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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 79 - Containment Isolation Design - RAI Numbers 6.2-106 S01, 6.2-110 S01, 6.2-123 S01, and 6.2-128 S01**

Enclosure 1 contains the GE Hitachi Nuclear Energy (GEH) response to the subject NRC RAIs originally transmitted via the Reference 1 letter and supplemented by NRC requests for clarification in Reference 2.

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

Sincerely,

Kathy Sedney for

James C. Kinsey
Vice President, ESBWR Licensing

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NRO

References:

1. MFN 06-393, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 79 Related to ESBWR Design Certification Application*, October 11, 2006
2. E-Mail from Shawn Williams, U.S. Nuclear Regulatory Commission, to George Wadkins, GE Hitachi Nuclear Energy, dated May 30, 2007 (ADAMS Accession Number ML071500023)

Enclosure:

1. MFN 06-461 Supplement 6 - Response to Portion of NRC Request for Additional Information Letter No. 79 - Related to ESBWR Design Certification Application - Containment Isolation Design - RAI Numbers 6.2-106 S01, 6.2-110 S01, 6.2-123 S01, and 6.2-128 S01

cc:

AE Cubbage	USNRC (with enclosures)
GB Stramback	GEH/San Jose (with enclosures)
RE Brown	GEH/Wilmington (with enclosures)
eDRF	RAI 6.2-106 S01: 0000-0076-1057
	RAI 6.2-110 S01: 0000-0076-8747
	RAI 6.2-123 S01: 0000-0076-5936
	RAI 6.2-128 S01: 0000-0076-7640

Enclosure 1

MFN 06-461 Supplement 6

Response to Portion of NRC Request for

Additional Information Letter No. 79

Related to ESBWR Design Certification Application

Containment Isolation Design

RAI Numbers 6.2-106 S01, 6.2-110 S01, 6.2-123 S01, and 6.2-128 S01

NRC RAI 6.2-106 S01:

The applicant's response to RAI 6.2-106 did not address the intent of the original RAI. A portion of the RAI is restated below:

In DCD, subsection 6.2.4.1, "Design Bases," under the heading "Safety Design Bases," the 3rd bullet states: "The design of isolation valves for lines penetrating the containment follows the requirements of General Design Criteria 54 through 57 'to the greatest extent practicable consistent with safety and reliability.'" [emphasis added]. The staff does not understand the intent of the highlighted phrase.

As applicable, remove this statement, request an exemption, or revise the statement to include, "... except as noted below," and then provide the specific exceptions.

GEH Response:

In DCD Tier 2, Revision 3, a reference was added to identify the exemptions from 10 CFR 50, Appendix A, General Design Criteria (GDC) 54 through 57. These exemptions are identified in DCD Tier 2, Table 1.9-6. As requested, DCD Tier 2, Subsection 6.2.4.1, first paragraph, third bullet, will be revised to remove the statement, "to the greatest extent practicable consistent with safety and reliability."

DCD Impact:

DCD Tier 2, Subsection 6.2.4.1, first paragraph, third bullet, will be revised as shown in the attached markup.

6.2.4.1 Design Bases

Safety Design Bases

- Containment isolation valves provide the necessary isolation of the containment in the event of accidents or other conditions and prevent the unfiltered release of containment contents that cannot be permitted by 10 CFR 50.34(a)(1) limits. Leak-tightness of the valves shall be verified by Type C test.
- Capability for rapid closure or isolation of pipes or ducts that penetrate the containment is performed by means or devices that provide a containment barrier to limit leakage within permissible limits;
- The design of isolation valves for lines penetrating the containment follows the requirements of General Design Criteria 54 through 57. Exemptions from these GDCs are listed in Table 1.9-6.
- Isolation valves for instrument lines that penetrate the DW/containment conform to the requirements of Regulatory Guide 1.11;
- Isolation valves, actuators and controls are protected against loss of their safety-related function from missiles and postulated effects of high and moderate energy line ruptures;
- Design of the containment isolation valves and associated piping and penetrations meets the requirements for Seismic Category I components;
- Containment isolation valves and associated piping and penetrations meet the requirements of the ASME Boiler and Pressure Vessel Code, Section III, Class 1, 2, or MC, in accordance with their quality group classification;
- The design of the control functions for automatic containment isolation valves ensures that resetting the isolation signal shall not result in the automatic reopening of containment isolation valves, and,
- Penetrations with trapped liquid volume between the isolation valves have adequate relief for thermally-induced pressurization.

