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MFN 06-178
Supplement 2

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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 29 Related to ESBWR Design Certification Application – Nuclear Boiler System - RAI Numbers 5.2-20 S02, and 5.2-22 S02**

Enclosure 1 contains GEH's response to the subject NRC RAIs transmitted via e-mail on June 6, 2007. Previous responses were provided in the Reference 1 and 2 letters.

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

Sincerely,

Kathy Sedney for

James C. Kinsey
Vice President, ESBWR Licensing

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NRO

References:

1. MFN 06-178, Letter from David Hinds to U.S. Nuclear Regulatory Commission, *Response to NRC Request for Additional Information Letter No. 29 Related to ESBWR Design Certification Application – Control Rod Drive System Structural Materials/Reactor Internal Materials & Integrity of Reactor Coolant Pressure Boundary – RAI Numbers 4.5-1 through 4.5-32 and 5.2-6 through 5.2-29*, dated June 16, 2006
2. MFN 06-178, Supplement 1, Letter from James C. Kinsey to U.S. Nuclear Regulatory Commission, *Response to Portion of NRC Request for Additional Information Letter No. 29 – Overpressure Protection Analysis and Safety Relief Valves - RAI Numbers 5.2-18 S01, 5.2-20 S01, and 5.2-22 S01*, dated May 3, 2007

Enclosure:

1. MFN 06-178. Supplement 2 - Response to Portion of NRC Request for Additional Information Letter No. 29 Related to ESBWR Design Certification Application – Nuclear Boiler System - RAI Numbers 5.2-20 S02, and 5.2-22 S02

cc:	AE Cubbage	USNRC (with enclosure)
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	RE Brown	GEH/Wilmington (with enclosure)
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	eDRF	0000-0074-1447

Enclosure 1

MFN 06-178, Supplement 2

Response to Portion of NRC Request for

Additional Information Letter No. 29

Related to ESBWR Design Certification Application

Nuclear Boiler System

RAI Numbers 5.2-20 S02, and 5.2-22 S02

NRC RAI 5.2-20

SRV set point drift and seat leakage are generic problems. Describe specific design features of the ESBWR SRVs. Compare the relative performance of ESBWR SRVs and SRVs currently installed in operating reactors. Provide a detailed description of any improvements between ESBWR SRV designs and presently operating plant SRVs in the areas of seat-leakage, set-point drift, and actuator reliability.

GE Response

The detailed design and selection of the ESBWR SRVs have not been finalized. Lessons learned from valves installed in current operating BWRs will be considered during the selection phase of the ESBWR SRVs. Historically, set point drift has been a concern with pilot operated valves. However, this concern has not been a problem with a direct acting type valve, which is in use in many of the more recent design BWRs. Seat leakage has been a concern with some direct acting valves. However, valve suppliers have continued to evaluate and incorporate design modifications pertaining to seat and disc geometry and materials to reduce seat leakage. GE will evaluate potential valve suppliers during the selection phase with an emphasis on optimum performance in the areas of set point drift, actuator reliability and seat leakage. Selection of a direct acting SRV for ESBWR is the most likely choice and provides an improvement over SRVs in current operating BWRs, which use 18 SRVs that are capable of remote actuation. The ESBWR design has reduced the number of SRVs that are capable of remote actuation from 18 to 10 because fewer SRVs are needed for depressurization because of the addition of the DPVs. This reduces the chance of inadvertent actuation and subsequent seat leakage. The remainder of the SRVs in the ESBWR are designed for safety mode only and are not capable of remote actuation. Both groups of valves are designed with nameplate set pressures that are higher than the set pressure of SRVs in current operating BWRs. This produces a higher simmer margin and makes it less likely that there will be leakage through the SRV. DCD Section 5.2.2.2.2 will be revised to clarify that only 10 SRVs are remote actuated from the control room.

The operability of the SRV when discharging water under low-pressure and high-pressure conditions was addressed in response to RAI 5.2-16. Review of the occurrence under high-pressure conditions showed that there was no water hammer, but there was a high initial SRV discharge line loading when the SRV first opened. Subsequent investigation showed that there were no adverse effects on the SRV and its associated piping. Therefore, water hammer is not expected to be a problem with the ESBWR SRVs.

