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Subject: **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**

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 06-302, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 54 Related to ESBWR Design Certification Application,* August 23, 2006

Enclosure:

1. 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

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)
eDRFs	0000-0057-4244, 0000-0057-2773

ENCLOSURE 1

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

NRC RAI 11.2-9

DCD Tier 2, Section 11.2.1 states that the system is designed to meet the guidance of RG1.143. However, there is no statement of the construction method for the piping other than in Table 11.2-1 which states ANSI B31.3. RG 1.143 states that the piping will be welded. ANSI/ASME B31.3 covers many fabrication methods in addition to welding (brazing/soldering, threaded joints, caulked, packed, straight thread, etc.). Please revise to reflect RG 1.143 guidance.

GE Response:

DCD Tier 2 Chapter 11 Section 11.2 will be revised as shown in the attached markup to indicate the LWMS complies with Regulatory Guide 1.143 guidance regarding liquid radwaste treatment systems.

NRC RAI 11.2-10

DCD Tier 2, Section 11.2.1 states that the system is designed to meet the guidance of RG 1.143. However, there is no statement of the material specification conformance to RG 1.143 paragraph 1.1.2. Explain how conformance to RG 1.143 will be assured.

GE Response:

DCD Tier 2 Chapter 11 Section 11.2 will be revised as shown in the attached markup to indicate the LWMS complies with Regulatory Guide 1.143 guidance regarding liquid radwaste treatment systems.

NRC RAI 11.4-12

DCD Tier 2, Section 11.4.2.3, "Detailed System Component Description," "Pumps" section, describes the types of pumps used but not the applicable Design & Construction Codes. Please revise DCD to address conformance to RG 1.143.

GE Response:

DCD Tier 2 Chapter 11 Section 11.4.2.3 Pumps will be revised as shown in the attached markup to reference the applicable codes per Regulatory Guide 1.143.

NRC RAI 11.4-13

DCD Tier 2, Section 11.4.2.3, "Detailed System Component Description," "Tanks" section, lists several codes but does not link these codes to the tanks' type of service. Please revise DCD to address conformance to RG 1.143.

GE Response:

DCD Tier 2 Chapter 11 Section 11.4.2.3 Tanks will be revised as shown in the attached markup to reference the noted requirements of Table 3.2-1. Table 3.2-1 refers the reader to Table 11.2-1 in LWMS to link codes to the tanks' type of service per Regulatory Guide 1.143.

NRC RAI 11.4-14

DCD Tier 2, Section 11.4.2.3, "Detailed System Component Description," "Piping" section, refers to design velocities but is silent on construction or fabrication codes. Please revise DCD to address conformance to RG 1.143.

GE Response:

DCD Tier 2 Chapter 11 Section 11.4.2.3 Piping will be revised as shown in the attached markup to reference the applicable codes per Regulatory Guide 1.143.

NRC RAI 12.2-11

The estimated annual beta air dose and annual gamma air dose due to airborne releases presented in DCD Tier 2, Table 12.2-18b could not be duplicated using the information presented in DCD Tier 2, Tables 12.2-15, 12.2-17, and 12.2-18a and the GASPAR II Code (NUREG/CR-4653).

Please address the following and update Table 12.2-18b accordingly:

a. Review and update the listed beta and gamma air doses, or describe and provide any modifiers applied in adjusting code results and update Table 12.2-18a.

b. Confirm the radiological unit used to report the beta and gamma air doses, either as mrad/year or mGy/year given that the rest of the data presented in the table are expressed in SI units.

GE Response:

a. Beta and gamma air doses are as follows:

- Beta air dose: 1.32E-02 mGy/year
- Gamma air dose: 1.16E-02 mGy/year

DCD Table 12.2-18b will be revised in the next update as noted in the attached markup.

b. The radiological unit used to report the beta and gamma air doses is an SI unit (mGy/year).

