GE Energy

David H. Hinds
Manager, ESBWR

PO Box 780 M/C L60
Wilmington, NC 28402-0780
USA

T 910 675 6363
F 910 362 6363
david.hinds@ge.com

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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 – RAI Numbers 11.2-11, 11.2-12, 11.2-14, 11.3-1 and 11.3-3**

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,

George Stramback
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 06-344 – Response to Portion of NRC Request for Additional Information Letter No. 54 Related to ESBWR Design Certification Application – Radioactive Waste Management – RAI Numbers 11.2-11, 11.2-12, 11.2-14, 11.3-1 and 11.3-3

cc:	AE Cubbage	USNRC (with enclosures)
	GB Stramback	GE/San Jose (with enclosures)
	eDRFs	0058-4587, 0058-4595, 0058-4599, 0058-4602, 0058-4605

ENCLOSURE 1

MFN 06-344

Response to Portion of NRC Request for

Additional Information Letter No. 54

Related to ESBWR Design Certification Application

Radioactive Waste Management

RAI Numbers 11.2-11, 11.2-12, 11.2-14, 11.3-1 and 11.3-3

NRC RAI 11.2-11

DCD Tier 2, Figure 11.2-1, "Liquid Waste Management System Process Diagram," does provide sufficient detail to assess the system's adequacy. Locations of components relative to other plant components and buildings are not shown. Update the diagram to include sufficient detail to identify all sources of liquid input volumes (e.g., condensate storage tank collection berm and individual building sumps), the points of collection of liquid waste, the flow paths of liquids through the system including all bypasses, and the specific points of release of liquid effluents to the environment (e.g., interface COL item with circulating water system), consistent with the guidance of Standard Review Plan (SRP) Section 11.2, Rev. 2, July 1981, Review Criterion III.1.

GE Response

DCD Tier 2 Chapter 11 will be revised to include a new Figure 11.2-2, "Liquid Waste Management System Process Stream Information Directory." Additionally, a description of Figure 11.2-2 has been added in Section 11.2. These attached improvements to the DCD are consistent with the guidance of Standard Review Plan (SRP) Section 11.2, Rev.2, July 1981, Review Criterion III.1.

NRC RAI 11.2-12

DCD Tier 2, Table 11.2-4 defines the probable maximum daily input volumes to the various subsystems of the liquid waste management system. Describe how the maximum daily volumes were derived from the potential input sources.

GE Response

DCD Tier 2, Table 11.2-4 is derived from the Liquid Waste Management System Design Specification.

The maximum waste generation values were estimated in accordance with US practice as specified in EPRI Report 4. Table 1, "Industry Average Daily Waste Generation." These values were adjusted for ABWR (1350MWe) design values and then corrected with an estimate for the specific design features of the ESBWR. For the Chemical Drain Subsystem, the ABWR design value was used because it is more conservative than the amount depicted in the EPRI report. Regarding the Detergent Drain Subsystem, normal US practice is for utilities to contract out their laundry, so a much smaller value is assumed for ESBWR Detergent Drain Waste.

Excerpt from LWMS Design Specification

PROBABLE INPUTS TO LWMS FROM OPERATIONAL OCCURRENCES

1. Subsystem	Maximum Liters/Day[1] (Gal/Day)
Equipment (low conductivity) Drain Subsystem	125,000 (33,025)[1]
Floor (high conductivity) Drain Subsystem	100,000 (26,420)[1]
Chemical Drain Subsystem	3,000 (793)[2]
Detergent Drain Subsystem	12,000 (3,170)[3]

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

[1] Maximum waste generation is estimated in accordance with US Practice value (specified in EPRI Report "4. Table 1 Industry Average Daily Waste Generation" (2.1.1.e)) and adjusted ABWR (1350 MWe) design value taking into account the specific design features for ESBWR (ex, RWCU overboard drain and RHR Flushing Water are not estimated as equipment drain generation).

[2] Comparing the EPRI report value and ABWR design value, ABWR design value is conservatively adopted.

[3] Laundry of contaminated clothing off-site is the normal practice in US operating plants, therefore a much smaller value is assumed for ESBWR Detergent Drain waste.

NRC RAI 11.2-14

DCD Tier 2, Table 3.2-1 identifies the condensate storage tank (CST) as a tank located outside DCD structures, and other yard tanks are identified as outside the scope of the DCD. Confirm that no tanks located in yard areas outside buildings, other than the CST, are likely to contain radioactivity. If any outside tanks are likely to contain radioactivity, describe their interface with the liquid waste management system.

