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Subject: Response to Portion of NRC Request for Additional Information Letter No. 102 Related to ESBWR Design Certification Application - Inservice Examination Methods and Access - RAI Number 5.2-62

Enclosure 1 contains the GE Hitachi Nuclear Energy (GEH) response to the subject NRC Request for Additional Information (RAI) transmitted via the Reference 1 letter.

Verified DCD changes associated with this RAI response are identified in the enclosed DCD markups by enclosing the text within a black box. The marked-up pages may contain unverified changes in addition to the verified changes resulting from this RAI response. Other changes shown in the markup(s) may not be fully developed and approved for inclusion in DCD Revision 5.

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

Sincerely,

James C. Kinsey
Vice President, ESBWR Licensing

D068
NRO

Reference:

1. MFN 07-315, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 102 Related to ESBWR Design Certification Application*, May 22, 2007

Enclosure:

1. MFN 08-366 - Response to Portion of NRC Request for Additional Information Letter No. 102 Related to ESBWR Design Certification Application - Inservice Examination Methods and Access - RAI Number 5.2-62

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eDRF	0000-0079-6864

Enclosure 1

MFN 08-366

Response to Portion of NRC Request for Additional Information Letter No. 102 Related to ESBWR Design Certification Application

Inservice Examination Methods and Access

RAI Number 5.2-62

Verified DCD changes associated with this RAI response are identified in the enclosed DCD markups by enclosing the text within a black box. The marked-up pages may contain unverified changes in addition to the verified changes resulting from this RAI response. Other changes shown in the markup(s) may not be fully developed and approved for inclusion in DCD Revision 5.

NRC RAI 5.2-62:

This RAI supercedes RAIs 6.6-1, 6.6-2, 6.6-3, 6.6-4, 5.2-51, 5.2-53, 5.2- 54 5.2-57, and 5.2-58. The staff requests that the applicant modify the DCD (1) to specify the inspection methods that are practical to use for inservice inspection (ISI) of welds in ASME Boiler and Pressure Vessel (B&PV) Code Class 1 and 2 austenitic and dissimilar metal welds, and (2) to add COL action items to Sections 5.2.4 and 6.6 for COL applicants to ensure that a COL applicant referencing the ESBWR will provide a detailed description of its plans to incorporate, during design and construction, access to piping systems to enable nondestructive examinations (NDE) of such welds during ISI.

By way of background, the staff understands that materials selected for use in ESBWR ASME B&PV Code Class 1 and 2 austenitic and dissimilar metal welds are not expected to encounter stress corrosion cracking or appreciable amounts of other forms of degradation based on currently available information. However, the staff notes that stress corrosion cracking was not expected in previously built PWRs and BWRs based on information that was available at the time of their licensing and construction. Accordingly, the staff considers that the design of components should include provisions to enable NDE to detect future component degradation, such as stress corrosion cracking. This is a critical attribute of any new reactor design.

The ASME B&PV Code, Section XI, as incorporated into 10 CFR 50.55a(g), currently allows for either ultrasonic or radiographic examination of welds in Code Class 1 and 2 piping systems. Please modify the DCD in Tier 1 to state that one or both of these types of examination is practical for ISI of austenitic and dissimilar metal welds. The staff notes that ultrasonic examination has advantages with respect to ALARA considerations, and with this change to the DCD, any design certification rule that might be issued for the ESBWR will preclude the granting of relief under 10 CFR 50.55a(g)(6) for ISI of such welds. Please confirm that austenitic or dissimilar metal welds in Class 1 and 2 piping systems will be accessible for examination by either ultrasonic or radiographic examination to satisfy § 50.55a(g)(3).

In support of these DCD changes, a COL applicant referencing the ESBWR design certification application should inform the staff of how it plans to meet all access requirements during construction and operation as required by 10 CFR 50.55a(g)(3)(i) and (ii). The staff notes that the preservice inspection (PSI) requirements are known at the time a component is ordered, and 10 CFR 50.55a(g) does not contain provisions for consideration of relief requests for impractical examination during the construction phases of the component. The COL action items requested above should reflect these considerations.

