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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 85 – Nuclear Boiler System – RAI Number 20.0-7**

Enclosure 1 contains GE's response to the subject NRC RAIs 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

DO68

Reference:

1. MFN 07-054, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 85 Related to the ESBWR Design Certification Application*, January 19, 2007

Enclosures:

1. MFN 07-183– Response to Portion of NRC Request for Additional Information Letter No. 85 – Nuclear Boiler System – RAI Numbers 20.0-7

cc:		
	AE Cubbage	USNRC (with enclosures)
	GB Stramback	GE/San Jose (with enclosures)
	BE Brown	GE/Wilmington (without enclosures)
	eDRF	0065-7119

Enclosure 1

MFN 07-183

Response to Portion of NRC Request for Additional Information Letter No. 085 Related to ESBWR Design Certification Application

Nuclear Boiler System

RAI Number 20.0-7

NRC RAI 20.0-7:

Inadequate Core Cooling (TMI-2 Action Item II.F.2) In view of the importance of reactor pressure vessel (RPV) level instrumentation for safety in BWRs, and the staff concerns reflected in GL-84-23, GL-92-04 and Bulletin 93-03, combined with the fact that ESBWR is a passive, natural circulation plant, confirmation is needed regarding the adequacy of the differential pressure (dp) method for the RPV level measurement. Please explain in detail, the systems design, operation and operator actions during transients, and demonstrate that the RPV level system is robust. For example, the vertical drop in the drywell for the ESBWR RPV water level reference leg instrument lines from the condensing chamber to the drywell wall is an important design detail that should be provided for review.

GE Response:

The detection of conditions indicative of inadequate core cooling is provided in the ESBWR design by the direct reactor pressure vessel (RPV) water level measurement instrumentation system.

The RPV water level is the primary variable in the BWR for indicating the availability of adequate core cooling. Water level sensing is provided by four independent divisions of differential pressure sensing instruments designed to be adequately redundant and unambiguous so that ESBWR level indication is acceptable without diverse methods of sensing and indication. Each division of level sensing instruments includes a differential pressure instrument for one of four measurement regions (Refer to DCD Tier 2, Figure 7.7-1) including fuel zone, wide range, narrow range (primarily used for power operation level indication and feedwater control logic), and shutdown range (used during refuel operations). Each division has its own set of RPV sensing line nozzle connections. More discussion on RPV level sensing design is found in DCD Tier 2, Subsection 7.7.1.

Improvement in the certainty of the ESBWR RPV water level indication is obtained from the ESBWR's natural circulation design. Flow patterns in the BWR vessel contribute small pressure perturbations that are sensed by the instruments as background noise, masking the true static pressure of a quiescent system. Flow velocity past the sensing line nozzles of the vessel can also have dynamic affects, either reducing or increasing the local pressure at the nozzle, and contributing to measurement uncertainty. The natural circulation flow of the ESBWR tends to be much slower and less turbulent, and the longer RPV annulus has fewer installed components that cause flow pattern disruptions. By comparison, the RPV water level instrumentation in ABWR and earlier BWR designs, with a shorter annulus region, must function over a wider core flow range that includes both the natural circulation condition, and a variable-rate forced circulation condition when the recirculation system pumps are in operation. Also, the jet pump internals typical of the earlier BWR designs create many additional flow obstacles in the annulus that contribute to flow pattern disruptions and add to level measurement uncertainty.

The ESBWR has addressed the issue regarding erroneously high water level indication upon vessel depressurization or due to events that cause vessel pressure reduction transients. The phenomenon, as noted in GL-84-23, GL-92-04 and Bulletin 93-03, is from the transient release of dissolved non-condensable gases in the reference leg volume that lifts a portion of the volume as the gases escape during which the reference and variable leg differential pressure reading is a false low value. The ESBWR water level instrumentation system design includes a constant metered purge water addition of deaerated condensate from the control rod drive hydraulic system to prevent the build-up of dissolved gasses in the reference leg. This design is consistent with the approved ABWR design, as well as the modifications made by the majority of the licensed BWR operating fleet in response to the generic letters and bulletin. Also, the ESBWR reference leg condensing chamber has a drain line the same as the ABWR design, which drains excess condensate to the variable leg instrument lines and thereby also minimizes dissolved gas buildup.

Further, the ESBWR level instrumentation, used for both protection system actuation signals and control room indication, includes temperature compensation to correct for ambient (drywell and reactor building) temperature changes that affect fluid density in the fixed or reference column legs. This is accomplished by using a process control system calculation module that adjusts the differential pressure transmitter measured value for changes in process fluid temperature of the fixed or reference legs. Thermocouples installed adjacent to the reference leg provide input to the calculation module and automatically adjust for the change in reference leg temperature and associated density. This compensation increases the accuracy of the indication under harsh conditions, and justifies a significant reduction in the associated instrument uncertainty calculations.

Additionally, the reference leg vertical runs in the primary containment are designed as short as practical. The vertical offset between the columns and the differential pressure sensors is treated in the uncertainty calculation as extensions to the column spans, and contributes uncertainty error to the measurement value. Minimizing the vertical offsets and the total sensing line lengths is recognized as necessary for accurate level measurement in the design of the RPV level sensing instrumentation. Refer to the RAI 7.1-40 for more information on vertical reference leg drop.

There are no specific operator actions required, regarding the RPV level sensing design, to mitigate measurement errors in the event of a postulated plant transient or accident. Detailed discussion of the design assumptions for and the analyzed plant responses to the postulated transient and accident events is provided in DCD Tier 2, Chapter 15.

Affected Documents:

No DCD change will be made as a result of NRC RAI 20.0-7.