GE Response

For the ESBWR design there are no tanks located in the balance of plant area and yard area that contain radioactivity. The CST is the only tank that is expected to contain low level radioactivity. There are no other tank interfaces necessary with LWMS

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

NRC RAI 11.3-1

DCD Tier 2, Section 11.3.2.2, under the "Materials" heading states that the components satisfy regulatory position 1.2.2 for materials and restates the cited paragraph. The cited paragraph is intended for liquid waste systems. The DCD should be revised to cite regulatory position 2.2 which is intended for gaseous systems. The DCD should be reviewed to ensure compliance with the additional guidance of regulatory position 2.2, Rev. 2, which adds the following requirement: "If the potential for an explosive mixture of hydrogen and oxygen exists, adequate provisions should be made to preclude buildup of explosive mixtures, or the system should be designed to withstand the effects of an explosion." (Note: it is not limited to "...without the loss of integrity.")

GE Response

DCD Tier 2 Chapter 11 Section 11.3.2.2 will be revised as shown in the attached markup to indicate that the material selected for the offgas system will comply with Regulatory Guide 1.143 and Regulatory Position 2.2.

NRC RAI 11.3-3

DCD Tier 1, Table 2.10.3-1 states that the offgas system (OGS) is designed to withstand internal hydrogen explosions. Describe how the design pressure of the components was selected to provide this capability. Provide numerical performance criteria for the hydrostatic test demonstrating this capability.

GE Response

The ESBWR offgas system is designed similar to offgas systems at other licensed BWRs designed since 1971 and specifically similar to the offgas system at Grand Gulf Nuclear Power Station.

The ESBWR offgas system design used the methodology outlined in GE report, NEDE-11146 "Pressure Integrity Design Basis for New Gas Systems", to establish hydrogen explosion pressure integrity in offgas piping. NEDE-11146 has been previously submitted and approved by the NRC to evaluate and establish design pressure integrity for the Grand Gulf offgas system during internal hydrogen explosions. The Grand Gulf UFSAR, Section 11.3.2.2.1.9, which references the use of NEDE-11146 to establish hydrogen explosion pressure integrity in offgas piping, is attached for your reference.

DCD Tier 2 Chapter 11 Section 11.3.2.2 will be revised as shown in the attached markup to indicate that the hydrogen explosion pressure integrity of the ESBWR offgas piping was designed and analyzed using the methodology outlined in NEDE-11146 and that this analysis demonstrated the ability of the ESBWR offgas piping to sustain an explosion without loss of integrity.

in their entirety, utilizing available valves or temporary plugs at atmospheric tank connections. Hydrostatic testing of piping systems is performed at a pressure 1.5 times the design pressure, but in no case at less than 75 psig. The test pressure is held for a minimum of 30 minutes with no leakage indicated. Pneumatic testing may be substituted for hydrostatic testing in accordance with the applicable codes.

11.3.2.2.1.8 Instrumentation and Control

This system is monitored by flow, temperature, pressure, and humidity instrumentation, and by hydrogen analyzers to ensure correct operation and control.

Instrumentation and controls are described in subsection 7.7.1.10. The operator is in control of the system at all times.

A radiation monitor after the offgas condenser continuously monitors radioactivity release from the reactor and input to the charcoal adsorbers. This radiation monitor is used to provide an alarm on high radiation in the offgas.

A radiation monitor is also provided at the outlet of the charcoal adsorbers to continuously monitor the rate from the adsorber beds. This radiation monitor is used to isolate the offgas system on high radioactivity to prevent treated gas of unacceptably high activity from entering the vent.

The activity of the gas entering and leaving the offgas treatment system is continuously monitored. Thus, system performance is known to the operator at all times. Provision is made for sampling and periodic analysis of the influent and effluent gases for purposes of determining their compositions. This information is used in calibrating the monitors and in relating the release to calculated environs dose. Process radiation instrumentation is described in subsection 7.6.1.2.

Environmental monitoring will be used; however, at the estimated low dose levels, it is doubtful that the measurements can distinguish doses from the plant from normal variation in background radiation.

11.3.2.2.1.9 Detonation Resistance

The pressure boundary of the system is designed to be detonation resistant. The pressure vessels are designed to withstand 350 psig static pressure, and piping and valving are designed to resist dynamic pressures encountered in long runs of piping at the design temperature. This analysis is covered in a proprietary report submitted to the NRC (Ref. 6).

4. Standards for Steam Surface Condensers, Sixth Edition, Heat Exchange Institute, New York, NY (1970).

5. Underhill, Dwight, et al., "Design of Fission Gas Holdup Systems," Proceedings of the Eleventh AEC Air Cleaning Conference, p. 217, 1970.

6. Nesbitt, L. B., "Design Basis for New Gas Systems," NEDE-11146, July 1971. (Proprietary)

7. USNRC NUREG-0016, Rev. 1, "Calculation of Releases of Radioactive materials in Gaseous and Liquid effluents from boiling water reactors (BWR-GALE Code)" - January 1979.