GEH Response:

According to the ASME B&PV Code, Section XI, either ultrasonic (UT) or radiographic (RT) examination of austenitic and dissimilar metal (DM) welds in Code Class 1 and 2 piping systems may be conducted to fulfill inservice inspection (ISI) requirements. This will be specified in DCD Tier 2, Subsection 5.2.4 for Class 1 and Section 6.6 for Class 2 components and piping systems. In addition, DCD Tier 2, Subsection 5.2.4.3.2 for Class 1 and Section 6.6.2 for Class 2, will be revised to describe the acceptable

methods for conducting austenitic and DM weld examinations for ASME Code, Section III, components and piping systems. The staff has requested that the DCD Tier 1 information be modified to state that one or both of these types of examination is practical for ISI of austenitic and dissimilar metal welds. In response to this RAI, and with NRC involvement, these changes will be designated as DCD Tier 2* text. DCD Tier 2* information cannot be changed without prior NRC approval, which is similar to the controls for DCD Tier 1 information. DCD Tier 2* text will be identified in DCD Tier 2 as italic text with brackets(e.g., *[example Tier 2* text]*).

It should be noted that, in most cases, UT examination is capable of meeting the Code requirements for examination of these welds. While UT has advantages with respect to ALARA considerations, it should also be noted that UT has limitations regarding inspection sensitivity in DM welds and austenitic stainless steel. UT sensitivity is impaired by a combination of course grains, equiaxed columnar or dendritic grains, and various combinations and layers that also include small randomly oriented grains. Typically, this results in a material that is anisotropic, highly attenuative, and with excessive noise levels. Therefore, it may be necessary to use the optional RT method in order to meet inspection requirements.

DCD Tier 2 specifies the plans to meet the access requirements during construction, as required by 10 CFR 50.55a(g)(3)(i) and (ii). The requirement to ensure that the design of the ESBWR provides access to all welds for proper preservice and inservice examination programs is described in the DCD Tier 2, Subsection 5.2.4.2. The staff has noted that the preservice inspection (PSI) requirements are known at the time a component is ordered, and 10 CFR 50.55a(g) does not contain provisions for consideration of relief requests for impractical examination during the construction phases of the component. The process that is being used by GEH for the design of the ESBWR is to require specific access requirements to support UT or RT examination in the equipment procurement specifications that are in compliance with the ASME Section XI Code. Additionally, the design procedural requirements for the 3D layout of the plant include acceptance criteria regarding access for inspection equipment and personnel. Through these procedural requirements, no deviations in providing the required access are expected, but this does not preclude design circumstances where access may not be completely possible. Other factors may include the type of inspection program that the COL Holder chooses to implement (e.g., risk-informed versus ASME Section XI Code based), which can also affect whether 100% weld accessibility can be achieved. Any access constraints will be fully documented in the PSI/ISI program, which is one of the operational programs addressed in DCD Tier 2, Section 13.4.

The requirement to ensure that the design of the ESBWR provides access to welds for proper preservice and inservice examination programs is described in the DCD Tier 2, Subsection 5.2.4.2 and Section 6.6.2. There are existing COL items in the DCD that require an applicant to address their specific program plans for implementing the preservice and inservice examination programs. They are identified as COL Item numbers 5.2-1-A and 6.6-1-A. However, two new COL items, 5.2-3-A and 6.6-3-A, will be added to address this RAI.

DCD Impact:

DCD Tier 2, Subsection 5.2.4, Subsection 5.2.4.2, Subsection 5.2.4.3.2, Subsection 5.2.6 (5.2-3-A), Section 6.6, Subsection 6.6.2, and Subsection 6.6.11 (6.6-3-A) will be revised as shown in the attached markups.

