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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 69 – Safety Analysis – RAI Numbers 15.3-4, 15.3-5 and 15.3-22**

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

D068

Reference:

1. MFN 06-381, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 69 Related to the ESBWR Design Certification Application*, October 11, 2006

Enclosures:

1. MFN 07-098– Response to Portion of NRC Request for Additional Information Letter No. 69 – Safety Analysis – RAI Numbers 15.3-4, 15.3-5 and 15.3-22

cc:	AE Cubbage	USNRC (with enclosures)
	GB Stramback	GE/San Jose (with enclosures)
	eDRF	0063-6340 for RAI 15.3-4
		0063-6340 for RAI 15.3-5
		0062-3895 for RAI 15.3-22

Enclosure 1

MFN 07-098

Response to Portion of NRC Request for Additional Information Letter No. 69 Related to ESBWR Design Certification Application

Safety Analysis

RAI Numbers 15.3-4, 15.3-5 and 15.3-22

NRC RAI 15.3-4:

Question Summary: Provide dose results and supporting information for the accident scenario involving the failure of a tank containing liquid radioactive wastes.

Full Text: A review of DCD Rev. 1, Tier 2, Section 15.3.16 indicates that dose results are not provided for the analysis assessing the failure of a tank containing liquid radioactive wastes. Address the following inconsistencies with NRC guidance and acceptance criteria; describe the method, basis and assumptions used in the analysis; provide a listing of parameters used in the analysis; update the text in DCD Section 15.3.16;revise all supporting tables in DCD Section 15.3.16; and revise DCD Section 15.0 and Tables 15.0-1 to 15.0-7, as needed:

a. DCD Section 15.3.16.3 states that dose results are presented in Table 15.3-14, but this table presents only noble gas release rates for a scenario involving offgasing from 1000 failed fuel rods.

b. DCD Section 15.3.16.3 states that parameters are listed in Tables 15.3-12 and 15.3-13. However, Table 15.3-12 deals with an event for stuck safety relief valves, and Table 15.3-13 presents parameters for a scenario involving the failure of 1000 fuel rods.

c. DCD Section 15.3.16.3 states that the iodine inventories are based on DCD Section 12.2, but it does not specify which type of liquid wastes was selected out DCD Section 12.2.

d. DCD Section 15.3.16 does not acknowledge the criteria and guidance of SRP Section 15.7.3. Specifically, 10 CFR Part 20 Appendix B effluent concentration limits, GDC 60, and basis for

e. DCD Section 15.3.16 does not identify the analytical method used ,i.e., methodology of NUREG-0016, NUREG-0133 (App. B for BWR),or other unspecified approach.

GE Response:

Item a

DCD Tier 2 Subsection 15.3.16.3 and the supporting tables have been revised in DCD Tier 2, Revision 2 to reflect the correct cross-referencing.

Item b

DCD Tier 2 Subsection 15.3.16.3 and the supporting tables have been revised in DCD Tier 2, Revision 2 to reflect the correct cross-referencing.

Item c

The iodine inventories are based on DCD Tier 2, Tables 12.2-13a through 12.2-13g. The values in these tables are to be revised in DCD Tier 2, Revision 3, as per the response to RAI 12.3-1 submitted in GE letter MFN 06-529 dated December 22, 2006.

Item d

Reference to SRP Section 15.7.3, 10 CFR 20 Appendix B effluent concentration limits, and GDC 60 is included in the proposed revised wording to DCD Tier 2, Subsection 15.3.16.3.

Item e

The liquid radwaste tank accident radiological analysis was reanalyzed using the revised liquid radwaste tank inventories in Tables 12.2-13a through 12.2-13g of the response to RAI 12.3-1. These revised DCD tables are to be included in DCD Tier 2, Revision 3. This revised analysis assumes the following:

- The entire combined iodine inventory of the liquid radwaste tanks (DCD Tier 2, Revision 3, Tables 12.2-13a through 12.2-13g) is conservatively released in the Radwaste Building as a result of the accident.
- The release of the tank iodine inventory to the environment is through the airborne pathway; no liquid effluent is released to the environment.
- It is conservatively assumed that the entire iodine inventory is released to the environment via the airborne pathway.
- The iodine activity is instantaneously released to the environment with no holdup or plateout.

With regard to the reasoning behind not considering liquid effluent release to the environment as a result of a liquid radwaste tank failure, DCD Tier 2, Revision 2, Section 11.2 states that the liquid waste management system (LWMS) complies with Regulatory Guide 1.143 guidance regarding liquid radwaste treatment systems.

Regulatory Guide 1.143, Rev 2. A. Introduction, states, in part – "This regulatory guide is being revised to provide design guidance acceptable to the NRC staff in regard to natural phenomena hazards, internal and external man-induced hazards, and quality group classification and quality assurance provisions for radioactive waste management systems, structures, and components. Further, it describes provisions for mitigating design basis accidents and controlling releases of liquids containing radioactive materials, e.g., spills or tank overflows, from all plant systems outside reactor containment."

Because the LWMS is being designed to Regulatory Guide 1.143, provisions will be in place to mitigate design basis accidents and control releases of liquids containing radioactive materials. The liquid effluent tanks are housed within the Radioactive Waste Building and provisions are in place to prevent overflow should some accident occur whereby a tank is somehow ruptured or punctured.

In addition, DCD Tier 2, Revision 2, Subsection 11.2.1 states that 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.

The marked up DCD Subsection 15.3.16 provided in the response to RAI 2.4-29 (MFN 06-226 dated July 31, 2006) contains revised wording to reflect the fact that no liquid as a result of tank failure will be released to the groundwater.

For these reasons, the liquid release to the environment as a result of a liquid radwaste tank accident is not considered. The airborne pathway was analyzed to show that even assuming a conservative airborne release of activity (iodine activity from all liquid radwaste tanks is discharged to the atmosphere), the resulting doses are minimal.

Affected Documents:

Changes to the DCD are attached to this RAI response and will be included in DCD Tier 2, Revision 3. Changes are made to:

- Table 15.0-7
- Section 15.3.16.3
- Table 15.3-17
- Table 15.3-18
- Table 15.3-19

NRC RAI 15.3-5:

Question Summary: A review of DCD Rev. 1,Tier 2, Section 15.3.16 indicates that the technical approach is not consistent with that described in SRP (NUREG-0800) Sections 15.7.3. II and 15.7.3.III.

Full Text: DCD Rev. 1, Tier 2, Section 15.3.16 indicates that the technical approach is not consistent with that described in SRP Sections 15.7.3. II and 15.7.3.III. The analysis considers only a single pathway involving airborne releases of radioactivity via the HVAC system. This approach takes credit for the presence of a liner designed to contain the volume of the tank into the compartment where the tank is assumed to be located. However, the text states that this design feature applies only to tanks containing "high level liquid radwaste." The implication is that tanks containing low level liquid radwaste would not be located in compartments that afford the same level of protection. Moreover, Sections 11.2 and 11.4 of the DCD emphasize the use of mobile liquid and wet-waste processing systems. Given this design, discuss if the analysis considers failure of tanks that are part portable waste treatment systems and whether the placement of portable radwaste processing systems are afforded the same level of protection as that to permanently installed tanks. Provide the basis as to why the stated approach is consistent with SRP Section 15.7.3.III, which states that: "Credit for liquid retention by unlined building foundations will not be given regardless of the building seismic category because of the potential for cracks. Credit is not allowed for retention by coatings or leakage barriers outside of the building foundations."

Address these inconsistencies with NRC guidance and acceptance criteria; describe the basis and assumptions used in the analysis; discuss why the release of a tank's content to surface or groundwater is not limiting in the analysis; update the text in DCD Section 15.3.16; and provide new or revise all supporting tables in DCD Section 15.3.16.

GE Response:

The liquid radwaste tank accident and lack of release to the groundwater is provided in detail in the responses to RAIs 2.4-29 and 15.3-4.

GE is following the guidance in SRP Section 15.7.3.III.1.b, which states that "The ETSB will consider the design features, e.g., steel liners or walls in building areas housing components, dikes for outdoor tanks, and overflow provisions incorporated to mitigate the effect of a postulated failure." Based on the Radwaste Building design discussed in the responses to RAIs 2.4-29 and 15.3-4, GE's position is that the design features of the Radwaste Building are sufficient to mitigate the effect of a postulated liquid radwaste tank failure.