Table 12.2-18b

ESBWR Annual Average Doses from Airborne Releases

	Annual Dose (mSv/year)							
PATHWAY	**T. BODY**	**GI-TRACT**	**BONE**	**LIVER**	**KIDNEY**	**THYROID**	**LUNG**	**SKIN**
PLUME	7.73E-03	7.73E-03	7.73E-03	7.73E-03	7.73E-03	7.73E-03	7.86E-03	2.08E-02
GROUND	5.00E-04	5.00E-04	5.00E-04	5.00E-04	5.00E-04	5.00E-04	5.00E-04	5.87E-04
VEGET								
ADULT	1.29E-03	1.25E-03	5.56E-03	1.37E-03	1.32E-03	2.75E-02	1.14E-03	1.12E-03
TEEN	2.00E-03	1.96E-03	9.12E-03	2.19E-03	2.11E-03	3.60E-02	1.84E-03	1.81E-03
CHILD	4.55E-03	4.43E-03	2.21E-02	4.96E-03	4.80E-03	6.89E-02	4.38E-03	4.33E-03
MEAT								
ADULT	4.29E-04	4.71E-04	2.05E-03	4.35E-04	4.27E-04	8.96E-04	4.17E-04	4.16E-04
TEEN	3.56E-04	3.80E-04	1.73E-03	3.65E-04	3.58E-04	6.97E-04	3.51E-04	3.49E-04
CHILD	6.61E-04	6.70E-04	3.25E-03	6.72E-04	6.63E-04	1.18E-03	6.54E-04	6.53E-04
MILK								
ADULT	5.67E-04	4.99E-04	2.32E-03	6.24E-04	5.85E-04	1.40E-02	4.76E-04	4.66E-04
TEEN	9.70E-04	8.89E-04	4.27E-03	1.12E-03	1.06E-03	2.23E-02	8.67E-04	8.47E-04
CHILD	2.21E-03	2.09E-03	1.05E-02	2.52E-03	2.41E-03	4.46E-02	2.09E-03	2.06E-03
INFANT	4.51E-03	4.38E-03	2.04E-02	5.22E-03	4.85E-03	1.08E-01	4.34E-03	4.28E-03
INHALE								
ADULT	5.32E-05	6.40E-05	2.43E-05	7.62E-05	9.64E-05	5.56E-03	1.06E-04	3.45E-05
TEEN	5.74E-05	6.88E-05	3.39E-05	9.17E-05	1.19E-04	7.14E-03	1.44E-04	3.48E-05
CHILD	5.43E-05	5.24E-05	4.56E-05	8.52E-05	1.09E-04	8.57E-03	1.21E-04	3.08E-05
INFANT	3.37E-05	2.87E-05	3.45E-05	6.58E-05	6.81E-05	7.82E-03	8.68E-05	1.77E-05
TOTAL	Annual Dose (mSv/year)							
ADULT	1.06E-02	1.05E-02	1.82E-02	1.07E-02	1.07E-02	5.62E-02	1.05E-02	2.34E-02
TEEN	1.16E-02	1.15E-02	2.34E-02	1.20E-02	1.19E-02	7.44E-02	1.16E-02	2.44E-02
CHILD	1.57E-02	1.55E-02	4.41E-02	1.65E-02	1.62E-02	1.31E-01	1.56E-02	2.85E-02
INFANT	1.28E-02	1.26E-02	2.87E-02	1.35E-02	1.31E-02	1.24E-01	1.28E-02	2.57E-02

Annual beta air dose = ~~2.63E-01 millirads~~1.32E-02 mGy
Annual gamma air dose = ~~2.32E-01 millirads~~1.16E-02 mGy

NRC RAI 12.2-12

The estimated annual average doses from airborne effluents listed in DCD Tier 2, Table 12.2-18b for the milk pathway do not specify whether the results are for cow milk or goat milk consumption. Insert a qualifier to DCD Tier 2, Table 12.2-18a or 12.2-18b stating the basis for the milk exposure pathway. Update either table accordingly.

GE Response:

Only cow milk has been considered for the milk pathway in the dose analysis.

DCD Table 12.2-18a will be revised in the next update as noted in the attached markup.