- The welder performance qualification test assembly required by ASME Section IX shall be welded under simulated access conditions. An acceptable test assembly will provide a Section IX welder performance qualification required by this Regulatory Guide.
- If the test assembly weld is to be judged by bend tests, a test specimen shall be removed from the location least favorable for the welder. If this test specimen cannot be removed from a location prescribed by Section IX, an additional bend test specimen is required. If the test assembly weld is to be judged by radiography or UT, the length of the weld to be examined shall include the location least favorable for the welder.
- Records of the results obtained in welder accessibility qualification shall be as certified by the manufacturer or installer, shall be maintained and shall be made accessible to authorized personnel.
- For accessibility, when restricted access conditions obscure the welder's line of sight, the use of visual aids such as mirrors shall be used. The qualification test assembly shall be welded under the more restricted access conditions using the visual aid required for production welding.
- Surveillance of accessibility qualification requirements is performed along with normal surveillance of ASME Section IX performance qualification requirements.

5.2.3.4.3 Nondestructive Examination of Tubular Products

For discussion of nondestructive examination of tubular products, refer to Subsection 5.2.3.3.3.

5.2.4 Preservice and Inservice Inspection and Testing of Reactor Coolant Pressure Boundary

This ~~subsection~~ describes the preservice and inservice inspection and system pressure test programs for NRC Quality Group A, ASME B&PV Code, Class 1 items. It describes these programs implementing the requirements of Subsection IWB of the ASME B&PV Code Section XI.[1]

According to the ASME B&PV Code, Section XI, either ultrasonic (UT) or radiographic (RT) examination are practical to use for inservice inspection (ISI) of welds in ASME Boiler and Pressure Vessel (B&PV) Code Class 1 and 2 austenitic and dissimilar metal (DM) welds. The COL Applicant is responsible for developing a plan and providing a full description of it's use during construction, preservice inspection, inservice inspection, and during design activities for components that are not included in the referenced certified design, to preserve accessibility to piping systems to enable nondestructive examinations (NDE) of ASME Code Class 1 austenitic and DM welds during ISI (see Section 5.2.6, COL Item 5.2-3-A for COL information).

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10 CFR 50.55a prescribes Section XI Editions and Addenda applicable to inservice inspection programs, subject to limitations and modifications found therein. Additionally, 10 CFR 50.55a provides an allowance to request alternatives to or relief from Code requirements. Section XI

[1] Items as used in this subsection are products constructed under a certificate of authorization (NCA-3120) and material (NCA-1220). See Section III, NCA-1000, footnote 2.

5.2.4.2 Accessibility

All items within the Class 1 boundary are designed to provide access for the examinations required by ASME Section XI, IWB-2500. Additional, considerations for accessibility are defined in IWA-1500 of Section XI. Items such as nozzle-to-vessel welds often may have inherent access restrictions when vessel internals are installed. Therefore, preservice examination shall be performed as necessary to achieve the required examination volume on these items prior to installation of internals, which would interfere with examination. Access is sufficient for the inservice examination of the volume described in Code Case N-613-1.

[The process that is being used by GEH in the certified design of the ESBWR, is to require specific access requirements to support the preferred UT or optional RT examination in the equipment procurement specifications that are in compliance with the ASME Section XI Code. Additionally, the design procedural requirements for the 3D layout of the plant include acceptance criteria regarding access for inspection equipment and personnel.] Through these procedural requirements, no deviations in providing the required access are expected. However, any design activities for components that are not included in the referenced ESBWR certified design, it is the responsibility of the COL Applicant to preserve accessibility to piping systems to enable nondestructive examinations (NDE) of ASME Code Class 1 austenitic and DM welds during ISI (see Section 5.2.6, COL Item 5.2-3-A for COL information).

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Reactor Pressure Vessel Access

Access for examinations of the ~~reactor pressure vessel (~~RPV~~)~~ is incorporated into the design of the vessel, biological shield wall and vessel insulation as follows:

RPV Welds - The shield wall and vessel insulation behind the shield wall are spaced away from the RPV outside surface to provide access for remotely operated ultrasonic examination devices as described in Subsection 5.2.4.3. Access for the insertion of automated devices is provided through removable insulation panels and at shield wall hatches in the upper drywell area. Platforms are attached to the biological shield wall to provide access for installation of remotely operated examination devices.

