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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 35 Related to ESBWR Design Certification Application – Radioactive Waste Management/Radiation Protection – RAI Numbers 11.5-22, 12.2-9 and 12.2-10**

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 06-199, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 35 Related to ESBWR Design Certification Application,* June 22, 2006

Enclosure:

1. MFN 06-212 – Response to Portion of NRC Request for Additional Information Letter No. 35 Related to ESBWR Design Certification Application – Radioactive Waste Management/Radiation Protection – RAI Numbers 11.5-22, 12.2-9 and 12.2-10

cc:

WD Beckner	USNRC (w/o enclosures)
AE Cubbage	USNRC (with enclosures)
LA Dudes	USNRC (w/o enclosures)
GB Stramback	GE/San Jose (with enclosures)
eDRF	0000-0055-0837 and 0000-0055-6393

ENCLOSURE 1

MFN 06-212

Response to Portion of NRC Request for Additional Information Letter No. 35 Related to ESBWR Design Certification Application Radioactive Waste Management/Radiation Protection RAI Numbers 11.5-22, 12.2-9 and 12.2-10

NRC RAI 12.2-9

The estimates of annual airborne releases presented in DCD Tier 2, Table 12.2-16 could not be duplicated using the information presented in Tables 12.2-15, 11.1-1, 11.3-1, 10.4-2, and 9.4-1, using the BWR-GALE Code (NUREG-0016). Please address the following in Table 12.2-15:

a. *Provide the basis for the offgas system flow rate or refer to the appropriate DCD section that presents this information. Reconcile different flow rates for this system, 54 vs 51 m^3/hr - see Table 11.3-1.*
b. *Update table to include parameters corresponding to input data cards no. 20 to 28 and 32 to the BWR-GALE code.*
c. *Regarding input cards no. 23 to 24, confirm that the use of charcoal and HEPA filters are consistent with HVAC system descriptions of Section 9.4 and Table 9.4-1.*
d. *Regarding input card no. 32, update entries on mass of charcoals to indicate whether the total amounts are for each operating train and state if only one or both trains will be used in parallel during routine operations.*
e. *Regarding input cards no. 20 to 21 and 25, confirm whether the steam used for the gland seal system is clean steam or main turbine steam. Section 10.3.1 states that main turbine steam is used, but Section 10.4.3 states that clean steam is used. Update table to include the gland seal holdup time and iodine partition factor.*
f. *Reconcile the basis for noble gas release rate, 740 MBq/sec in Table 12.2-15 vs 3700 MBq/sec in Table 11.3.-1 as the average annual or normal operational release rates. Check for consistency with Table 11.1-1.*

In Table 10.4-2:

g. *Update table to include the air ejector holdup time and iodine partitioning factor.*

In Table 11.3-1:

h. *Provide the basis of the major offgas maximum permissible concentration and its applicability to the analysis.*

Update Tables 12.2-15, 10.4-2 and 11.3-1 accordingly.

GE Response

(a) The offgas system flow rate of 51 m^3/hr (30 scfm) presented in Table 11.3-1 corresponds to the standard flow rate (at 70°F). Table 11.3-1 also provides a gaseous waste stream temperature of 95°F. The adjusted flow rate of 54 m^3/hr in Table 12.2-15 corresponds to the higher offgas stream temperature (100°F) assumed for the annual airborne release

analysis. For clarification, Table 11.3-1 will be revised to add "standard" to the offgas system flow rate. Table 12.2-15 is also revised to add the assumed offgas stream temperature to differentiate from the standard flow rate provided in Table 11.3-1.

(b) The actual BWR-GALE code (NUREG-0016) was not used in the annual airborne release analysis, however, the methodology of the code was used. The proposed changes to Table 12.2-15 reflects the updated parameters based on the responses to parts (a), and (c) through (h) of this RAI.

Table 12.2-15

Airborne Sources Calculation

Calculation Bases	
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 χ/Q	2.0E-06 s/m^3
Meteorology D/Q	4.0E-09 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 cm^3/g
K_d (Xe)	330 cm^3/g
K_d (Ar)	6 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 in coolant

(c) Regarding input cards 23 (containment building releases) and 24 (turbine building releases), it is confirmed that use of charcoal and HEPA filters is consistent with HVAC system descriptions of Section 9.4 and the associated tables. No credit is taken for

filtration of any radionuclides from containment and the turbine building, as well as the auxiliary (card 27) and radwaste (card 28) buildings. Table 12.2-15 will not be modified to reflect this fact.