Table 12.2-18a

Airborne Offsite Dose Calculation Bases

Meteorology χ/Q	Table 12.2-15
Meteorology D/Q	Table 12.2-15
Meteorology Boundary	Table 12.2-15
Airborne Release Source Term	Table 12.2-16
Calculation Methodology	Regulatory Guide 1.109
Computer Code Utilized	GASPAR II (NUREG/CR-4653)
Individual Consumption Rates	Table E-5 of Reg. Guide 1.109
Misc. Calculation Inputs (other than Reg. Guide 1.109 default values):	
Midpoint of plant operating life	30 years
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
Annual Average Doses from Airborne Releases	Table 12.2-18b

NRC RAI 12.2-13

The estimated annual doses to the thyroid associated with the drinking pathway presented in DCD Tier 2, Table 12.2-20b could not be duplicated using the information presented in DCD Tier 2, Tables 12.2-19b and 12.2-20a and LADTAP II Code (NUREG/CR-4013). Review and update Table 12.2-20a to include any other assumptions used in the analysis but not listed in this table.

GE Response:

Liquid dose parameters used in LADTAPII are those included in Regulatory Guide 1.109 for maximum exposure and included as default values in LADTAPII. The following parameters have also been considered:

- 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

Similarly to airborne dose analysis, the following parameters, which are not set out in Regulatory Guide 1.109 and are site-specific, have been used:

- Fraction of the year that leafy vegetables are grown: 0.75
- Fraction of the year that milk cows are on pasture: 0.5
- Fraction of milk-cow feed intake that is from pasture while on pasture: 0.75
- Fraction of the year that beef cattle are on pasture: 0.5
- Fraction of beef cattle feed intake that is from pasture while the cattle are on pasture: 0.75

DCD Table 12.2-20a will be revised in the next update as noted in the attached markup. Please note that the change regarding the "Discharge Canal Flow Rate" reflects the response to RAI 12.2-10.

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
Transit times from discharge to the receiving water body to exposure location	- for all pathway except drinking water: instantaneous - for drinking water: 12 hr - for irrigated foods: instantaneous
Irrigation Rate	0.001 $m^3/m^2/d$
~~Liquid Pathway Offsite Annual Doses~~	~~Table 12.2-20b~~
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
Fraction of year that leafy vegetables are grown	0.75
Animal milk considered for milk pathway	Cow
Liquid Pathway Offsite Annual Doses	Table 12.2-20b

NRC RAI 12.2-14

The exposure pathway associated with the consumption of irrigated foods is not included in DCD Tier 2, Table 12.2-20b. The omitted pathways are the consumption of vegetables, leafy vegetables, meat, and milk for the maximum exposed individual. Expand the analysis to include doses associated with the consumption of irrigated foods and update Table 12.2-20b in presenting all associated results. Update DCD Tier 2, Table 12.2-20a in describing all related model parameters and their assumed values used in the revised analysis.

GE Response:

In the liquid dose analysis, contribution from irrigated foods is usually negligible and has not been considered in the same way as in other safety analyses (ABWR).

Default values from Regulatory Guide 1.109 were used in LADTAPII, except for the irrigation rate. This parameter is site dependent, and could be "0"; i.e. North Anna ESP 5.4.1.1 does not consider the irrigation pathway because the use of water from Lake Anna for this purpose is negligible.

Revised calculations have been performed using the irrigation rate of 0.001 $m^3/(m^2 \cdot day)$ per the German code BMI 3.37 "General principle of calculation for radiation exposure resulting from radioactive effluents in exhaust air and in surface water". This value is considered conservative, in view of the large site-dependent differences between Germany and US in terms of population density, agricultural distribution, river-water uses, etc.

DCD Table 12.2-20b will be revised in the next update as noted in the attached markup.

