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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 96 Related to ESBWR Design Certification Application – Technical Specifications – RAI Number 16.2-119**

Enclosure 1 contains GE's response to the subject NRC RAI transmitted via the Reference 1 letter.

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

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NRO

References:

1. MFN 07-231, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 96 Related to ESBWR Design Certification Application,* April 12, 2007

Enclosures:

1. MFN 07-305 – Response to Portion of NRC Request for Additional Information Letter No. 96 Related to ESBWR Design Certification Application – Technical Specifications – RAI Number 16.2-119

cc:

AE Cubbage	USNRC (with enclosures)
DH Hinds	GE (with enclosures)
RE Brown	GE (w/o enclosures)
eDRFs	0068-2792

Enclosure 1

MFN 07-305

Response to Portion of NRC Request for

Additional Information Letter No. 96

Related to ESBWR Design Certification Application

- Technical Specifications -

RAI Number 16.2-119

NRC RAI 16.2-119

Clarify the number of SRVs required for overpressure protection. In DCD Tier 2, Revision 3, Chapter 16, LCO 3.4.1, the number of operable SRVs was changed to include only 2 SRVs instead of 18 SRVs. DCD Tier 2, Revision 3, Chapter 16, B 3.4.1, states that this LCO addresses only those requirements for operability of the vessel overpressure protection system that satisfy the Level B service limit. However, DCD Tier 2, Revision 3, Section 5.2.2.3.3 states: "--the pressure increase is effectively terminated by a relief flow equivalent to 3 of the 18 valves." In response to RAI 5.2-27, GE stated that only one SRV is needed to prevent exceeding the ASME limit during the ASME overpressure protection event. The other 17 SRVs are needed for the ATWS event.

A. *Please clarify the conflicting statements in the DCD and RAI response. How many SRVs are required for overpressure protection? State clearly in the DCD the number of SRVs credited in the overpressure protection analysis.*

B. *Since GE takes credit for 17 SRVs in the ATWS analysis, all 18 SRVs should be included in the TS to satisfy the Level C service limit.*

GE Response

A. The number of reactor vessel pressure relief valves required for the full MSIV closure with flux scram AOO scenario was addressed previously in response to RAI 5.2-27 (re: GE Energy Letter MFN-06-178, June 16, 2006):

> "Figure 5.2-4b shows that the steam flow required to prevent continued pressurization is about 2% of rated steam flow (sustained flow rate after SRV opening). Each SRV provides 5% of rated steam flow. Using the information on the figure, it can be concluded that only one SRV is needed to prevent over-pressurization. Figure 5.2-4b shows that after the SRVs open there are 0.5 full power seconds of steam flow before the flow rate settles at 2%, which occurs within 10 seconds. The time required for one SRV to pass the flow needed to stop the pressurization is calculated to be 30 seconds. From Figure 5.2-4d, when the bottom head pressure curve is extrapolated from time 38 seconds at the same pressurization rate, i.e. same slope, for 20 seconds the resulting pressure is 9 MPa and is within the ASME limit. Therefore, only one SRV is needed to prevent exceeding the ASME limit in the ASME overpressure protection event."

What Figure 5.2-4b shows is that the vessel pressurization is immediately arrested by a relief valve discharge flow equivalent to approximately 15% full rated steam flow. The analysis model is based on the valves lifting and achieving full flow at 3% above nominal lift set pressure, or 8.62 MPaG (1250 psig). This is the pressure peak of the vessel steam dome predicted by the analysis shown in Figures 5.2-4a through 5.2-4f. As noted in the response to RAI 5.2-27, the energy/mass content of the predicted steam discharge needed to stop vessel pressurization prior to steady-state flow is an initial discharge flow of about 15% rated steam flow which rapidly decreases to approximately 2% rated steam flow that occurs within the first 10 seconds following the predicted relief valve lift. Based on an individual valve discharge capacity rating of about 5% full rated steam flow, this leads to the conclusion statement that "the pressure increase is effectively terminated by a relief flow of equivalent to 3 of the 18 valves" stated in DCD Tier 2 Subsection 5.2.2.3.3.

Postulating that the total value of this 10-second discharge is through only one SRV, the vessel pressure continues to increase above the peak value shown on Figure 5.2-4d, and the rise extrapolated from this assumption results in a peak vessel pressure that remains within the allowed 10% vessel pressure increase limit. The peak occurs at about 20 seconds after single valve lift and the estimated steam dome peak pressure is about 9 MPaG (1305 psig), which is less than the allowed 9.136 MPaG (1325 psig) under the ASME Code for Service Condition B.

The design capacity of ESBWR SRVs is being increased to achieve a total capacity up to 102% rated steam flow from the combined 10 SRVs plus 8 SVs. Thus, the single SRV will actually have greater than 5% rated steam flow discharge capacity and the consequent predicted vessel peak pressure would be slightly lower. Thus, only one SRV is actually required for ASME Code vessel overpressure protection. This will be clarified in the DCD.

