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MFN 08-344

Docket No. 52-010

April 18, 2008

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555-0001

Subject: Response to Portion of NRC Request for Additional Information Letter No. 85 Related to ESBWR Design Certification Application - Containment Systems - RAI Number 6.2-148

Enclosure 1 contains the GE Hitachi Nuclear Energy (GEH) response to the subject NRC RAI transmitted via the Reference 1 letter. DCD Markups related to this response are provided in Enclosure 2.

Verified DCD changes associated with this RAI response are identified in the enclosed DCD markups by enclosing the text within a black box. The marked-up pages may contain unverified changes in addition to the verified changes resulting from this RAI response. Other changes shown in the markup(s) may not be fully developed and approved for inclusion in DCD Revision 5.

If you have any questions or require additional information, please contact me.

Sincerely,

James C. Kinsey

James C. Kinsey
Vice President, ESBWR Licensing

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NRO

Reference:

1. MFN 07-054, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 85 Related to ESBWR Design Certification Application*, January 19, 2007

Enclosures:

1. MFN 08-344 - Response to Portion of NRC Request for Additional Information Letter No. 85 Related to ESBWR Design Certification Application - Containment Systems - RAI Number 6.2-148
2. MFN 08-344 - Response to Portion of NRC Request for Additional Information Letter No. 85 Related to ESBWR Design Certification Application - Containment Systems - RAI Number 6.2-148 - DCD Markups

cc:	AE Cubbage	USNRC (with enclosures)
	DH Hinds	GEH/Wilmington (with enclosures)
	GB Stramback	GEH/San Jose (with enclosures)
	RE Brown	GEH/Wilmington (with enclosures)
	eDRF	0000-0077-1081

Enclosure 1

MFN 08-344

Response to Portion of NRC Request for Additional Information Letter No. 85 Related to ESBWR Design Certification Application

Containment Systems

RAI Number 6.2-148

NRC RAI 6.2-148:

DCD, Tier 2, Revision 2, Section 6.2.1.1.2 states that "On the upstream side of the vacuum breaker, a DC solenoid operated isolation valve designed to fail-close is provided." Please state what type of a valve it is and how the fail-close function is provided.

GEH Response:

The vacuum breaker isolation valve (VBIV) is a pneumatically operated fail-as-is safety-related valve that isolates a leaking or stuck open vacuum breaker (VB). Both the VB and VBIV are located in the drywell side of the diaphragm floor. See Figure 6.2-28 (RAI 19.2-6 S01, MFN 08-330, dated April 4, 2008) for an illustration of the VB and VBIV. The VBIV valve type will be of similar design to a triple offset metal-seated butterfly valve. Automatic actuation logic will close the VBIV based upon an open indication provided by the VB proximity sensors with temperature confirmation or indication of bypass leakage provided by temperature sensors. These temperature sensors are located within the cavity of the VB/VBIV assembly. Additional temperature sensors are located in close proximity to the VB outlets screens and in the drywell and wetwell.

During a loss-of-coolant accident (LOCA), if a VB leaks, these same temperature sensors will detect a decrease in temperature differential between the hot drywell gas leaking past the VB seat and the wetwell gas. This will generate a signal to close the VBIV. Proximity sensors located on the VB seat can also generate a close signal if they detect a stuck-open VB coincident with a separate temperature confirmation. The safety-related logic and control is independent of the safety-related Distributed Control and Information System (Q-DCIS), and logic for each individual VBIV is independent of the other VBIVs. In addition to automatic control, the valve can be manually opened or closed.

DCD Tier 2, Subsection 6.2.1.1.2 will be revised to include the description of the VBIV and the VBIV automatic actuation logic. In addition, DCD Tier 2, Table 3.2-1 and Table 3.11-1 will be revised to include the VBIVs. DCD Tier 1 Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) revisions to address the VBIV automatic actuation logic are included in responses to RAI 14.3-213 (MFN 08-086 Supplement 12, dated March 20, 2008) and 14.3-233 (MFN 08-086 Supplement 22, dated April 30, 2008).

DCD Impact:

DCD Tier 1, Table 3.2-1, Table 3.11-1, and Subsection 6.2.1.1.2 will be revised as shown in the attached markup.

Enclosure 2

MFN 08-344

Response to Portion of NRC Request for Additional Information Letter No. 85 Related to ESBWR Design Certification Application

Containment Systems

RAI Number 6.2-148

DCD Markups

Verified DCD changes associated with this RAI response are identified in the enclosed DCD markups by enclosing the text within a black box. The marked-up pages may contain unverified changes in addition to the verified changes resulting from this RAI response. Other changes shown in the markup(s) may not be fully developed and approved for inclusion in DCD Revision 5.

Table 3.2-1

Classification Summary

Principal Components[1]		Safety Class.[2]	Location[3]	Quality Group[4]	QA Req.[5]	Seismic Category[6]	Notes
T	**CONTAINMENT AND ENVIRONMENTAL CONTROL SYSTEMS**						
T10	**Containment System**						
1.	Upper and lower drywell airlocks and equipment hatches, wetwell access hatch, and safety-related instrumentation	2	CV	B	B	I	
2.	Wetwell/drywell vacuum breakers	2	CV	B	B	I	
3.	Vacuum Breaker "Closed" Proximity Instrumentation	3	CV	—	B	I	
4.	Vacuum Breaker "Open" Proximity Instrumentation.	~~N~~3	CV	—	~~E~~B	~~II~~I	
5.	Vacuum Breaker Isolation Valves	2	CV	B	B	I	
6.	Refueling bellows	N	CV	—	E	I	
7.	Vacuum Breaker/Isolation Valve Temperature Sensor Instrumentation.	3	CV	—	B	I	

Table 3.11-1

Electrical and Mechanical Equipment for Environmental Qualification

Components	Quantity	Location (note 1)	Function (note 2)	Required Operation Time (note 3)	Qualification Program (note 4)
T10 Containment System					
Vacuum Breakers	3	CV	ESF	72hr	MH
Vacuum Breaker Isolation Valves	3	CV	ESF	72hr	MH

- The containment structure shall withstand coincident fluid jet forces associated with the flow from the postulated rupture of any pipe within the containment.
- The containment structure shall accommodate flooding to a sufficient depth above the active fuel to maintain core cooling and to permit safe removal of the fuel assemblies from the reactor core after the postulated DBA.
- The containment structure shall be protected from or designed to withstand hypothetical missiles from internal sources and uncontrolled motion of broken pipes, which could endanger the integrity of the containment.
- The containment structure shall direct the high energy blowdown fluids from postulated LOCA pipe ruptures in the DW to the pressure suppression pool and to the Passive Containment Cooling System (PCCS).
- The containment system shall allow for periodic tests at the calculated peak or reduced test pressure to measure the leakage from individual penetrations, isolation valves and the integrated leakage rate from the containment structure to confirm the leak-tight integrity of the containment.
- The Containment Inerting System establishes and maintains the containment atmosphere to $\leq 3\%$ by volume oxygen during normal operating conditions to ensure inert atmosphere operation.
- PCCS shall remove post-LOCA decay heat from the containment for a minimum of 72 hours, without operator action, to maintain containment pressure and temperature within design limits.

6.2.1.1.2 Design Features

The containment structure is a reinforced concrete cylindrical structure, which encloses the Reactor Pressure Vessel (RPV) and its related systems and components. Key containment components and design features are exhibited in Figures 6.2-1 through 6.2-5. The containment structure has an internal steel liner providing the leak-tight containment boundary. The containment is divided into a DW region and a WW region with interconnecting vent system. The functions of these regions are as follows:

- The DW region is a leak-tight gas space, surrounding the RPV and reactor coolant pressure boundary, which provides containment of radioactive fission products, steam, and water released by a LOCA, prior to directing them to the suppression pool via the DW/WW Vent System. A relatively small quantity of DW steam is also directed to the PCCS during the LOCA blowdown.
- The WW region consists of the suppression pool and the gas space above it. The suppression pool is a large body of water to absorb energy by condensing steam from SRV discharges and pipe break accidents. The pool is an additional source of reactor water makeup and serves as a reactor heat sink. The flow path to the WW is designed to entrain radioactive materials by routing fluids through the suppression pool during and following a LOCA. The gas space above the suppression pool is leak-tight and sized to collect and retain the DW gases following a pipe break in the DW, without exceeding the containment design pressure.

The DW/WW Vent System directs LOCA blowdown flow from the DW into the suppression pool.

The containment structure consists of the following major structural components: RPV support structure (pedestal), diaphragm floor separating DW and WW, suppression pool floor slab, containment cylindrical outer wall, cylindrical vent wall, containment top slab, and DW head. The containment cylindrical outer wall extends below the suppression pool floor slab to the common basemat. This extension is not part of containment boundary, however, it supports the upper containment cylinder. The reinforced concrete basemat foundation supports the entire containment system and extends to support the RB surrounding the containment. The refueling bellows seal extends from the lower flange of the reactor vessel to the interior of the reactor cavity. This extension is also not part of the containment boundary, however, it provides a Seismic Category I seal between the upper drywell and reactor well during a refueling outage.

The design parameters of the containment and the major components of the containment system are given in Tables 6.2-1 through 6.2-4. A detailed discussion of their structural design bases is given in Section 3.8.

Drywell

The DW (Figure 6.2-1) comprises two volumes: (1) an upper DW volume surrounding the upper portion of the RPV and housing the main steam and feedwater piping, GDCS pools and piping, PCCS piping, ICS piping, SRVs and piping, Depressurization Valves (DPVs) and piping, DW coolers and piping, and other miscellaneous systems; and (2) a lower DW volume below the RPV support structure housing the lower portion of the RPV, fine motion control rod drives, other miscellaneous systems and equipment below the RPV, and vessel bottom drain piping.

The upper DW is a cylindrical, reinforced concrete structure with a removable steel head and a diaphragm floor constructed of steel girders with concrete fill. The RPV support structure separates the lower DW from the upper DW. There is an open communication path between the two DW volumes via upper DW to lower DW connecting vents, built into the RPV support structure. Penetrations through the liner for the DW head, equipment hatches, personnel locks, piping, electrical and instrumentation lines are provided with seals and leak-tight connections.

The DW is designed to withstand the pressure and temperature transients associated with the rupture of any primary system pipe inside the DW, and also the negative differential pressures associated with containment depressurization events, when the steam in the DW is condensed by the PCCS, the GDCS, the FAPCS, and cold water cascading from the break following post-LOCA flooding of the RPV.

For a postulated DBA, the calculated maximum bulk DW temperature and absolute pressure in Table 6.2-5 remain below their design values, shown in Table 6.2-1.

Three ~~V~~vacuum breakers are provided between the DW and WW. The vacuum breaker is a process-actuated valve, similar to a check valve, see Figure 6.2-28. 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~~ each vacuum breaker, pneumatically operated fail-as-is safety-related isolation valves are provided to isolate a leaking or stuck open vacuum breakera DC-powered solenoid-controlled and spring-operated backup 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 backup isolation valve to prevent extra bypass leakage due to the opening created bythrough the vacuum breaker and therefore maintain the pressure suppression capability of the containment. In addition to the proximity sensors, there are temperature sensors located between the vacuum breaker and the isolation valve. These sensors will detect a rise in temperature due to the hot drywell gas bypass, relative to the wetwell gas, which will generate another control signal to close the isolation valve. The safety-related logic and control of the isolation valve is independent of the safety-related Q-DCIS. The isolation valve can also be manually opened or closed. For more discussion on the logic control of the vacuum breaker isolation valves, see Subsection 7.3.6. Redundant vacuum breaker systems are provided to protect against a single failure of vacuum breaker, that is, failure to open or failure to close when required. The design DW-to-WW pressure difference and the vacuum breaker full open differential pressure are given in Table 6.2-1.

The vacuum breaker and vacuum breaker isolation valves are protected from pool swell loads by structural shielding/debris screen designed for pool swell loads determined based on the Mark II/III containment design. Both valves are located in the drywell and connected to the wetwell gas space by a penetration through the diaphragm floor. The structural shielding/debris screen is located in the wetwell gas space at the inlet side of the penetration.

A safety-related PCCS is incorporated into the design of the containment to remove decay heat from DW following a LOCA. The PCCS uses six elevated heat exchangers (condensers) located outside the containment in large pools of water at atmospheric pressure to condense steam that has been released to the DW following a LOCA. This steam is channeled to each of the condenser tube-side heat transfer surfaces where it condenses and the condensate returns by gravity flow to the GDCS pools. Noncondensable gases are purged to the suppression pool via vent lines. The PCCS condensers are an extension of the containment boundary, do not have isolation valves, and start operating immediately following a LOCA. These low pressure PCCS condensers provide a thermally efficient heat removal mechanism. No forced circulation equipment is required for operation of the PCCS. Steam produced, due to boil-off in the pools surrounding the PCCS condensers, is vented to the atmosphere. There is sufficient inventory in these pools to handle at least 72 hours of decay heat removal. The PCCS is described and discussed in detail in Subsection 6.2.2.

The containment design includes a Drywell Cooling System (DCS) to maintain DW temperatures during normal operation within acceptable limits for equipment operation as described in Subsection 9.4.8.

Protection against the dynamic effects from the piping systems is provided by the DW structure. The DW structure provides protection against the dynamic effects of plant-generated missiles (Section 3.5).

An equipment hatch for removal of equipment during maintenance and an air lock for entry of personnel are provided in both the lower and upper DW. These access openings are sealed under