(d) Regarding input card 32, Table 12.2-15 provides the correct masses for the charcoal used in the annual airborne release analysis. Each guard tank contains 7,500 kg charcoal, and each adsorber tank contains 27,750 kg charcoal. During normal operations, offgas flow is through one guard tank and all eight adsorber tanks (2 trains of 4 tanks in parallel), which is consistent with DCD Figure 11.3-1. Table 12.2-15 will be revised in the next DCD revision to reflect that the masses provided are for each tank.

(e) Regarding input cards 20, 21, and 25, it was conservatively assumed in the annual airborne release analysis that the steam used for the gland seal system is main turbine steam. The actual source of steam for the gland seal system in DCD Tier 2, Chapter 10 is currently under review and possible revision; however, for the purposes of the annual airborne release, main turbine steam is conservatively used.

No gland seal steam flow (input card 20), hold up time (input card 21), or iodine partition factors (input card 25) were used in the annual airborne release analysis. Instead, the DCD Table 12.2-16 turbine gland seal annual airborne release values were generated by applying the annual radioiodine releases from the gland seal condenser exhaust (0.81 Ci/yr per μCi/g of I-131 in the reactor coolant, and 0.22 Ci/yr per μCi/g of I-133 in the reactor coolant, per Section 2.2.6.1 of NUREG-0016) to the normal iodine coolant concentrations for those two isotopes. DCD Table 12.2-15 will be revised in the next DCD revision to reflect the fact that the NUREG-0016 Section 2.2.6.1 parameters were used.

(f) The noble gas release rate of 740 MBq/sec in Table 12.2-15 is correct, and is the value that was used in the annual airborne release analysis. This is consistent with the normal operation noble gas release rate provided in Table 11.1-1. The design parameter provided for the release rate in Table 11.3-1 ("Design Basis annual average noble radiogas release rate") is contradictory. The words "annual average" will be deleted in the next revision of the DCD. The proposed revised table is provided below.

Table 11.3-1

Offgas System Design Parameters*

Design Parameter	Design Value
Design ~~B~~basis ~~annual average~~ noble radiogas release rate	3700 MBq/s (100,000 μCi/s)
Assumed air in-leakage	51 m^3/h standard (30 scfm)
Xenon delay	60- day
Maximum gaseous waste stream temperature	67 °C (153 °F)
Charcoal temperature (approximate)	35 °C (95 °F)
Maximum cooler condenser temperature	18 °C (65 °F)
Chilled water temperature	7°C (45°F)
Gaseous waste stream temperature	35 °C (95 °F)
Nominal recombiner preheater temperature	177 °C (351 °F)
Maximum recombiner preheater temperature	210 °C (410 °F)
Out-of-service hydrogen/oxygen catalytic recombiner minimum temperature	121 °C (250°F)
Minimum activated charcoal ignition temperature	156 °C (313 °F)
Minimum air bleed supply rate	0.17 m^3/min (6 scfm)
Air bleed to standby recombiner train at startup and normal operation	0.17 m^3/min (6 scfm)
Radiolytic gas flow range	0 to 8.6 m^3/min (302 scfm)
Charcoal adsorber vault temperature range	29 °C (84 °F) to 40 °C (104 °F)
Charcoal particle size	8 – 16 mesh (USS) with less than 0.5% under 20 mesh
Charcoal moisture content	< 5% by weight
~~Major~~ Maximum offgas activity ~~maximum permissible~~ input concentration ~~(MPC)~~	5.9E+6 Bq/cm^3

* For additional information on radioactive releases, refer to Subsection 11.1 or 12.2.

(g) No steam jet air ejector holdup time (input card 22) was assumed in the annual airborne release analysis. As for the iodine partitioning factor (input card 26), its value is irrelevant, as the offgas from the air ejector enters the offgas system, where the charcoal guard tank and adsorber tanks retain the iodine. As a result, no iodine is released to the environment via the offgas system. This is reflected in DCD Table 12.2-16, where there are no offgas system release values provided for iodine. No changes will be made to either DCD Table 12.2-15 or Table 10.4-2.

(h) The major offgas activity maximum permissible concentration (MPC) in DCD Table 11.3-1 is simply the maximum design capacity source term (450,000 μCi/sec, based on 100 μCi/sec/MWt for 4500 MWt per Branch Technical Position ETSB 11-5 of Standard Review Plan 11.3) divided by the minimum flow of the offgas system (0.17 m^3/min, taken from DCD Table 11.3-1). This value is provided in Table 11.3-1 for information only and is not applicable to the annual airborne release analysis. For better clarification, the term is to be changed to "Maximum offgas activity input concentration." The change is reflected in the revised Table 11.3-1 above.

