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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 71 – Radiation Protection – RAI Number 12.2-9S01**

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

If you have any questions or require additional information regarding the information provided here, please contact me.

Sincerely,

Kathy Sedney for

James C. Kinsey
Project Manager, ESBWR Licensing

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NRO

Reference:

1. MFN 06-383, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 71 Related to the ESBWR Design Certification Application*, October 4, 2006

Enclosures:

1. MFN 06-212, Supplement 2– Response to Portion of NRC Request for Additional Information Letter No. 71 – Radiation Protection – RAI Number 12.2-9S01

cc:	AE Cubbage	USNRC (with enclosures)
	GB Stramback	GE/San Jose (with enclosures)
	RE Brown	GE/Wilmington (with enclosures)
	eDRF	0067-6853

Enclosure 1

MFN 06-212, Supplement 2

Response to Portion of NRC Request for Additional Information Letter No. 71 Related to ESBWR Design Certification Application

Radiation Protection

RAI Number 12.2-9S01

NRC RAI No. 12.2-9 S01:

The estimates of total annual airborne effluent releases presented in DCD Tier 2, Revision 1, Table 12.2-16 could not be duplicated using the information contained GE responses to RAI No. 12.2-9 (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). 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 following below provides an explanation for the values in DCD Tier 2, Revision 3, Table 12.2-16.

Reactor Building Releases

The noble gas and particulate values are calculated by taking the sum of the Containment Building and Auxiliary Building values from NUREG-0016 Table 2-12 and multiplying them by the appropriate adjustment factors. The adjustment factors for noble gas and particulates are calculated by the formulas:

$$\begin{aligned} Noble\ Gases &= \frac{Power}{3400} \times \frac{Availability}{0.80} \times \frac{Env\,Rel}{50000} = 0.621 \\ Particulates &= \frac{Power}{3400} \times \frac{Availability}{0.80} \times \frac{Env\,Rel}{0.0037} = 0.659 \end{aligned} \quad (1)$$

The adjustment factors are based upon the ratio of 4590 MWth plant power for the ESBWR to 3400 MWth for the NUREG-0016 standard plant; availability (0.92 for ESBWR); ratio of gases released, 20,000 μCi/s for ESBWR compared to 50,000 μCi/s for the NUREG-0016 standard plant; and I-131 reactor water concentrations of 0.00157 μCi/g for ESBWR compared to 0.0037 μCi/g for the NUREG-0016 standard plant.

The release values for the iodines are calculated by starting with the normal operation iodine water source term in DCD Tier 2, Table 11.1-4b. Table 1-2 of NUREG-0016 provides the annual normalized iodine release rate for the Containment Building and Auxiliary Building for both power operation and for outages. Since the ESBWR does not have an Auxiliary Building, this value is added to the Containment Building value to determine the Reactor Building

releases. The normal operation releases in Table 1-2 of NUREG-0016 are based on the NUREG-0016 availability of 80%. These releases are adjusted to the ESBWR availability of 92%, and then multiplied by the DCD Tier 2, Table 11.1-4b iodine water source term values. Similarly, the outage releases in Table 1-2 of NUREG-0016 are adjusted by the ESBWR outage fraction (8%) and multiplied by the DCD iodine source term values.

Tritium is calculated in accordance with Paragraph 2.2.15.1 of NUREG-0016.

Turbine Building Releases

These values for the noble gases and particulates are calculated by taking the Turbine Building values from NUREG-0016 Table 2-12 and multiplying them by the adjustment factors described in Equation (1) above.

The methodology for determining the iodine releases is the same as described above for the Reactor Building, with two exceptions:

- The Turbine Building values from Table 1-2 of NUREG-0016 were used for normalized releases
- The iodine moisture carryover fraction (2%) was applied to the total, in accordance with Section 2.2.4.2 of NUREG-0016

Tritium is calculated in accordance with Paragraph 2.2.15.1 of NUREG-0016.

Radwaste Building Releases

The noble gas and particulate release values are calculated by taking the Radwaste Building values from NUREG-0016 Table 2-12 and multiplying them by the adjustment factors described in Equation (1) above.

The methodology for determining the iodine releases is the same as described above for the Reactor Building, with the only difference being that the Radwaste Building values from Table 1-2 of NUREG-0016 were used for normalized releases.

