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MFN 06-219
Supplement 2

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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 36 – Steam and Power Conversion System – RAI Numbers 10.3-4 S01 and 10.3-6 S01 – Supplement 2**

Enclosure 1 contains GE's response to the subject NRC RAI transmitted via Reference 1 which is a supplemental request to the RAI transmitted via Reference 2. The original RAI response was submitted to the NRC in Reference 3.

If you have any questions or require additional information regarding the information provided here, please contact me.

Sincerely,

Kathy Sedney for

James C. Kinsey
Project Manager, ESBWR Licensing

D068
NRC/NRO

Reference:

1. E-mail request from M. Vaaler (NRC) to D. Lewis (GE) dated March 6, 2007. Subject: Supplemental RAIs for Sections 10.2, 10.3 and Section 12. (ACN: ML070670050)
2. MFN 06-200, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 36 Related to the ESBWR Design Certification Application*, June 22, 2006.
3. MFN 06-219, Letter from David Hinds to the U.S. Nuclear Regulatory Commission, *Partial Response to NRC Request for Additional Information Letter No. 36 Related to ESBWR Design Certification Application – Steam and Power Conversion System and Radioactive Waste Management - RAI Numbers 10.3-1 through 10.2-9 and 11.1-1 through 11.1-3,* July 19, 2006.

Enclosure:

1. MFN 06-219 Supplement 2– Response to Portion of NRC Request for Additional Information Letter No. 36 – RAI Numbers 10.3-4 S01 and 10.3-6 S01, Supplement 2

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Enclosure 1

MFN 06-219
Supplement 2

Response to Portion of NRC Request for Additional Information Letter No. 36 Related to ESBWR Design Certification

Steam and Power Conversion System

RAI Numbers 10.3-4 S01 and 10.3-6 S01

For historical purposes, the original text and the GE response of RAI 10.3-4 is included. The original attachments and DCD mark-ups are not included to prevent confusion.

NRC RAI 10.3-4

Section 10.3.6 indicates that the steam and feedwater component materials that are within the reactor coolant boundary (RCPB) are addressed in Section 5.2 but the material specifications and grades for the steam and feedwater system components that are outside of the RCPB are not listed in 10.3.6 nor 10.4.7. Please provide a complete list of all material specifications and grades that are used in steam, feedwater and condensate systems by component types including weld filler metal. Specify the Code Class for all portions of both systems.

GE Response

Please refer to DCD Chapter 1, Table 1.7-1 for the material types used in the steam, feedwater and condensate system. Code classifications, if applicable, are listed in Table 3.2-1. Weld filler material, as agreed during our telephone conversation, will not be specified in the DCD/COLA but will be identified in the site construction contractors welding program.

No Tier 2 change will be made in response to this RAI.

NRC RAI 10.3-4 Supplement 1

Received from an email dated March 6, 2007 from Marlayna Vaaler (NRC):
Reference: GE response Letter MFN-06-219, dated July 19, 2006, which addressed NRC RAI Letter No. 36, dated June 22, 2006. [ACN: ML070670050]

Section 10.3.6 of the DCD indicates that the steam and feedwater component materials that are within the reactor coolant pressure boundary (RCPB) are addressed in Section 5.2. The staff noted that the material specifications and grades for steam and feedwater system components that are outside of the RCPB are not listed in Section 10.3.6 nor Section 10.4.7. In RAI 10.3-4, the staff requested that the applicant list material specifications and grades, including weld filler material, for steam and feedwater components outside of the RCPB.

The applicant's response to RAI 10.3-4, in GE letter MFN 06-219, dated July 19, 2006, is incomplete for the following reasons:

1. The response refers the staff to DCD Chapter 1, Table 1.7-1 for material types used in the aforementioned systems. However, Table 1.7-1 does not list material specifications and grades for Class 2 feedwater and main steam components.

2. *In response to RAI 10.3-6, the applicant references Section 5.2 and Table 5.2-4. Neither Section 5.2 or Section 10.3.6 state that Class 2 main steam and feedwater specifications are listed in Table 5.2-4.*

The staff requests that the applicant clarify whether the material specifications and grades for Class 2 components are the same as for Class 1 components. If so, modify DCD Section 10.3.6 to provide clarification.

