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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 238 Related to ESBWR Design Certification Application – RAI Number 14.3-403**

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 14.3-403 is addressed in Enclosure 1.

If you have any questions about the information provided, please contact me.

Sincerely,

Richard E. Kingston

Richard E. Kingston
Vice President, ESBWR Licensing

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NRO

Reference:

1. MFN 08-643, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request For Additional Information Letter No. 238 Related to ESBWR Design Certification Application*, dated August 8, 2008.

Enclosure:

1. MFN 08-832 - Response to NRC Request for Additional Information Letter No. 238 Related to ESBWR Design Certification Application - RAI Number 14.3-403.

cc: AE Cubbage USNRC (with enclosure)
RE Brown GEH/Wilmington (with enclosure)
DH Hinds GEH/Wilmington (with enclosure)
eDRF 0000-0092-4597

Enclosure 1

MFN 08-832

Response to Portion of NRC Request for

Additional Information Letter No. 238

Related to ESBWR Design Certification Application

RAI Number 14.3-403

NRC RAI 14.3-403

In DCD Revision 5 Tier 2, Section 7.2.1.3.1 in conformance with 10 CFR 50.34(f)(2)(xxiii)[II.K.2.10], Anticipatory Reactor Trip, states that the reactor will trip in response to a loss of all feedwater event. This is an anticipatory trip actuated on loss of power to two of the four main FW pumps. This design feature should be included Tier 1, Section 2.2.7, Table 2.2.7-2.

GEH Response

GEH concurs with your request. Tier 1, Section 2.2-7, Table 2.2.7-2 will be revised to add “Loss of all feedwater flow event” in parenthesis after the “Power Generation Bus Loss” scram initiator as shown in the attached DCD markup. The loss of feedwater flow event is detected by loss of the power generation bus. Therefore, the loss of all feedwater flow anticipatory trip shown in Tier 2, Section 7.2.1.3.1 refers to the Power Generation Bus Loss scram event in DCD Tier 1, Section 2.2.7, Table 2.2.7-2.

To clarify that the loss of all feedwater event is the same as the Power Generation Bus Loss scram initiator, DCD Tier 2, Sections 7.2.1.2.4.2, 7.2.1.3, 7.2.1.5.4, 7.3.5.3.1, 7.4.4.3.1 and Table 7.2-1 will be revised to make the description of the Power Generation Bus Loss scram initiator and Loss of All Feedwater Flow event consistent throughout the chapter as shown in the attached DCD markup.

DCD Impact

DCD Tier 1, Table 2.2.7-2 and Tier 2, Sections 7.2.1.2.4.2, 7.2.1.3, 7.2.1.5.4, 7.3.5.3.1, 7.4.4.3.1, Table 7.2-1, will be revised in Revision 6 as noted in the attached markup.

Attachment 1

RAI Number 14.3-403

Tier 1 - DCD Markup

Table 2.2.7-2

RPS Automatic Functions, Initiators, and Associated Interfacing Systems

Function	Initiator	Interfacing System
Reactor scram	NMS PRNM trip condition	NMS
	NMS SRNM trip condition	NMS
	CRD charging header pressure low	CRDS
	Turbine stop valve closed position	-
	Turbine control valve control oil pressure low	-
	Condenser pressure high	-
	Power Generation Bus Loss (Loss of all feedwater flow event)	-
	MSIV closed position	NBS
	Reactor Pressure high	NBS
	RPV reactor level low (Level 3)	NBS
	RPV reactor level high (Level 8)	NBS
	DW pressure high	CMS
	Suppression pool average temperature high	CMS
	High simulated thermal power (feedwater temperature biased)	NBS, NMS
	Feedwater temperature exceeding allowable simulated thermal power vs. FW temperature domain.	NBS, NMS

Attachment 2

RAI Number 14.3-403

Tier 2 - DCD Markup

7.2.1.2.4.2 Initiating Circuits

The RPS logic initiates a reactor scram in the individual sensor channels when any one or more of the conditions listed below exist (IEEE Std. 603, Section 4.1, 4.2 and 4.4). The system monitoring the process condition is indicated in parentheses. These conditions are:

- High drywell pressure (CMS),
- Turbine stop valve (TSV) closure (RPS),
- Turbine control valve (TCV) fast closure (RPS),
- NMS-monitored SRNM and APRM conditions exceed acceptable limits (NMS),
- High reactor pressure (NBS),
- Low reactor pressure vessel (RPV) water level (Level 3) decreasing (NBS),
- High RPV water level (Level 8) increasing (NBS),
- Main steam line isolation valve (MSIV) closure (Run mode only) (NBS),
- Low control rod drive HCU accumulator charging header pressure (CRDS),
- High suppression pool temperature (CMS),
- High condenser pressure (RPS),
- Power generation bus loss (Loss of all feedwater [FW] flow)(Run mode only) (RPS),
- High simulated thermal power (FW temperature biased) (NBS and NMS),
- Feedwater temperature exceeding allowable simulated thermal power vs. FW temperature domain (NBS),
- Operator-initiated manual scram (RPS), and
- Reactor Mode Switch in Shutdown position (RPS).

With the exception of the NMS outputs, the MSIV closure, TSV closure and TCV fast-closure, loss of all FW flow due to a~~loss of~~ power generation bus loss, main condenser pressure high, and manual scram outputs, systems provide sensor outputs through the RPS RMU.

The MSIV Closure, TSV closure and TCV fast-closure, loss of power generation bus, manual scram output, and main condenser pressure high signals are provided to the RPS through hardwired connections. The NMS trip signal is provided to the RPS through fiber optic cable. The systems and equipment providing trip and scram initiating inputs to the RPS for these conditions are discussed in the following subsections.

detect the TSV closure. The TSVs are components of the main turbine. The position switches are components of the RPS.

Turbine Control Valve Fast Closure: Low oil pressure in the hydraulic trip system, which is indicative of TCV fast-closure, is detected by separate pressure transmitters on each of the four TCV hydraulic mechanisms. Each pressure transmitter provides a 4 - 20 mA signal through hard-wired connections to the DTM in each of the four RPS divisional trip channels. The TCV closure trip occurs in each division of trip logic when any two or more sensor channels detect low oil pressure in the hydraulic trip system. The TCV hydraulic mechanisms are components of the main turbine. The pressure transmitters are components of the RPS.

Turbine Bypass Valve Position: The Turbine Bypass Valves (TBV) provide position limit switch inputs to the RPS as a permissive to inhibit reactor trip on TSV closure or TCV fast closure if the TBVs open to their 10% position within a defined period of time. One switch with four sets of contacts is mounted on each valve. Each contact is associated with one of the four RPS divisions to permit two-out-of-four logic. The position switches are components of the RPS.

High Condenser Pressure: High condenser pressure is detected by separate pressure transmitters mounted on the main condenser. Each pressure transmitter provides an analog output signal through hard-wired connections to the DTM in each of the four RPS divisional trip channels. The pressure transmitters are components of the RPS. The reactor scram at high condenser pressure shuts off steam flow to the main condenser and protects the main turbine. This is an anticipatory scram in that high condenser pressure also trips the main turbine and prevents TBV operation.

~~Loss of~~ Power Generation Bus Loss (Loss of All Feedwater Flow Event): The plant electrical system has four power generation buses operating at 13.8 kV. Although all four buses are normally energized, the loads on these buses are arranged such that any three of the four buses can support the necessary FW pumps required for power generation. Specifically, these buses supply power for the FW pumps and circulating water pumps. In the Run mode at least three of the four buses must be powered.

If the sensor (one per division) on each bus detects a low voltage, indicating that less than three buses are operating, the two-out-of-four logic initiates a scram after a preset delay time. This delay time (less than one second) is to allow the auto transfer from the Unit Auxiliary Transformer (UAT) feed to the Reserve Auxiliary Transformer (RAT) feed to restore normal bus voltages. Loss of more than one power generation bus is indicative of loss of the FW pumps and flow. It is also indicative of loss of condenser vacuum from the loss of the circulating water pumps.

~~The purpose of a scram~~This is an anticipatory scram on loss of the power generation buses ~~is~~ to mitigate the RPV water level drop to Level 1 following the loss of FW pump function. This scram terminates additional steam production within the RPV before Level 3 is reached.