Affected Documents:

No DCD changes will be made as a result of this RAI response.

NRC RAI 15.3-22:

DCD Tier 2, Rev. 1, Section 15.3.12.1 states that the power level will settle at a new steady state without violating the thermal limits. Section 15.3.12.2 states that the operator may take action to limit the power rise. Flux scram occurs if no operator action is taken. Therefore, for the thermal limits not to be violated either a scram or an operator action is required. Thus, the statement in Section 15.3.12.1 is not correct. If there is no additional failure why is this transient in the infrequent events?

(1) Quantify the temperature and reactivity changes.

(2) Provide the reason why this transient should not be classified as an AOO.

GE Response:

Item (1)

The event discussed in Subsection 15.3.12 results from an assumed misoperation of the cooling water controls for the Reactor Water Cleanup /Shut Down Cooling (RWCU/SDC) system heat exchangers. This Subsection identifies two scenarios. The first scenario involves bypassing the Regenerative Heat Exchanger (RHX) such that the RWCU/SDC system water enters the vessel at temperature lower than expected during normal operation. The second scenario corresponds to the first scenario but occurs during start up condition.

First Scenario:

During normal operation, the reactivity change caused by misoperation of the RWCS/SDC is small because the increase in the core subcooling will be very small. The capacity of each RWCS/SDC train for reactor cleanup is 1% of the rated feedwater (FW) flow rate. By considering this rated flow rate of 1%, a core inlet flow temperature of 517.5°F and a minimum RWCS/SDC water injection temperature of 100°F, the FW inlet temperature into the reactor vessel will slowly decrease by about 3.63°F. Furthermore, under normal operation, the mixing of the FW with the recirculating water from the steam separators diminishes the temperature impact at the core because the ratio of the recirculation water flow rate from the steam separators to the FW flow rate is about 4 to 1, the core inlet water temperature drops by less than 1°F. This temperature change is within the expected core inlet water temperature variation of 4.9°F (522.4°F -517.5°F) noted in DCD Tier 2, Table 4.4-1b. Therefore, the reactivity change caused by this very small and slow temperature change is small as seen in the "Moderator Temperature Coefficient for Reference Core Design" plot (DCD Tier 2, Figure 4.3-3) and no quantification of the reactivity changes is needed.

Second Scenario:

The inadvertent SDC event during startup may potentially add positive reactivity such that the neutron monitoring system set point of about 15% RTP may be reached causing a scram

(Chapter 16 of DCD Tier 2, Rev. 2, Table 3.3.1.4-1 (page 2 of 2)). However, during this condition where the reactor is at or near critical, the slow power increase resulting from the cooler moderator temperature is controlled by the operator in the same manner as is normally done to control power in the start up range.

The discussion of the first scenario indicates that the thermal limits are not violated because the system settles to a new steady state and no scram or operator action is required. The second scenario occurs during a condition where the effect of the feedwater temperature is also small and where a flux scram at about 15% RTP may occur. Either occurrence ensures that the thermal limits are not reached. An operator action may also take place to control the feedwater temperature in the same manner as normally done to control power in the start up range and prevent the flux scram. The statement in Subsection 15.3.12.1 "the system would settle at a new steady state without violating fuel thermal limits" is correct.

Because Subsection 15.3.12.1 should only identify the causes, the last sentence of the subsection will be deleted. Editorial changes will also be made to DCD Tier 2, Subsections 15.3.12.2 and 15.3.12.3. The proposed changes are described below under the "Affected Documents" section.

Item (2)

The event described in Subsection 15.3.12 is classified as an Infrequent Event rather than an Anticipated Operational Occurrence (AOO) because the annual probability of occurrence of the event is one event in 1,000,000 years (see DCD Tier 2, Table 15A-3). This probability of occurrence is much less than the annual probability of occurrence for an AOO (once in less than 100 years).

Affected Documents:

DCD Tier 2, Subsection 15.3.12 will be revised as noted below:

Subsection 15.3.12.1

FROM:

> "A shutdown cooling malfunction leading to a moderate temperature decrease could result from misoperation of the cooling water controls for the RWCU/SDC system heat exchangers. The resulting temperature decrease would cause a slow insertion of positive reactivity into the core. If the operator did not act to control the power level, the system would settle at a new steady state without violating fuel thermal limits and without any measurable increase in nuclear system pressure."