NRC RAI 5.2-20 S01:

In response to RAI 5.2-20 provided in MFN 06-178 (June 16, 2006), GE stated that the detailed design and selection of the ESBWR safety/relief valves (SRVs) have not been finalized. In response to RAI 5.2-22 in MFN 06-178, GE states that a purchase specification, which uses the GE Environmental Qualification experience base, will be prepared for the SRVs. The SRVs will be subject to the Environmental and Dynamic Qualification program. The NRC staff is requesting that GE specify its acceptance criteria for the design and qualification of the SRVs to be used in the ESBWR, including appropriate ITAACs. While reviewing DCD 5.2.2, I found out that GE included ASME NB-7520, Pilot operated pressure relief valves and NB-7540 Pilot operated pressure relief valves with auxiliary device. In response to our RAI 5.2-20, GE told us that the pilot operated SRVs had lot of problems and they implied that they will be using only direct acting SRVs. Then why GE is including NB-7520 AND 7540? I see a contradiction ...."

GE Response:

To address the supplemental request, it is beneficial to address the last item first. ASME Boiler and Pressure Vessel (B&PV) Code Section III, Subsubarticle NB-7540, "Safety Valves and Pilot Operated Pressure Relief Valves With Auxiliary Actuating Devices," applies to the safety relief valve (SRV) design used in current GE designed Advanced Boiling Water Reactor (ABWR) units that are operating or under construction, and that also serve as a reference for the ESBWR design. That is, these SRVs are direct-acting spring-closed safety valves with external pneumatic actuating mechanisms for performing auxiliary pressure relief functions. ASME B&PV Code Section III, Subsubarticle NB-7510, "Safety, Safety Relief and Relief Valves," are the rules applicable to the overpressure protection system valves, and particularly to the ESBWR safety valves (SVs) that provide additional overpressure protection capacity as described in DCD Tier 2, Subsection 5.2.2. ASME B&PV Code Section III, Subsubarticle NB-7520, "Pilot Operated Pressure Relief Valves," are the applicable rules for an alternative SRV design, using a small mechanical SV as a pilot mechanism to control the actuation of the main valve that has a disk operated by a fluid-driven piston.

There are a few possible configurations for pilot operated SRVs. Pilot operated SRVs may be built with steam under the main disk seat that isolates the steam inlet, similar to the direct-acting SRV, but with steam pressure applied to a larger piston surface to hold the valve shut in place of a large spring. Alternately, pilot operated SRVs may be built with steam pressure over the main disk to hold it closed and isolate the steam outlet, with steam pressure applied to both sides of an actuating piston. Both of these configurations rely on pilot valve lift to exhaust steam so that it depressurizes the piston steam chamber on the side holding the main disk closed to allow the main disk to open. The third approach to pilot operated SRV design is a configuration with pressure over the main disk that isolates the steam inlet, with no steam pressure on the disk piston and the piston chamber normally evacuated with the pilot valve closed. The third pilot operated SRV configuration operates by pilot valve lift to pressurize the piston chamber and drive the main disk open.

The pilot operated SRV configuration in some previously licensed BWRs that has proven to be less reliable than comparable plants with direct-acting SRVs uses a configuration with steam pressure over the main disk isolating the valve outlet and a depressurize-to-open actuation method. These earlier domestic BWR pilot operated SRVs are mostly of a single manufacturer and product design series. Direct extension of the experience with this SRV design to currently offered design types, makes and models of pilot operated SRVs is not appropriate. Lessons learned from the experience history with this SRV design are considered in the selection of overpressure protection valves for the ESBWR. Thus, the ESBWR project continues to evaluate potential suppliers and models of valves to serve each the ESBWR SRV functions and ESBWR SV function.