Design Requirements

The containment isolation function automatically closes fluid penetrations of fluid systems not required for emergency operation. Fluid penetrations supporting ESF systems have remote manual isolation valves that can be closed from the control room, if required.

The isolation criteria for the determination of the quantity and respective locations of isolation valves for a particular system conform to General Design Criteria 54, 55, 56, 57, and Regulatory Guide 1.11. Redundancy and physical separation are required in the electrical and mechanical design to ensure that no single failure in the containment isolation function prevents the system from performing its intended functions.

Protection of Containment Isolation Function components from missiles is considered in the design, as well as the integrity of the components to withstand seismic occurrences without loss of operability. For power-operated valves used in series, no single event can interrupt motive power to both closure devices. Pneumatic powered or equivalent containment isolation POVs

are designed to fail to the closed position for containment isolation upon loss of the operator gas supply or electrical power.

The containment isolation function is designed to Seismic Category I. Safety and quality group classifications of equipment and systems are found in Table 3.2-1. Containment isolation valve functions are identified in Tables 6.2-16 through 6.2-42.

Penetration piping is evaluated for entrapped liquid subject to thermally-induced pressurization following isolation. The preferred pressure relief method is through a self-relieving penetration by selection and orientation of an inboard isolation valve that permits excess fluid to be released inward to the containment. Use of a separate relief valve to provide penetration piping overpressure protection is permissible on a case-by-case basis when no other isolation valve selection option is available.

The criteria for the design of the LD&IS, which provides containment and reactor vessel isolation control, are listed in Subsection 7.1.2. The bases for assigning certain signals for containment isolation are listed and explained in Subsection 7.3.3.

NRC RAI 6.2-110 S01:

Original RAI 6.2-110 referred to DCD, Tier 2, Revision 1, Section 6.2.4.2.2, "Instrument Lines Penetrating Containment," and Section 6.2.4.3.2.5, "Evaluation Against Regulatory Guide (RG) 1.11." The original RAI questioned whether the instrument lines in the ESBWR design conformed with the provisions of RG 1.11. In GE's response, DCD, Revision 3 contains additional information in Section 6.2.4.2.2. RAI 6.2-110 also asked the applicant to identify and describe, in the DCD tables, all instrument lines penetrating containment. In GE's response, DCD, Revision 3, Table 6.2-47 lists many instrument lines.

Supplemental Request:

The applicant's response is incomplete. The DCD, Revision 3, text specifically addresses some, but not all, of the provisions of RG 1.11, and appears to mean to address the remaining provisions by stating that the instrument lines "follow all the recommendations of Regulatory Guide 1.11." The staff cannot review or verify a simple assertion of conformance to a RG.

Further, the new information in Table 6.2-47 is incomplete. Most or all of the instrument line listings have containment penetration identifying numbers ending in "TBD" (presumably "To Be Determined") and give no information regarding compliance with RG 1.11.

Considering that the design of the instrument lines appears to be incomplete, provide in the DCD complete information demonstrating conformance with each of the specific regulatory positions of RG 1.11, for every instrument line.

GEH Response:

DCD Tier 2, Subsection 6.2.4.2.2, first paragraph, will be revised to address these comments. Specifically, the revision will address compliance with Regulatory Guide 1.11 in significantly more detail. Penetration numbers have not yet been defined for the instrument line penetrations; however, the attached DCD revision addresses the comments in this RAI related to the design of the instrument lines.

DCD Impact:

DCD Tier 2, Subsection 6.2.4.2.2, first paragraph, will be revised as shown in the attached markup.

6.2.4.2.2 Instrument Lines Penetrating Containment

Sensing instrument lines penetrating the containment follow all the recommendations of Regulatory Guide 1.11, as follows.

