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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 40 Related to ESBWR Design Certification Application – ESBWR Probabilistic Risk Assessment – RAI Numbers 19.1-8, 19.1-17, 19.2-6, 19.2-10, 19.2-13 and 19.2-18**

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 06-222, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 40 Related to ESBWR Design Certification Application,* July 5, 2006

Enclosure:

1. MFN 06-257 – Response to Portion of NRC Request for Additional Information Letter No. 40 Related to ESBWR Design Certification Application – ESBWR Probabilistic Risk Assessment – RAI Numbers 19.1-8, 19.1-17, 19.2-6, 19.2-10, 19.2-13 and 19.2-18

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	0000-0056-5715

ENCLOSURE 1

MFN 06-257

Response to Portion of NRC Request for

Additional Information Letter No. 40

Related to ESBWR Design Certification Application

ESBWR Probabilistic Risk Assessment

RAI Numbers 19.1-8, 19.1-17, 19.2-6, 19.2-10,

19.2-13 and 19.2-18

NRC RAI 19.1-8

Discuss how the operating efficiency of the Passive Containment Cooling System (PCCS) (including thermo-physical properties, heat transfer coefficients, steam condensation efficiency, fission product removal, and axial and radial velocity distribution within the condenser tubes) is impacted by each of the following: (a) large quantities of non-condensible gases such as CO2 and H2, (b) corium-concrete interaction (CCI) - generated aerosols including plugging effects, and (c) increases in Isolation Condenser (IC) pool temperatures as the event progresses. Support the responses with an appropriate analysis for each case.

GE Response

(a) Effect of non-condensable gases on a prototype PCC condenser performance was determined in the full scale PANTHER's test. Steam and non-condensable gases were supplied to a prototype condenser over the complete range of operating conditions to demonstrate the capability of the equipment to handle post-LOCA fission product and heat removal. Test objectives that are related to the effects of non-condensable gases on condenser performance are as follows:

- Confirm that when a mixture of steam and non-condensable gases flows into the PCC condenser inlet, the uncondensed gases will be discharged from the vent line and the condensate will be discharged from the drain line.

- To provide sufficient test data to confirm the adequacy of TRACG to predict the quasi-steady state heat rejection performance of a prototype PCC condenser over a range of non-condensable gas flow rates.

- Determine and quantify any differences in the effects of non-condensable buildup in the PCC condenser tubes between lighter-than-steam and heavier-than-steam gases.

An overview of the test results for the above objectives is as follows:

- The objective in the first bullet above was confirmed in the test. In the PCCS system design, the non-condensable gases are scrubbed in the suppression pool via the vent line and the condensate is transferred to the GDCS pool via the drain line resulting in fission product removal from the drywell.

- The condensation efficiency dropped with the higher fraction of non-condensable gases for a given inlet pressure.

- The heavier-than-steam gases fall through the PCC condenser while the lighter than steam gas mixes with steam.

The results of the above tests were used for validation of some features of the TRACG program.

Document references 1, 2, and 3 below submitted to the NRC earlier provides test data and results of the effect of non-condensable gases on the PCC condenser performance.

1. Letter from J. E. Quinn (GE) to R. W. Borchardt (NRC), Thermal-Hydraulic Data Report of Panthers-PCC tests, MFN 057-95, April 14, 1995
2. Letter from J. E. Quinn (GE) to T. E. Quay (NRC), SBWR, Appendices to Thermal-Hydraulic Data Report of Panthers-PCC tests, MFN 075-95, May 11, 1995
3. Letter from J. E. Quinn (GE) to T. E. Quay (NRC), SBWR- Data Analysis Report of Panthers-PCC tests, MFN 098-95, July 6, 1995

(b) During a severe accident, the conditions during which PCCS is required to operate, the lower drywell is flooded with a water height of 10 meters or higher. With such water height, the concentration of aerosols above water which is generated due to corium-concrete interaction at the lower drywell floor is significantly small (reference NUREG/CR-5901) which does not impact PCCS performance.

(c) The IC/PCCS pool temperature increases from a normal operating temperature (open pool temperature under ambient atmospheric condition) and reaches a constant boiling temperature of 100 deg C as the IC operates. The IC and PCCS performance evaluation is based on assuming the pool is at its boiling point temperature at the ambient condition. The Panther's test validated PCCS performance with a pool temperature of 100 deg. C.

