HITACHI

GE Hitachi Nuclear Energy

James C. Kinsey
Vice President, ESBWR Licensing

PO Box 780 M/C A-55
Wilmington, NC 28402-0780
USA

T 910 675 5057
F 910 362 5057

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Subject: Response to Portion of NRC Request for Additional Information Letter No. 96 Related to ESBWR Design Certification Application - Emergency Core Cooling Systems - RAI Number 6.3-78

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.

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

Sincerely,

James C. Kinsey
Vice President, ESBWR Licensing

D068
NRO

Reference:

1. MFN 07-231, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 96 Related to ESBWR Design Certification Application*, April 12, 2007

Enclosures:

1. MFN 08-084 - Response to Portion of NRC Request for Additional Information Letter No. 96 Related to ESBWR Design Certification Application - Emergency Core Cooling Systems - RAI Number 6.3-78
2. MFN 08-084 - Response to Portion of NRC Request for Additional Information Letter No. 96 Related to ESBWR Design Certification Application - Emergency Core Cooling Systems - RAI Number 6.3-78 – 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	0000-0075-9371R1

Enclosure 1

MFN 08-084

Response to Portion of NRC Request for Additional Information Letter No. 96 Related to ESBWR Design Certification Application

Emergency Core Cooling Systems

RAI Number 6.3-78

NRC RAI 6.3-78:

In DCD Tier 2, Revision 3, Section 6.3.2.7.2, the "Biased open check valve" name is changed to "GDCS check valve," and Figure 6.3-3, which was showing the "Biased Open Check Valve," is deleted. The Description of Change provided with DCD Revision 3 states: "Revised description of GDC check valve." It does not explain why the valve design was changed, although it seems there was a significant change in the design of the check valve. The check valve will be normally open instead of biased-open. Please address the following:

A. *Describe the design differences between the old and the new design.*

B. *Add the typical check valve figure in the DCD as before.*

C. *Confirm that the check valves used for injection and equalization are of different types.*

D. *Provide additional information demonstrating that the core remains covered considering failure of GDCS check valves as the single active failure for design basis LOCA events. Provide this information for the cases where reactor vessel pressure is higher than that of the GDCS and the check valve fails to close.*

GEH Response:

A. The old design was a biased-open, tilting disk check valve installed in a horizontal piping run. The new design is a normally open, piston check valve installed in a horizontal or vertical piping run. DCD Tier 2, Subsection 6.3.2.7.2, will be revised to more fully describe the design requirements for the Gravity-Driven Cooling System (GDCS) injection and equalization line check valves.

B. A specific valve design has not yet been selected; however, since there will not be any unique characteristics in this valve design, a figure in DCD Tier 2 is not necessary.

C. The GDCS injection and equalization line check valves are the same design. These lines are not redundant lines, are subject to different differential pressure and flow conditions during a loss-of-coolant accident (LOCA), and therefore would not benefit from the use of different check valve designs to eliminate/minimize the possibility of common mode failures.

D. An Inspections, Tests, Analyses and Acceptance Criteria (ITAAC) item will be added to DCD Tier 1, Subsection 2.4.2 and Table 2.4.2-3, to perform type testing of the GDCS check valves to measure the fully open flow coefficient (Cv) in the reverse flow direction, and to verify the measured value is less than the value assumed in the LOCA analyses. This verification will confirm that the core would remain covered in the event of a GDCS check valve failure following a LOCA, despite back flow through the GDCS injection line.

DCD Impact:

DCD Tier 1, Subsection 2.4.2 and Table 2.4.2-3, and DCD Tier 2, Subsection 6.3.2.7.2, will be revised as shown in the attached markup.

Enclosure 2

MFN 08-084

Response to Portion of NRC Request for Additional Information Letter No. 96 Related to ESBWR Design Certification Application

Emergency Core Cooling Systems

RAI Number 6.3-78

DCD Markups

2.4.2 Emergency Core Cooling System - Gravity-Driven Cooling System

Design Description

Emergency core cooling is provided by the Gravity-Driven Cooling System (GDCS) located within containment in conjunction with the ADS in case of a LOCA.

(1) The functional arrangement of the GDCS is as listed in Table 2.4.2-1 and shown on Figure 2.4.2-1.

(2) a. Components identified in Table 2.4.2-1 as ASME Code Section III are designed, fabricated, installed, and inspected in accordance with the ASME Code, Section III requirements.

b. Piping identified in Table 2.4.2-1 as ASME Code Section III are designed, fabricated, installed, and inspected in accordance with the ASME Code, Section III requirements.