Additionally, clearly identify in Section 10.3.6 the material specifications and grades for Class 2 and Class 3 (if applicable) piping and components (including weld filler material) of steam and feedwater piping systems, rather than making references to other sections of the DCD.

Although the piping and components referred to in Section 10.4.7 of the DCD are non-ASME Code Class 1, 2 or 3, the staff requires that the material specifications be discussed in Section 10.4.7 as part of the applicant's explanation of the steps taken in the ESBWR design to mitigate the effects of material degradation due to erosion/corrosion. See supplemental RAI 10.3-6.

GE Response

Feedwater system materials classified as ASME Section III Class 2 are the same as those specified for Class 1 components. These materials are listed in Table 5.2-4. However, in order to address this specific request, the material specifications and grades for Class 1 and Class 2 piping and components of steam and feedwater piping are to be identified in DCD Tier 2, Revision 4, Subsection 10.3.6 and Table 10.3-2. There is no ASME Section III Class 3/Quality Group C piping in ESBWR steam, feedwater, or condensate system piping.

Refer to the original response in RAI 10.3-4 for the previously agreed upon position on weld filler materials. See the response to RAI 10.3-6 Supplement 1 for information on non-ASME Code Class piping.

DCD Impact

DCD Tier 2 Subsection 10.3.6 and Table 10.3-2 are to be revised in DCD Revision 4 as noted in the attached markup.

For historical purposes, the original text and the GE response of RAI 10.3-6 is included. The original attachments and DCD mark-ups are not included to prevent confusion.

NRC RAI 10.3-6

Describe the mitigation steps taken in the ESBWR design related to: 1) Utilization of erosion/corrosion resistant materials, 2) specification of an adequate corrosion allowance and 3) consideration on minimizing the effects of erosion/corrosion in the design of all ESBWR feedwater, steam and condensate system piping from effects such as fluid velocity, bend locations and flash points.

GE Response

The TMSS piping is designed to consider the effects of erosion/corrosion for a 60 year life expectancy. Piping containing dry, single phase steam is constructed of carbon steel. Piping exposed to wet, two-phase steam is constructed of erosion/corrosion resistant low alloy steel. Velocities in the TMSS piping to the high pressure turbine are limited to reduce the potential for pipe erosion. Low point drains are provided for collecting and draining moisture and to help reduce the potential for water carryover to the high and low pressure turbines. In addition to material selection, pipe size and layout may also be used to minimize the potential for erosion/corrosion in systems containing water or two-phase flow.

Section 10.3.6, Steam and Feedwater System Material, references Section 5.2 which contains Table 5.2-4. This table shows that Carbon Steel, SA-333, GR 6 will be used for the main steam piping and Low Allow, SA-335, Grade P22 will be used for the feedwater piping.

No Tier 2 change will be made in response to this RAI. DCD Table 5.2-4, Rev. 01 will be included for ease of review.

NRC RAI 10.3-6 Supplement 1

Received from an email dated March 6, 2007 from Marlayna Vaaler (NRC):
Reference: GE response Letter MFN-06-219, dated July 19, 2006, which addressed NRC RAI Letter No. 36, dated June 22, 2006. [ACN: ML070670050]

In RAI 10.3-6, the staff requested that the applicant describe the mitigation steps taken in the ESBWR design related to: 1) utilization of erosion/corrosion resistant materials, 2) specification of an adequate corrosion allowance, and 3) consideration on minimizing the effects of erosion/corrosion in the design of all ESBWR feedwater, steam and condensate system piping from effects such as fluid velocity, bend locations and flash points.

In GE letter MFN-06-219, dated July 19, 2006, the applicant stated the following:

The TMSS piping is designed to consider the effects of erosion/corrosion for a 60 year life expectancy. Piping containing dry, single phase steam is constructed of carbon steel. Piping exposed to wet, two-phase steam is constructed of erosion/corrosion resistant low alloy steel. Velocities in the TMSS piping to the high pressure turbine are limited to reduce the potential for pipe erosion. Low point drains are provided for collecting and draining moisture and to help reduce the potential for water carryover to the high and low pressure turbines. In addition to material selection, pipe size and layout may also be used to minimize the potential for erosion/corrosion in systems containing water or two-phase flow.