NRC RAI 19.1-17

Provide pipe wall thickness of the PCCS and IC inlet lines. Also, provide inlet pipe location relative to PCCS/IC pool, and confirm if it is insulated.

GE Response

PCCS Condenser Steam Inlet Pipe
250-mm (10-inch) Nominal Diameter, Sch 40s (stainless steel)
Not insulated

ICS Condenser Steam Inlet Pipe
350-mm (14-inch) Nominal Diameter, Sch 80 (carbon steel) (reference ICS P&ID, DCD Table 5.2-4)
Insulated and enclosed in a guard pipe (reference DCD Tier 2, Section 5.4.6.2.2)

NRC RAI 19.2-6

Provide additional information regarding the drywell to suppression chamber vacuum breakers, including drawings showing the vacuum breaker, proximity/position sensors, and DC motor-operated valve that would provide isolation if the vacuum breaker sticks open or leaks in its closed position (as described in Section 4.18.3.1 of the PRA).

GE Response

DCD Section 6.2.1.1.2, fifth paragraph under the heading "Drywell" provides description of the drywell-to wetwell vacuum breaker and the upstream isolation valve. This paragraph will be revised to read as follows:

"Vacuum breakers are provided between the DW and WW. The vacuum breaker is self-actuating valve, similar to a check valve. The purpose of the DW-to-WW vacuum breaker system is to protect the integrity of the diaphragm floor slab and vent wall between the DW and the WW, and the DW structure and liner, and to prevent back-flooding of the suppression pool water into the DW. The vacuum breaker is provided with redundant proximity sensors to detect its closed position. On the upstream side of the vacuum breaker, a DC solenoid operated ~~butterfly~~ isolation valve designed to fail-close is provided. The vacuum breaker is illustrated in Figure 6.2-28. During a LOCA, when the vacuum breaker opens and allows the flow of gas from WW to DW to equalize the DW and WW pressure and subsequently does not completely close as detected by the proximity sensors, a control signal will close the upstream ~~butterfly~~ isolation valve to prevent extra bypass leakage due to the opening created by the vacuum breaker and therefore maintain the pressure suppression capability of the containment. Redundant vacuum breaker systems are provided to protect against a single failure of vacuum breaker, i.e., failure to open or failure to close when required. The design DW-to-WW pressure difference and the vacuum breaker full open differential pressure is given in Table 6.2-1."

Figure 6.2-28 shown below will be added in DCD Tier 2.