NRC RAI 12.2-10

The annual radionuclide source term estimates presented in DCD Tier 2, Table 12.2-19b could not be duplicated using the information presented in Tables 12.2-19a, 12.2-20a, 11.2-3, 11.2-4, 11.1-3, and 9.3-2, using the BWR-GALE Code (NUREG-0016). Please address the following and update Tables 12.2-19a, 12.2-19b, 12.2-20a and Section 12.2.4 accordingly:

In Table 12.2-19a:

a. The values for the total steam flow rate and mass of water in reactor vessel are inconsistent with that of Table 11.1-3, once unit conversions are made.
b. Confirm the value given for the fraction of reactor coolant activity in low purity waste stream (0.11 vs 0.101).
c. This table includes a waste stream (regenerant waste) that is not listed in Section 11.2.2 and Tables 11.2-3 and 9.3-2.
d. The entry for detergent waste is not supported with the corresponding set of parameters and data.
e. Update the table to include parameters corresponding to input data cards no. 20 to 28 to the BWR-GALE code.

In Table 12.2-19b:

f. Explain differences in the listing of radionuclides, deletion of 14 nuclides and additions of 6 nuclides, as compared to its prior version.

In Table 12.2-20a:

g. Reconcile inconsistency between a liquid effluent discharge rate of 20,000 L/min from the liquid waste management system (LWMS) against the value of 83,000 L/day as an estimate of the input to the LWMS – see Table 11.2-4.

In Section 12.4:

h. Update list of references to include all those cited in the text.

GE Response:

(a) It has been discovered that the DCD Table 11.1-3 values for ESBWR reactor water mass, cleanup system flow rate, and steam flow rate were given in units of lb or lb/hr, instead of the correct units of kg or kg/hr. The corrected values are provided in the table below, which will be incorporated into the next DCD revision:

Table 11.1-3

Calculational Parameters For Source Term Adjustment

A. Plant Parameters for Source Term Adjustment		
Parameter	**Reference Plant**	**ESBWR**
Thermal Power, MWt	3400	4500
Reactor Water Mass, kg	1.7E+5	~~6.7~~43.06E+5
Cleanup System Flow Rate, kg/hr	5.8E+4	~~1.9~~38.76E+~~5~~4
Steam Flow Rate, kg/hr	6.8E+6	~~1.9~~38.76E+~~7~~6
Ratio of Condensate Demineralizer Flow Rate to Steam Flow Rate.	1	1

B. Removal Parameters for Source Term Adjustment			
Parameter	**Iodines**	**Rb, Cs**	**All Others**
Fraction removed by cleanup system	0.9	0.5	0.9
Fraction removed by condensate demineralizers	0.9	0.5	0.9
Ratio of concentration in steam and reactor water	0.02	0.001	0.001
Fraction of radionuclides in steam treated by condensate demineralizer.	1	1	1

In addition, the following changes are to be made to Table 12.2-19a:

Table 12.2-19a

Average Annual Liquid Release Calculation Parameters

Thermal power level	4500 MWth
Total steam flow	1.~~927E~~93E+07 lb/hr
Mass of water in reactor vessel	~~1.486~~6.74E+~~07~~05 lb
Clean-up demineralizer flow	~~4.25~~1.93E+05 lb/hr
Condensate demineralizer regenerative time	0 days
Condensate demineralizer flow fraction	1
High Purity Waste:	
High purity flow rate	1.0E+04 gal/day
Fraction of reactor coolant activity	0.11
Decontamination factor for iodine	1000
Decontamination factor for Cs and Rb	100
Decontamination factor for others	1000
Collection time	1.7 days
Process and discharge time	1.8 days
Fraction discharged	0.01
Low Purity Waste:	
Low purity flow rate	2.9E+03 gal/day
Fraction of reactor coolant activity	0.~~101~~115
Decontamination factor for iodine	10,000
Decontamination factor for Cs and Rb	200
Decontamination factor for others	10,000
Collection time	9.5 days
Process and discharge time	0.2 days
Fraction discharged	0.1
Chemical Waste:	
Chemical waste flow rate	7.9E+02 gal/day
Fraction of reactor coolant activity	0.11
Decontamination factor for iodine	10,000
Decontamination factor for Cs and Rb	200
Decontamination factor for others	10,000

Table 12.2-19a

Average Annual Liquid Release Calculation Parameters

Collection time	0.5 days
Process and discharge time	0.2 days
Fraction discharged	0.1
~~Regenerant~~ Detergent Waste:	
~~Regenerant~~ Detergent waste flow rate	1.1E+03 gal/day
Decontamination factor for iodine	1
Decontamination factor for Cs and Rb	1
Decontamination factor for others	1
Collection time	3.~~8~~0 days
Process and discharge time	0.~~08~~29 days
Fraction discharged	0.~~017~~165
Detergent waste decontamination factor	0

(b) The low purity waste stream fraction of reactor coolant activity is 0.115. Table 12.2-19a is to be updated in the next DCD revision.