- Each line includes a 6 mm (¼-inch) diameter orifice such that in the event of a piping or component failure, leakage is reduced to the maximum extent practical consistent with other safety requirements. The rate of coolant loss is within the makeup capability, the integrity and functional performance of secondary containment and associated safety systems is maintained and the potential offsite exposure is substantially below the guidelines of 10 CFR 100.
- Each line is provided with a self-actuated excess flow check valve located outside containment, as close as practical to the containment. These check valves are designed to remain open as long as the flow through the instrument lines is consistent with normal plant operation; however, if the flow rate is increased to a value representative of a loss of piping integrity outside containment, the valves will close. These valves will reopen automatically when the pressure in the instrument line is reduced.
- The instrument lines are designated as Quality Group B up to and including the isolation valve, located and protected to minimize the likelihood of damage, protected or separated to prevent failure of one line from affecting the others, accessible for inspection and not so restrictive that the response time of the connected instrumentation is affected.

~~Each line has a 6 mm (1/4 inch) orifice inside the DW, as close to the beginning of the instrument line as possible, a manually operated isolation valve just outside the containment followed by an excess flow check valve. The instrument line is designed such that the instrument response time is acceptable with the presence of the orifice, and that the flow restriction is not plugged.~~

NRC RAI 6.2-123 S01:

RAI 6.2-123 noted that the influent and effluent lines of the containment inerting system, described in DCD, Tier 2, Revision 1, Sections 6.2.4.3.2.1 and 6.2.4.3.2.2, had all of their containment isolation valves (CIVs) outside of containment, but without adequate justification per the guidelines of SRP 6.2.4, Rev. 2 (section II.d.), RG 1.141, and national standard ANS-56.2/ANSI N271-1976 (sections 3.6.5 and 3.7).

The applicant's response provided DCD changes (later made in DCD Revision 3) to address the guidelines.

Supplemental Request:

The DCD revision (Revision 3) satisfies the provisions of the guidance documents, except as described in the following two items:

A. *The guidelines state that both CIVs in a line may be located outside of containment if it is not practical to place one inside containment. The DCD does not address this point. If, in fact, it is practical to place one CIV inside containment, justify the deviation from the guidelines.*

B. *The option of having both CIVs outside containment is available only for engineered safety feature (ESF) or ESF-related systems, or systems needed for safe shutdown of the plant. Tables 6.2-36 through 6.2-38 state that the containment inerting system lines are not ESF. Discuss in the DCD whether the containment inerting system lines satisfy this criterion (for example, are ESF-related or needed for safe shutdown), and, if not, justify the deviation from the guidelines.*

GEH Response:

A. For the Containment Inerting System, the location of one containment isolation valve (CIV) inside containment is not practical in that locating both CIVs outside containment protects the valves from the harsh environment of the wetwell and drywell. Also locating both CIVs outside containment allows accessibility for maintenance, inspection and testing during reactor operation. DCD Tier 2, Subsection 6.2.4.3.2.1, Influent Lines to Containment, under Containment Inerting System, and Subsection 6.2.4.3.2.2, Effluent Lines from Containment, under Containment Inerting System, will be revised to include this information, along with the data previously incorporated in the DCD Tier 2, Subsections 6.2.4.3.2.1 and 6.2.4.3.2.2 in response to RAI 6.2-123. A similar CIV arrangement was previously reviewed and approved by the staff in NUREG-1503. "Final Safety Evaluation Report Related to the Certification of the Advanced Boiling Water Reactor Design," Section 6.2.4, on pages 6-26 and 6-27, as it applied to the Advanced Boiling Water Reactor (ABWR) Containment Purge System, based on the same justifications provided in response to this RAI to be incorporated into DCD Tier 2, Subsections 6.2.4.3.2.1 and 6.2.4.3.2.2.

B. The Containment Inerting System is not an Engineered Safeguards Feature (ESF) system, an ESF related system, or a system needed for safe shutdown. Justification for deviation from the guidelines is described above in response to part A of this RAI.

DCD Impact:

DCD Tier 2, Subsection 6.2.4.3.2.1, Influent Lines to Containment, under Containment Inerting System, and Subsection 6.2.4.3.2.2, Effluent Lines from Containment, under Containment Inerting System, will be revised as shown in the attached markup.