Mechanical Vacuum Pump

The Xe-133 and Xe-135 values are calculated by taking the values from NUREG-0016 Section 2.2.7.1 and multiplying by the ratio of the ESBWR noble gas release (20,000 μCi/s) by the NUREG-0016 noble gas release (50,000 μCi/s). The I-131 value is calculated by taking the value from NUREG-0016 Section 2.2.7.1, and multiplying it by the iodine carryover (2.0%) and by the I-131 normal operation water concentration from DCD Tier 2, Table 11.1-4b.

Turbine Seal

As discussed in the previous response to RAI 12.2-9 (MFN 06-212), the DCD Tier 2, Table 12.2-16 turbine gland seal annual airborne release values are 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 Tier 2, Table 11.1-4b).

Offgas System

The holdup times for the offgas system are based on the parameters specified in DCD Tier 2, Table 12.2-15. The normal operation source term for the noble gases entering the offgas system are provided in DCD Tier 2, Table 11.1-2b. The design basis source term for Ar-41 is provided in Section 2.2.23 of NUREG-0016. The normal operation source term for Ar-41 is calculated by multiplying the design basis value by the ratio of the noble gas normal operation source term to the design basis source term (20,000 divided by 100,000, per DCD Table 11.1-1). The offgas system release values in DCD Tier 2, Table 12.2-16 are determined by applying the offgas bed calculated holdup times to the normal operation source terms.

For C-14, guidance is provided for releases from the offgas system in Section 2.2.22.2 of NUREG-0016. Two values in the equation provided in Section 2.2.22.2 of NUREG-0016 are modified to apply to ESBWR:

m (mass of water in the core) = 34,200 kg
p (plant capacity factor) = 0.92

Drywell Releases

The drywell releases are based upon the standard NUREG-0016 assumptions of 2.5 gpm steam and water leaks, and 24 purges per year, with 365 hours between each purge.

The iodine and other equivalent water release is:

$$\mathrm{Re}l = (L_S C + L_W FF) * 63.09 \qquad (2)$$

Where:

Re*l* is the equivalent water release (grams/sec),
L_S and L_W are the leakage rate for steam and water respectively (2.5 gpm each),
C is the steam carryover fraction (2% for iodines, 0.1% for other nuclides),
FF is the flash fraction for water (0.4), and
63.09 is equal to 3785.412 grams/gallon divided by 60 seconds per minute.

The resulting value for iodines is 66.24 grams/sec and for other nuclides is 63.25 grams/sec.

For tritium the steam carry over is set to 1.0.

For noble gases, the release is:

Noble Gas Environmental Release (20,000 μCi/s) * 63.09 * L_W (2.5 gpm) divided by the steam flow rate of 9650 tons/hr (10^3 kg/hr). The resulting equivalent release is 1.18 μCi/sec.

In order to determine the noble gas values for DCD Tier 2, Table 12.2-16, the following equation is used:

$$R_i = N_p R_T \frac{A_i}{A_T} \frac{(1-e^{-\lambda_i t})}{\lambda_i} \tag{3}$$

Where:

R_i = annual release rate for isotope i, in Ci/yr,
N_p = number of purges per year (24 as described above),
R_T = noble gas release rate (1.18 μCi/sec),
A_i / A_T = ratio of design basis steam activity of isotope i to total design basis noble gas steam activity,
λ_i = decay constant,
t = number of seconds in year divided by N_p.

The equation for iodines is similar:

$$R_i = N_p \cdot \mathrm{Rel}I \cdot EnvI_i \cdot (1-0.9) \cdot \frac{(1-e^{-\lambda_i t})}{\lambda_i} \tag{4}$$

Where:

$RelI$ = iodine water release rate (66.24 grams/sec) described in Equation (2),
$EnvI_i$ = the environmental iodine water concentration for isotope i (μCi/gram),
0.9 = condensation removal factor of 90%.

The equation for other nuclides is:

$$R_i = N_p \cdot \mathrm{Rel}O \cdot EnvO_i \cdot (1-0.9) \cdot \frac{(1-e^{-\lambda_i t})}{\lambda_i} \tag{5}$$

Where:

$RelO$ = other nuclide water release rate (63.25 grams/sec) described in Equation (2),
$EnvO_i$ = the environmental other nuclide water concentration for isotope i (μCi/gram).

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