(c) Regenerant waste should be renamed detergent waste. Table 12.2-19a is to be updated in the next DCD revision.

(d) As discussed in (c), regenerant waste should be renamed detergent waste. Table 12.2-19a is to be updated in the next DCD revision.

(e) BWR-GALE input data cards 20 to 28 are not representative of the treatment of liquid discharges and do not have any influence on the results obtained. The aforementioned input data cards are related to gaseous effluents, not liquid effluents, and are discussed in the response to RAI 12.2-9.

(f) The differences in the listing of radionuclides results from the work performed to respond to RAI 12.2.2.3-4. Table 12.2-19b was revised to be consistent with the radionuclides in Table 12.2-17. Table 12.2-19b reflects all the radionuclides obtained from the BWR-GALE output. The output is performed automatically without prior selection by the user and includes all the isotopes in its library, although the value is not printed when it is not radiologically significant.

(g) Table 11.2-4 is related to the generation rate of liquid radioactive wastes. The liquid effluent discharge rate of 20,000 liters/min in Table 12.2-20a is the flow of the discharge canal, i.e. the dilution flow for the liquid radioactive wastes. The term "Liquid Effluent

Discharge Rate" in Table 12.2-20a will be changed to "Discharge Canal Flow Rate". The proposed revised table is provided below.

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
~~Liquid Effluent~~ Discharge Canal Flow Rate	2.0E+04 liters/min
Shore-Width Factor	0.2
Dilution Factor	10
Liquid Pathway Offsite Annual Doses	Table 12.2-20b

(h) The following references will be included in the next DCD revision:

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

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

12.2-6 NEDO-25257, "Radiation Exposure from Airborne Effluents – The REFAE Code," E. W. Bradley and D. Nguyen, July 1980.

12.2-7 USNRC Regulatory Guide 1.109, "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," Revision 1, October 1977.

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

NRC RAI 11.5-22

A review of DCD Tier 2, Section 1.9.2 (Applicability to Regulatory Criteria) revealed that it is inconsistent with Section 11.5.7.3 addressing the implementation of site-specific radiological effluent monitoring programs by COL applicant. Currently, Table 1.9-21 does not include Regulatory Guide 4.15 in its listing of applicable guides to the ESBWR. Since Section 11.5.7.3 endorses the applicability of Regulatory Guide 4.15, it follows that it should be listed in Table 1.9-21 (NRC Regulatory Guides Applicability to ESBWR). Clarify inconsistencies between DCD Sections 11.5 and 1.9.2, and update DCD Table 1.9-21 accordingly.*

** Regulatory Guide 4.15 – Quality Assurance for Radiological Monitoring Programs (Normal Operations) – Effluent Streams and the Environment, Rev. 1, 2/79*

GE Response

DCD Table 1.9-21 will be revised in the next update as noted in the attached markup.

Table 1.9-21

NRC Regulatory Guides Applicability to ESBWR

RG No.	Regulatory Guide Title	Appl. Rev.	Issued Date	ESBWR Appli-cable?	Comments
1.203	Transient and Accident Analysis Methods	0	12/2005		
1.204	Guidelines for Lightning Protection of Nuclear Power Plants	0	11/2005		
1.205	Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants	0	05/2006	No	
4.15	Quality Assurance for Radiological Monitoring Programs (Normal Operations) – Effluent Streams and the Environment	1	02/1979	Yes	
5.1	Serial Numbering of Fuel Assemblies for Light-Water-Cooled Nuclear Power Reactors	0	12/1972	No	Withdrawn 01/15/1998
5.7	Entry/Exit Control for Protected Areas, Vital Areas, and Material Access Areas	1	05/1980	Yes	
5.12	General Use of Locks in the Protection and Control of Facilities and Special Nuclear Materials	0	11/1973	Yes	
5.44	Perimeter Intrusion Alarm Systems	3	10/1997	Yes	
5.61	Intent and Scope of the Physical Protection Upgrade Rule Requirements for Fixed Sites	0	06/1980	Yes	Safeguards information provided
5.65	Vital Area Access Controls, Protection of Physical Security Equipment, and Key and Lock Controls	0	09/1986	Yes	
5.66	Access Authorization Program for Nuclear Power Plants	0	06/1991	Yes	Shared with COL
8.2	Guide for Administrative Practices in Radiation Monitoring	0	02/1973	—	COL
8.5	Criticality and Other Interior Evacuation Signals	1	03/1981	Yes	