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

9. 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

10. Slade, David H., "Meteorology and Atomic Energy, TID-24190, July 1968.

11. "Airborne Releases from BWRs for Environmental Impact Evaluations," NEDO-21159-2, 1978.

12. American Nuclear Society, ANSI Std. 18.1, and ANSI Std. N237-1976, Table 5

13. Letter from W. T. Cottle to NRC Document Control Desk, GNRO-91/00148, August 15, 1991, Subject: Schedule for UFSAR Changes Reflecting Termination of Construction Permit No. CPPR-119 for GGNS Unit 2

14. Deleted

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 LWMS Process Stream Information Directory and simplified flow diagram is provided in Figure 11.2-2. 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.

Influent Streams → Processing System (LWMS) → Effluent Streams

Influent Stream	Text Description	Applicable Drawing
RWCU/SDC Overboard	DCD 5.4.8.1.2	DCD Figure 5.1-4
FAPCS Overboard	DCD 5.4.8.1.2	DCD Figure 9.1-1
Drywell LCW Drain	DCD 5.2.5.2.1	-
Drywell HCW Drain	DCD 5.2.5.2.1	-
RB Drain	DCD 9.3.3 & Table 9.3-2	DCD Figure 1.2-1
TB Drain	DCD 9.3.3 & Table 9.3-2	DCD Figure 1.2-12
RW/B Drain	DCD 9.3.3 & Table 9.3-2	DCD Figure 1.2-21
CD Drain	DCD 9.2.6.1	-
LWMS	DCD 11.2	DCD Figure 11.2-1

Processing System	Text Description	Applicable Drawing
LWMS	DCD 11.2	DCD Figure 11.2-1

Effluent Stream	Text Description	Applicable Drawing
LWMS	DCD 11.2	DCD Figure 11.2-1
CSTS	DCD 9.2.6.2	-
Offsite Discharge	DCD 9.2.9	-

Abbreviations:

RWCU/SCD - Reactor Water Cleanup/Shutdown Cooling System
FAPCS ---- Fuel and Auxiliary Pools Cooling System
LCW ------ Low Conductivity Waste
HCW ----- High Conductivity Waste
CD ------- Condensate Demineralizer
LWMS ---- Liquid Waste Management System
CSTS ----- Condensate Storage and Transfer System

Figure 11.2-2. Liquid Waste Management System Process Stream Information Directory

Calculation methods for translation of detonation pressures into wall thickness are summarized in the ANSI-55.4 (Reference 11.3-6). Equipment are designed and constructed in accordance with the requirements of Table 11.3-2.

Materials

Per Regulatory Guide 1.143, Regulatory Position 2.2, materials for pressure-retaining components of process systems[1] are selected from those covered by the material specifications listed in Section II, Part A of the ASME Boiler and Pressure Vessel Code, except that malleable, wrought or cast-iron materials, and plastic pipe are not allowed in this application. The components satisfy all of the mandatory requirements of the material specifications with regard to manufacture, examination, repair, testing, identification, and certification.

Pressure Relief

Adequate pressure relief is provided at all locations where it is possible to isolate a portion of the system containing a potential heat source that could cause excessive pressure. Adequate pressure relief is also provided downstream of pressure reducing valves to protect equipment from overpressure.

Equipment Room Ventilation Control

The equipment rooms are under negative ventilation control. The equipment in the equipment rooms is qualified for the environmental conditions it is expected to see.

Differential pressure between general areas and equipment cells is sufficient to maintain a flow of air from clean areas into potentially contaminated areas. In addition, the TBHV is capable of removing sufficient heat from the process piping, equipment, motors, and instrumentation so as to maintain the environmental temperatures as established. All equipment cell and charcoal vault ventilation air is discharged without passing through occupied areas to the Turbine Building compartment exhaust system and the plant vent stack, where effluent radiation monitoring is performed.

Leakage

The leakage criteria apply from the steam jet air ejector through the OGS, including all process equipment and piping in between as shown on Figure 11.3-1. Leakage from the process through purge or tap lines to external atmospheric pressure is sufficiently low so it is undetectable by "soap bubble" test. This requirement does not apply to in-line process valves.

Instrument panels (e.g., hydrogen analyzers) connected to process gas are enclosed, the enclosure maintained under a negative pressure, and vented to an equipment vault or to building ventilation. To reduce instrument line leakage, welded rather than threaded connections are used wherever possible.

Vents and Drains

Offgas System drains, depending on source, are routed to either the condenser hotwell or to the radwaste system. All piping is provided with high point vents and low point drains to permit system drainage following the hydrostatic test. A water drain is provided on the process lines

1 "Process System" refers to that portion of the OGS that normally processes SJAE Offgas.

