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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 228 – Related to ESBWR Design Certification Application – Main Steam Isolation Valves – RAI Number 5.4-61**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) response to a portion of the U.S. Nuclear Regulatory Commission Request for Additional Information (RAI) sent by NRC Letter 228 (Reference 1). The GEH response to RAI Number 5.4-61 is addressed in Enclosure 1. Proposed DCD changes are shown in Enclosure 2.

If you have any questions about the information provided, please contact me.

Sincerely,

Richard E. Kingston

Richard E. Kingston
Vice President, ESBWR Licensing

D068
NRO

Reference:

1. MFN 08-623, *Letter from the U.S. Nuclear Regulatory Commission to Robert E. Brown, Request for Additional Information Letter No. 228, Related To ESBWR Design Certification Application*, dated August 6, 2008

Enclosures:

1. Response to Portion of NRC Request for Additional Information Letter No. 228 – Related to ESBWR Design Certification Application – Main Steam Isolation Valves – RAI Number 5.4-61
2. Response to Portion of NRC Request for Additional Information Letter No. 228 – Related to ESBWR Design Certification Application – Main Steam Isolation Valves – DCD Markups – RAI Number 5.4-61

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Enclosure 1

MFN 08-794

Response to Portion of NRC Request for

Additional Information Letter No. 228

Related to ESBWR Design Certification Application

Main Steam Isolation Valves

RAI Number 5.4-61

NRC RAI 5.4-61:

NRC Full Text:

Revision 5 to ESBWR DCD removes specific design descriptions for some components to be used in the ESBWR plant. For example, the specific valve design description has been removed from Subsection 5.4.5.2.2, 'Main Steam Isolation Valves Description' in ESBWR DCD (Revision 5), and replaced with a discussion of design parameters for those valves. GEH is requested to provide additional design details for the main steam isolation valves, consistent with the level of detail that was provided in DCD, Revision 4. As an alternative, GEH may establish a COL Information Item in the DCD for the COL applicant to describe the implementation of the DCD design parameters for components to be used in the ESBWR plant to the extent necessary to support the COL application.

GEH Response:

GEH reviewed this RAI with the NRC staff by telephone conference on Tuesday, September 16, 2008. The NRC staff requested that GEH do a point-by-point check of the design parameters included in DCD Revision 4 compared to DCD Revision 5 for the MSIVs. Based on the clarification obtained from that phone conference, the following DCD revision comparison has been assembled:

DCD Tier 2 Rev 4 Section 5.4.5	**DCD Tier 2 Rev 5 Section 5.4.5**
*Valve pattern/type***	*--------to be added------*
Flow resistance	Flow resistance
*Disk force balance on opening***	*--------to be added------*
Stem sealing*	--------
*Valve actuation method***	*--------to be added------*
*Actuator brief description***	*--------to be added------*
*Stem speed control***	*--------to be added------*
Valve pilot system	Valve pilot system
Valve design Press/Temp	Valve design Press/Temp
Design fluid transport conditions	Design fluid transport conditions
Seismic category of assembly	Seismic category of assembly
Quality Group, ASME Code	Quality Group, ASME Code
Design life conditions	Design life conditions
Accident service conditions	Accident service conditions
Accident duration	Accident duration
Pneumatic services facilities*	---------
Pneumatic supply accessories*	---------

DCD Tier 2 Rev 4 Section 5.4.5	**DCD Tier 2 Rev 5 Section 5.4.5**
---------	Valve installation
---------	Leak integrity
---------	Direction of flow isolation
---------	Blowdown control
---------	Stem travel

The above comparison addresses the design parameters contained in DCD Revision 4 vs. DCD Revision 5, as requested. The parameters are arranged in the order in which they are presented in DCD Revision 4. Three parameters contained in DCD Revision 4 (left-hand column with single asterisks) are not pertinent to the DCD Revision 5 discussion of nuclear boiler system (NBS) isolation design and are not included as items to be added in the right-hand column. DCD Revision 5 also includes five additional parameters that are not included in DCD Revision 4, as shown in the right hand column.

Five parameters are found in DCD Revision 4 that are not included in DCD Revision 5 (left-hand column *italics with double asterisk*). GEH will address these five design parameters for the main steam isolation valves that were included in DCD Revision 4 as a change to DCD Tier 2, Subsection 5.4.5.

Additionally, based on design similarity and the common discussion under Subsection 5.4.5, GEH will similarly address these same five parameters for the feedwater isolation valves (FWIV).

Also, because the MSIVs are referenced in additional portions of the DCD, several additional changes are made for consistency as listed below.