(3) a. Pressure boundary welds in components identified in Table 2.4.2-1 as ASME Code Section III meet ASME Code Section III requirements.

b. Pressure boundary welds in piping identified in Table 2.4.2-1 as ASME Code Section III meet ASME Code Section III requirements.

(4) a. Each component identified in Table 2.4.2-1 as ASME Code Section III retains its pressure boundary integrity at under internal pressures that will be experienced during service.

b. The piping identified in Table 2.4.2-1 as ASME Code Section III retains its pressure boundary integrity at design pressure.

(5) a. The seismic Category I equipment identified in Table 2.4.2-1 can withstand seismic design basis loads without loss of safety function.

b. Each of the lines identified in Table 2.4.2-1 for which functional capability is required is designed to withstand combined normal and seismic design basis loads without a loss of its functional capability.

(6) The minimum set of displays, alarms and controls, based on the applicable codes and standards, including HFE evaluations and emergency procedure guidelines, is available in the main control room.

(7) The equipment qualification of GDCS components is addressed in Tier 1 Section 3.8.

(8) a. The GDCS injections lines provide sufficient flow to maintain water coverage one meter above TAF for 72 hours following a design basis LOCA.

b. The GDCS equalizing lines provide sufficient flow to maintain water coverage one meter above TAF for 72 hours following a design basis LOCA.

(9) The GDCS squib valve used in the injection and equalization open as designed.

(10) a. Check valves designated in Figure 2.4.2-1 as having an active safety-related function open, close, or both open and also close under system pressure, fluid flow, and temperature conditions.

b. The GDCS injection line check valves meet the criterion for maximum fully open flow coefficient in the reverse flow direction.

(11) Control Room indications and controls are provided for the GDCS.

(12) GDCS squib valves maintain RPV backflow leak tightness and maintain reactor coolant pressure boundary integrity during normal plant operation.

(13) Each GDCS injection line includes a nozzle flow limiter to limit break size.

(14) Each GDCS equalizing line includes a nozzle flow limiter to limit break size.

(15) Each of the GDCS divisions is powered from their respective safety-related power divisions.

(16) Each mechanical division of the GDCS outside the drywell is physically separated from the other divisions with the exception of divisions B and C connected to pool B/C as shown in Figure 2.4.2-1.

(17) The GDCS pools A, B/C, and D are sized to hold a minimum drainable water volume.

(18) The GDCS pools A, B/C, and D are of sized for holding a specified minimum water level.

(19) The minimum elevation change between minimum water level of GDCS pools and the centerline of GDCS injection line nozzles is sufficient to provide gravity-driven flow.

(20) The minimum drainable volume from the suppression pool to the RPV is sufficient to meet long-term post-LOCA core cooling requirements.

(21) The long-term GDCS minimum equalizing driving head is based on RPV Level 0.5.

(22) The GDCS Deluge squib valves open as designed.

Refer to Subsection 2.2.15 for "Instrumentation and Controls Compliance with IEEE Standard 603."

Inspections, Tests, Analyses and Acceptance Criteria

Table 2.4.2-3 provides a definition of the inspections, test and/or analyses, together with associated acceptance criteria for the Gravity-Driven Cooling System.

Table 2.4.2-3

ITAAC For The Gravity-Driven Cooling System

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
10a. Check valves designated in Figure 2.4.2-1 as having an active safety-related function open, close, or both open and also close under system pressure, fluid flow, and temperature conditions.	Type tests of valves for opening, closing, or both opening and also closing, will be conducted.	Based on the direction of the differential pressure across the valve, each check valve opens, closes, or both opens and closes, depending upon the valve's safety functions.
10b. The GDCS injection line check valves meet the criterion for maximum fully open flow coefficient in the reverse flow direction.	Type tests of the GDCS check valves to determine the fully open flow coefficient in the reverse flow direction will be conducted.	A report exists that documents that the fully open flow coefficient for the GDCS injection line check valves in the reverse flow direction is less than the value assumed in the LOCA analysis.

safety-related thermocouples monitoring the lower drywell temperature do not sense the temperature to be greater than a preset value. The initiation signal opens the deluge valve on each separate deluge line to allow GDCS pool water to drain to the lower drywell. This water aids in cooling the molten core.

Equipment and Component Description

The following describes the GDCS squib valve, deluge valve and biased-open check valve, which are unique system components that are not used in previous BWR designs.

Squib Valve

The function of the squib valve is to open upon an externally applied signal and to remain in its full open position without any continuing external power source in order to admit reactor coolant makeup into the reactor pressure vessel in the event of a LOCA. The valves also function in the closed position to maintain RPV backflow leaktight and maintain reactor coolant pressure boundary during normal plant operation. The GDCS squib valves have a C_v that will permit development of full GDCS flow. The valve is a horizontally mounted, straight through, long duration submersible, pyrotechnic actuated, non-reclosing valve with metal diaphragm seals and flanged ends. The valve design is such that no leakage is possible across the diaphragm seals throughout the 60-year life of the valve. The squib valve is classified as Quality Group A, Seismic Category I, and ASME Section III Class 1. The valve diaphragm forms part of the reactor pressure boundary and as such is designed for RPV service level conditions.

Illustrated in Figure 6.3-2 is a typical squib valve design that satisfies GDCS system requirements. This valve has similar design features to the ADS depressurization valve.

Valve actuation initiates upon the actuation of either of two squib valve initiators, a pyrotechnic booster charge is ignited, and hot gasses are produced. To minimize the probability of common mode failure, the injection line squib valve pyrotechnic booster charge is from a different batch than from the batch used in equalizing line squib valves. When these gasses reach a designed pressure, a tension bolt holding a piston breaks allowing the piston to travel downward until it impacts the ram and nipple shear caps. Once the piston impacts the ram and nipple shear caps, the nipples are sheared. The ram and shear caps are then driven forward and are locked in place at the end of stroke by an interference fit with the nipple retainer. This lock ensures that the nipples cannot block the flow stream and provides a simple means of refurbishment by simply unthreading the plug. A switch located on the bottom of the valve provides a method of indication to the control room of an actuated valve. The shear nipple sections are designed to produce clean shear planes.

The piston is allowed to backup after shearing the nipples. Standard metal seals are installed on the piston to reduce the potential of ballistic products from entering the flow stream.

The squib valve can be completely refurbished once fired. The squib valve housing, nipples, adapter flanges, actuator housing, indicator switch body, indicator plunger, head cap, coupling, collar and adapter are machined. The piston, ram, and tension bolt are made from heat treated material for necessary strength.

GDCS Check Valve

The GDCS check valves are designed and installed such that the ~~check~~ valves ~~is~~are fully open ~~when~~ with zero differential pressure ~~is applied~~ across the ~~check~~ valve and fully closed with a low reverse differential pressure to prevent back flow. ~~The full open position is accomplished by valve design and installation.~~ The check valve is a long duration submersible, piston check valve (of suitable pattern such as Y-pattern or axial flow) installed in a horizontal or vertical piping run. The valve meets the requirements for minimum fully open flow coefficient in the forward flow direction and maximum fully open flow coefficient in the reverse flow direction. The reverse flow coefficient addresses the case in which ~~requirements for~~ a check valve ~~stuck~~ sticks in the fully open position following a LOCA. Type testing is performed to verify the valve meets the reverse flow coefficient requirement. The results of the testing and a comparison of the measured flow coefficient to the maximum value will be documented in a report. The check valve is classified as Quality Group A, Seismic Category I, and ASME Section III Class 1.

Remote check valve position indication is provided in the main control room by position-indication instrumentation.

Deluge Valve

The deluge valve is a 50 mm (2 inch) squib valve similar in design to the SLC squib valves or ADS depressurization valves. To minimize the probability of common mode failure, the deluge valve pyrotechnic booster material is different from the booster material in the other GDCS squib valves. The pyrotechnic charge for the deluge valve is qualified for the severe accident environment in which it must operate.

6.3.2.7.3 Safety Evaluation

GDCS performance evaluation during a LOCA is covered in Subsection 6.3.3.

All piping and valves (including supports) connected with the RPV, including squib valves, and up to and including the check valve are classified as follows:

- Safety-Related
- Quality Group: A
- Seismic Category: I

All piping and valves (including supports) connecting the GDCS pools and S/P to the check valve, and all piping and valves (including supports) connecting GDCS pool to lower drywell are classified as follows:

- Safety-Related
- Quality Group: B
- Seismic Category: I

The electrical design is classified safety-related.

6.3.2.7.4 Testing and Inspection Requirements

Performance Tests

During fabrication, the GDCS components are subjected to various tests and examinations as required by the ASME Code, including hydrostatic testing and operability testing.

The GDCS is tested for its operational ECCS function during the preoperational test program. Each component is tested for power source, range, setpoint, position indication, etc.