RPV Head, RPV Studs, Nuts and Washers - The RPV head is dry stored on the refueling floor during refueling operations. Removable insulation is designed to provide access for manual ultrasonic examinations of RPV head welds. RPV nuts and washers are dry stored and are accessible for visual (VT-1) examination. RPV studs may be volumetrically examined in place or when removed.

Bottom Head Welds - Access to the bottom head to shell welds is provided from the lower drywell area through shield wall hatches and removable insulation panels around the cylindrical lower portion of the vessel. This design provides access for manual or automated ultrasonic examination equipment. Sufficient access is provided for partial penetration nozzle welds (i.e., CRD penetration and instrumentation nozzle welds) for performance of the visual VT-1 and VT-3 examinations. ~~during the system leakage and system hydrostatic examinations.~~ These welds are also accessible to perform the Code required VT-2 examinations during system leakage testing as required by ASME Code Section XI, IWB-2500-1.

RAI 5.2-68

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. According to the ASME B&PV Code, Section XI, either ultrasonic (UT) or radiographic (RT) examination are practical to use for inservice inspection (ISI) of welds in ASME Boiler and Pressure Vessel (B&PV) Code Class 1 per DCD Chapter 5, and Class 2 per DCD Chapter 6, austenitic and dissimilar metal welds. UT is the preferred inspection method because of it's ALARA advantages over RT. However, RT may be used in cases where UT cannot meet the necessary inspection requirements. The design to perform preservice inspection on the reactor vessel is based on the requirements of the ASME Code Section XI, specified in Table 1.9-22. For the required preservice examinations, the reactor vessel meets 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 outside diameter surfaces (or a combination of those techniques) using automated ultrasonic examination equipment. The RPV nozzle-to-shell welds are 100% accessible for preservice inspection but might have limited areas that may not be accessible from the outer surface for inservice examination techniques. ~~If accessibility is limited, an inservice inspection program relief request should be prepared and submitted for review by the NRC staff based on the Code Edition and Addenda in effect and inservice inspection techniques available at the time of COL application.~~

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In most cases, inner radius examinations are performed from the outside of the nozzle using several compound angle transducer wedges to obtain complete coverage of the required examination volume. Alternatively, nozzle inner radius examinations may be performed using enhanced visual techniques, as allowed by 10 CFR 50.55a(b)(2)(xxi).

Visual Examination

Visual examination methods VT-1, VT-2 and VT-3 are be conducted in accordance with ASME Section XI, IWA-2210. In addition, VT-2 examinations meet the requirements of IWA-5240.

Where direct visual VT-1 examinations are conducted without the use of mirrors or with other viewing aids, clearance (of at least 610 mm (24 in.) of clear space) is provided where feasible for the head and shoulders of a man within a working arm's length (508 mm (20 in.)) of the surface to be examined.

At locations where leakages are normally expected and leakage collection systems are located (e.g., valve stems and pump seals), the visual VT-2 examination verifies that the leakage collection system is operative.

Piping runs shall be clearly identified and laid out such that insulation damage, leaks and structural distress are evident to a trained visual examiner.

Surface Examination

Magnetic particle and liquid penetrant examination techniques are performed in accordance with ASME Section XI, IWA-2221 and IWA-2222, respectively. Direct examination access for

5.2.6 COL Information

5.2-1-~~A~~H Preservice and Inservice Inspection Program ~~Plan~~Description

The COL ~~holder~~Applicant is responsible for providing a full description~~the development~~ of the preservice and inservice inspection programs~~plans~~ and augmented inspection programs, by supplementing, as necessary, the information in Subsection 5.2.4, and to provide milestones for their implementation. The requirements are described in Subsections 5.2.4.1 through 5.2.4.10 and~~that~~ are based on the ASME Code, Section XI (DCD Subsection 5.2.4.~~12~~11). RAI 5.2-64

5.2-2-H Leak Detection Monitoring

The COL H~~h~~older is responsible for the development of a procedure to convert different parameter indications for identified and unidentified leakage into common leak rate equivalents and leak rate rate-of-change values.