Manual Scram: Two manual scram switches and the Reactor Mode Switch provide diverse means to initiate manually a reactor scram independent of conditions within the sensor channels, divisions of trip logic, and trip actuators. When the Reactor Mode Switch is placed in the

- TCV fast closure,
- Main condenser pressure high,
- Power generation bus loss (loss of all FW flow),
- FW temperature biased STP trip,
- CRD HCU accumulator-charging-header-pressure low,
- Suppression pool temperature high,
- RPS divisional automatic trip (auto-scram) (each of the four: Div. 1, 2, 3, 4 automatic trip),
- RPS divisional manual trip (each of the four: Div. 1, 2, 3, 4 manual trip),
- Manual scram trip (two: both Manual A and Manual B),
- Reactor Mode Switch in Shutdown position,
- Shutdown mode trip bypassed,
- Non-coincident NMS trip mode in effect (in NMS),
- NMS trip mode selection switch still in non-coincident position, with Reactor Mode Switch in Run position (in NMS),
- Division in which channel A (B, C, or D) sensors are bypassed (four),
- Trip conditions in Channel A (B, C, or D) and Channel A (B, C, or D) sensors bypassed (four),
- Division 1 (2, 3, or 4) TLU out-of-service bypass (four),
- CRD accumulator-charging-header-pressure low trip bypass,
- Any CRD accumulator-charging-header trip with bypass switch still in bypass position and the Reactor Mode Switch in Startup or Run mode,
- Auto-scram test switch in test mode (manual trip of automatic logic) (four),
- TSV closure trip bypassed,
- TCV fast closure trip bypassed,
- MSIV closure trip bypassed,
- NMS SRNM trip bypassed with the Reactor Mode Switch in Run position,
- Non-coincident NMS trip bypassed with the Reactor Mode Switch in Run position,
- RPV water level high trip bypassed,

operability. This satisfies the repair requirement of IEEE Std. 603, Section 5.10 while maintaining plant availability.

The RPS consists of four redundant divisions identical in design and independent in operation. Although each division constitutes a separate trip system, normally each division can make two-out-of-four trip decisions with or without a division of sensors being bypassed. There are four instrument channels provided for each process variable being monitored, one for each RPS division. Four sensors, one per division, are provided for each variable. When more than four sensors are required to monitor a variable the outputs of the sensors are combined into only four instrument channels. The logic in each division does not depend on absolute time of day and is asynchronous with respect to the other divisions. No division depends on the correct operation of another division. There is no combination of MCR-initiated bypasses that can unacceptably degrade the RPS.

7.2.1.3 Safety Evaluation

Table 7.1-1 identifies the RPS and the associated codes and standards applied, in accordance with the Standard Review Plan NUREG-0800. This subsection addresses I&C systems conformance to regulatory requirements, guidelines, and industry standards.

7.2.1.3.1 Code of Federal Regulations

10 CFR 50.55a(a)(1), Quality Standards for Systems Important to Safety:

- Conformance: The RPS conforms to these standards.

10 CFR 50.55a(h), Protection and Safety Systems, compliance with IEEE Std. 603:

- Conformance: Safety-related systems are designed to conform to Regulatory Guide (RG) 1.153 and IEEE Std. 603. Separation and isolation are preserved both mechanically and electrically in accordance with IEEE Std. 603, Section 5.6 and RG 1.75. The RPS is divisionalized and is designed with redundancy so that failure of any instrument does not interfere with the system operation. Electrical separation is maintained between the redundant divisions.

10 CFR 50.34(f)(2)(v) [I.D.3], Bypass and Inoperable Status Indication:

- Conformance: The RPS design of bypass and inoperable status indication conforms to these requirements and is consistent with the conformance of the RPS design to RG 1.47. It also conforms to the requirements for control and protection system interaction, as described in IEEE Std. 603, Sections 5.8 and 6.3.

10 CFR 50.34(f)(2)(xxiii)[II.K.2.10], Anticipatory Reactor Trip:

- Conformance: The reactor will trip in response to a Loss of All Feedwater Flow Event. This is an anticipatory trip actuated on a power generation bus loss event~~loss of power to two of the four main FW pumps~~. The reactor will also trip on a turbine trip only if an insufficient number of bypass valves opens within a prescribed time period.

persist until the scram valves are re-closed. Each division of trip logic sends a separate rod withdrawal block signal to the RC&IS when this bypass exists in the division. This operational bypass condition is alarmed in the MCR.

