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MFN 06-231 Supplement 3

Docket No. 52-010

October 24, 2007

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. 39 - Containment Systems - RAI Numbers 6.2-90 S01 and 6.2-91 S01**

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

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

Reference:

1. MFN 06-202, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 39 Related to ESBWR Design Certification Application*, June 22, 2006

Enclosure:

1. MFN 06-231 Supplement 3 - Response to Portion of NRC Request for Additional Information Letter No. 39 - Related to ESBWR Design Certification Application - Containment Systems - RAI Numbers 6.2-90 S01 and 6.2-91 S01

cc:

AE Cubbage	USNRC (with enclosures)
GB Stramback	GEH/San Jose (with enclosures)
RE Brown	GEH/Wilmington (with enclosures)
eDRF	0000-0075-5379

Enclosure 1

MFN 06-231 Supplement 3

Response to Portion of NRC Request for

Additional Information Letter No. 39

Related to ESBWR Design Certification Application

Containment Systems

RAI Numbers 6.2-90 S01 and 6.2-91 S01

NRC RAI 6.2-90:

DCD Tier 2, Section 6.2.6.3, "Containment Isolation Valve Leakage Rate Test (Type C)," states that, for the flowmeter method, water may be used as a test medium for Type C tests, "if applicable."

Option A, section III.C.2.(a), "Test Pressure," states: "Valves, unless pressurized with fluid (e.g., water, nitrogen) from a seal system, shall be pressurized with air or nitrogen at a pressure of Pa."

Option B, section III.B., begins: "Type B pneumatic tests... and Type C pneumatic tests...." Applicable guidance is in ANSI/ANS-56.8-1994, section 3.3.5, "Test Medium," which states, in part, "Type B and Type C tests shall be conducted with air or nitrogen."

The leakage rate tests for containment isolation valves (CIVs) served by seal systems are not Type C tests per se and are addressed in RAI 6.2-91.

Delete the option for water as a Type C test medium from the DCD.

GEH Response:

As per 10 CFR 50 Appendix J, III.C.2.(b), testing of CIVs served by seal system are Type C tests. Testing some CIVs with water as a test medium is appropriate for a CIV that may be justified equivalent to a valve served by a seal system. Always applying Section III.C.2.(a) to all systems penetrating the containment could result in putting the plant in a less safe condition, and would not always ensure that post-accident leakage would be minimized. For example, the Reactor Water Cleanup/Shutdown Cooling (RWCU/SDC) system has two independent trains for (a) maintaining reactor water purification during plant operations and (b) providing nonsafety-related reactor shutdown cooling. Unlike testing with water, testing its CIVs with nitrogen requires that a shutdown cooling train to be taken out-of-service, and thus, it would not be available if a malfunction occurred in the other shutdown cooling train. Therefore, applying Section III.C.2.(a) would reduce shutdown cooling function redundancy, and thus, would put the plant in a less safe condition. Plus, the RWCU/SDC system is kept filled with water, and is designed and maintained for operation at the full reactor power pressure condition has a closed loop outside containment, and thus, its design pressure is about 20 times the post-accident containment pressure. Therefore, any post-accident CIV leakage would still be contained within RWCU/SDC system.

The DCD Tier 2, Section 6.2.6.3 second paragraph, second to last sentence is revised as shown in Attachment A.

NRC RAI 6.2-90 S01:

The applicant's response begins by citing Appendix J, but the citation is from Option A of Appendix J and does not apply to Option B. The staff anticipates that all new reactors will choose to comply with Option B for all types of containment leakage rate tests (Types A, B, and C) due to Option B's less-restrictive requirements and longer test intervals. This makes Option A-based arguments of limited value. Even within Option A, the applicant's position is debatable.

An additional significant problem with the applicant's position is that both Options of Appendix J require that the sum of all Type B and Type C leakage rates shall be less than a specified acceptance criterion. Liquid-based leakage rates cannot be directly summed with gas-based leakage rates due to the different units of measurement. The liquid-based leakage rates must first be converted to gas-based leakage rates, and the staff's long-standing position is that useable conversions from liquid-based leakage rates to gas-based leakage rates are not technically possible.

A. *Clarify in the DCD that "Type C" means testing with air or nitrogen and eliminate water as an allowed Type C test medium.*

B. *For Options A or B, address the testing of the CIVs in systems such as RWCU/SDC under the requirements for seal systems.*

   - *For Option B, an alternate or additional approach is to use the provision in NEI 94-01, Rev. 0, section 6.0, which states that no tests are required for containment boundaries (including CIVs) which do not constitute potential containment atmospheric leakage pathways during and following a design basis accident.*

GEH Response:

DCD Tier 2, Subsection 6.2.6.3 will be revised to delete the option for water as a Type C test medium. This section will also be revised as discussed in the response to RAI 6.2-91 S01 to clarify the requirements for testing containment isolation valves (CIVs) with qualified seal systems, such as CIVs in the RWCU/SDC system, and to include the referenced provision in NEI 94-01.