Both this request and RAI 5.2-22 ask "that GE specify its acceptance criteria for the design and qualification of the SRVs to be used in the ESBWR" and the Inspections, Test, Analyses, and Acceptance Criteria (ITAAC) applicable to these valves. As noted in the previous reply to RAI 5.2-22, purchase specification(s) will be prepared for the ESBWR SRVs and SVs that invoke(s) the necessary environmental qualification requirements. A specification has yet to be written, but will use the cumulative experience available from previous GE BWR projects and programs developed to address environmental qualification. As identified in DCD Tier 1, Subsection 1.2.2.1, equipment qualification of components is part of the ITAAC verifications for basic configuration for systems. Correspondingly, DCD Tier 1, Table 2.1.2-2, Item 1, contains an ITAAC to confirm the basis configuration for the Nuclear Boiler System. Therefore, this ITAAC includes programmatic reviews of SRV design and environmental qualifications.

NRC RAI 5.2-20 S02

E-mail from Shawn Williams:

GE's RAI response to supplemental RAIs 5.2-20 and 5.2-22, MFN 06-178, states that purchase specification for the safety relief valves (SRVs) "has yet to be written." GE further explains that the DCD, Tier 1, Revision 3, Table 2.1.2-2, Item 1, contains an ITAAC to confirm the basic configuration for the Nuclear Boiler System (NBS) and that inspections shall be conducted with the acceptance criteria that "the as-built NBS conforms to the basic configuration as defined in Subsection 2.1.2." GE's position is that this ITAAC includes programmatic reviews of the SRV design and environmental qualifications, which meets the intent of the supplemental RAI for which staff requested that "GE specify its acceptance criteria for the design and qualification of the SRVs to be used in the ESBWR, including appropriate ITAACs."

DCD, Tier 1, Revision 3, Section 1.2.2.1 (4), "Verifications for Basic Configuration for Systems," states that the basic configuration ITAAC includes "Tests or type tests of active safety-related valves identified in the Design Description to demonstrate that the valves are qualified to perform their safety-related functions under design basis differential pressure, system pressure, fluid temperature, ambient temperature, minimum voltage, and minimum and/or maximum stroke times."

A. The referenced ITAAC is not sufficient. Revise the ITAAC table to include verification for the SRV discharge capacity and setpoints to demonstrate that the as-built is consistent with the assumptions of the safety analyses.

B. Include a COL Applicant or COL Holder Item to the DCD to ensure that operating experience, for example, issues identified in Regulatory Issue Summary 00-012, "Resolution of Generic Safety Issue B-55, 'Improved Reliability of Target Rock Safety Relief Valves'," IE Circular 79-18, "Proper Installation of Target Rock Safety Relief Valves," Bulletin 74-04, "Malfunction of Target Rock Safety Relief Valves," and NUREG-0763, "Guidelines for Confirmatory in-plant Tests of Safety Relieve Valve Discharges for BWR Plants" are addressed when the SRVs are procured.

C. Revise the DCD, Tier 1, Section 1.2.2.1 to expand the environmental qualification verifications to include mechanical equipment such as seals and gaskets.

GEH Response

A. ITAACs that address verification of the SRV/SV discharge capacity and setpoints were added to Table 2.1.2-3 in DCD Tier 1 Revision 4. Refer to the attached mark-up of Table 2.1.2-3. The relevant sections are enclosed in boxes.

B. The selection of a specific valve design for the SRVs and SVs consider relevant operating experience, including the documents referenced in the RAI. If there are specific requirements related to installation, testing or maintenance of the valve design selected to ensure reliability, those requirements are documented on drawings, in procedures or in other appropriate documents. Therefore, no COL Applicant or COL Holder actions are required. No change to the DCD will be made.

C. DCD Tier 1, Revision 4, expands the environmental qualification verifications to include mechanical equipment. Refer to the attached mark-up of DCD Tier 1, Subsection 1.1.1. The relevant sections are enclosed in boxes.

DCD Impact

DCD Revision 4 incorporates comments A and C. No additional DCD changes are needed.

NRC RAI 5.2-22

What provisions have been employed to ensure that valve and valve actuator specifications include design requirements for operation under expected environmental conditions (i.e. radiation, temperature, humidity, and vibration)?

