shoreline								
Adult	1.75E-06	1.49E-06	1.49E-06	1.49E-06	1.49E-06	1.49E-06	1.49E-06	1.49E-06
Teenager	9.77E-06	8.35E-06	8.35E-06	8.35E-06	8.35E-06	8.35E-06	8.35E-06	8.35E-06
Child	2.04E-06	1.74E-06	1.74E-06	1.74E-06	1.74E-06	1.74E-06	1.74E-06	1.74E-06
Irrigated Foods:								
Vegetables								
Adult		5.77E-05	8.14E-05	7.01E-05	1.53E-04	5.56E-05	4.58E-05	5.35E-05
Teenager		9.12E-05	1.16E-04	7.78E-05	2.16E-04	7.38E-05	5.91E-05	6.48E-05
Child		2.08E-04	1.91E-04	1.05E-04	4.08E-04	1.18E-04	9.31E-05	9.04E-05
Leafy Vegetables								
Adult		7.69E-06	1.02E-05	8.77E-06	5.05E-05	7.14E-06	5.66E-06	7.44E-06
Teenager		6.63E-06	7.95E-06	5.30E-06	3.99E-05	5.19E-06	3.95E-06	4.93E-06
Child		1.14E-05	9.83E-06	5.41E-06	5.89E-05	6.23E-06	4.67E-06	4.91E-06
Milk								
Adult		1.58E-05	2.77E-05	2.24E-05	1.17E-04	1.76E-05	1.26E-05	1.35E-05
Teenager		2.84E-05	4.34E-05	2.61E-05	1.83E-04	2.57E-05	1.76E-05	1.75E-05
Child		6.81E-05	7.17E-05	3.39E-05	3.63E-04	4.12E-05	2.78E-05	2.52E-05
Meat								
Adult		3.10E-06	6.18E-06	5.35E-06	7.11E-06	4.87E-06	4.16E-06	5.97E-06
Teenager		2.54E-06	4.16E-06	3.08E-06	4.66E-06	3.11E-06	2.58E-06	3.51E-06
Child		4.70E-06	5.20E-06	3.53E-06	6.36E-06	3.79E-06	3.13E-06	3.45E-06
Total								
Adult	**1.75E-06**	**1.63E-02**	**2.43E-03**	**1.66E-03**	**1.48E-03**	**6.06E-04**	**2.68E-04**	**2.04E-03**
Teenager	**9.77E-06**	**1.78E-02**	**2.59E-03**	**1.34E-03**	**1.48E-03**	**6.28E-04**	**2.98E-04**	**1.68E-03**
Child	**2.04E-06**	**2.31E-02**	**2.56E-03**	**1.29E-03**	**2.96E-03**	**6.66E-04**	**3.44E-04**	**8.77E-04**
Infant		**1.09E-04**	**1.46E-04**	**9.02E-05**	**2.75E-03**	**1.09E-04**	**8.36E-05**	**9.58E-05**