TO:

> "A shutdown cooling malfunction leading to a moderate temperature decrease could result from misoperation of the cooling water controls for the RWCU/SDC system heat exchangers. The resulting temperature decrease would cause a slow insertion of positive reactivity into the core."

Subsection 15.3.12.2

Sequence of Events

FROM:

> "......During startup, scram may occur. In either case, no thermal limits are reached. The sequence of events for this event is a slow rise in reactor power. The operator may take action to limit the power rise. Flux scram occurs if no operator action is taken."

TO:

> ".....During startup, a flux scram may occur. During full power operation or startup, no thermal limits are reached. The sequence of events for this event is a slow rise in reactor power. The operator may take action to limit the power rise."

Subsection 15.3.12.3

FROM:

> "During startup or shutdown, this power rise is terminated by a flux scram before fuel thermal limits are approached."

TO:

> "During startup, if the power rise is such that the neutron flux setpoint is reached, the power rise is terminated by a flux scram before fuel thermal limits are approached."

Table 15.0-7

ESBWR Event Classifications and Radiological Acceptance Criteria

Event*	Accident Class**		Radiological Acceptance Criteria***					
	Infrequent Event	Accident	10 CFR 20, App. B, Table 2, Column 2	10 CFR 20.1301	GDC 19, 5 rem TEDE	2.5 rem TEDE	6.3 rem TEDE	25 rem TEDE
Loss of Feedwater Heating With Failure of Selected Control Rod Run-In	X				+	X		
Inadvertent SDC Function Operation	X				+	X		
Control Rod Withdrawal Error During Refueling	X				+	X		
Control Rod Withdrawal Error During Startup	X				+	X		
Control Rod Withdrawal Error During Power Operation	X				+	X		
Inadvertent Opening of a Depressurization Valve	X				+	X		
Inadvertent Opening of a Safety/Relief Valve	X				+	X		
Stuck Open Safety/Relief Valve	X				+	X		
Feedwater Controller Failure – Maximum Demand	X				+	X		
Pressure Regulator Failure - Opening of All Turbine Control and Bypass Valves	X				+	X		
Pressure Regulator Failure – Closure of All Turbine Control and Bypass Valves	X				+	X		
Generator Load Rejection with Total Turbine Bypass Failure	X				+	X		
Turbine Trip with Total Turbine Bypass Failure	X				+	X		
Liquid-Containing Tank Failure	X		X		X	X		

Table 15.0-7

ESBWR Event Classifications and Radiological Acceptance Criteria

Event*	Accident Class**		Radiological Acceptance Criteria***					
	Infrequent Event	Accident	10 CFR 20, App. B, Table 2, Column 2	10 CFR 20.1301	GDC 19, 5 rem TEDE	2.5 rem TEDE	6.3 rem TEDE	25 rem TEDE
Fuel Assembly Loading Errors (mislocated and misoriented)	X				+	X		
Spent Fuel Cask Drop Accident		X			+		X	
Failure of Small Line Carrying Primary Coolant Outside Containment		X			+	X		
Feedwater Line Break Outside Containment		X			+	X		
Reactor Water Cleanup / Shutdown Cooling System Failure Outside Containment		X			+	X		
Control Rod Drop Accident (radiological analysis)		X			+		X	
Main Steamline Break Outside Containment		X			X	X		
LOCA Inside Containment Radiological Analysis, (including all leakage paths)		X			X			X
Fuel Handling Accident		X			+		X	
Waste Gas System Leak or Failure ++				X	+			

* Based on SRP 15 and ABWR FSER (Reference 3) events involving a radiological consequence.

** From Table 15.0-2.

*** Based on the 10 CFR regulations and SRP 15.

+ Bounded by the LOCA Inside Containment and Main Steamline Break Outside Containment radiological analyses.

++ Classified as a special event.

15.3.16 Liquid Containing Tank Failure

15.3.16.1 Identification of Causes

An unspecified event causes the complete release of the radioactive inventory in all tanks containing radionuclides in the liquid radwaste system. Postulated events that could cause a release of the inventory of a tank are sudden unmonitored cracks in the vessel or operator error. Small cracks and consequent low level releases are bounded by this analysis and should be contained without any significant release.