DCD Impact:

DCD Tier 2, Subsection 5.4.5 will be revised as noted in the attached markup. Additionally, consistency changes will be made to DCD Tier 2, Table 3.9-8, Subsection 6.2.6.3, and Subsection 16.3.6.1.3

Enclosure 2

MFN 08-794

Response to Portion of NRC Request for

Additional Information Letter No. 228

Related to ESBWR Design Certification Application

Main Steam Isolation Valves
DCD Markups

RAI Number 5.4-61

Table 3.9-8

Inservice Testing

No.	Qty	Description [g]	Valve Type (i)	Act (b)	Code Class (a)	Code Cat. (c)	Valve Func. (d)	Norm Pos	Safety Pos.	Fail Safe Pos	CIV	Test Para (e)	Test Freq. (f)
(Deleted)													
F001A/B/ C/D	4	Inboard MSIV (g10)	~~GB~~ GT	NO PM	1	A	A	O	C	C	Y	L P SC FC	App J 2 yrs CS CS
F002A/B/ C/D	4	Outboard MSIV (g10)	~~GB~~ GT	AO PM	1	A	A	O	C	C	Y	L P SC FC	App J 2 yrs CS CS
F006	10	Safety relief valve (SRV) (g1)	RV	SA NO	1	A, C	A	C	O/C	N/A	--	R	5 yrs
F003	8	Safety Valve (g1)	RV	SA	1	A, C	A	C	O/C	N/A	--	R	5 yrs
F004	8	DPV on the stub tube connected to the RPV	SQ	EX	1	D	A	C	O	as-is	--	X P	E2 2 yrs
(Deleted)													
F010	1	Inboard MSIV upstream drain line inboard containment isolation valve	GT QBL	NO	1	A	A	O	C	C	Y	L P SC FC	App J 2 yrs 3 mo 3 mo

Power Generation Design Bases

The main steamlines and feedwater lines isolation systems are designed to:

- Open the MSIVs or FWIVs against a specified maximum system differential pressure;
- Allow rated steam flow and feedwater flow to be achieved without exceeding the specified design pressure drop; and
- Be designed so an MSIV or FWIV remains open if one of two solenoid-operated pilot valves fails.

5.4.5.2 Main Steamlines Isolation

5.4.5.2.1 System Description

The main steamlines isolation system is a fail-safe system, that isolates the main steamlines during normal, upset, and accident conditions under the full range of reactor pressures and flow conditions. The system consists of eight MSIV assemblies mounted in four tandem pairs in the main steamlines with one valve of each pair installed inboard of the containment penetration and one valve of each pair installed outboard of the containment penetration. The MSIVs provide isolation of the main steamlines for high-energy line breaks, for containment isolation, and when required during plant shutdown condition. The MSIVs are designed to pass rated steam flow within a design pressure drop, and to limit steamline loss-of-coolant-accident (LOCA) inflow to protect containment until the valves are closed. A detailed description of the system is provided below. The detailed description includes all of the functional details required to satisfy the isolation design objectives. The system is shown schematically as part of the Nuclear Boiler System (NBS) in Figure 5.1-2.

5.4.5.2.2 Detailed Main Steam Isolation Valves Description

MSIV characteristics are presented in Table 5.4-1.

The MSIVs are designed to a pressure and temperature consistent with the RPV maximum design conditions. MSIVs are installed welded-in to the main steamlines to maximize the reactor coolant pressure boundary (RCPB) and containment penetration integrity. Each MSIV is designed to accommodate saturated steam at plant operating conditions. The MSIVs assemblies and associated supports are designed to Seismic Category I requirements. The MSIVs form part of the RCPB and are therefore Quality Group A, and designed and fabricated to ASME Code Section III, Class 1 requirements. The safety-related portions of interconnecting piping are Quality Group C and designed to ASME Code Section III, Class 3 requirements.

The MSIVs are designed for a minimum life at the specified operating conditions. In addition to minimum wall thickness required for the design pressure, a corrosion allowance is added for the minimum design life (see Table 5.4-1).

MSIV type is a gate pattern with reducing venturi inlet and outlet nozzles to fit the steamline diameter to the valve. The design shall use removable internals for all wear parts and surfaces to permit ease of replacement, or allow refurbishment maintenance outside the valve body. The actuator shall be a high-pressure piston cylinder type. The valve actuator shall be capable of developing sufficient force for opening or closing the valve against a differential up to reactor design pressure, and to close against worst-case break flow. Operating power shall come from process-medium integral actuation (preferred design) or high-pressure nitrogen (or nitrogen-spring) yoke-mounted actuation (alternate design).

