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MFN 08-415

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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 157 - Related to ESBWR Design Certification Application – RAI Number 4.6-28 Supplement 1**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) response to the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) sent by the Reference 1 NRC letter. GEH response to RAI Number 4.6-28 Supplement 1 is addressed in Enclosures 1 and 2.

Verified DCD changes associated with this RAI response are identified in the enclosed DCD markups by enclosing the text within a black box. The marked-up pages may contain unverified changes in addition to the verified changes resulting from this RAI response. Other changes shown in the markups may not be fully developed and approved for inclusion in DCD Revision 5.

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

Sincerely,

James C. Kinsey

James C. Kinsey
Vice President, ESBWR Licensing

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NRO

Reference:

1. MFN 08-234, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 157 Related to the ESBWR Design Certification Application*, dated March 5, 2008.
2. MFN 07-446, *Response to Portion of NRC Request for Additional Information Letter No. 44 – Related to ESBWR Design Certification Application – RAI Numbers 4.6-28 and 4.6-34*, dated August 20, 2007.

Enclosures:

1. MFN 08-415 – Response to Portion of NRC Request for Additional Information Letter No. 157 - Related to ESBWR Design Certification Application – RAI Number 4.6-28 S01
2. MFN 08-415 – Response to Portion of NRC Request for Additional Information Letter No. 157 - Related to ESBWR Design Certification Application – DCD Markups from the Response to RAI Number 4.6-28 S01

cc:	AE Cubbage	USNRC (with enclosure)
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	RE Brown	GEH/Wilmington (with enclosure)
	DH Hinds	GEH/Wilmington (with enclosure)
	eDRF	0000-0083-5467

Enclosure 1

MFN 08-415

Response to Portion of NRC Request for

Additional Information Letter No. 157

Related to ESBWR Design Certification Application

RAI Number 4.6-28 S01

NRC RAI 4.6-28 S01

The response provided by GEH proposed to resolve the question of core thermal limit violation by introducing SRI. To complete the response GEH needs to address the following questions:

1. *As stated previously, the SCRRI system was designed to lower power (following a transient) to avoid shutting the reactor down. The proposed SRI does this ahead of SCRRI insertion so that SCRRI will not violate thermal limits. If SRI lowers power, why is SCRRI needed?*
2. *The case of partial SCRRI failure i.e., to be inserted on half of the core and not on the other half and the possibility of introduction of core instability has not been discussed.*
3. *Is there a possibility of partial SRI insertion disturbing symmetry and introducing instabilities?*
4. *Confirm that SRI will be added to TS in addition to SCRRI*

GEH Response

1. *As stated previously, the SCRRI system was designed to lower power (following a transient) to avoid shutting the reactor down. The proposed SRI does this ahead of SCRRI insertion so that SCRRI will not violate thermal limits. If SRI lowers power, why is SCRRI needed?*

SCRRI has been kept for added operational flexibility and as an additional layer of defense against system failures. SCCRI could be used for events occurring at a low exposure where the slower moving control rods will be effective in quickly lowering power for a bottom peaked axial power profile. SCRRI will help mitigate the water level drop due to collapsed voids that occurs with SRI.

2. *The case of partial SCRRI failure i.e., to be inserted on half of the core and not on the other half and the possibility of introduction of core instability has not been discussed.*

Four power supply groups power the FMCRDs that insert control rods for SCRRI. The FMCRDs assigned to each power supply group are distributed throughout the core to insure that whole core is controlled during SCRRI. Failure of a single power supply group during SCCRI would diminish the power reduction but the control distribution would remain adequate. Single FMCRD failure is the only other creditable failure and would not result in core instabilities.

3. *Is there a possibility of partial SRI insertion disturbing symmetry and introducing instabilities?*

The SRI rod pattern is chosen such that the entire core is controlled and affected when control rods are inserted. SRI uses the Hydraulic Control Units (HCU) to insert control rods quickly to mitigate the axial power shift seen on high exposure cores. HCUs control 2 rods arranged such that the pairs are in the same quadrant but separated enough such that a single HCU failure behaves similarly to a single rod failure of the higher worth rod, such that with a single HCU failure the entire core is still controlled. See DCD Tier 2, Revision 4, Chapter 4, Figure 4.3-5 for HCU assignment map.

