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Subject: Response to Portion of NRC Request for Additional Information Letter No. 126 Related to ESBWR Design Certification Application, RAI Numbers 14.3-181, 14.3-182, 14.3-186, 14.3-187, 14.3-309, and 14.3-310

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) response to the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) sent by NRC letter dated December 20, 2007 (Reference 1). RAI Numbers 14.3-181, 14.3-182, 14.3-186, 14.3-187, 14.3-309, and 14.3-310 are addressed in Enclosure 1.

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
Vice President, ESBWR Licensing

D068
NRO

Reference:

1. MFN 07-718, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request For Additional Information Letter No. 126 Related To ESBWR Design Certification Application*, dated December 20, 2007

Enclosure:

1. Response to Portion of NRC Request for Additional Information Letter No. 126 Related to ESBWR Design Certification Application, RAI Numbers 14.3-181, 14.3-182, 14.3-186, 14.3-187, 14.3-309, and 14.3-310

cc:	AE Cubbage	USNRC (with enclosure)
	GB Stramback	GEH/San Jose (with enclosure)
	RE Brown	GEH/Wilmington (with enclosure)
	DH Hinds	GEH/Wilmington (with enclosure)
	EDRF Section	0000-0081-4162 (RAI 14.3-181)
		0000-0081-5095 (RAI 14.3-182)
		0000-0069-4260 (RAI 14.3-186)
		0000-0081-0583 (RAI 14.3-187)
		0000-0081-0596 (RAI 14.3-309)
		0000-0081-0599 (RAI 14.3-310)

MFN 08-086 Supplement 18

Enclosure 1

*Response to Portion of NRC Request for Additional Information Letter No. 126 Related to ESBWR Design Certification Application

RAI Numbers 14.3-181, 14.3-182, 14.3-186, 14.3-187, 14.3-309, and 14.3-310

*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.

NRC RAI 14.3-181

NRC Summary:

Loss of Motive Power Position

NRC Full Text:

DCD Tier 1, Revision 4, Section 2.1.2, Nuclear Boiler System, Table 2.1.2-1 Nuclear Boiler System Mechanical Equipment SRV position during Loss of Motive Power Position is shown as "closed for relief mode". Clarification is needed. The safety relief valves (SRVs) are normally closed and when the power supply to the Solenoid valve is lost, what happens to the valve?

GE Response

The safety-relief valve (SRV) is a spring-closed safety valve for releasing excess fluid pressure from the reactor coolant pressure boundary (RCPB). The safety-mode operation is by mechanical lift on increasing pressure above the spring set-pressure value and the valve closes after a predetermined pressure reduction. To provide a means for nuclear boiler depressurization at any operating pressure, the SRV is equipped with an accessory pneumatic-actuator for relief-mode override. The pneumatic actuator is controlled by solenoid-operated pilot valves. If any closed SRV loses power it will remain closed unless RCPB pressure exceeds the overpressure setpoint. If any open SRV loses power then it will close so long as the RCPB pressure is below the overpressure setpoint.

DCD Impact

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

NRC RAI 14.3-182

NRC Summary:

DPV Test

NRC Full Text:

DCD Tier 1, Revision 4, Section 2.1.2 Nuclear Boiler System, Table 2.1.2-1, ITAAC # 24

The test pressure is given as " 1000 psig or greater." Please justify the use of "greater" in this acceptance criteria.

GEH Response

An original purpose of the DPV during SBWR development was to respond to a high-pressure condition during an ATWS event scenario. For this reason, opening the DPV at a pressure above the mechanical lift set pressures of the SRVs and SVs (greater than 1,270 psig) is appropriate. The prototype valve inlet design pressure/temperature specification is 1,500 psig at 595°F. In the ESBWR, the DPV is also intended to provide an ECCS depressurization function, and depressurization may begin with the plant at or near rated operating pressure (1,040 psia).

Because of the inlet design pressure and temperature specification, testing for the prototype DPV has been safely performed at a facility for type testing at pressures above 1,000 psig. A central requirement of the ITAAC is for testing of the booster assemblies to demonstrate that the required gas generation rate and sustained pressurization to drive the actuator assembly is reliably achieved. The booster assembly testing does not require testing of whole DPVs, and is based on standard pyrotechnic test and measurement techniques that are safer to conduct than a test conducted on a pressurized DPV. Prototype testing is the basis for determining the booster assembly acceptance criteria. The testing is documented in a report made available to the NRC in response to RAI Nos 3.9-1 Supplements 01and 02 (MFN 06-127, Supplement 1).