The applicant's response to RAI 10.3-6 only referenced the TMSS system and does not address main steam, feedwater and condensate piping, as requested in the RAI. Please provide a response that addresses RAI 10.3-6 for ALL main steam, feedwater and condensate system piping (ASME Code Class and non-Code piping) in the ESBWR design.

GE Response

The ESBWR standard plant has a 60-year design life. As part of the design of the condensate, feedwater and main steam piping, an erosion-corrosion evaluation is performed. The evaluation is used to determine the expected erosion-corrosion rate, i.e. yearly reduction in wall thickness, based on the system geometry, system configuration, and chemical properties of the process fluid and piping. With the erosion rate known, the results are compared against the 60-year design life. Areas that do not meet the design life are addressed by piping configuration changes, material substitutions, or a combination of both.

These evaluations are considered useful; however, an inspection program is ultimately required to evaluate the actual loss of wall thickness in piping that is sensitive to erosion-corrosion in an operating plant. Therefore, systems identified in NRC Generic Letter 89-08 are subject to an Augmented Inservice Inspection Program. The Erosion–Corrosion portion of the Augmented Inservice Inspection program is described in Subsection 6.6.7 of DCD Tier 2, Rev. 3.

NRC regulatory guidance on the Condensate and Feedwater System Safety Analysis Report is provided in NUREG-0800, Standard Review Plan, Section 10.4.7, Revision 4. This document states that evaluation of feedwater system materials is performed under section 10.3.6 of the Standard Review Plan. However, NUREG-0800, Section 10.3.6, only applies to ASME Section III Class 2 and 3 pressure boundary components of the steam and feedwater systems. Therefore, specific material selection for non-ASME Section III Code Class 1, 2, or 3 feedwater piping is not addressed in the DCD.

The remainder of the non-ASME Code Class 1, 2, or 3 Condensate and Feedwater System piping is designed and fabricated with consideration given to the deleterious effects of erosion-corrosion. As stated above, an evaluation of the initial system design is performed and changes are made as needed in order to meet the 60-year design life. Further, an inspection program is developed in accordance with industry and regulatory guidance.

DCD Impact

In order to specifically address this request, DCD Tier 2 Subsection 10.4.7 is to be revised in DCD Revision 4 as noted in the attached markup.

Steam is supplied to the cross around steam re-heaters in the Main Turbine system as turbine load is increased. Steam pressure is regulated at low power levels.

If a large, rapid load reduction occurs, steam is bypassed directly to the condenser via the turbine bypass system (see Subsection 10.4.4 for a description of the turbine bypass system).

10.3.3 Evaluation

All components and piping for the TMSS are designed in accordance with the codes and standards listed in Section 3.2. This ensures that the TMSS accommodates operational stresses resulting from static and dynamic loads, including steam hammer and relief valve discharge loads, normal and abnormal environmental conditions, and includes provisions to limit water entrainment. Operating and maintenance procedures include adequate precautions to avoid steam hammer.

The break of a main steam line or any branch line does not result in offsite radiation exposures in excess of the limits of 10 CFR 100 because of the safety features designed into the plant. The main steamline pipe break accident outside containment is addressed in Chapter 15, and high energy pipe failure is discussed in Section 3.6.

10.3.4 Inspection and Testing Requirements

Inspection and testing are in accordance with the requirements of Section 6.6. The main steam line is hydrostatically tested to confirm leak tightness.

10.3.5 Water Chemistry (PWR)

This section applies to a Pressurized Water Reactor (PWR), and is therefore not applicable.

10.3.6 Steam and Feedwater System Materials

Steam and feedwater component materials that are within the Reactor Coolant Pressure Boundary are addressed in Section 5.2.