4. *Confirm that SRI will be added to TS in addition to SCRRI*

The requirements for SRI are under Specification 3.7.6 "Selected Control Rod Run-In (SCRRI) and Selected Rod Insertion (SRI) Functions" in Chapter 16 of the DCD Tier 2.

The Reporting Requirement 5.6.3.a.5 will be updated to match the title of Specification 3.7.6.

DCD Impact

DCD Tier 2, Subsections 4.6.1.2 and 16.5.6.3 will be revised as noted in the markups in Enclosure 2.

Enclosure 2

MFN 08-415

Response to Portion of NRC Request for

Additional Information Letter No. 157

Related to ESBWR Design Certification Application

DCD Markups from the Response to RAI Number 4.6-28 S01

Verified DCD changes associated with this RAI response are identified in the enclosed DCD markups by enclosing the text within a black box. The marked-up pages may contain unverified changes in addition to the verified changes resulting from this RAI response. Other changes shown in the markups may not be fully developed and approved for inclusion in DCD Revision 5.

4.6.1.2 Description

The CRD system is composed of three major elements:

- Electro-hydraulic fine motion control rod drive (FMCRD) mechanisms,
- Hydraulic control units (HCU), and
- Control rod drive hydraulic subsystem (CRDHS).

The FMCRDs provide electric-motor-driven positioning for normal insertion and withdrawal of the control rods and hydraulic-powered rapid insertion (scram) of control rods during abnormal operating conditions.

The hydraulic power required for scram is provided by high-pressure water stored in the individual HCUs. Each HCU contains a nitrogen-water accumulator charged to high pressure and the necessary valves and components to scram two FMCRDs. Additionally, during normal operation, the HCUs provide a flow path for purge water to the associated FMCRDs.

The CRDHS supplies clean, demineralized water that is regulated and distributed to provide charging of the HCU scram accumulators and purge water flow to the FMCRDs during normal operation. The CRDHS is also the source of pressurized water for purging the Reactor Water Cleanup/Shutdown Cooling (RWCU/SDC) system pumps and the Nuclear Boiler System (NBS) reactor water level reference leg instrument lines. Additionally, the CRDHS provides high pressure makeup water to the reactor during events in which the feedwater system is unable to maintain reactor water level. This makeup water is supplied to the reactor via a bypass line off the CRD pump discharge header that connects to the feedwater inlet piping via the RWCU/SDC return piping.

The CRD system performs the following functions:

- Controls changes in core reactivity by positioning neutron-absorbing control rods within the core in response to control signals from the Rod Control and Information System (RC&IS).
- Provides movement and positioning of control rods in increments to enable optimized power control and core power shape in response to control signals from the RC&IS.
- Provides the ability to position large groups of rods simultaneously in response to control signals from the RC&IS.
- Provides rapid control rod insertion (scram) in response to manual or automatic signals from the Reactor Protection System (RPS) so that no fuel damage results from any plant AOO.
- In conjunction with the RC&IS, provides automatic electric motor-driven insertion of the control rods simultaneously with hydraulic scram initiation. This provides an additional, diverse means of fully inserting a control rod.
- Supplies rod status and rod position data for rod pattern control, performance monitoring, operator display and scram time testing by the RC&IS.
- In conjunction with the RC&IS, prevents undesirable rod pattern or rod motions by imposing rod motion blocks in order to protect the fuel.