The pressure value is, of course, a requirement that is coupled with a response time to reach full-open for the acceptance criterion. The DPV is designed to have rapid opening in order to halt the consequences of pressure increase in the vessel with the event initial conditions of normal operation at rated thermal power. Thus, the DPV acceptance criterion is that the booster assembly design shall be demonstrated to reliably develop sufficient force for an opening response time equal to or less than 0.45 second with a DPV inlet pressure of 1,000 psig or greater.

DCD Impact

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

NRC RAI 14.3-186

NRC Summary:

SRV Opening delay time

NRC Full Text:

DCD Tier 1, Revision 4, Section 2.1.2 Nuclear Boiler System, Table 2.1.2-3

DCD Tier 2 Table 15.2-1 includes SRV Safety function delay time of 0.2 seconds. This delay time is a critical parameter in TRACG calculations and hence should be included in the ITAAC Table 2.1.2-3. Please update DCD Tier 1 accordingly.

GEH Response

The SRV safety actuation (mechanical lift) function is modeled in TRACG calculations with a delay time of 0.2 seconds and a valve opening time of 1.5 seconds for Anticipated Operational Occurrences (AOOs), Infrequent Events (IEs) and specified Special Events. The bounding overpressure event analyzed is a Main Steam Isolation Valve - Flux Scram (MSIVF), which is a Special Event. The analysis for this Special Event assumes the SRV delay and opening time included in DCD Tier 2, Revision 4, Table 15.2-1. The delay and opening time assumed for the AOOs, IEs and the MSIVF event is conservative compared to the SRV opening time of 0.5 seconds, with no delay time, assumed in ATWS events and included in DCD Tier 2, Revision 4, Table 15.5.3. DCD Tier 1, Revision 4, Table 2.1.2-3, Item 18 states that the opening time for the SRVs in the safety mode (mechanical lift), from the time the reactor pressure exceeds the valve set pressure to the time the valve is fully open, must be less than or equal to 0.5 seconds. Therefore, the SRV delay and opening times included in DCD Tier 2, Revision 4, Table 15.2-1 are conservative and are ensured by the DCD Tier 1, Revision 4, Table 2.1.2-3 Item 18. The specified opening time of the SRVs that are procured and installed in the plant will maintain significant margin to the analytical value utilized in the TRACG calculations for AOOs, IEs and the MSIVF event listed in DCD Tier 2, Revision 4, Table 15.2-1. Thus, DCD Tier 1 includes the necessary requirements for SRV actuation times to ensure the analyses remain conservative.

DCD Impact

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

NRC RAI 14.3-187

NRC Summary:

SRV Vacuum Breaker

NRC Full Text:

The SRV discharge vacuum breaker ITAAC is deleted in DCD Revision 4. The list of DCD changes provided by GEH indicates that the capacity and setpoint will be verified after fuel loading, as appropriate. Clarify why shop tests or type tests can not be performed to verify the capacity and set point.

GE Response

An ITAAC will be restored to type test vacuum breaker cracking pressure and full-lift flow capacity. Cracking pressure is the minimum pressure differential at which the vacuum breaker disk unseats. Design cracking pressure and full-lift flow capacity acceptance criteria are analytically determined for the restoration of gas pressure in the SRV discharge lines to prevent a liquid slug being drawn up the discharge line when steam in the line condenses following an SRV discharge. There will not be an installed verification of these characteristics.

DCD Impact

DCD Tier 1 Subsection 2.1.2, Item 29 and Table 2.1.2-3, ITAAC # 29 will be revised as noted in the attached markup.

NRC RAI 14.3-309

NRC Summary:

MSIV testing under preoperational conditions

NRC Full Text:

In ITAAC Table 2.1.2-3, for clarity in ITAAC #15, the staff requests that the applicant justify the acceptability of testing of as-built MSIVs under preoperational conditions. There is an inconsistency in the ITA in that it is not clear how testing at preoperational conditions will verify the DC which specifies MSIV fast closing under design differential pressure, fluid flow and temperature conditions

In addition, the AC does not provide documenting the results of type testing, as allowed for in the ITA, if that is the method used for verification. The staff requests that the applicant modify the AC to include the results of type testing in the report

GEH Response

Based on the comments above, ITA and AC for DCD Tier 1 Table 2.1.2-3, ITAAC #15 will be revised as the following:

Design Description	Inspections, Tests, Analyses	Acceptance Criteria
The MSIVs are capable of fast closing under design differential pressure, fluid flow and temperature conditions.	Type tests of the as-built MSIV will be conducted in accordance with the design and purchase specifications to demonstrate that the MSIVs will fast close under design conditions.	Report(s) document that type testing demonstrates MSIVs are capable of fast closure in not less than 3 seconds and not more than 5 seconds under design conditions..

DCD Impact

DCD Tier 1 Table 2.1.2-3, ITAAC #15 will be revised as shown in the attached markup.

NRC RAI 14.3-310

NRC Summary:

MSIV leakage

NRC Full Text:

In ITAAC Table 2.1.2-3, for clarity in ITAAC #16, the staff requests that the applicant specify "normal means" in the DC (i.e., the staff assumes this to be through use of safety related equipment rather than the normal operator air supply). In addition, the staff requests the applicant to justify the acceptability of testing under pre-operational conditions. Finally, the staff requests that the AC be consistent in verifying the DC (i.e., report should document the means by which MSIVs are closed and are consistent with the "normal means" specified).

GEH Response

Based on the comments above, DCD Tier 1 Section 2.1.2 (16) and DC and AC for Table 2.1.2-3, ITAAC #16 will be revised as the following:

Design Description	**Inspections, Tests, Analyses**	**Acceptance Criteria**
When all four inboard or outboard MSIVs are stroked from full-open to full-closed position by their actuators, the combined leakage through the MSIVs for all four MSLs will be less than or equal to the design bases assumption value.	Tests at preoperational conditions along with analysis will be performed on the as-built MSIVs to determine the leakage as adjusted to the specified design conditions.	Report(s) document that, when all MSIVs are stroked from the full-open to full-closed position by their actuators, the combined leakage through the MSIVs for all four MSLs is less than or equal to a total combined leakage (corrected to standard conditions) of ~0.0623 m^3/minute (~2.2ft^3/minute) for post-LOCA leakage.

DCD Impact

DCD Tier 1 Section 2.1.2, Item 16 and Table 2.1.2-3, ITAAC #16 will be revised as noted in the attached markup.

(17) The opening pressure for the SRVs mechanical lift mode satisfies the overpressure protection analysis.

(18) The opening time for the SRVs in the overpressure operation of self-actuated or mechanical lift mode, which is measured from when the pressure exceeds the valve set pressure to when the valve is fully open, shall be less than or equal to the opening time used in the ATWS analyses. ~~The opening time for the SRVs (in the overpressure operation of self-actuated or mechanical lift mode) is measured from when the pressure exceeds the valve set pressure to when the valve is fully open shall be less than or equal to the design opening time.~~

(19) The steam discharge capacity of each SRV satisfies (i.e., is greater than or equal to that used in) the overpressure protection analysis.

(20) The opening pressure for the SVs satisfies (i.e., is less than or equal to that used in) the overpressure protection analysis.

(21) The opening time for the SVs is measured from when the pressure exceeds the valve set pressure to when the valve is fully open shall be less than or equal to the design opening time.

(22) The steam discharge capacity of each SV satisfies (i.e., is greater than or equal to that used in) the overpressure protection analysis.

(23) The relief-mode actuator (and safety-related appurtenances) can open each SRV with the drywell pressure at design pressure.

(24) When actuated by an ~~initiator~~(igniter charge), the booster assembly opens each DPV in less than or equal to the design opening time (opening time to full rated capacity)~~and design conditions~~.

(25) Each DPV minimum flow capacity is sufficient to support rapid depressurization of the RPV (i.e., has a flow capacity that is greater than or equal to the design flow capacity under design basis conditions).

(26) The equipment qualification of the NBS components is addressed in Tier 1, Section 3.8.

(27) The containment isolation portions of the NBS are addressed in Tier 1, Subsection 2.15.1.

(28) Vacuum breakers are provided on SRV discharge lines to reduce the post-discharge reflood height of water in the discharge lines.

(29) The SRV discharge line (SRVDL) vacuum breakers close to prevent steam bypass to the drywell during SRV discharge, and open following a discharge completion to permit pressure equalization with the drywell and prevent ingestion of a water slug into the SRVDL.

(30) The pressure loss coefficient of each of the following components is within the uncertainty band of the pressure loss coefficient used in the natural circulation flow analysis

- Steam separator
- Fuel bundle
- Fuel support piece orifice
- Control rod guide tubes
- Shroud support