Table 12.2-20b

Liquid Pathway Dose Results in mSv/year

	Doses (mSv/year)							
PATHWAY	**Skin**	**Bone**	**Liver**	**Total Body**	**Thyroid**	**Kidney**	**Lung**	**GI-LLI**
Drinking								
Adult		6.48E-05	9.24E-05	7.31E-05	1.13E-03	5.82E-05	3.57E-05	6.29E-05
Teenager		6.15E-05	8.05E-05	4.52E-05	9.74E-04	4.81E-05	2.77E-05	4.58E-05
Child		1.75E-04	1.63E-04	6.82E-05	2.41E-03	9.43E-05	5.27E-05	6.51E-05
Infant		1.87E-04	1.95E-04	6.11E-05	3.77E-03	9.68E-05	5.39E-05	5.65E-05
Fish								
Adult		2.15E-02	4.50E-03	3.08E-03	4.75E-04	1.14E-03	3.59E-04	2.36E-03
Teenager		2.33E-02	4.71E-03	2.17E-03	4.50E-04	1.17E-03	4.28E-04	1.91E-03
Child		3.00E-02	4.27E-03	1.61E-03	4.83E-04	9.93E-04	3.40E-04	8.07E-04
Infant		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Shoreline								
Adult	3.63E-06	3.11E-06	3.11E-06	3.11E-06	3.11E-06	3.11E-06	3.11E-06	3.11E-06
Teenager	2.03E-05	1.74E-05	1.74E-05	1.74E-05	1.74E-05	1.74E-05	1.74E-05	1.74E-05
Child	4.24E-06	3.63E-06	3.63E-06	3.63E-06	3.63E-06	3.63E-06	3.63E-06	3.63E-06
Infant	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Irrigated Foods:								
Vegetables								
Adult		1.00E-04	1.24E-04	9.41E-05	2.09E-04	5.66E-05	3.22E-05	3.74E-05
Teenager		1.63E-04	1.95E-04	9.31E-05	3.05E-04	8.39E-05	4.71E-05	4.49E-05
Child		3.80E-04	3.27E-04	9.65E-05	5.93E-04	1.36E-04	7.34E-05	5.42E-05
Infant								
Leafy Vegetables								
Adult		1.31E-05	1.56E-05	1.18E-05	7.66E-05	7.40E-06	3.98E-06	5.53E-06
Teenager		1.16E-05	1.33E-05	6.39E-06	6.14E-05	5.99E-06	3.16E-06	3.65E-06
Child		2.03E-05	1.68E-05	5.06E-06	9.11E-05	7.27E-06	3.69E-06	3.12E-06
Infant								
Milk								
Adult		3.27E-05	4.72E-05	3.45E-05	1.77E-04	2.09E-05	9.83E-06	8.94E-06
Teenager		5.87E-05	8.00E-05	3.62E-05	2.79E-04	3.39E-05	1.59E-05	1.15E-05
Child		1.41E-04	1.34E-04	3.64E-05	5.54E-04	5.48E-05	2.47E-05	1.46E-05
Infant								
Meat								
Adult		5.33E-06	7.21E-06	5.48E-06	7.45E-06	4.00E-06	2.58E-06	4.76E-06
Teenager		4.39E-06	5.38E-06	2.87E-06	5.15E-06	2.80E-06	1.76E-06	2.77E-06
Child		8.09E-06	6.87E-06	2.77E-06	7.44E-06	3.46E-06	2.12E-06	2.28E-06
Infant								
TOTAL								
Adult	**3.63E-06**	**2.17E-02**	**4.79E-03**	**3.30E-03**	**2.08E-03**	**1.29E-03**	**4.46E-04**	**2.48E-03**
Teenager	**2.03E-05**	**2.36E-02**	**5.10E-03**	**2.37E-03**	**2.09E-03**	**1.36E-03**	**5.41E-04**	**2.04E-03**
Child	**4.24E-06**	**3.07E-02**	**4.92E-03**	**1.82E-03**	**4.14E-03**	**1.29E-03**	**5.00E-04**	**9.50E-04**
Infant	**0.00E+00**	**1.87E-04**	**1.95E-04**	**6.11E-05**	**3.77E-03**	**9.68E-05**	**5.39E-05**	**5.65E-05**

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.

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

11.2 LIQUID WASTE MANAGEMENT SYSTEM

The ESBWR Liquid Waste Management System (LWMS) is designed to control, collect, process, handle, store, and dispose of liquid radioactive waste generated as the result of normal operation, including anticipated operational occurrences.