- In conjunction with the RC&IS, prevents the RDA by detecting rod separation and imposing rod motion block.
- Provides rapid control rod insertion (scram) in response to signals from the Diverse Protection System (DPS). Also in response to signals from the DPS, provides Alternate Rod Insertion (ARI), an alternate means of actuating hydraulic scram, should an Anticipated Transient Without Scram (ATWS) occur.
- In conjunction with the RC&IS, provides for Selected Control Rod Run-In (SCRRI), and Select Rod Insertion (SRI).
- Prevents rod ejection from the core due to a break in the drive mechanism pressure boundary or a failure of the attached scram line by means of a passive brake mechanism for the FMCRD motor and a scram line inlet check valve.
- Supplies high-pressure makeup water to the reactor when the normal makeup supply system (feedwater) is unable to prevent reactor water level from falling below the normal water level range.
- Supplies purge water for the RWCU/SDC System pumps.
- Provides a continuous flow of water to the NBS to keep the reactor water level reference leg instrument lines filled.

The design bases and further discussion of both the RC&IS and RPS, and their control interfaces with the CRD system, are presented in Chapter 7.

The CRD System is arranged in a manner that separates the safety-related equipment from the nonsafety-related portions of the system. The FMCRDs are mounted to the reactor vessel bottom head inside primary containment. The HCUs are housed in four dedicated rooms located directly outside of the primary containment at the basemat elevation of the Reactor Building (RB). These rooms are arranged around the periphery of the primary containment wall. Each HCU room serves the FMCRDs associated with one quadrant of the reactor core. The HCUs are connected to the FMCRDs by the scram insert piping that penetrates the primary containment wall.

The balance of the nonsafety-related hydraulic system equipment (pumps, valves, filters, etc.) is physically separated from the HCUs and housed in a separate room in the reactor building. It is connected to the HCUs by the nonsafety-related FMCRD purge water header, HCU charging water header and scram air header. These headers are classified as Seismic Category II so that they will maintain structural integrity during a seismic event and not degrade the functioning of the HCUs.

4.6.1.2.1 Fine Motion Control Rod Drive Mechanism

The FMCRD used for positioning the control rod in the reactor core is a mechanical/hydraulic actuated mechanism (Figures 4.6-1 and 4.6-2). An electric motor-driven ball-nut and ball screw assembly is capable of positioning the drive at both a minimum of 36.5 mm (1.44 in.) increments and continuously over its entire range at a speed of 28 ± 5 mm/sec. Hydraulic pressure is used for scrams. The FMCRD penetrates the bottom head of the reactor pressure vessel. The FMCRD does not interfere with refueling and is operative even when the head is removed from the reactor vessel.

5.6 Reporting Requirements

5.6.2 Radioactive Effluent Release Report

[-- **NOTE** --
A single submittal may be made for a multiple unit station. The submittal shall combine sections common to all units at the station; however, for units with separate radwaste systems, the submittal shall specify the releases of radioactive material from each unit.
--]

The Radioactive Effluent Release Report covering the operation of the unit during the previous year shall be submitted prior to May 1 of each year in accordance with 10 CFR 50.36a. The report shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit. The material provided shall be consistent with the objectives outlined in the ODCM and Process Control Program and in conformance with 10 CFR 50.36a and 10 CFR Part 50, Appendix I, Section IV.B.1.

5.6.3 CORE OPERATING LIMITS REPORT (COLR)

a. Core operating limits shall be established prior to each reload cycle, or prior to any remaining portion of a reload cycle, and shall be documented in the COLR for the following:

1. Specification 3.2.1, "LINEAR HEAT GENERATION RATE (LHGR)"

2. Specification 3.2.2, "MINIMUM CRITICAL POWER RATIO (MCPR)"

3. Specification 3.3.1.4, "Neutron Monitoring System (NMS) Instrumentation," Function 3

4.[Specification 3.7.4, "Main Turbine Bypass System"

5.] Specification 3.7.6, "Selected Control Rod Run-In (SCRRI) and Selected Rod Insertion (SRI) Functions"

[Any additional individual specifications that address core operating limits must be referenced here.]

b. The analytical methods used to determine the core operating limits shall be those previously reviewed and approved by the NRC, specifically those described in the following documents:

{ Identify the Topical Report(s) by number and title or identify the staff Safety Evaluation Report for a plant specific methodology by NRC letter and date. The COLR will contain the complete identification for each of the Technical