The MSIVs are designed to close under peak accident environmental radiation, pressure, and temperature conditions. In addition, they are designed to remain closed under long-term post-accident environmental conditions (see Table 5.4-1). The MSIVs must provide bi-directional flow isolation to prevent steam discharge to the external environment, and to limit steam blow-back into containment through a ruptured main steamline in the event of a LOCA. Pressure drop is adjusted by the sizing of valve flow orifice diameter of the inboard and outboard MSIVs to meet design requirements. The closed MSIV leak rate is sufficiently low to provide a margin for wear and degradation during operating service so that total leakage remains within the design allowable for the cumulative leak rate through all four main steamlines. The bidirectional isolation capability and valve orifice sizing prevents excess steam mass and energy from entering the containment during the initial containment pressurization of a LOCA. Each MSIV is nominally designed for minimal flow disruption in the full-open position to limit acoustic loads in the steam portion of the NBS. Stem travel is sufficient to clear the flow stream and prevent stem assembly flow interaction when the valve is full-open minimizing deleterious effects caused by flow-induced vibration.

Valve closure occurs when both of two automatic control pilot solenoid-operated valves (SOVs) are deenergized. Speed shall be controlled by cylinder inlet and exhaust path orifice sizing and factory set to provide the design stroke speed under rated operating and accident flow conditions. The MSIV actuates at two closing speeds (see Table 5.4-1), including a fast isolation closure by the automatic pilots, and a slow-closure speed for exercise. A separate SOV pilot valve, manually operated from the control room, is provided for a slow-closure partial- or full-stroke exercise cycle testing.

The MSIVs are supplied pneumatic service, as required, for maintenance testing and open-stroke exercising.

5.4.5.2.3 Main Steam Isolation Operation

The MSIVs are remote-manually operated from the main control room. Each valve is individually controllable. During normal plant operation, the MSIVs can be tested by cycling them in the slow closing speed (this may require reduction in reactor power to maintain steam flow and pressure within limits). Once initiated, the test sequence is automatic. After normal plant shutdown, the valves can be closed with remote manual switches.

The MSIVs close at fast speed on various automatic signals indicating abnormal plant conditions, including:

- Reactor low water level;
- Main steamline high flow;
- Low turbine inlet pressure;
- Main steamline tunnel (outside containment) high ambient temperature;
- Low condenser vacuum (unless procedurally bypassed); and

- Turbine building high main steamline ambient temperature.

In the most demanding case (a main steamline rupture downstream of an outboard MSIV), steam flow quickly increases until a venturi flow restrictor installed in each reactor vessel steam nozzle prevents further increase. During the initial part of valve closure travel the MSIV stem movement causes little effect on flow reduction because the RPV venturi restrictor chokes the flow. When the valve is sufficiently closed, the flow area approximately matches the venturi restrictor and, thereafter, steam flow is reduced as a function of the valve area versus travel characteristic.

5.4.5.3 Feedwater Lines Isolation

5.4.5.3.1 Feedwater Isolation Description

The feedwater lines isolation system is a fail-safe system that isolates the feedwater lines during normal, upset, and accident conditions under the full range of reactor and feedwater system pressures and flows. The system consists of four FWIVs, four FWCVs, and two branch connection isolation valves, as shown schematically as part of the NBS in Figure 5.1-2. One FWCV is installed as the inboard containment isolation valve and each of two in-series FWIVs are installed as outboard containment isolation valves in each feedwater line. The branch connection on each feedwater line is installed between the penetration outboard end and the first FWIV, and is isolated by a testable check valve. This arrangement satisfies the requirements of General Design Criteria (GDC) 55. The second FWIV and FWCV provide functional redundancy to meet the safety-related isolation design function requirements.

5.4.5.3.2 Detailed Feedwater Isolation Valves Description

FWIV, FWCV and the branch isolation valve characteristics are presented in Table 5.4-1. The FWCVs provide the primary isolation in the event of a HELB in the feedwater piping outboard of the NBS system. The testable check valves, along with the inboard containment isolation FWCVs, provide isolation in the event of a HELB in the branch connected piping systems. The FWIVs provide primary isolation in the event of a feedwater line LOCA, and for a vessel overfill (reactor level high) event.

