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Subject: **Response to Portion of NRC RAI Letter No. 320 Related to ESBWR Design Certification Application – DCD Tier 2 Section 3.9 – Mechanical Systems and Components; RAI Number 3.9-134 S02**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) response to a portion of the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) letter number 320 sent by NRC letter dated March 18, 2009 (Reference 1). RAI Number 3.9-134 S02 is addressed in Enclosure 1. Enclosure 2 contains the DCD changes to Tier 1 and Tier 2 as a result of GEH's response to this RAI. Verified DCD changes associated with these RAI responses are identified in the enclosed DCD markups by enclosing the text within a black box.

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

Sincerely,

Lee F. Dougherty for

Richard E. Kingston
Vice President, ESBWR Licensing

Reference:

1. MFN 09-195 Letter from U.S. Nuclear Regulatory Commission to R. E. Brown, GEH, *Request For Additional Information Letter No. 320 Related to ESBWR Design Certification* dated March 18, 2009

Enclosure:

1. Response to Portion of NRC RAI Letter No. 320 Related to ESBWR Design Certification Application - DCD Tier 2 Section 3.9 – Mechanical Systems and Components; RAI Number 3.9-134 S02
2. Response to Portion of NRC RAI Letter No. 320 Related to ESBWR Design Certification Application - DCD Markups for RAI Number 3.9-134 S02

cc:	AE Cubbage	USNRC (with enclosures)
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	eDRF Section	0000-0102-5833 (RAI 3.9-134 S02)

Enclosure 1

MFN 09-363

Response to Portion of NRC Request for

Additional Information Letter No. 320

Related to ESBWR Design Certification Application

DCD Tier 2 Section 3.9

Mechanical Systems and Components

RAI Numbers 3.9-134 S02

NRC RAI 3.9-134 S02

The GEH response includes a discussion of their general design approach, stating that the main steam lines and branch connection piping for the safety relief valves will be designed to avoid the possibility of any acoustic resonance. However, GEH has not yet submitted the actual design parameters. GEH is requested to submit the actual design parameters of the main steam piping and SRV branch piping, or provide additional detail (design requirements, criteria, methods) to provide assurance that the possibility of acoustic resonance will be avoided and provide associated ITAAC in order to verify this design commitment.

GEH Response

The design of the main steam (MS), safety relief valve (SRV) and safety valve (SV) piping is not final at this time; therefore, an ITAAC will be added to DCD Tier 1 to verify that this piping is designed such that the structural integrity of the piping is not adversely affected by acoustic vibration. In addition, DCD Tier 2, Sections 5.4.9.2, 5.4.13.2 and Appendix 3L.4.1 will be revised to describe this design commitment.

GEH has performed preliminary acoustic resonance calculations for the MS, SRV and SV piping based on preliminary design information. These calculations show that the calculated Strouhal numbers are outside the range for which adverse impacts due to acoustic resonances would occur. The calculations were performed at 100% and 102% power.

DCD Impact

a. DCD Tier 1, Section 2.1.2 and Table 2.1.2-3 will be revised as shown in the attached markup.

b. DCD Tier 2, sections 5.4.9.2 and 5.4.13.2 will be revised as shown in the attached markup.

c. DCD Tier 2, Appendix 3L.4.1 will be revised as shown in the attached markup.

Enclosure 2

MFN 09-363

Response to Portion of NRC Request for

Additional Information Letter No. 320

Related to ESBWR Design Certification Application

DCD Markups for RAI Number 3.9-134 S02

(30) The pressure loss coefficient of each of the following components is within the uncertainty band of the pressure loss coefficient used in the natural circulation flow analysis:

- Steam separator
- Fuel bundle
- Fuel support piece orifice
- Control rod guide tubes
- Shroud support

(31) The free volume for each of the following components is within the uncertainty band of the free volume used in the natural circulation flow analysis:

- RPV
- Downcomer
- Core
- Chimney
- Separator/dryer

(32) The hydraulic diameter, geometry of the heated surfaces, and flow area in fuel assemblies are within the uncertainty band of the geometry used in the natural circulation flow analysis.

(33) ~~NBS software is developed in accordance with the software development program described in Section 3.2.~~ (Deleted)

(34) ~~NBS minimum inventory of alarms, displays, controls, and status indications in the main control room are addressed in section 3.3.~~ (Deleted)

(35) ~~Conformance with IEEE Standard 306 requirements by the safety-related control system, structures, systems and components is addressed in Subsection 2.2.15.~~ (Deleted)

(36) The main steam line and SRV/SV branch piping geometry precludes acoustic resonance conditions from occuring at plant normal operating conditions.

Inspections, Tests, Analyses and Acceptance Criteria

Table 2.1.2-3 provides a definition of the inspections, tests and/or analyses, together with associated acceptance criteria for the NBS.