DCD Impact:

DCD Tier 2, Subsection 6.2.6.3, will be revised as shown in the attached markup.

NRC RAI 6.2-91:

DCD Tier 2, Section 6.2.6.3, fourth paragraph, first sentence, states: "Valves that are in lines designed to be, or remain, filled with a liquid for at least 30 days subsequent to a LOCA are leakage rate tested with that liquid at a pressure not less than 1.1 Pac." This is not consistent with, and is less conservative than, the requirements of Option A or the requirements associated with Option B of Appendix J, through ESBWR's commitment to conform to Regulatory Guide 1.163 through proposed Technical Specification 5.5.9.

Option A, section III.C.2.(b), "Test Pressure," states: "Valves, which are sealed with fluid from a seal system shall be pressurized with that fluid to a pressure not less than 1.10 Pa." Section III.C.3., "Acceptance Criterion," states:

> *"The combined leakage rate for all penetrations and valves subject to Type B and C tests shall be less than 0.60 La. Leakage from containment isolation valves that are sealed with fluid from a seal system may be excluded when determining the combined leakage rate: Provided, That;*
>
> *(a) Such valves have been demonstrated to have fluid leakage rates that do not exceed those specified in the technical specifications or associated bases, and*
>
> *(b) 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 Pa."*

For Option B, NEI 94-01, Revision 0, section 6.0, states, in part:

> *"Primary containment barriers sealed with a qualified seal system shall be periodically tested to demonstrate their functionality in accordance with the plant Technical Specifications. Specific details of the testing methodology and requirements are contained in ANSI/ANS 56.8-1994 and should be adopted by licensees with applicable systems.... Leakage from containment isolation valves that are sealed with a qualified seal system may be 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 assume the sealing function for at least 30 days at a pressure of 1.10 Pa."*

ANSI/ANS-56.8-1994 contains the following definition and criteria:

> *"qualified seal system. A system that is capable of sealing the leakage with a liquid at a pressure no less than 1.1 Pac for at least 30 days following the DBA [design basis accident]."*
>
> *"3.4 Qualified seal system testing requirements. Primary containment barriers sealed with a qualified seal system are not required to be local leakage rate tested. If a seal system is used as a primary containment barrier, it shall be periodically tested to prove its functionality. This functional test shall demonstrate that the seal system is capable of sealing the primary containment barrier(s) with the sealing liquid at a differential pressure of not less than 1.1 Pac for at least 30 days following a DBA. Qualified seal system testing is as specified in the plant's licensing basis."*

Revise the DCD to conform to these requirements.

GEH Response:

Comment is accepted. DCD Tier 2, Section 6.2.6.3, fourth paragraph will be deleted and replaced with three new paragraphs.

The DCD change is shown in Attachment A.

NRC RAI 6.2-91 S01:

RAI 6.2-91 requested DCD revisions to better reflect the regulatory requirements related to seal systems. The applicant's response was:

> *"Comment is accepted. DCD Tier 2, Section 6.2.6.3, fourth paragraph will be deleted and replaced with three new paragraphs."*

Staff reviewed the DCD, Tier 2, Revision 3, Section 6.2.6.3. Please address the following:

A. *2nd paragraph, 4th sentence: insert "Option A" after "Appendix J" to clarify that the exemption discussed is only necessary under Option A of Appendix J.*

B. *4th paragraph, 1st sentence: "sealed system" should be "seal system."*

C. *4th paragraph, 2nd sentence: There are many more requirements to be a qualified seal system (see original RAI 6.2-91). Revise this sentence to ensure it is complete and accurate. Also, a system does not have to have been designed specifically or exclusively to be a seal system, but can still be a qualified seal system if it meets the criteria for one (see original RAI 6.2-91).*

D. *5th paragraph, 2nd sentence: delete parenthetical phrase citing an exemption because no exemption is needed when there is a qualified seal system.*

E. *5th paragraph and 6th paragraphs, 2nd bullets: the word "assume" should be "assure" (error in NEI 94-01; see Option A for similar, correct language).*

F. *6th paragraph, 1st sentence: change "leak tested" to "local leakage rate tested" to be more consistent with ANS 56.8 section 3.4.*

G. *6th paragraph: The paragraph, as a whole, needs revision. The applicant would do well to quote directly from NEI 94-01, Rev. 0, and ANS 56.8, section 3.4 and the definition of "qualified seal system." Also, the staff recommends this additional guidance from SRP 6.2.6, Rev. 3 - March 2007:*

> *"...a qualified seal system is defined in ANSI/ANS-56.8-1994 as a system that is capable of sealing the leakage with a liquid at a pressure no less than 1.1 Pa, for at least 30 days following the DB LOCA. The staff's position is that the analysis of the sealing capability includes the assumption of the most limiting single failure of any active component. Also, unless there is a virtually unlimited supply of sealing liquid (such as from a suppression pool or recirculation sump), limits for liquid leakage rate should be assigned to these valves based on analysis and included in the plant technical specifications. Periodic leakage rate*

testing, using the sealing liquid as the test medium, is then needed to ensure that the technical specification limits are maintained."

GEH Response:

DCD Tier 2, Subsection 6.2.6.3, will be revised to include the information requested.

DCD Impact:

DCD Tier 2, Subsection 6.2.6.3, will be revised as shown in the attached markup.

6.2.6.3 Containment Isolation Valve Leakage Rate Test (Type C)

Type C tests are performed on all containment isolation valves required to be tested per 10 CFR 50 Appendix J Option A or Option B. Containment isolation valves subject to Type C tests are listed within Tables 6.2-16 through 6.2-42.

Type C tests (like Type B tests) are performed by local pressurization using either the pressure-decay or flowmeter method. The test pressure is applied in the same direction as when the valve is required to perform its safety function, unless it can be shown that results from tests with pressure applied in a different direction are equivalent or conservative. For the pressure-decay method, test volume is pressurized with air or nitrogen to at least P_a. As an exemption from 10 CFR 50 Appendix J, Option A, Section III.D.2.(b)(ii), can be satisfied by testing at the end of periods when containment integrity is not required by the plant's Technical Specifications at a lower test pressure specified in the Technical Specification applied between the door seals with an acceptable maximum measured leakage rate of 0.01 L_a. The rate of decay of pressure of the known test volume is monitored to calculate the leakage rate. For the flowmeter method, the required test pressure is maintained in the test volume by making up air, or nitrogen~~, or water (for valves served by seal system or valves equivalent to a valve served by a seal system)~~ through a calibrated flowmeter. The flowmeter fluid flow rate is the isolation valve leakage rate.

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 Design Basis Accident (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 will be 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 will be 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 will be 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.

~~Valves which are sealed with a fluid from a sealed system or valves not provided with a seal system and may be justified to be equivalent to valves with seal system shall be tested in accordance with 10 CFR 50 Appendix J Option A or Option B as given below. A valid justification for equivalency of such valves is that they are in lines designed to be, or remain, filled with water for at least 30 days subsequent to a LOCA.~~

~~Option A of Appendix J – Valves sealed with a seal system shall be pressurized with the seal system fluid to a pressure not less than 1.10 P_a. Valves not provided with a seal system, which may be justified to be equivalent to valves with seal system, will be leakage rate tested with water (exemption from 10 CFR 50 Appendix J) to a pressure not less than 1.10 P_a. In both cases the measured leakage may not be converted to equivalent air leakage and may be excluded when determining the combined leakage rate of components subject to Type B and Type C tests 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~~
- ~~For sealed valves, the installed isolation valve seal water system fluid inventory is sufficient to assume the sealing function for at least 30 days at a pressure of 1.10 P_a.~~

~~Option B of Appendix J – As per ANS 56.8 Section 3.4, valves sealed with a fluid from a qualified seal system are not required to be leak tested and the testing of seal system shall be as per Section 3.4 of ANS 56.8. However valves not provided with a seal systems, which have been justified to be equivalent to valves with seal systems, may be leakage rate tested with water to a pressure not less than 1.10 P_a. The measured leakage may not be converted to equivalent air leakage, and may be excluded when determining the combined leakage rate of components subject to Type B and Type C tests 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~~
- ~~For sealed valves the installed isolation valve seal water system fluid inventory is sufficient to assume the sealing function for at least 30 days at a pressure of 1.10 P_a.~~

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

- For Y-globe MSIVs only, testing will be 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. Normat 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 will 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 will drive 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 will be 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.

~~All test connections, vent lines, or drain lines consisting of double or multiple barriers (for example, two valves in series, one valve and a cap, or one valve and a flange) that are connected between isolation valves and form a part of the containment boundary and are 25.4-mm (1-inch) or less in size may not be Type-C tested due to their infrequent use, because the multiple barrier configurations are maintained using an administrative control program.~~

~~Type C testing shall be performed in the correct direction of the leakage path unless it can be demonstrated that testing in the reverse direction is equivalent or more conservative. The correct direction of the leakage path is from inside the containment to outside containment.~~

Instrument lines that penetrate containment conform to Regulatory Guide 1.11 and may not be Type-C tested. The lines that connect to the reactor coolant pressure boundary include a restricting orifice inside containment, are Seismic Category I, and terminate in Seismic Category I instruments. The instrument lines also include manual isolation valves and excess flow check valves or equivalent. These valves are normally open and are considered extensions of the containment, whose integrity is continuously demonstrated during normal operation. In addition, these lines are subject to the periodic Type A test, because they are open (up to the pressure boundary instruments) during the ILRT. Leak-tight integrity is also verified during functional and surveillance activities as well as visual observations during operator tours.

The combined leakage rate of all components subject to Type B (Subsection 6.2.6.2) and Type C tests shall not exceed 60% of L_a.