Table 2.1.2-3

ITAAC For The Nuclear Boiler System

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
27. The containment isolation portions of the NBS are addressed in Tier 1, Subsection 2.15.1.	See Tier 1 Subsection 2.15.1.	See Tier 1 Subsection 2.15.1.
28. Vacuum breakers are provided on SRV discharge lines to reduce the post-discharge reflood height of water in the discharge lines.	An inspection will be performed to confirm that the vacuum breakers are installed.	Inspection report(s) document that the vacuum breakers are installed on the SRV discharge lines. An analysis exists that demonstrates that the vacuum breaker capacity and setpoint limit the water column in the discharge line.
29. The SRV discharge line (SRVDL) vacuum breakers close to prevent steam bypass to the drywell during SRV discharge, and open following a discharge completion to permit pressure equalization with the drywell and prevent ingestion of a water slug into the SRVDL	Type test will be performed on the vacuum breaker for disk-closed leakage at line pressure during SRV discharge, disk cracking (unseating) pressure, and full-open flow capacity.	Test report will document the following test criteria are met: • At SRVDL line pressure during SRV discharge the vacuum breaker leak rate is less than or equal to design leak rate; • The disk unseat begins at design cracking pressure; and, • At disk full lift the vacuum breaker achieves equal to or greater than design flow capacity.

Table 2.1.2-3

ITAAC For The Nuclear Boiler System

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
15. The MSIVs are capable of fast closing under design differential pressure, fluid flow and temperature conditions.	Type tests ~~Tests~~ of the as-built MSIV ~~will be conducted under preoperational test conditions or type testing of an MSIV~~ will be conducted in accordance with the design and purchase specifications to demonstrate that the MSIVs will fast close under design conditions.	Report(s) document that type testing demonstrates MSIVs are capable of fast closure in not less than 3 seconds and not more than 5 seconds under design conditions.
16. When all four inboard or outboard MSIVs are ~~closed by normal means~~stroked from full-open to full-closed position by their actuators, the combined leakage through the MSIVs for all four MSLs will be less than or equal to the design bases assumption value.	Tests at preoperational conditions along with analysis will be performed on the as-built MSIVs to determine the leakage as adjusted to the specified design conditions.	Report(s) document that, when all MSIVs are ~~closed~~stroked from the full-open to full-closed position by their actuators, the combined leakage through the MSIVs for all four MSLs is less than or equal to a total combined leakage (corrected to standard conditions) of ~0.0623 m^3/minute (~2.2 ft^3/minute) for post-LOCA leakage.
17. The opening pressure for the SRVs mechanical lift mode satisfies the overpressure protection analysis, by lifting at its nominal setpoint pressure.	Type test (at a facility) or setpoint test will be conducted in accordance with the ASME Code to certify the valve.	Report(s) document that testing/type testing verifies the mechanical lift nominal setpoint pressure of 8.366 $\pm$ 0.251 MPa gauge (1213 $\pm$ 36.39 psig).

(7) Each mechanical train of safety-related NBS equipment located in the Reactor Building outside the drywell is physically separated from the other trains.

(8) ~~Instrumentation and Control~~Isolation Capability

a. The MSIVs close upon command

b. The FWIVs close upon command

~~a.~~c. NBS minimum inventory of alarms, displays, and status indications in the main control room are addressed in section 3.3~~Control Room alarms, displays, and/or controls provided for the NBS are defined in Table 2.1.2-2.~~

~~b.The MSIVs close upon any of the following conditions:~~

~~-Main Condenser Vacuum Low (Run mode)~~

~~-Turbine Area Ambient Temperature High~~

~~-MSL Tunnel Ambient Temperature High~~

~~-MSL Flow Rate High~~

~~-Turbine Inlet Pressure Low~~

~~-Reactor Water Level Low~~

(9) ~~Repositional~~ Repositionable valves (not including the DPVs (squib-activiated valves) or safety/relief valves) designated in Table 2.1.2-2 as having an active safety-related function open, close, or both open and also close under ~~design~~ differential pressure, fluid flow, and temperature conditions.

(10) ~~The pneumatically operated valve(s) shown in Figure 2.1.2-2 closes (opens) if either electric power to the valve actuating solenoid is lost, or pneumatic pressure to the valve(s) is lost.~~Deleted

(11) Check valves designated in Table 2.1.2-1 as having an active safety-related function open, close, or both open and also close under ~~design~~ system pressure, fluid flow, and temperature conditions.

(12) The throat diameter of each MSL flow restrictor is sized for design choke flow requirements.

(13) Each MSL flow restrictor has taps for two instrument connections to be used for monitoring the flow through ~~each~~ its associated MSL.

(14) The combined steamline volume from the RPV to the main steam turbine stop valves and steam bypass valves is sufficient to meet the assumptions for AOOs and infrequent events.

(15) The MSIVs are capable of fast closing under design differential pressure, fluid flow and temperature conditions.

(16) When all four inboard or outboard MSIVs are stroked from a full-open to full-closed position by their actuators~~closed by normal means~~, the combined leakage through the MSIVs for all four MSLs will be less than or equal to the design bases assumption value.