Table 2.1.2-3

ITAAC For The Nuclear Boiler System

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
32. The hydraulic diameter, the geometry of heated surfaces, and flow area in fuel assemblies are within the uncertainty band of the geometry used in the natural circulation flow analysis.	As-built dimension inspection and analyses will be performed to determine the geometry of the fuel assemblies to be loaded.	A rReport(s) exists and concludes that the hydraulic diameter, the geometry of heated surfaces, and flow area in the fuel assemblies are within the uncertainty band of the geometry used in the natural circulation flow analysis.
33. NBS software is developed in accordance with the software development program described in Section 3.2. (Deleted)	Section 3.2.	Section 3.2.
34. NBS minimum inventory of alarms, displays, controls, and status indications in the main control room are addressed in Section 3.3..(Deleted)	See Section 3.3..	See Section 3.3.
35. Conformance with IEEE Standard 306 requirements by the safety-related control system, structures, systems and components is addressed in Subsection 2.2.15.(Deleted)	See Subsection 2.2.15	See Subsection 2.2.15
36. The main steam line and SRV/SV branch piping geometry precludes acoustic resonance conditions from occuring at plant normal operating conditions.	Analysis of the as-built piping system and equipment for acoustic resonance at plant normal operating conditions.	Report(s) exist and conclude that the main steam line and SRV/SV branch piping geometry preclude acoustic resonance conditions from occurring at plant normal operating conditions.

3L.4 STEAM DRYER EVALUATION PROGRAM

3L.4.1 Steam Dryer Design and Performance

The ESBWR steam dryer consists of a center support ring with dryer banks on top and a skirt below. A typical steam dryer is shown in Figure 3L-2. The dryer units, made up of steam drying vanes and perforated plates, are arranged in six parallel rows called dryer banks. The ESBWR steam flow rate is approximately 15% higher than ABWR. The ESBWR RPV has a larger inner diameter at the vessel flange than ABWR, which allows dryer banks to be extended, thereby accommodating the higher steam flow. The additional dryer unit face area results in approximately the same flow velocity through the drying vanes as ABWR and help maintain moisture removal performance requirements. The support ring is supported by RPV support brackets. The steam dryer assembly does not physically connect to the chimney head and steam separator assembly. The cylindrical skirt attaches to the support ring and projects downward to form a water seal around the array of steam separators. Normal operating water level is approximately mid-height on the steam dryer skirt.

Wet steam from the core flows upward from the steam separators into an inlet header, then horizontally through the inner perforated plate, the dryer vanes and the outlet perforated plates, then vertically in the outlet header and out into the RPV dome. Dry steam then exits the RPV through the steam outlet nozzles. Moisture (liquid) is separated from the steam by the vane surface and the hooks attached to the vanes. The captured moisture flows downward, under the force of gravity, to a collection trough that carries the liquid flow to vertical drain channels. The liquid flows by gravity through the vertical drain channels to the lower end of the skirt where the flow exists below the normal water level.

The prototype for the ESBWR steam dryer builds on the successful operating experience of the ABWR steam dryer. Although the ESBWR steam dryer will have a larger diameter and wider vane banks to accommodate close to 15% higher steam flow, the vane height, skirt length, outer hood setback from the main steam nozzle, and water submergence will be similar to the ABWR steam dryer. The ESBWR steam dryer also draws experience from operating plant replacement steam dryer program fabrication, testing and performance. Steam dryers recently tested and installed in BWR/3 and BWR/4 plants had experienced high pressure loads under extended power uprate operating conditions. These loads were characterized by an abnormally high pressure tone at approximately 155 Hz that emanated from an acoustic resonance in one or more of the safety relief valve (SRV) standpipes. The replacement steam dryers were specifically designed to withstand the FIV and acoustic resonance loading that led to fatigue failures in the steam dryers for these plants. In addition, the SRV standpipes and main steamline branch lines in ESBWR are specifically designed to ~~mitigate~~ preclude SRV/branch line resonances that could be a significant contributor to steam dryer loading at normal operating conditions. Table 3L-1 provides a comparison between major configuration parameters of the ESBWR, the ABWR prototype and a BWR/3 replacement steam dryer.

3L.4.2 Materials and Fabrication

Current industry and replacement steam dryer practices are applied to the materials and fabrication of the ESBWR steam dryer. The steam dryer materials are selected to be resistant to corrosion and stress corrosion cracking in the BWR steam/water environment, see Table 4.5-1.

the steam stub lines), loads from fast closure of the turbine stop and/or control valves (for the main steamlines), and waterhammer loads (for the feedwater lines); and

- Provide for long-term leak-tight isolation of the RPV and the containment.

Power Generation Design Bases

The main steam and feedwater lines are designed to:

- Transport steam from the reactor vessel through the steamlines over the full range of reactor power operation and, in conjunction with the MSIVs, limit the pressure drop from the reactor to the turbine to less than the design value;
- Supply water to the reactor vessel through the feedwater lines over the full range of reactor power operation; and
- Permit flooding of the steamlines up to the main turbine stop valves during refueling and other shutdowns without the need for adding temporary supports.