B. Limiting Conditions for Operation (LCOs) for the ESBWR Technical Specifications reflect the criteria specified in 10 CFR 50.36 consistent with evaluations of these criteria as reflected in the Standard Technical Specifications for the most recent Boiling Water Reactor (BWR) designs, NUREG-1434, "Standard Technical Specifications General Electric Plants, BWR/6," Revision 3.1. From NUREG-1434, the Bases for Specification 3.4.4, "Safety/Relief Valves," states:

> "From an overpressure standpoint, the design basis events are bounded by the MSIV closure with flux scram event described above. Reference 3 discusses additional events that are expected to actuate the S/RVs." [Where Reference 3 is "FSAR, Section 15"].

The ESBWR Technical Specifications presentation follows the NUREG-1434 STS in requiring one more than the minimum number of safety relief valves (SRVs) necessary to protect overpressurization during design basis events (i.e., accommodating single failure of an SRV).

DCD Tier 2 Section 15.5.4 addresses the analyses for Anticipated Transient Without Scram (ATWS) and the ESBWR design providing the associated additional pressure relief capability. The additional SRVs designed to provide support for ATWS mitigation do not meet one or more of the 10CFR 50.36(c)(2)(ii) criteria for inclusion as Technical Specification Limiting Conditions for Operation as was presented in response to RAI 16.0-1 (re: GE Energy Letter MFN 06-263, August 8, 2006; refer to Criterion 3 Table, line item #265). As safety-related components of the ESBWR design, any degradation or non-conforming condition in the SRV capacity credited for ATWS mitigation would have the quality assurance requirements of 10 CFR Part 50, Appendix B applied, including Corrective Actions for any adverse conditions.

DCD Impact

In response to Part A of this RAI, DCD Tier 2, Subsections 5.2.2.3.2 and 5.2.2.3.3 will be revised as shown on the following page. No DCD changes will be made in response to Part B of this RAI.

SRV Capacities

~~Sizings of the~~ SRV capacities are based on establishing an adequate margin from the peak vessel bottom pressure to the vessel code limit in response to pressurization events.

~~The method used to determine total valve capacity is as follows.~~

~~Whenever~~ **The analysis method assumes that whenever** the system pressure increases to the valve ~~spring~~**mechanical lift** set pressure of a group of valves, these valves ~~are assumed to~~ begin opening and ~~to~~ reach full open at 103% of ~~the valve spring~~ set pressure **value**~~. Only one SRV is required to open to prevent exceeding the ASME limit in the ASME overpressure protection event. Eighteen SRVs are included in the ESBWR design. The other 17 SRVs are needed for the ATWS event~~. **The valve discharge capacity increases from zero flow at the lift set pressure to rated discharge capacity at 103% of set pressure.**

5.2.2.3.3 Evaluation of Results

Total SRV Capacity

The required total SRV capacity is determined by analyzing the pressure rise from a MSIV closure transient with flux scram. Results of this analysis are given in Figure 5.2-4a through Figure 5.2-4f. The peak vessel bottom pressure calculated is below the acceptance limit of 9.481 MPa gauge (1,375 psig). Figure 5.2-4a through Figure 5.2-4f show the MSIV isolation event with flux scram. The pressurization is not dynamic and does not significantly overshoot the relief valve setpoint ~~and ceases to increase once a single relief valve opens~~. Figure 5.2-4d shows that peak vessel pressure is only a function of the valve setpoint. This is because the higher steam volume-to-power ratio of the ESBWR causes the pressure rate prior to scram to be much lower than operating BWRs. After a scram, the pressure rates due to stored energy release are correspondingly lower.

The peak pressure in these events is the relief valve ~~setpoint~~**maximum analytical pressure limit**, because **at the slow vessel pressurization rate the pressure increase is almost instantaneously terminated by a relief valve discharge flow equivalent to about 15% of rated steam flow**~~, at these low pressurization rates, with large margin to the SRV setpoints, the pressure increase is effectively terminated by a relief flow of equivalent to 3 of the 18 valves~~. **The total energy/mass discharge needed to terminate vessel pressurization can be determined from the discharge plot in Figure 5.2-4b and applied to a single SRV. With only a single SRV lift, the vessel would continue to pressurize beyond the peak pressure plotted on Figure 5.2-4d. The total energy discharge through a single SRV conservatively requires approximately 20 seconds. Assuming a fixed discharge capacity at the initial lift setpoint plus 3%, and since the rate of vessel pressurization is nearly linear, the peak pressure can be estimated for single SRV overpressure response. The peak dome pressure, and correspondingly the peak bottom head pressure, would remain below the ASME Code Section III Service Condition B limit. Thus, ESBWR vessel overpressure protection is satisfied with a single SRV.**

~~Peak vessel bottom pressure is 8.71 Mpa gauge (1,263 psig) and peak dome pressure is 8.62 Mpa gauge (1,250 psig) at 38s.~~