The feedwater isolation system is designed to a pressure and temperature commensurate with the maximum feedwater system conditions, which bound the RPV maximum design conditions. The feedwater isolation system and associated supports are design to meet Seismic Category I requirements. The inboard containment isolation FWCVs, the two outboard containment isolation FWIVs and the containment isolation branch testable check valves are part of the RCPB and are designated Quality Group A, and are designed and fabricated to ASME Code Section III, Class 1 requirements. The remainder of the feedwater isolation system is designated Quality Group B, and the valves are designed and fabricated to ASME Code Section III, Class 2 requirements.

The feedwater isolation system components are designed for a minimum life at the specified operating conditions. In addition to minimum wall thickness required for the design pressure, a corrosion allowance is added for the minimum design life (see Table 5.4-1).

FWIV type is a gate pattern with reducing venturi inlet and outlet nozzles to fit the steam line diameter to the valve. The design shall use removable internals for all wear parts and surfaces to permit ease of replacement, or allow refurbishment maintenance outside the valve body. The actuator shall be a high-pressure piston cylinder type. The valve actuator shall be capable of developing sufficient force for closing the valve at the design pressure differential indicated on Table 5.4-1, and for opening the valve as required to support feedwater injection for reactor makeup. Operating power shall come from process-medium integral actuation (preferred design) or high-pressure nitrogen (or nitrogen-spring) yoke-mounted actuation (alternate design). Valve closure occurs when both of two automatic control pilot solenoid-operated valves (SOVs) are energized. Speed shall be controlled by cylinder inlet and exhaust path orifice sizing and factory set to provide the design stroke speed under rated operating and accident flow conditions.

The FWIVs, FWCVs and branch piping testable check valves are designed to close under peak accident environmental radiation, pressure, and temperature conditions. The portion of the feedwater system that forms the feedwater penetration zone is designed to a pressure that is above that of the BOP feedwater system design pressure to provide protection for the rest of the RCPB from malfunctions of the FWCS. When required to isolate the feedwater lines, the FWIV closures is assured by designing them for operation at a pressure well above the design pressure of the BOP feedwater system. In addition, they are designed to remain closed under long-term post-accident environmental conditions (see Table 5.4-1). The FWIVs and FWCVs are designed to tolerate the loads resulting from the most rapid closure condition, and to mitigate to the extent practical the hydraulic affects of rapid closure.

The branch isolation valves are testable checks and also designed to tolerate loads resulting from the most rapid valve closure condition. The disk has a design-augmented load to assist leak-tight seating. The augmented load is low enough to allow condensate makeup systems to push open the disk for post-event injection into the RPV without restoration of any actuation or control power to the valves.

The FWIVs, and feedwater lines branch connection testable check isolation valves, are supplied pneumatic service, as required, for maintenance testing and open-stroke exercising.

5.4.5.3.3 Feedwater Isolation System Operation

The FWIVs are remote-manually operated from the main control room. Each valve is individually controllable. During low-power plant operation, the FWIVs can be exercised by cycling them one feedwater line at a time. After normal plant shutdown, the valves can be maintained closed or open with remote manual switches.

The FWIVs close on various automatic signals indicating abnormal plant conditions, including:

- Feedwater lines differential pressure with coincident drywell high pressure;
- Drywell high pressure with coincident lower drywell high water level;
- Reactor low-low water level with a time delay; and
- Reactor high water level.

The FWCVs close on feedwater flow deceleration and reversal indicating abnormal feedwater system conditions upstream of the NBS interface. Similarly, the branch line testable check valves will close on flow deceleration and reversal indicating abnormal conditions upstream of the NBS branch connection interface. The testable check valves also close if feedwater system

All isolation valve seats that are exposed to containment atmosphere subsequent to a LOCA are tested with air or nitrogen at containment peak accident pressure P_a.

Per ANSI/ANS-56.8-1994 (for Option A) and NEI 94-01, Revision 0 (for Option B), a Type C local leakage rate test may not be performed for the following cases:

- Primary containment boundaries that do not constitute potential primary containment atmospheric pathways during and following a DBA;
- Boundaries sealed with a qualified seal system; or
- Test connection vents and drains between primary containment isolation valves that are one inch or less in size, administratively secured closed and consist of a double barrier.

Per ANSI/ANS-56.8-1994, a qualified seal system is "a system that is capable of sealing the leakage with a liquid at a pressure no less than 1.1 P_{ac} [equivalent to P_a in 10 CFR 50, Appendix J] for at least 30 days following the DBA." Type C valves with a qualified seal system are periodically tested to prove functionality by pressurizing the line with the sealing fluid to a pressure of not less than 1.10 P_a. The measured leakage is excluded when determining the combined leakage rate, provided that:

- Such valves have been demonstrated to have fluid leakage rates that do not exceed those specified in the technical specifications or associated bases; and
- The installed isolation valve seal-water system fluid inventory is sufficient to assure the sealing function for at least 30 days at a pressure of 1.10 P_a.