5.4.9.2 Description

The main steamlines consist of carbon steel piping originating at reactor vessel nozzles and running to the main steamline header in the turbine building. From the main steamline header, there are four lines that run to and terminate at the turbine stop valves. The feedwater lines are low alloy steel piping beginning from the interface at the seismic restraint just inside the steam tunnel through containment penetration into the drywell and then branching to lines connecting to reactor vessel nozzles. The main steam and feedwater piping from the reactor through the isolation valves in the reactor building is shown schematically in Figure 5.4-3. Further descriptions of the main steamlines downstream of the outboard MSIVs and the feedwater lines upstream of the seismic restraint for the outboard isolation valves are contained in Sections 10.3 and 10.4, respectively.

The SRV standpipes and main steamline branch lines in ESBWR are specifically designed to preclude SRV/branch line resonances that could be a significant contributor to steam dryer loading at normal operating conditions.

The main steamlines are Quality Group A and ASME Section III, Class 1 from the RPV through the outboard MSIVs. They are Seismic Category I from the RPV to the seismic interface restraint downstream of the outboard MSIV. The main steamlines from the outboard MSIV to the turbine stop valves are described in Section 10.3 and Table 3.2-1.

The four steam stub lines consist of low alloy steel piping originating at the reactor vessel nozzles and running to the respective ICS train steam supply line interface connection, and include pairs of DPVs mounted at the terminal ends. The DPVs are described in Subsection 5.4.13. The steam stub lines are Quality Group A, ASME Section III, Class 1, and Seismic Category I. The steam stub lines are mounted to the RPV as nominally horizontal piping, sloped back to the reactor vessel to assure moisture drainage away from the ICS steam line or the DPV inlets.

The feedwater lines are Quality Group A and ASME Section III, Class 1 from the RPV through the outboard containment isolation valves, including the branch isolation valves; Quality Group B and ASME Section III, Class 2 from the outboard containment isolation valves to the seismic

Detailed Description

The use of a combination of SRVs and DPVs to accomplish the vessel depressurization function minimizes components and maintenance as compared to using only SRVs or only DPVs for this function. By using the SRVs for two different purposes, the number of DPVs required is minimized. By using DPVs for the additional depressurization capability needed beyond what the SRVs can provide, the total number of SRVs, SRV discharge lines, and quenchers in the suppression pool are minimized. The need for SRV maintenance, periodic calibration and testing, and the potential for simmering are all minimized with this arrangement.

The SRV standpipes and main steamline branch lines in ESBWR are specifically designed to preclude SRV/branch line resonances that could be a significant contributor to steam dryer loading at normal operating conditions.

The SRVs and DPVs and associated controls and actuation circuits are located or protected so that their functions cannot be impaired by consequential effects of the accidents. The designs are able to withstand or are protected from the effects of flooding, pipe whip and jet impingement. NBS components are qualified to withstand long-term drywell environmental conditions during plant power operation and the harsh environments postulated for DBAs inside containment, including temperature, pressure, and radiation. Further details are provided in Section 3.11.

DPVs are designed with flange connections to allow whole valve removal or reinstallation. They are designed, however, so that routine maintenance and inspection can be accomplished at their installed locations. Mechanical joining is used to attach parts such as the shear cap hinge and shaft, position probe, actuator subassembly, and the pyrotechnic gas generating booster assembly. Cable connections are made up with mechanical disconnects. These assembly methods facilitate easy removal or reinstallation for maintenance, testing, parts renewal, or rebuilding of either whole valves or critical portions with the minimum practical worker resident time in the drywell.

Figure 5.4-5 depicts a DPV assembly in the closed and open positions. The DPVs are of a non-leak/non-simmer/non-maintenance design. They are straight-through, pyrotechnic-actuated, non-reclosing valves with a metal diaphragm seal. The valve size provides about twice the depressurization capacity as a SRV. The DPV is closed with a cap covering the inlet chamber. The cap shears off when pushed by a valve plunger that is actuated by the explosive initiator-booster. This opens the inlet hole through the plug. The sheared cap is hinged such that it drops out of the flow path and does not block the valve. This design has been demonstrated effective to open down to zero vessel-to-drywell pressure differential. The DPVs are designed so that there is no leakage across the cap throughout the life of the valve.

The DPVs form a part of the RCPB, and therefore, are Quality Group A, ASME Section III, Class 1, and Seismic Category I. The DPV inlet side design pressure, outlet-side design pressure, valve body materials and design life are provided in Table 5.4-4. The design life includes remaining functional after being subjected to a variety of normal and abnormal pressure-temperature transients, including two cycles of full depressurization of the reactor. Certain components, such as the initiator-boosters, require periodic replacement. The DPV operating fluid conditions, rated flow capacity of each DPV, specified response times (opening time to full rated capacity) of the DPVs are provided in Table 5.4-4.