The ESBWR Radwaste Building is designed to seismic requirements as specified in Subsection 3.8.4. In addition, the concrete walls of all compartments containing high level liquid radwaste are provided with a sealant up to a height capable of containing the release of all the liquid radwaste in the compartment. Because of these design capabilities, it is considered remote that any major event involving the release of liquid radwaste into these volumes would result in the release of these liquids to the environment via the liquid pathway. Releases as a result of major cracks would instead result in the release of the liquid radwaste to the compartment and then to the building sump system for containment in other tanks or emergency tanks. A complete description of the liquid radwaste system is found in Section 11.2, except for the tank inventories, which are found in Section 12.2.

A liquid radwaste release caused by operator error is also considered a remote possibility. Operating techniques and administrative procedures emphasize detailed system and equipment operating instructions. A positive action interlock system is also provided to prevent inadvertent opening of a drain valve. Should a release of wastes occur, the sealed concrete walls would contain the release until the floor drain sump pumps in the building capture and contain such spills.

The probability of a complete tank release is considered low enough to warrant this event as an Infrequent Event.

15.3.16.2 Sequence of Events and Systems Operations

Following a failure, the area radiation alarms would be expected to alarm at one minute with operator intervention following at approximately five minutes after release. However, the rupture of a waste tank would be contained and allow the operator time to develop and setup a means to process the contained waste. Gases would be processed through the Radwaste Building HVAC system as described in Subsections 9.4.3, 11.5.3.2.8 and 12.3.3.2.4.

Liquid release would be contained within the sealed concrete walls and would present no immediate threat to the environment leaving the operator sufficient time (on the order of hours) in which to recover systems to pump the release into holding tanks or emergency tanks.

15.3.16.3 Results

A single pathway is considered for release of fission products to the environment via airborne releases. The liquid pathway is not considered because of the mitigation capabilities of the Radwaste Building, following the guidance of SRP Section 15.7.3.III.1.b. General Design Criterion (GDC) 60 is met, as the release of radioactive materials in this case is suitably controlled.

For the airborne pathway, volatile iodine species in the tank using the cumulative inventories in Tables 12.2-13a through 12.2-13g are considered. Although isolation is expected within minutes of the occurrence, release of 100% of the iodine inventory is conservatively assumed instantaneously with no holdup or plateout. Specific parameters for this analysis are found in Tables 15.3-17 and 15.3-18.

No liquid or significant (from airborne species) ground contamination is expected. Airborne doses are given in Table 15.3-19 and are a fraction of the 2.5 rem TEDE offsite and 5 rem onsite criteria. The effluent concentration limits of 10 CFR 20 Appendix B are met, as no liquid effluent is released to the environment as a result of the tank failure.

Table 15.3-17

Radwaste System Failure Accident Parameters

I	**Data and Assumptions Used to Estimate Source Terms**	
A.	Source inventory	Tables 12.2-13a through 12.2-13g (combined)
B.	Fraction of iodine released	100%
C.	Duration of accident	Instantaneous
II.	**Control Room Parameters**	
A.	Control Room Volume, m^3	2.2E+03
B.	Unfiltered intake, liters/sec	200
C.	Occupancy Factors	RG 1.183
III	**Dispersion and Dose Data**	
A.	Atmospheric Dispersion Factors	
	Offsite (sec/m^3)	2.0E-03
	Control Room (sec/m^3)	Table 2.0-1
B.	Dose conversion assumptions	RG 1.183
C.	Activity released	Table 15.3-18
D.	Dose consequences	Table 15.3-19

Table 15.3-18

Radwaste System Failure Accident Isotopic Airborne Release to Environment (megabecquerel)

Isotope	Activity (MBq)
I-131	9.7E+04
I-132	9.4E+03
I-133	7.8E+04
I-134	6.2E+03
I-135	3.1E+04
Total I	2.2E+05

Table 15.3-19

Radwaste System Failure Accident Dose Results

Exposure Location	Maximum Calculated TEDE (rem)	Acceptance Criterion TEDE (rem)
Exclusion Area Boundary (EAB)	7.2E-02	2.5
Low Population Zone (LPZ)	7.2E-02	2.5
Control Room	5.1E-02	5.0