- All discharge paths to the environment are monitored. The normal effluent path is monitored by the Process Radiation Monitoring System and the equipment areas are monitored by the Area Radiation Monitoring System.
- Dilution steam flow to the steam jet air ejector is monitored and alarmed, and the valving is required to be such that loss of dilution steam cannot occur without coincident closure of the process gas suction valve(s) so that the process gas is sufficiently diluted if it is flowing at all.

Charcoal Adsorber Bypass

A piping and valving arrangement is provided, which allows isolation and bypass of the charcoal adsorber vessel most likely to catch fire or become wetted with water, while continuing to process the offgas flow through the remaining adsorber vessels. A nitrogen purge can be injected upstream of the vault entrance so that further combustion is prevented and the charcoal is cooled below its ignition temperature. Capability is provided to employ all or a portion of the charcoal adsorber vessels (either guard bed or charcoal beds) to treat the offgas flow during normal or off-standard process operating conditions. Capability is also provided to completely bypass all charcoal adsorber vessels during plant startup and/or when fuel performance allows.

The main purpose of this bypass is to protect the charcoal during preoperational and startup testing when gas activity is zero or very low and when moisture is most likely to enter the charcoal beds. The bypass valve arrangement is such that no single valve failure or valve misoperation would allow total charcoal bypass. The bypass mode of charcoal operation is not normal for power operation. However, it may be used if the resulting activity release is acceptable.

Valves

All valves with operators located on the gas process stream are operable from the main control room. Where radiation levels permit, valves handling process fluids are installed in service areas where maintenance can be performed if needed during operation.

Nitrogen and Air Purge

A nitrogen purge and air supply line is connected to the offgas process just upstream of the first in-line charcoal adsorber vessel (guard bed). This arrangement is to allow the vessel to be nitrogen purged after a possible fire is detected or dried with heated air if the charcoal is wetted, while the offgas flow is bypassed around it and through the remaining charcoal vessels. Another nitrogen purge line is also provided just upstream of the remaining charcoal adsorber vessels that allow them to be purged, if required, without interrupting the processing of offgas through the guard bed. The isolation valves in the nitrogen and air purge lines and the connection for the gas supply are accessible from outside the charcoal vault.

11.3.2.2 Component Design

For portions of the system that may contain an explosive mixture, the design provides for ignition sources to be minimized and the system to be able to sustain an explosion without loss of integrity. This analysis is covered in proprietary report NEDE-11146 (reference 11.3-11).

11.3.7.2 Results

The DBA evaluation assumptions are given in Table 11.3--4, the isotopic flows and releases in Table 11.3-5 and Table 11.3-6, and the meteorology and dose results in Table 11.3-7.

The dose results are given in Table 11.37 and are within the limiting 25 mSv (2.5 Rem) whole body dose for an infrequent event or the 5 mSv (0.5 Rem) frequent event limitation of Branch Technical Position ESTB 11-5.

11.3.8 COL Information

11.3.8.1 Offgas System Data

Offgas System design parameters, major equipment items as well as other system data, as shown in tables 11.3-2, are to be defined by the COL applicant.

11.3.9 References

11.3-1 Code of Federal Regulations 10 CFR 50, Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions to Meet the 'As Low As Is Reasonably Achievable' for Radioactive Material in Light-Water Cooled Nuclear Power Reactors."

11.3-2 Code of Federal Regulations 10 CFR 20, "Standards for Protection Against Radiation."

11.3-3 Nuclear Regulatory Commission (NRC), Regulatory Guide 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants."

11.3-4 American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section VIII - Division 1.

11.3-5 American Institute of Steel Construction (AISC), Manual of Steel Construction

11.3-6 American National Standards Institute, "Gaseous Radioactive Waste Processing Systems for Light Water Reactor Plants," ANSI/ANS-55.4.

11.3-7 W.E. Browning, et al., "Removal of Fission Product Gases from Reactor Offgas Streams by Absorption," June 11, 1959, Oak Ridge National Laboratory (ORNL) CF59-6-47.

11.3-8 D.P. Seigwarth, "Measurement of Dynamic Absorption Coefficients for Noble Gases on Activated Carbon," Proceedings of the12th AEC Air Cleaning Conference.

11.3-9 Dwight Underhill, et al., "Design of Fission Gas Holdup Systems, Proceedings of the Eleventh AEC Air Cleaning Conference," 1970, p. 217.

11.3-10 General Electric Co., "Radiological Accident Evaluation - The CONAC03 Code," NEDO-21143-1, December 1981.

11.3-11 General Electric Co., "Pressure Integrity Design Basis for New Off-Gas Systems," NEDE-11146, July 1971 (Proprietary).