GE Response

A purchase specification, which utilizes the extensive GE Environmental Qualification experience base, will be prepared for the SRV. This specification defines the design and qualification requirements for the SRV. The SRV will be subjected to Environmental and Dynamic Qualification as defined in the purchase specification. The purchase specification will define the environmental conditions such as radiation, temperature, pressure and humidity and the seismic and dynamic conditions, which include the required response spectra. Also, the purchase specification will define the requirements for the Environmental and Dynamic Qualification Program, such as radiation aging, thermal aging, mechanical aging and vibration testing.

NRC RAI 5.2-22 S01:

In response to RAI 5.2-20 provided in MFN 06-178 (June 16, 2006), GE stated that the detailed design and selection of the ESBWR safety/relief valves (SRVs) have not been finalized. In response to RAI 5.2-22 in MFN 06-178, GE states that a purchase specification, which uses the GE Environmental Qualification experience base, will be prepared for the SRVs. The SRVs will be subject to the Environmental and Dynamic Qualification program. The NRC staff is requesting that GE specify its acceptance criteria for the design and qualification of the SRVs to be used in the ESBWR, including appropriate ITAACs.

GE Response:

Response to this supplemental request is provided with the response to RAI 5.2-20 S01 that addresses the same issues.

NRC RAI 5.2-22 S02

E-mail from Shawn Williams:

GE's RAI response to supplemental RAIs 5.2-20 and 5.2-22, MFN 06-178, states that purchase specification for the safety relief valves (SRVs) "has yet to be written." GE further explains that the DCD, Tier 1, Revision 3, Table 2.1.2-2, Item 1, contains an ITAAC to confirm the basic configuration for the Nuclear Boiler System (NBS) and that inspections shall be conducted with the acceptance criteria that "the as-built NBS conforms to the basic configuration as defined in Subsection 2.1.2." GE's position is that this ITAAC includes programmatic reviews of the SRV design and environmental qualifications, which meets the intent of the supplemental RAI for which staff requested that "GE specify its acceptance criteria for the design and qualification of the SRVs to be used in the ESBWR, including appropriate ITAACs."

DCD, Tier 1, Revision 3, Section 1.2.2.1 (4), "Verifications for Basic Configuration for Systems," states that the basic configuration ITAAC includes "Tests or type tests of active safety-related valves identified in the Design Description to demonstrate that the valves are qualified to perform their safety-related functions under design basis differential pressure, system pressure, fluid temperature, ambient temperature, minimum voltage, and minimum and/or maximum stroke times."

A. The referenced ITAAC is not sufficient. Revise the ITAAC table to include verification for the SRV discharge capacity and setpoints to demonstrate that the as-built is consistent with the assumptions of the safety analyses.

B. Include a COL Applicant or COL Holder Item to the DCD to ensure that operating experience, for example, issues identified in Regulatory Issue Summary 00-012, "Resolution of Generic Safety Issue B-55, 'Improved Reliability of Target Rock Safety Relief Valves'," IE Circular 79-18, "Proper Installation of Target Rock Safety Relief Valves," Bulletin 74-04, "Malfunction of Target Rock Safety Relief Valves," and NUREG-0763, "Guidelines for Confirmatory in-plant Tests of Safety Relieve Valve Discharges for BWR Plants" are addressed when the SRVs are procured.

C. Revise the DCD, Tier 1, Section 1.2.2.1 to expand the environmental qualification verifications to include mechanical equipment such as seals and gaskets.

GEH Response

A. ITAACs that address verification of the SRV/SV discharge capacity and setpoints were added to Table 2.1.2-3 in DCD Tier 1 Revision 4. Refer to the attached mark-up of Table 2.1.2-3. The relevant sections are enclosed in boxes.

B. The selection of a specific valve design for the SRVs and SVs consider relevant operating experience, including the documents referenced in the RAI. If there are specific requirements related to installation, testing or maintenance of the valve design selected to ensure reliability, those requirements are documented on drawings, in procedures or in other appropriate documents. Therefore, no COL Applicant or COL Holder actions are required. No change to the DCD will be made.

C. DCD Tier 1, Revision 4, expands the environmental qualification verifications to include mechanical equipment. Refer to the attached mark-up of DCD Tier 1, Subsection 1.1.1. The relevant sections are enclosed in boxes.

DCD Impact

DCD Revision 4 incorporates comments A and C. No additional DCD changes are needed.

Table 2.1.2-3

ITAAC For The Nuclear Boiler System

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
15. The MSIVs are capable of fast closing under design differential pressure, fluid flow and temperature conditions.	Tests of the as-built MSIV will be conducted under preoperational test conditions or type testing of an MSIV will be conducted in accordance with the design and purchase specifications to demonstrate that the MSIVs will fast close.	Report(s) document that testing demonstrates MSIVs are capable of fast closure in not less than 3 seconds and not more than 5 seconds.
16. When all MSIVs are closed by normal means, the combined leakage through the MSIVs for all four MSLs will be less than or equal to the design bases assumption value.	Tests at preoperational conditions along with analysis will be performed on the as-built MSIVs to determine the leakage as adjusted to the specified design conditions.	Report(s) document that, when all MSIVs are closed, the combined leakage through the MSIVs for all four MSLs is less than or equal to a total combined leakage (corrected to standard conditions) of ~0.0623 m^3/minute (~2.2 ft^3/minute) for post-LOCA leakage.
17. The opening pressure for the SRVs mechanical lift mode satisfies the overpressure protection analysis.	Type test (at a facility) or setpoint test will be conducted in accordance with the ASME Code to certify the valve.	Report(s) document that testing/type testing verifies the mechanical lift nominal setpoint pressure of 8.366 $\pm$ 0.251 MPa gauge (1213 $\pm$ 36.39 psig).
18. The opening time for the SRVs (in the overpressure operation of self-actuated or mechanical lift mode) from when the pressure exceeds the valve set pressure to when the valve is fully open shall be less than or equal to the design opening time.	Analysis and type tests (at a test facility) will be conducted in accordance with the ASME Code to ensure that the valves open within the design opening time.	Report(s) document that tests and analyses exist and conclude that opening time for the SRVs for the overpressure operation mode is less than or equal to 0.5 seconds.

Table 2.1.2-3

ITAAC For The Nuclear Boiler System

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
19. The steam discharge capacity of each SRV satisfies the overpressure protection analysis.	Type tests (at a facility) will be conducted in accordance with the ASME Code for relief valve certification.	Report(s) document that valve capacity stamping on each SRV records the certified capacity at rated setpoint of 138 kg/s (304 lbm/s) minimum.
20. The opening pressure for the SVs satisfies the overpressure protection analysis.	Type tests (at a facility) or setpoint tests will be conducted in accordance with the ASME Code to certify the valve.	Report(s) document that testing/type testing verifies the mechanical lift nominal setpoint pressure of 8.503 $\pm$ 0.255 MPa gauge (1233 $\pm$ 36.99 psig).
21. The opening time for the SVs from when the pressure exceeds the valve set pressure to when the valve is fully open shall be less than or equal to the design opening time.	Analysis and type tests (at a test facility) will be conducted in accordance with the ASME Code to ensure that the valves open within the design opening time.	Report(s) document that tests and analyses exist and conclude that opening time for the SVs is less than or equal to 0.5 seconds.
22. The steam discharge capacity of each SV satisfies the overpressure protection analysis.	Type tests (at a facility) will be conducted in accordance with the ASME Code for relief valve certification.	Report(s) document that valve capacity stamping on each SV records the certified capacity at rated setpoint of 140.2 kg/s (309 lbm/s) minimum.
23. The relief-mode actuator (and safety-related appurtenances) can open each SRV with the drywell pressure at design pressure.	An analysis and/or type test will be performed to demonstrate the capacity of the relief-mode actuation for each SRV.	Test/analysis report(s) conclude that the relief-mode actuation has the capacity to lift the SRVs to the full open position one time with the drywell pressure at the drywell design pressure.

1. INTRODUCTION

This document provides the Tier 1 material of the ESBWR Design Control Document (DCD).

1.1 DEFINITIONS AND GENERAL PROVISIONS

1.1.1 Definitions

The definitions below apply to terms which may be used in the Design Descriptions and associated Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC).