The bypass is automatically removed whenever the Reactor Mode Switch is put in either the Startup or Run mode, regardless of whether the CRD charging pressure bypass switches are in their bypass positions. However, a separate alarm would result in the MCR if any of the switches were left in the bypass position when the Reactor Mode Switch is in either the Startup or Run mode.

- MSIV closure for MSIV bypass (indicated operational bypass): The scram trip for MSIV closure is automatically bypassed in each division whenever the Reactor Mode Switch is in the Shutdown, Refuel, or Startup position - with reactor pressure in the associated sensor channel less than a predetermined setpoint. This bypass condition is alarmed in the MCR and permits plant operation when the MSIVs are closed during low power operation. The bypass is automatically removed if the Reactor Mode Switch is moved to the Run position. This bypass permits the RPS to be placed in its normal energized state for operation at low power levels with the MSIVs either closed or not fully open.

- Special MSIV operational bypass (indicated operational bypass): Four manually-operated bypass switches are made available in the MCR to permit the bypass of trip signals from closed MSIVs on any one of the four main steam lines. This bypass permits continued reactor operation at reduced reactor power and steam flow when one steam line must be isolated for a prolonged period of time. This operational bypass is alarmed in the MCR.

- ~~Loss of p~~Power generation bus loss trip bypass (indicated operational bypass): The ~~Loss of~~ Power Generation Bus Loss (Loss of All Feedwater Flow Event) scram trip function is automatically bypassed whenever the Reactor Mode Switch is in the Shutdown, Refuel, or Startup position. This bypass condition is alarmed in the MCR and is automatically removed if the Reactor Mode Switch is moved to the Run position.

- Reactor Mode Switch in Shutdown position bypass (indicated operational bypass): The RPS scram trip caused by the Reactor Mode Switch being placed in the Shutdown position is automatically bypassed after a time delay of approximately 10 seconds. This operational bypass condition permits resetting of the trip actuators and re-energization of the scram pilot valve solenoids and is alarmed in the MCR.

- NMS SRNM scram trip functions with Reactor Mode Switch in the Run position bypass: Whenever the Reactor Mode Switch is in the Run position, SRNM reactor scram trip functions are automatically bypassed. However, this bypass is not alarmed because it is the normal condition with the Reactor Mode Switch in the Run position. This bypass condition is indicated in the MCR. The SRNM rod block functions also are disabled when the Reactor Mode Switch is in the Run position.

- Non-coincident NMS scram trips in Run mode bypass: Whenever the Reactor Mode Switch is in the Run position, and the coincident/non-coincident NMS trip remains in the non-coincident position, the non-coincident NMS scram trip functions are automatically disabled (bypassed). This logic is an NMS function.

between the components associated with each of the four separate divisions. The mode switch positions and their related bypass and trip/reset functions are as follows.

- Shutdown Position:
  - Initiates a reactor scram,
  - Enables NMS non-coincident trips,
  - Enables a manual CRD charging pressure trip bypass,
  - Enables automatic bypass of the TCV fast closure trip,
  - Enables automatic bypass of the TSV closure trip,
  - Enables automatic bypass of the MSIV closure trip, and
  - Enables automatic bypass of the ~~loss of~~ power generation bus loss (Loss of All FW Flow) trip.
- Refuel Position:
  - Enables NMS non-coincident trips,
  - Enables the manual CRD charging pressure trip bypass,
  - Enables automatic bypass of the TCV fast closure trip,
  - Enables automatic bypass of the TSV closure trip,
  - Enables automatic bypass of the MSIV closure trip, and
  - Enables automatic bypass of the Power Generation Bus Loss (Loss of All FW Flow) trip.
- Startup Position:
  - Enables NMS non-coincident trips,
  - Disables the manual CRD charging pressure trip bypass,
  - Enables the automatic bypass of the MSIV closure trip,
  - Enables automatic bypass of the TCV fast closure trip,
  - Enables automatic bypass of the TSV closure trip, and
  - Enables automatic bypass of the ~~loss of~~ power generation bus loss (Loss of All FW Flow) trip.
- Run Position:
  - Disables all trip bypasses enabled by any of the other three modes, and

Table 7.2-1

Sensors Used in Functional Performance of RPS

Sensor Description	Number of Sensors
NMS (LPRM)	256
NMS (SRNM)	12
NBS reactor vessel pressure	4
Drywell pressure	4
RPV narrow range water level	4
Charging pressure to control rod hydraulic unit accumulator	4
MSIV position switches	16
TSV position switches	4
TCV hydraulic trip system oil pressure	4
TBV position switches	48
Power generation bus voltage (Loss of All FW flow)	4
Condenser pressure	12
Suppression pool temperature	64
Feedwater temperature	8

- Conformance: The SSLC/ESF complies by providing automatic indication of bypassed and inoperable status (IEEE Std. 603, Sections 5.8, 6.2, and 7.2).