6.2.4.3.2.1 Influent Lines to Containment
Tables 6.2-33 through 6.2-42 identifies the isolation valve functions in the influent lines to the containment.

Fuel and Auxiliary Pool Cooling System
The lines from the Fuel and Auxiliary Pool Cooling System penetrate the containment separately and are connected to the drywell spray, the suppression pool and to the GDCS pools. In each of these lines there is one pneumatic-operated or equivalent– shutoff valve outside and one check valve inside the containment. Only the GDCS pool return line pneumatic-operated or equivalent shutoff valve is automatically closed on a containment isolation signal.
Subsection 9.1.3.3 contains additional information about the containment isolation design for FAPCS including any justifications for deviation from the GDC 56 requirements.

Chilled Water System
Isolation is provided for the Chilled Water System (CWS) cooling lines penetrating containment. It is assumed that the non safety-related Seismic Category II coolant boundary of the CWS or Drywell Cooling System heat exchanger may fail, opening to the containment atmosphere. Therefore, Criterion 56 is applied to the design of the CWS containment penetration. The CWS containment influent lines have a pneumatic-operated or equivalent shutoff valve outside and a pneumatic-operated or equivalent shutoff inside the containment.

Containment Inerting System
The penetration of the Containment Inerting System consists of two tandem quarter-turn or equivalent shutoff valves (normally closed) in parallel with two tandem stop or shutoff valves. All isolation valves on these lines are outside of the containment so that they are not exposed to the harsh environment of the wet well and dry well and are accessible for maintenance, inspection and testing during reactor operation ~~to provide accessibility to the valves.~~ Both containment isolation valves are located as close as practical to the containment. The valve nearest to the containment is provided with a capability of detection and termination of a leak. The piping between the containment and the first isolation valve and the piping between the two isolation valves are designed as per requirements of SRP 3.6.2. These piping are also designed to:

- Meet Safety Class 2 design requirements~~;~~
- Withstand the containment design temperature~~;~~
- Withstand internal pressure from containment structural integrity test~~;~~
- Withstand loss-of-coolant accident transient and environment~~;~~
- Meet Seismic Category I design requirements~~; and~~
- Are protected against a high energy line break outside of containment when needed for containment isolation.

6.2.4.3.2.2 Effluent Lines from Containment

Tables 6.2-33 through 6.2-42 identify the isolation functions in the effluent lines from the containment.

Fuel and Auxiliary Pools Cooling System Suction Lines
The FAPCS suction line from the GDCS pool is provided with two power-assisted shutoff valves, one pneumatic-operated or equivalent inside and one pneumatic-operated or equivalent outside the containment.
Before it exits containment, the FAPCS suction line from the suppression pool branches into two parallel lines, each of which penetrate the containment boundary. Once outside, each parallel flow path contains two pneumatic isolation valves in series after which the lines converge back into a single flow path. Because the penetration can be under water under certain accident conditions, there can be no isolation valve located inside the containment. The valves are located as close as possible to the containment.
Subsection 9.1.3.3 contains additional information about the containment isolation design for FAPCS

Chilled Water System
The CWS effluent lines penetrating the containment each has a pneumatic-operated or equivalent shutoff valve outside containment and a pneumatic-operated or equivalent shutoff valve inside the containment.

Containment Inerting System

The penetration of the Containment Inerting System consists of two tandem quarter-turn shutoff valves (normally closed) in parallel with tandem stop or shutoff valves. All isolation valves on these lines are outside of the containment so that they are not exposed to the harsh environment of the wet well and dry well and are accessible for maintenance, inspection and testing during reactor operation. ~~to provide accessibility to the valves.~~ Both containment isolation valves are located as close as practical to the containment. The valve nearest to the containment is provided with a capability of detection and termination of a leak.
The piping between the containment and the first isolation valve and the piping between the two isolation valves are designed as per requirements of SRP 3.6.2. These piping are also designed to:

- ~~M~~meet Safety Class 2 design requirements~~;~~
- ~~W~~withstand the containment design temperature~~;~~
- ~~W~~withstand internal pressure from containment structural integrity test~~;~~
- ~~W~~withstand loss-of-coolant accident transient and environment~~;~~
- ~~M~~meet Seismic Category I design requirements~~; and~~
- ~~A~~are protected against a high energy line break outside of containment when needed for containment isolation.