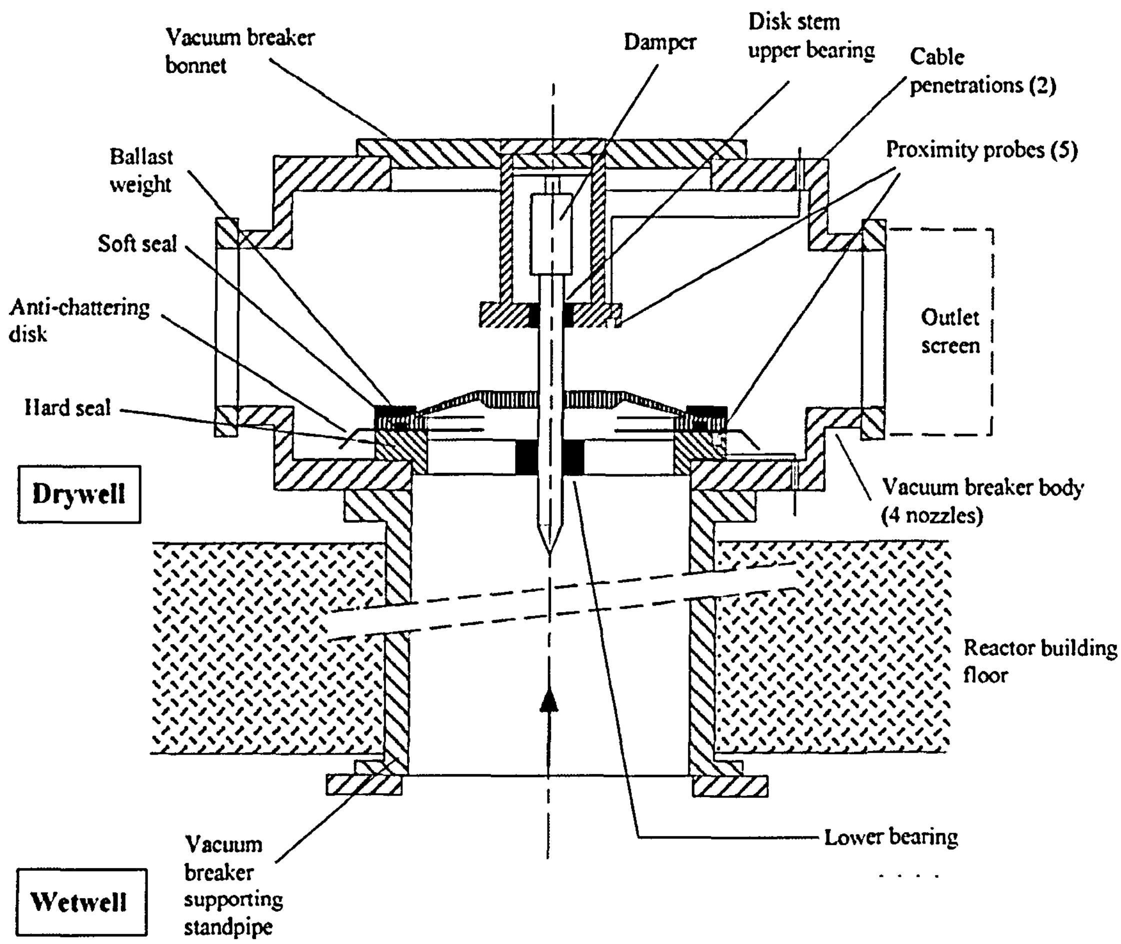

Figure 6.2-28. Vacuum Breaker Design Features

NRC RAI 19.2-10

Discuss the safety classification of the vacuum breakers, proximity/position sensors, and DC motor-operated isolation valves. Given the importance of these systems, structures, or components (SSCs), explain why the latter SSCs are not included in Tier 1 and 2 of the DCD (e.g., the DC motoroperated isolation valves are not mentioned in Section 2.15 of Tier 1, and the vacuum breakers, proximity/position sensors, and DC motor-operated isolation valves are not mentioned in Sections 19.5.3 and 19.5.10 of Tier 2), and system ITAAC.

GE Response

The vacuum breakers and the solenoid operated isolation valves are classified as safety related equipment. The proximity sensors located at the closed position are safety related, quantity of four (4) each in an independent safety-related instrument division. The proximity sensor (quantity = 1) located at the open position is non-safety related instrument.

Vacuum breakers, isolation valves and proximity sensors are described in DCD Tier 2, Section 6.2.1.1.2 and therefore it is not necessary to describe in Section 19.5.

The requested Tier 1 additions from this RAI and other RAIs will be evaluated and responded to, after the NRC and GE have agreed on a Tier 1 content change determination process.

Clarification Note: Referring to RAI text, please note that the isolation valves are solenoid-operated instead of motor-operated.

NRC RAI 19.2-13

Provide an estimate of the gap between the disk and seating surface that would exist if the total vacuum breaker leakage is at the maximum allowable value and uniformly distributed among all of the vacuum breakers. Discuss the ability of the position indication transducer to detect/measure such a gap. (The analysis in the PRA assumes that the position switch which provides annunciation in the control room can sense a gap between the disk and the seating surface corresponding to a leak area of 1 cm2.)

GE Response

The DW-to-Wetwell leakage requirement is based on an effective leakage area of $A/K^{0.5} = 1\ cm^2$. The design requirement for maximum effective leakage area for each vacuum breaker with the hard seat only is given in terms of an equivalent area $A/K^{0.5} = 0.2\ cm^2$.

The proximity sensors are required to measure gap with a measurement resolution of 100 microinch or better. This implies that for an open area of cylindrical surface having a diameter of 508-mm (20-inch) and a height of 0.00254-mm (100 microinch), a leakage area is 0.04 cm^2 can be detected by the sensor.

NRC RAI 19.2-18

Provide elevations of the containment venting system in both the suction and discharge sides. Also provide the length of various pipe sections in the vent lines.

GE Response

The containment venting function is a part of the containment inerting system (CIS) described in DCD Tier 2, Section 9.4.9. The containment venting when required is via the wetwell penetration at the exhaust side of CIS. The design details of venting system such as pipe lengths has not been completed and is considered beyond the scope of the DCD.