The COL H~~h~~older is responsible for the development of procedures for monitoring, recording, trending, determining the source(s) of leakage, and evaluating potential corrective action plans. (DCD Subsection 5.2.5.9)

5.2-3-A Preservice and Inservice Inspection NDE Accessibility Plan Description

The COL Applicant is responsible for developing a plan and providing a full description of it's use during construction, preservice inspection, inservice inspection, and during design activities for components that are not included in the referenced certified design, to preserve accessibility to piping systems to enable nondestructive examinations (NDE) of ASME Code Class 1 austenitic and DM welds during ISI (DCD Section 5.2.4). RAI 5.2-62

5.2.7 References

5.2-1 D. A. Hale, "The Effect of BWR Startup Environments on Crack Growth in Structural Alloys," Trans. of ASME, Vol. 108, January 1986.

5.2-2 F. P. Ford and M. J. Povich, "The Effect of Oxygen/Temperature Combinations on the Stress Corrosion Susceptibility of Sensitized T-304 Stainless Steel in High Purity Water," Paper 94 presented at Corrosion 79, Atlanta, GA, March 1979.

5.2-3 Electric Power Research Institute, "BWR Water Chemistry Guidelines - 2004 Revision," EPRI TR-1008192, October 2004.

5.2-4 B. M. Gordon, "The Effect of Chloride and Oxygen on the Stress Corrosion Cracking of Stainless Steels: Review of Literature," Material Performance, NACE, Vol. 19, No. 4, April 1980.

6.6 PRESERVICE AND INSERVICE INSPECTION AND TESTING OF CLASS 2 AND 3 COMPONENTS AND PIPING

The ESBWR meets requirements for periodic inspection and testing of Class 2 and 3 systems in GDC 36, 37, 39, 40, 42, 43, 45 and 46, as specified in part in 10 CFR Section 50.55a, and as detailed in Section XI of the ASME Code. Compliance with the preservice and inservice examinations of 10 CFR 50.55a, as detailed in Section XI of the Code, satisfies in part the requirements of GDC 36, 37, 39, 40, 42, 43, 45 and 46. ESBWR meets SRP 6.6, Revision 1 acceptance criteria by meeting the ISI requirements of these GDC and 10 CFR 50.55a for the areas of review described in Subsection I of the SRP.

This subsection describes the preservice and inservice inspection and system pressure test programs for Quality Groups B and C, that is, ASME Code Class 2 and 3 items, respectively, as defined in Table 3.2-3. This section describes those programs implementing the requirements of ASME Boiler and Pressure Vessel (B&PV) Code, Section XI, Subsections IWC and IWD.

According to the ASME B&PV Code, Section XI, either ultrasonic (UT) or radiographic examination (RT) are practical to use for inservice inspection (ISI) of welds in ASME Boiler and Pressure Vessel (B&PV) Code Class 1 and 2 austenitic and dissimilar metal welds. The COL Applicant is responsible for developing a plan and providing a full description of it's use during construction, preservice inspection, inservice inspection, and during design activities for components that are not included in the referenced certified design, to preserve accessibility to piping systems to enable nondestructive examinations (NDE) of ASME Code Class 2 austenitic and dissimilar metal welds during ISI (see Section 6.6.11, COL Item 6.6-3-A for COL information). RAI 5.2-62

A preservice and inservice inspection program for Class 2 and 3 components and piping is based on the ASME code, Section XI, Edition and Addenda specified in accordance with 10 CFR 50.55a subject to limitations and modifications found therein. Additionally, 10 CFR 50.55a provides an allowance to request alternatives to or relief from ASME Section XI Code requirements. The development of preservice and inservice inspection programs is the responsibility of the COL Holder, and shall be based on the ASME Code, Section XI, Edition and addenda approved in 10 CFR 50.55a(b) 12 months before initial fuel load. RAI 5.2-63 The COL Applicant is responsible for providing a full description of the PSI/ISI programs and augmented inspection programs for Class 2 and 3 components and piping by supplementing, as necessary, the information in Section 6.6. The COL Applicant will also provide milestones for their implementation (see Section 6.6.11, COL Item 6.6-1-A for COL information). ~~The COL Applicant will provide a description of this program and its implementation. (See Subsection 6.6.11.)~~ RAI 5.2-64