NRC RAI 6.2-128 S01:

RAI 6.2-128 noted that DCD, Tier 2, Revision 1, Tables 6.2-39 through 6.2-42 did not include information covering the Chilled Water, High Pressure Nitrogen Gas Supply, and Process Radiation Monitoring Systems.

In DCD, Revision 3, the applicant filled in the tables.

Supplemental Request:

The new information is generally acceptable, but the staff has the following questions.

A. *For the Chilled Water and High Pressure Nitrogen Gas Supply Systems, the stated applicable basis is GDC 57. The applicant's revised response to RAI 6.2-129 (ML071030343) recognizes that no ESBWR system credits a closed system inside containment (per GDC 57) as a containment isolation barrier. Please correct the tables in the DCD.*

B. *For the High Pressure Nitrogen Gas Supply and Process Radiation Monitoring Systems, the tables indicate that DCD, Tier 2 figures for the systems are "N/A." Why are system figures not applicable? When will figures be provided?*

C. *Closure times for CIVs in the High Pressure Nitrogen Gas Supply System are unacceptable. See Supplemental RAI 6.2-109 for details.*

GEH Response:

A. These tables for the Chilled Water System (CWS) and High Pressure Nitrogen Gas Supply System (HPNSS) were corrected in DCD Tier 2, Revision 4, to indicate GDC 56 as the applicable basis.

B. For the HPNSS, DCD Tier 2, Table 6.2-40, will be revised to reference the appropriate DCD Tier 2 figures. For the Process Radiation Monitoring System (PRMS), the response to RAI 6.2-127 S01 will provide the appropriate DCD Tier 2 changes.

C. As part of the response to RAI 6.2-109 S01 (MFN 06-461 Supplement 5, dated November 6, 2007), the closure times for these containment isolation valves (CIVs) have been changed from <30 seconds to <15 seconds. The proposed revision to DCD Tier 2, Table 6.2-40, was provided in the RAI 6.2-109 S01 response.

DCD Impact:

DCD Tier 2, Table 6.2-40, will be revised as shown in the attached markup.

Table 6.2-40

Containment Isolation Valve Information for the High Pressure Nitrogen Gas Supply System

Penetration Identification	P54-MPEN-0001		P54-MPEN-0002	
Valve No.	F0026	F027	F009	F010
Applicable Basis	GDC 56	GDC 56	GDC 56	GDC 56
Tier 2 Figure	~~N/A9.3-4~~	~~N/A9.3-4~~	~~N/A9.3-4~~	~~N/A9.3-4~~
ESF	No	No	No	No
Fluid	Air/N_2	Air/N_2	N_2	N_2
Line Size	50 mm	50 mm	50 mm	50 mm
Type C Leakage Test	Yes	Yes	Yes	Yes
Pipe Length from Cont. to Inboard/Outboard Isolation Valve	COL holder to provide	COL holder to provide	COL holder to provide	COL holder to provide
Leakage Through Packing[a]	(a_1)	N/A	(a_1)	N/A
Leakage Past Seat[b]	(b_2)	(b_2)	(b_2)	(b_2)
Location	Outboard	Inboard	Outboard	Inboard
Valve Type	GB, QT	CK	GB, QT	CK
Operator[c]	AO	PM	AO	PM
Normal Position	Open	Open/Closed	Open	Open/Closed
Shutdown Position	Open/Closed	Open/Closed	Open/Closed	Open/Closed
Post-Acc Position	Closed	Closed	Closed	Closed
Power Fail Position	Closed	Closed	Closed	Closed
Cont. Iso. Signal[d]	C,H	Q	C,H	Q
Primary Actuation	Automatic	Automatic	Automatic	Automatic
Secondary Actuation	Remote manual	Process Actuated	Remote manual	Process Actuated
Closure Time (sec.)	< 30	N/A	< 30	N/A
Power Source	Div. 2, 4	N/A	Div. 2, 4	N/A

Note: For explanation of codes, see legend on Table 6.2-15.