10 CFR 50.34 (f)(2)(xiv) [II.E.4.2], Containment Isolation Systems:

- Conformance: The SSLC/ESF logic controlling containment isolation functions conforms to these criteria.

10 CFR 50.34 (f)(2)(xxiii) [II.K.2.10], Anticipatory Reactor Trip:

- Conformance: The SSLC/ESF initiates the ICS in response to a Loss of All Feedwater Flow Event. This is an anticipatory trip actuated on loss of power to two of the four main FW pumps.

10 CFR 52.47(a)(1)(iv), Resolution of Unresolved and Generic Safety Issues:

- Conformance: Resolution of unresolved and generic safety issues is discussed in Section 1.11.

10 CFR 52.47(a)(1)(vi), ITAAC in Design Certification Applications:

- Conformance: ITAAC are provided for the I&C systems and equipment in Tier 1.

10 CFR 52.47(a)(1)(vii), Interface Requirements:

- Conformance: There are no interface requirements for this section.

10 CFR 52.47(a)(2), Level of Detail:

- Conformance: The level of detail provided for the SSLC/ESF within the DCD conforms to this requirement.

10 CFR 52.47(b)(2)(i), Innovative Means of Accomplishing Safety Functions:

- Conformance: The I&C design does not use innovative means for accomplishing safety functions.

7.3.5.3.2 General Design Criteria

GDC 1, 2, 4, 13, 19, 20, 21, 22, 23, and 24:

- Conformance: The SSLC/ESF design complies with these GDCs.

7.3.5.3.3 Staff Requirements Memorandum

SRM on SECY-93-087, Item II.Q Defense Against Common-Mode Failures in Digital Instrument and Control Systems:

- Conformance: The Reactor Trip (Protection) System and ESF designs conform to Item II.Q of SRM on SECY-93-087 (BTP HICB-19) in conjunction with the implementation of the DPS, described in Section 7.8.

10 CFR 50.55a(h), Criteria for Protection Systems for Nuclear Power Generating Stations (IEEE Std. 603):

- Conformance: Separation and isolation is preserved both mechanically and electrically, in accordance with IEEE Std. 603, Section 5.6 and 6.3, and RG 1.75. The ICS is divisionalized and redundantly designed so failure of any instrument does not interfere with the system operation. Electrical separation is maintained between the redundant divisions.

10 CFR 50.34(f)(2)(v)[I.D.3], Bypass and Inoperable Status Indication:

- Conformance: The ICS design conforms to this requirement because it is an ECCS.

10 CFR 50.34(f)(2)(xxiii)[II.K.2.10], Anticipatory Reactor Trip:

- Conformance: The ICS will initiate in response to a Loss of All Feedwater Flow Event. This is an anticipatory trip actuated on loss of power to two of the four main feedwater pumps.

10 CFR 52.47(a)(1)(iv), Resolution of Unresolved and Generic Safety Issues:

- Conformance: Resolution of unresolved and generic safety issues is discussed in Section 1.11.

10 CFR 52.47(a)(1)(vi), ITAAC in Design Certification Applications:

- Conformance: ITAAC are provided for the I&C systems and equipment in Tier 1.

10 CFR 52.47(a)(1)(vii), Interface Requirements:

- Conformance: There are no interface requirements for ICS.

10 CFR 52.47(a)(2), Level of Detail:

- Conformance: The level of detail provided for the ICS within the DCD conforms to this BTP.

10 CFR 52.47(b)(2)(i), Innovative Means of Accomplishing Safety Functions:

- Conformance: The I&C design does not use innovative means for accomplishing safety functions.

7.4.4.3.2 General Design Criteria

In accordance with the SRP for Section 7.4 and Table 7.1-1, the following GDC are addressed for the ICS:

GDC 1, 2, 4, 13, 19 , 20, 21, 22, 23, and, 24:

- Conformance: The ICS design conforms to these GDC.