Acceptance Criteria means the performance, physical condition, or analysis results for a structure, system, or component that demonstrates a design commitment is met.

Analysis means a calculation, mathematical computation, or engineering or technical evaluation. Engineering or technical evaluations could include, but are not limited to, comparisons with operating experience or design of similar structures, systems, or components.

As-built means the physical properties of the structure, system or component, following the completion of its installation or construction activities at its final location at the plant site.

Cold shutdown means a *safe shutdown* with the average reactor coolant temperature ≤ 93.3°C (200°F).

Containment means the Primary Containment System, unless explicitly stated otherwise.

Design Commitment means that portion of the Design Description that is verified by ITAAC.

Design Description means that portion of the design that is certified.

Division (for electrical systems or equipment) is the designation applied to a given safety-related system or set of components that is physically, electrically, and functionally independent from other redundant sets of components.

Equipment Identification Number as used in Tier 1 means the designation on a Tier 1 figure and is not representative of an actual equipment number or tag number.

Equipment Qualification

For purposes of ITAAC:

Environmental Qualification: Type tests, or type tests and/or analyses, of the safety-related mechanical components and electrical equipment demonstrate qualification to applicable normal, abnormal and design basis accident conditions without loss of the safety-related function for the time needed to perform the safety-related function. These harsh environmental conditions, as applicable to the bounding design basis accident(s), are as follows: expected time-dependent temperature and pressure profiles, humidity, chemical effects, radiation, aging, submergence, and their synergistic effects which have a significant effect on equipment performance.

As used in the associated ITAAC, the term "safety-related electrical equipment" constitutes the equipment itself, connected instrumentation and controls, connected electrical components (such as cabling, wiring, and terminations), and the lubricants necessary to support performance of the safety-related functions of the safety-related electrical components identified as being subject to the environmental qualification requirements.

As used in this paragraph, "safety related mechnical components" refers to mechanical parts, subassemblies or assemblies that are categorized as Quality Group A, B or C. Mechanical components qualification also may be by type tests, analyses or a combination of tests and analyses of individual parts or subassemblies or of complete assemblies rather than by testing the individual parts or subassemblies separately.

Safety-related equipment located in a mild environment will be qualified for their environmental requirements through specifications and certifications to the environments; however, for a mild environment, only safety-related digital instrumentation and control equipment will be addressed by ITAAC in Tier 1, consistent with NRC guidance in NUREG-0800, Section 14.3. Additionally, EMI susceptibility and emissions qualification is performed by type testing for the safety-related digital instrumentation and control equipment and is not specifically addressed in an ITAAC. ITAAC address analyses of material data for safety-related mechanical equipment located in a harsh environment.

Seismic Qualification: Type tests, analyses, or a combination of type tests and analyses of the Seismic Category I mechanical and electrical equipment (including connected instrumentation and controls) may be used to demonstrate that the as-built equipment, including associated anchorage, is qualified to withstand design basis dynamic loads without loss of its safety-related function.

Functional Arrangement/Physical Arrangement (for a Building) means the arrangement of the building features (e.g., floors, ceilings, walls, basemat and doorways) and of the structures, systems, or components within, as specified in the building Design Descriptions.

Functional Arrangement (for a System) means the physical arrangement of systems and components to provide the service for which the system in intended, and which is described in the system Design Description.

Hot shutdown means a *safe shutdown* with the average reactor coolant temperature > 215.6°C (420°F).

Hot standby means a subcritical or critical condition (1) with thermal power (including decay heat) ≤ 5% of rated, (2) in which reactor temperatures and pressures are near normal operating conditions, and (3) from which normal power operation can readily be achieved.

Inspect or **Inspection** means visual observations, physical examinations, or review of records based on visual observation or physical examination that compare the structure, system, or component condition to one or more Design Commitments. Examples include, but are not limited to, walk-downs, configuration checks, measurements of dimensions, and non-destructive examinations.

Inspect for Retrievability of a display means to visually observe that the specified information appears on a monitor when summoned by the operator.

Operate means the actuation, control, running, and/or shutting down (*e.g.*, closing, turning off) of equipment.