Unless there is essentially an unlimited supply of sealing fluid, valve-specific leakage rate limits are assigned, based on analyses to assure fluid inventory for 30 days at a pressure of 1.10 P_a assuming the most limiting single failure of any active component, and included in the Technical Specifications.

The following exemptions from 10 CFR 50 Appendix J Option A or Option B ~~are~~ is taken for Type C test for MSIVs:

- ~~For Y-globe MSIVs only, testing is preformed at a pressure less than P_a as specified in Technical Specifications. This is justified because the design of the Y-globe MSIVs is such that the test pressure that is applied between two MSIVs in the same line is in the reverse direction for the upstream MSIV. Normal test pressure tends to unseat the upstream valve disc and results in a meaningless test. Also, leakage testing at a lower differential pressure across the Y-globe MSIV is more severe and conservative than at higher differential pressure. The Y-globe MSIV seat and disc are made of steel for which the lower differential pressure does not have enough force to deform the seat and disc interface to seal off the micro-openings between the two parts. A lower test pressure drives the air across the opening whereas a higher differential pressure may actually seal some of the leakage paths.~~
- The measured leakage rate of MSIV in a Type C test is excluded when determining the combined leakage rate of components subject to Type B and Type C tests. The justification for this exemption from 10 CFR 50 Appendix J requirement is because it is excluded from L_a which is redefined in Subsection 6.2.6.1.1.

SURVEILLANCE		FREQUENCY
SR 3.6.1.3.7	Verify each automatic CIV actuates to the isolation position on an actual or simulated isolation signal.	24 months
SR 3.6.1.3.8	Verify a representative sample of reactor instrumentation line EFCVs actuate on a simulated instrument line break to restrict flow.	24 months
SR 3.6.1.3.9	Verify combined MSIV leakage rate through all four main steam lines is ≤ 1.57 E-03 standard m^3/sec (200 scfh) when tested at ≥ ~~0.5~~ P_a.	In accordance with the Containment Leakage Rate Testing Program
SR 3.6.1.3.10	Verify the combined leakage rate for both feedwater lines is ≤ 7.00E-04 standard m^3/min (2.47E-02 scfm) when tested at P_a.	In accordance with the Containment Leakage Rate Testing Program

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.6.1.3.8

This SR requires periodic verification that for a representative sample of reactor instrumentation line EFCVs each reduces flow on a simulated line break. This SR provides assurance that the instrumentation line EFCVs will perform to increase margin to predicted radiological consequences during the postulated instrumentation line break event evaluated in Reference 3.

This 24 month Frequency was developed to be consistent with the normal refueling interval. This interval will allow the SR to be performed during a plant outage because of the potential for an unplanned plant transient if the SR is performed with the reactor at power.

SR 3.6.1.3.9

This SR requires periodic verification that the leakage rate through each main steam line is within the specified limit when tested at ~~0.5~~ ≥ P_a. ~~The reduced test pressure is an exemption to 10 CFR 50, Appendix J (Ref. 6) as presented in Reference 4.~~ The analyses in Reference 3 are based on the specified leakage limit.

The MSIV leakage rate must be verified at a frequency in accordance with Containment Leakage Rate Testing Program. These periodic testing requirements verify that the containment leakage rate does not exceed the leakage rate assumed in the safety analyses in Reference 3. Maintaining the MSIVs OPERABLE requires compliance with requirements of 10 CFR 50, Appendix J (Ref. 6), as modified by approved exemptions.

SR 3.6.1.3.10

This SR requires periodic verification that the combined leakage rate for both feedwater line leakage paths is within limits. The leakage rate must be verified in accordance with Containment Leakage Rate Testing Program. These periodic testing requirements verify that the containment leakage rate does not exceed the leakage rate assumed in the safety analyses in References 3 and 4. Maintaining the combined feedwater line leakage paths OPERABLE requires compliance with requirements of 10 CFR 50, Appendix J (Ref. 6), as modified by approved exemptions, which are identified in the Containment Leakage Rate Testing Program.

BASES

REFERENCES

1. 10 CFR 52.47(a)(2)(iv).
2. 10 CFR 50, Appendix A, "General Design Criteria for Nuclear Power Plants," GDC 19.
3. Section 15.4.
4. ~~Section 6.2.~~(Not used)
5. Section 6.2, Tables 6.2-15 through 6.2-45.
6. 10 CFR 50, Appendix J, "Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors."