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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 41 Related to ESBWR Design Certification Application – Preservice and Inservice Inspection and Testing of the Reactor Coolant Pressure Boundary – RAI Numbers 5.2-50 through 5.2-58**

Enclosure 1 contains GE's response to the subject NRC RAIs transmitted via the Reference 1 letter. This completes GE's response to RAI Letter No. 41

If you have any questions about the information provided here, please let me know.

Sincerely,

Kathy Sedney for

David H. Hinds
Manager, ESBWR

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Reference:

1. MFN 06-220, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 41 Related to ESBWR Design Certification Application,* July 10, 2006

Enclosure:

1. MFN 06-290 – Response to Portion of NRC Request for Additional Information Letter No. 41 Related to ESBWR Design Certification Application – Preservice and Inservice Inspection and Testing of the Reactor Coolant Pressure Boundary – RAI Numbers 5.2-50 through 5.2-58

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ENCLOSURE 1

MFN 06-290

Response to Portion of NRC Request for

Additional Information Letter No. 41

Related to ESBWR Design Certification Application

Preservice and Inservice Inspection and Testing

of the Reactor Coolant Pressure Boundary

RAI Numbers 5.2-50 through 5.2-58

NRC RAI 5.2-50

Provide a discussion on Code Cases listed in DCD Tier 2, Table 5.2-1 that have not been approved for use by the NRC including a basis for their use (i.e. N–634, –491-2).

GE Response

GE will remove reference to un-approved code cases and provide a justification for the use of newer Code Cases that are not yet in the Regulatory Guides, i.e., N-634. In the "Remarks" column for Code Case N-634, the following words will be added: "This case allows attachment of non-pressure retaining materials meeting the requirements of NF-2000 to Subsection CC liners in the same manner as permitted under Subsection NE for MC components, except that welding and examination are required to meet the requirements of Subsection CC." Reference to N-491-2 will be deleted.

See Attached Mark-Up of Table 5.2-1, Pages 5.2-37 through 5.2-40

NRC RAI 5.2-51

Section 5.2.4.2 states that all items within the Class 1 boundary are designed to provide access for examinations required by ASME Section XI. However, the following sentence indicates that accessibility for preservice (PSI) and inservice inspection (ISI) is the responsibility of the COL holder. Please address this potential conflict and provide verification that the design provides accessibility for complete inspection in accordance with ASME Code, Section XI, Subarticle IWA-1500, and the requirements of 10 CFR 50.55a(g)(3)(I). Verify that these requirements are incorporated in the design process for Class 1 components.

GE Response

The reference in Section 5.2.4.2 that access for PSI and ISI is the responsibility of the COL holder is a restatement of the ASME Code requirement IWA-1400 (Owner's Responsibility), item (b). As indicated in the comment Subsection IWA-1500 provides general requirement statements for design and Section 5.2.4.2 addresses specific access issues. Insofar as the task of ensuring access is delegated to the design organization, there is no conflict with the statements made in 5.2.4.2. But since the Code does not relieve the Owner from this responsibility, it would be incorrect to state it otherwise. No DCD change is required.

NRC RAI 5.2-52

The ESBWR Design uses a minimum spool piece length of L=2T+152 mm. Explain why this distance is sufficient to perform qualified ultrasonic examinations of the thickness range of component in the ESBWR design.

GE Response

The basis of spool piece length L=2T+152 mm is Section XI, Appendix D, which specifies L=2T + 50.8 mm. 2 in. (50.8) is an allowance for the transducer footprint and where "T" is the material thickness, 2T is a full ultrasonic V-path for a 45 degree transducer. The additional 4 in. (101.2 mm) is an allowance for scanner tracks, other beam paths, etc. No DCD change is required.

NRC RAI 5.2-53

Clarify whether all austenitic to austenitic welds, that require an ultrasonic examination, are accessible from both the near and far side of the weld side. If not, discuss how a qualified UT examination will be performed.

GE Response

Access for examination from both sides of austenitic welds for UT will be provided wherever practical. It is understood that UT is the method of choice for ISI; therefore, unless a design constraint or prohibitive cost would make two-sided access impractical it will be provided. Where the spool length provision is not met, a case-by-case evaluation is performed. If two-sided access is not available for UT, the RT method may be used alone or in conjunction with UT as allowed by IWA-2231. The recent development of Digital RT offers reduced exposure times and greater latitude than film radiography, making RT a more practical alternative to UT than in the past. In DCD Section 5.2.4.3.2, before the paragraph on "Alternative Examinations" the following paragraph will be inserted: "Radiographic Examination ASME Section XI, IWA-2230 includes radiographic examination as a volumetric examination method. Section XI requires that the requirements of Article 2 of Section V be used for methodology. Radiography may be accomplished with x-rays or gamma rays and has historically been performed using film as the recording media. Due to ALARA, personnel access limitations in the work area when radiography is performed, radiography is not used as often as ultrasonic examination for Inservice Inspection. Use of computed and digital radiographic systems can result in greater latitude and reduced overall exposure times and make radiography a more practical examination method for Inservice Inspection. For the ESBWR, radiography may be used alone as a volumetric method or it may be used to supplement ultrasonic examination to improve coverage of the required examination volume."

See attached mark up of page 5.2-25 from Section 5.2.4.3.2

NRC RAI 5.2-54

Describe all dissimilar metal welds within the Class 1 system that require volumetric examination as part of the PSI and/or ISI program. Confirm that all configurations will allow for access from both the near and far sides of the weld.

GE Response

At this stage in design, all of the dissimilar metal weld locations are not known. However, access to both sides of the weld will be addressed as in 5.2.53 above.

See attached mark up of page 5.2-25 from Section 5.2.4.3.2

NRC RAI 5.2-55

Section 5.2.4.2 states that nozzle-to-vessel welds often may have inherent access restrictions when vessel internals are installed. Please explain the cause of these inherent access restrictions. Please verify that these welds and nozzles are designed to be inspected in accordance with the ASME Code, Section XI, without the need for the COL holder to request relief from the regulations.

GE Response

The provisions for nozzle-to-vessel welds were developed in conjunction with the NRC staff during the licensing of the ABWR. The staff accepted and understood the inherent limitation of examination from the vessel outside surface (which in some cases may be slightly less than the 90% permitted under IN 98-42). It is primarily a small segment of the outside of the nozzle bore to vessel transition that is obstructed. The staff acknowledged that limitation for ISI but asked that during an appropriate stage in fabrication, a complete UT for PSI be performed. That provision was added to the DCD for the ABWR and the same words have been repeated here based on the previously settled NRC position. It is our understanding that with these words incorporated into the DCD as a licensing basis, the DCD is sufficient to address the 10CFR50 requirements on this issue and that no further relief requests would be required. No DCD change is required.

NRC RAI 5.2-56

Section 5.2.4.3.1 references category B-E and Section 5.2.4.5 references IWB-4000. Neither Category B-E nor Article IWB-4000 are included in the ASME Code Section XI, 2001 Edition with the 2003 Addenda. Provide references consistent with ASME Code Section XI, 2001 Edition with the 2003 Addenda.

GE Response

The reviewer is correct that category B-E is deleted. The VT-2 examination of the partial penetration nozzles is covered under B-P. The B-E category will be editorially removed from paragraph 5.2.4.3.1. The reviewer is also correct on the reference to IWB-4000; that reference will also be editorially deleted.

See attached Mark-Ups of Section 5.2.4.3.1 from page 5.2-23 and 5.2.4.5 from page 5.2-26.

NRC RAI 5.2-57

Clarify whether there are any cast components within the Class 1 system that will require a PSI and or ISI volumetric inspection. If so, clarify these components will have a specification that requires a casting process that strictly controls grain size to make ultrasonic examination less difficult and more reliable than castings with a large grain structure (i.e. that will be inspectible per a qualified Appendix VIII procedure).

GE Response

At this stage of design, the number of cast components is not known. However, the issue with UT of castings is generally acknowledged to be limited to austenitic castings. Therefore, where austenitic castings must be used, the issue of qualified UT access from only the wrought side of the weld will be addressed as in 5.2-53 and 5.2-54 above. Note that not only are austenitic stainless steel castings acknowledged to be a low risk for IGSCC in general (similar to stainless steel weld metal) but also low carbon CF-3 and CF-3M with supplemental ferrite controls will be used. Also, the wrought side of stainless steel welds will utilize low carbon grades, e.g., 316L. Therefore, as ESBWR plants approach ISI in the future, relatively few of these welds will probably be examined under a risk-based ISI program.

See attached mark up of page 5.2-25 from Section 5.2.4.3.2

NRC RAI 5.2-58

The DCD indicates that the design to perform pre-service inspection is based on the requirements of the ASME Code, Section XI, 2001 Edition with the 2003 Addenda. Clarify whether the ESBWR Design is such that the COL applicant will be able to meet ALL of the ASME Section XI requirements including any limitations and modifications currently listed in 10CFR50.55a.

GE Response

The ESBWR design will allow examination of all components to the requirements of ASME Section XI as clarified by 10CFR50 and IN 98-42, and the provisions for nozzle-to-vessel welds addressed in 5.2-55 above. We have reviewed 10CFR50.55a and believe that none of its limitations or modifications to the ASME Code requirements impact the compliance of the ESBWR design with respect to PSI and ISI in ways not addressed previously in these responses. No DCD change is required.

provided on welds and components, which require frequent access for examination or are located in high radiation areas. Welds are located to permit ultrasonic examination from at least one side, but where component geometries permit, access from both sides is provided.

Restrictions: For piping systems and portions of piping systems subject to volumetric and surface examination, the following piping designs are not used:

- valve to valve;
- valve to reducer;
- valve to tee;
- elbow to elbow;
- elbow to tee;
- nozzle to elbow;
- reducer to elbow;
- tee to tee; and
- pump to valve.

Straight sections of pipe and spool pieces shall be added between fittings. The minimum length of the spool piece has been determined by using the formula L = 2T + 152 mm, where L equals the length of the spool piece (not including weld preparation) and T equals the pipe wall thickness.

5.2.4.3 Examination Categories and Methods

5.2.4.3.1 Examination Categories

The examination category of each item in accordance with ASME Section XI, IWB-2500 will be is listed in the preservice and inservice inspection programs prepared by the COL holder. The items will be listed by system and line number where applicable. The preservice and inservice inspection programs will also state the method of examination for each item.

For the preservice examination, all of the items selected for inservice examination shall be performed once in accordance with ASME Section XI, IWB-2200, with the exception of the examinations specifically excluded by ASME Section XI from preservice requirements, such as VT-3 examination of valve body and pump casing internal surfaces (B-L-2 and B-M-2 examinations categories, respectively) and the visual VT-2 examinations for category B-P.

5.2.4.3.2 Examination Methods

Ultrasonic Examination of the Reactor Vessel

Ultrasonic examination for the RPV is conducted in accordance with the ASME Code, Section XI. The design to perform preservice inspection on the reactor vessel shall be based on the requirements of the ASME Code Section XI, 2001 Edition with 2003 Addenda. For the required preservice examinations, the reactor vessel shall meet the acceptance standards of Section XI, IWB-3510. The RPV shell welds are designed for 100% accessibility for both preservice and inservice inspection. RPV shell welds may be examined from the inside or

rectangular box 305 x 305 x 508 mm located within 12 m from the transducer. Space for a second examiner to monitor the instrument shall be provided if necessary.

Insulation removal for inspection is to allow sufficient room for the ultrasonic transducer to scan the examination area. A distance of 2T plus 152 mm, where T is pipe thickness, is the minimum required on each side of the examination area. The insulation design generally leaves 406 mm on each side of the weld, which exceeds minimum requirements.

Radiographic Examination ASME Section XI, IWA-2230 includes radiographic examination as a volumetric examination method. Section XI requires that the requirements of Article 2 of Section V be used for methodology. Radiography may be accomplished with x-rays or gamma rays and has historically been performed using film as the recording media. Due to ALARA, personnel access limitations in the work area when radiography is performed, radiography is not used as often as ultrasonic examination for Inservice Inspection. Use of computed and digital radiographic systems can result in greater latitude and reduced overall exposure times and make radiography a more practical examination method for Inservice Inspection. For the ESBWR, radiography may be used alone as a volumetric method or it may be used to supplement ultrasonic examination to improve coverage of the required examination volume.

Alternative Examination Techniques

As provided by ASME Section XI, IWA-2240, alternative examination methods, a combination of methods, or newly developed techniques may be substituted for the methods specified for a given item in this section, provided that they are demonstrated to be equivalent or superior to the specified method. This provision allows for the use of newly developed examination methods, techniques, etc., which may result in improvements in examination reliability and reductions in personnel exposure. IWA-2240 as written in the 1997 Addenda of ASME Section XI must be used when applying these provisions.

5.2.4.3.3 Data Recording

Manual data recording is performed where manual ultrasonic examinations are performed. Electronic data recording and comparison analysis are to be employed with automated ultrasonic examination equipment. Signals from each ultrasonic transducer are fed into a data acquisition system in which the key parameters of any reflectors are recorded. The data to be recorded for manual and automated methods are:

- location;
- position;
- depth below the scanning surface;
- length of the reflector;
- transducer data including angle and frequency; and
- calibration data.

The data so recorded shall be compared with the results of subsequent examinations to determine the behavior of the reflector.

5.2.4.3.4 Qualification of Personnel and Examination Systems for Ultrasonic Examination

Personnel performing examinations shall be qualified in accordance with ASME Section XI, Appendix VII. Ultrasonic examination systems shall be qualified in accordance with industry accepted programs for implementation of ASME Section XI, Appendix VIII. Qualification to ASME Section XI, Appendix VIII, in compliance with the provisions of 10CFR50, 50.55a shall be considered as a satisfactory alternative to Regulatory Guide 1.150.

5.2.4.4 Inspection Intervals

The inservice inspection intervals for the ESBWR conform to Inspection Program B as described in Section XI, IWB-2412. Except where deferral is permitted by Table IWB-2500-1, the percentages of examinations completed within each period of the interval shall correspond to Table IWB-2412-1 Inspection Program B provides for Inspection Intervals of a nominal length of 10 years with allowance for up to a year variation to coincide with refueling outages.

5.2.4.5 Evaluation of Examination Results

Examination results are evaluated in accordance with ASME Section XI, IWB-3000 with repairs based on the requirements of IWA-4000. Re-examination shall be conducted in accordance with the requirements of IWA-2200. The recorded results shall meet the acceptance standards specified in IWB-3400.

5.2.4.6 System Leakage and Hydrostatic Pressure Tests

System Leakage Tests

As required by Section XI, IWB-2500 for Category B-P, a system leakage test shall be performed in accordance with IWB-5200 on all Class 1 components and piping within the pressure-retaining boundary following each refueling outage. For the purposes of the system leakage test, the pressure-retaining boundary is defined in IWB-5222. The system leakage test shall include a VT-2 examination in accordance with IWA-5240. The system leakage test will be conducted at a pressure not less than that corresponding to 100% rated reactor power. The system hydrostatic test (described below), when performed, is acceptable in lieu of the system leakage test.

Hydrostatic Pressure Tests

A system hydrostatic test may be performed in lieu of a system leakage test, and when required for repairs, replacements, and modifications per IWA-4540. The test shall include all Class 2 or 3 pressure retaining components and piping within the boundaries defined by IWB-5230 or the boundary of a repair or replacement as applicable. The system hydrostatic test shall include a VT-2 examination in accordance with IWA-5240. For the purposes of determining the test pressure for the system hydrostatic test in accordance with IWB-5230, the nominal operating pressure shall be the maximum operating pressure indicated in the Process Flow Diagram (PFD) for the Nuclear Boiler System.

5.2.4.7 Code Exemptions

As provided in ASME Section XI, IWB-1220, certain portions of Class 1 systems are exempt from the volumetric and surface examination requirements of IWB-2500. Complete list will be

Table 5.2-1

Reactor Coolant Pressure Boundary Components (Applicable Code Cases)

Number	Title	Applicable Equipment	Remarks
N-60-5	Material for Core Support Structures, Section III, Division 1	Core Support	Accepted per RG 1.84
N-71-17	Additional Materials for Subsection NF, Classes 1, 2, 3 and MC Component Supports Fabricated by Welding, Section III, Division I.	Component Support	Conditionally Accepted per RG 1.84
N-122-1	Stress Indices for Structure Attachments, Class 1, Section III, Division 1.	Piping	Accepted per RG 1.84
N-247	Certified Design Report Summary for Component Standard Supports, Section III, Division 1, Classes 1, 2, 3 and MC.	Component Support	Accepted per RG 1.84
N-249-14	Additional Material for Subsection NF, Classes 1, 2, 3 and MC Component Supports Fabricated Without Welding, Section III, Division 1.	Component Support	Conditionally Accepted per RG 1.84
N-318-5	Procedure for Evaluation of the Design of Rectangular Cross-Section Attachments on Class 2 or 3 Piping, Section III, Division 1.	Piping	Conditionally Accepted per RG 1.84
N-319-3	Alternate Procedure for Evaluation of Stress in Butt Weld Elbows in Class 1 Piping, Section III, Division 1.	Piping	Accepted per RG 1.84
N-391-2	Procedure for Evaluation of the Design of Hollow Circular Cross-Section Welded Attachments on	Piping	Accepted per RG 1.84

Table 5.2-1

Reactor Coolant Pressure Boundary Components (Applicable Code Cases)

Number	Title	Applicable Equipment	Remarks
	Class 1 Piping. Section III, Division 1.		
N-392-3	Procedure for Evaluation of the Design of Hollow Circular Cross-Section Welded Attachments on Classes 2 and 3 Piping, Section III, Division 1.	Piping	Accepted per RG 1.84
N-580-1	Use of Alloy 600 With Columbium Added, Section III, Division 1.	Core Support	Accepted per RG 1.84
N-608	Applicable Code Edition and Addenda, NCA-1140(a)(2), Section III, Division 1.	All Code Components	Accepted per RG 1.84
N-632	Use of ASTM A 572, Grades 50 and 65 for Structural Attachments to Class CC Containment Liners, Section III, Division 2.	Containment	Accepted per RG 1.84
N-634	Alternatives to the Provisions of CC-2511 for Structural Attachments to Class CC Containment Liners, Section III, Division 2.	Containment	This case allows attachment of non-pressure retaining materials meeting the requirements of NF-2000 to Subsection CC liners in the same manner as permitted under Subsection NE for MC components, except that welding and examination are required to meet the requirements of Subsection CC
N-236-1	Repair and Replacement of Class	Containment	Conditionally Accepted

Table 5.2-1

Reactor Coolant Pressure Boundary Components (Applicable Code Cases)

Number	Title	Applicable Equipment	Remarks
	MC Vessels		Per RG 1.147
N-307-2	Revised Examination Volume for Class 1 Bolting, Table IWB-2500-1, Examination Category B-G-1, when the Examinations are Conducted from the Drilled Hole	RPV Studs	Accepted per RG 1.147
N-416-2	Alternative Rules for Hydrostatic Testing of Repair or Replacement of Class 2 Piping	Piping	Conditionally Accepted Per RG 1.147
N-435-1	Alternative Examination Requirements for Vessels with Wall Thicknesses 2 in. or Less	Class 2 Vessels	Accepted Per RG 1.147
N-457	Qualification Specimen Notch Location for Ultrasonic Examination of Bolts and Studs	Bolts and Studs	Accepted Per RG 1.147
N-460	Alternative Examination Coverage for Class 1 and 2 Welds	Class 1 & 2 Components and Piping	Accepted Per RG 1.147
N-463-1	Evaluation Procedures and Acceptance Criteria for Flaws in Class 1 Ferritic Piping that Exceed the Acceptance Standards of IWB-3514-2	Piping	Accepted Per RG 1.147
N-479-1	Boiling Water Reactor (BWR) Main Steam Hydrostatic Test	Main Steam System	Accepted Per RG 1.147

N-613-1	Ultrasonic Examination of Penetration Nozzles in Vessels, Examination Category B-D, Item Nos. B3.10 and B3.90, Reactor Nozzle to Vessel Welds, Figs. IWB 2500-7(a), (b), and (c), Section XI, Division 1	Reactor Vessel	Accepted Per RG 1.147