10.3.6.1 Fracture Toughness of Class 2 Components

The materials in the ASME Code Section III, Class 2, portion of the TMSS meet the fracture toughness requirements of NC-2300, "Fracture Toughness Requirements for Material". The Class 2 portion of the TMSS is defined in Figure 3.2-1 and Table 3.2-3.

10.3.6.2 Materials Selection and Fabrication

The materials specified for use in Class 2 components conform to Appendix I to ASME Code Section III, and to Parts A, B, and C of Section II of the Code.

Material specifications for the ASME Code Section III Class 1 and 2 portions of main steam and feedwater systems are listed in Table 10.3-2.

Conformance with the applicable regulatory guides is described in subsection 1.9.2.

Regulatory Guide 1.84, "Design and Fabrication and Material, Code Case Acceptability, ASME Section III," describes acceptable code cases that are used in conjunction with the above specifications.

Table 10.3-2
ASME Section III Class 1 and 2 Steam and Feedwater System Materials

Component	Form	Material	Specification (ASTM/ASME)
Main Steam System			
Steam Pipe	Seamless	Carbon Steel	SA-333, Grade 6
Steam Pipe Fittings	Forging Or Fitting	Carbon Steel Carbon Steel	SA 350, Grade LF2 or SA-508, Grade 1 SA-420, Grade WPL-6
Feedwater System			
Pipe	Seamless	Low Alloy	SA-335, Grade P22
Fittings	Forging	Low Alloy	SA-336, Grade F22

During startup and shutdown, FW flow is automatically regulated by the low flow control valve. The low flow control valve can also regulate flow from a condensate pump to the reactor vessel for initial fill and cleanup. Control valves at the discharge of the LP heaters regulate condensate flow to control the feedwater tank level and to isolate flow to the storage tank when the low flow control valve is used to by-pass the feedwater pumps and storage tank during direct condensate flow to the reactor vessel.

Feedwater heater No. 7 can be used to control reactor power during startup and power maneuvers by controlling final feedwater temperature. The maximum feedwater temperature is limited to less than or equal to 215.6°C (420°F) at all power levels by use of administrative controls, equipment design, or a combination of both..

The C&FS has sufficient capacity and control stability to accommodate normally anticipated step and ramp changes in reactor power. In conjunction with the Turbine Bypass System, the system is capable of accepting a full generator load rejection without reactor trip and without the operation of reactor safety relief valves.

10.4.7.3 Evaluation

The C&FS does not serve or support any safety-related function. Systems analyses show that failure of this system cannot compromise any safety-related system/function or prevent safe shutdown. C&FS component failure analysis results are provided in Table 10.4-6.

During operation, radioactive steam and condensate are present in the FW heating portion of the system, which includes the extraction steam piping, FW heater shells, heater drain piping, and heater vent piping. Shielding and access control are provided as necessary (see Chapter 12). The C&FS is designed to minimize leakage with welded construction utilized where practicable. Relief valve discharges and operating vents are channeled through closed systems.

If it is necessary to remove a component from service such as a FW heater, pump, or control valve, continued operation of the system is possible by use of the multi-string arrangement and the provisions for isolating and bypassing selected equipment and sections of the system.

The majority of the condensate and FW piping considered in this section is located within the nonsafety-related Turbine Building. The portion that connects to the seismic interface restraint outside the containment is located in the steam tunnel between the Turbine and Reactor Buildings. This portion of the piping is analyzed for dynamic effects from postulated seismic events. The FW control system is designed to ensure that there could not be large sudden changes in FW flow that could induce water hammer.

The C&FS piping is designed with consideration given to the deleterious effects of erosion-corrosion. The system layout and materials selected are evaluated to ensure that the system meets the ESBWR 60-year design life. Inspection programs are established and conducted using guidance in NRC Generic Letter 89-08.

The C&FS trip logic and control schemes respectively use coincident logic and redundant controllers and input signals to support plant availability goals and avoid spurious trips. This specifically includes all FW heater level controllers, all C&FS flow and minimum flow controllers, and pump suction pressure trips, FW heater string isolation/high level trips and C&FS bypass system(s) operation.