6.6.1 Class 2 and 3 System Boundaries

The Class 2 and 3 system boundaries for both preservice and inservice inspection programs and the system pressure test program item boundaries include all or part of the following:

- Nuclear Boiler System (NBS)
- Isolation Condenser System (ICS)

operate during any mode of normal operation and cannot be tested adequately, however, are included with the Class 2 portion of the system.

- Cooling water and seal water systems or portions of these systems that are designed to maintain functioning of safety-related components and systems.
- Systems or portions of systems that are connected to the reactor coolant pressure boundary and are capable of being isolated from that boundary during all modes of normal reactor operation by two valves each of which is normally closed or capable of automatic closure.
- Systems, other than radioactive waste management systems, not covered by the above three paragraphs, that contain or may contain radioactive material and whose postulated failure would result in conservatively calculated potential offsite doses (reference Regulatory Guide 1.183), that exceed 0.5 rem to the whole body or its equivalent to any part of the body.

6.6.2 Accessibility

All items within the Class 2 and 3 boundaries are designed to provide access for the examinations required by IWC-2500 and IWD-2500.

[The process that is being used by GEH in the certified design of the ESBWR, is to require specific access requirements to support the preferred UT or optional RT examination in the equipment procurement specifications that are in compliance with the ASME Section XI Code. Additionally, the design procedural requirements for the 3D layout of the plant include acceptance criteria regarding access for inspection equipment and personnel.] Through these procedural requirements, no deviations in providing the required access are expected. However, any design activities for components that are not included in the referenced ESBWR certified design, it is the responsibility of the COL Applicant to preserve accessibility to piping systems to enable nondestructive examinations (NDE) of ASME Code Class 2 austenitic and DM welds during ISI (see Section 6.6.11, COL Item 6.6-3-A for COL information).

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Class 2 and Class 3 Piping, Pumps, Valves and Supports

The design and pPhysical arrangement of piping pumps, ~~and~~ valves, and supports provide personnel access to each weld location for performance of volumetric and surface (magnetic particle or liquid penetrant) examinations (Class 2 only), and sufficient access to supports for performance of visual VT-1 and VT-3 examinations in accordance with Subsection IWF. The design of the nuclear power plant structures, systems, and components provides access for the performance of inservice testing (IST) and inservice inspection (ISI) as required by the applicable ASME Code. Working platforms are provided in some areas to facilitate servicing of pumps and valves. Removable thermal insulation is provided on welds and components, which require frequent access for examination or are located in high radiation areas. Welds are located to permit 100% volumetric examination from at least one side, but where component geometry permits, access from both sides is provided.

RAI 3.9-179

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

6.6.11 COL Information

6.6-1-A PSI/ISI Program Description

The COL Applicant ~~will~~is responsible for providinge a full description of the PSI/ISI programs and augmented inspection programs for Class 2 and 3 components and piping by supplementing, as necessary, the information in Section 6.6. The COL Applicant will also provide milestones for ~~full program~~their implementation (DCD Section 6.6). RAI 5.2-64

6.6-2-H ASME Code Description

The COL Holder will define the applicable ~~ed~~edition and addenda of the ASME Code in the plant specific ISI program (Subsection 6.6.10.2).

6.6-3-A PSI/ISI NDE Accessibility Plan Description

The COL Applicant is responsible for developing a plan and providing a full description of it's use during construction, preservice inspection, inservice inspection, and during design activities for components that are not included in the referenced certified design, to preserve accessibility to piping systems to enable nondestructive examinations (NDE) of ASME Code Class 2 austenitic and dissimilar metal welds during ISI (DCD Section 6.6). RAI 5.2-62

6.6.12 References

None.