The LWMS is housed in the radwaste building and consists of the following four subsystems:

- equipment (low conductivity) drain subsystem;
- floor (high conductivity) drain subsystem;
- chemical drain subsystem;
- detergent drain subsystem;

A LWMS Process Diagram depicting all four subsystems is provided in Figure 11.2-1. A conceptual radwaste building general arrangement is provided in Figures 1.2-21 thru 1.2-25. The LWMS equipment codes and component capacities are provided in Tables 11.2-1, 11.2-2a, 11.2-2b, and 11.2-2c, respectively. The normal and maximum daily inputs, and process decontamination factors for the LWMS subsystems are provided in Tables 11.2-3 and 11.2-4, respectively.

The equipment and floor drainage collection system, a major input source to the LWMS, is described in Subsection 9.3.3.

Process and effluent radiological monitoring and sampling systems are described in Section 11.5.

The LWMS complies with Regulatory Guide 1.143 guidance regarding liquid radwaste treatment systems.

11.2.1 Design Bases

Safety Design Bases

The LWMS has no safety-related function.

Power Generation Design Bases

- The LWMS has the capability to process the maximum anticipated quantities of liquid waste without impairing the operation or availability of the plant during both normal and expected occurrence conditions, satisfying the requirements of 10 CFR 20 and 10 CFR 50 (see Table 11.2-4 for time to process maximum inputs).
- Alternate process subsystem cross-ties and adequate storage volumes are included in the LWMS design to provide for operational and anticipated surge waste volumes.
- The LWMS is designed so that no potentially radioactive liquids can be discharged to the environment unless they have first been monitored and diluted as required. Off-site radiation exposures on an annual average basis are within the limits of 10 CFR 20 and 10 CFR 50.
- The LWMS is designed to meet the requirements of General Design Criterion (GDC) 60 and Regulatory Guide 1.143.

The estimated shipped waste volumes from processing dry active wastes are presented in Table 11.4-2.

Container Storage Subsystem

On-site storage space for 6-months volume of packaged waste is provided. Packaged waste includes HICs, shielded filter containers and 55-gallon (200-liter) drums as necessary. The container storage schemes and sequencing is shown in Figure 11.4-1

11.4.2.3 Detailed System Component Description

The major components of the SWMS are as follows:

Pumps

Two types of pumps are utilized in the SWMS.

The SWMS process pumps are centrifugal pumps constructed of materials suitable for the intended service.

Air-operated, double-diaphragm type pumps are utilized in dewatering stations.

Pump codes are per the noted requirements of Table 3.2-1 for K20 Solid Waste Management Systems.

Tanks

Tanks are sized to accommodate a sufficient volume of waste sludges or bead resin to fill a HIC. The SWMS tanks are sized for normal plant waste volumes with sufficient excess capacity to accommodate equipment downtime and expected maximum volumes that may occur. The tanks are constructed of stainless steel to provide a low corrosion rate during normal operation. They are provided with mixing eductors and/or air spargers. The capability exists to sample all SWMS tanks. All SWMS tanks are vented through a filtration unit and the exhausted air is eventually discharged into the plant vent. The SWMS tanks are designed in accordance with ASME Section III, Class 3; API 620; API 650 or AWWA D-100.

The vent and overflow nozzles of the spent resin tank are equipped with fine mesh screens to minimize spread of particulate contamination to the radwaste tank vent system.

Tank codes are per the noted requirements of Table 3.2-1 for K20 Solid Waste Management Systems.

Piping

Piping used for hydraulic transport of slurries such as ion exchange resins, filter backwash (sludge), and waste tank sludge are specifically designed to assure trouble-free operation. Pipe flow velocities are sufficient to maintain a flow regime appropriate to the slurry being transported (ion exchange resins, filter backwash, or tank sludge). An adequate water/solids ratio is maintained throughout the transfer. Slurry piping is provided with automatic flushing with a sufficient water volume to flush the pipe clean after each use, e.g., at least two pipe volumes.

Piping codes are per the noted requirements of Table 3.2-1 for K20 Solid Waste Management Systems.