HITACHI

GE Hitachi Nuclear Energy

James C. Kinsey
Vice President, ESBWR Licensing

PO Box 780 M/C A-55
Wilmington, NC 28402-0780
USA

T 910 675 5057
F 910 362 5057
jim.kinsey@ge.com

MFN 08-086, Supplement 16

Docket No. 52-010

March 20, 2008

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555-0001

Subject: **Response to Portion of NRC Request for Additional Information Letter No. 126 Related to ESBWR Design Certification Application RAI Numbers 14.3-163, 14.3-165 and 14.3-203**

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 NRC letter dated December 20, 2007 (Reference 1).

Enclosure 1 contains the GEH response to RAI Numbers 14.3-163, 14.3-165 and 14.3-203. The enclosed changes will be incorporated in the upcoming DCD Revision 5 submittal.

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 markup(s) 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

D068
NRO

Reference:

1. MFN 07-718, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request For Additional Information Letter No. 126 Related To ESBWR Design Certification Application*, December 20, 2007.

Enclosure:

1. Response to Portion of NRC Request for Additional Information Letter No. 126 Related to ESBWR Design Certification Application – RAI Numbers 14.3-163, 14.3-165, and 14.3-203

cc:	AE Cubbage	USNRC (with enclosure)
	GB Stramback	GEH/San Jose (with enclosure)
	RE Brown	GEH/Wilmington (with enclosure)
	DH Hinds	GEH/Wilmington (with enclosure)
	eDRF	0000-0081-0533 – RAI 14.3-203
		0000-0081-2636 – RAI 14.3-163
		0000-0082-1186 – RAI 14.3-165

MFN 08-086, Supplement 16

Enclosure 1

Response to Portion of NRC Request for Additional Information Letter No. 126 Related to ESBWR Design Certification Application

RAI Numbers 14.3-163, 14.3-165 and 14.3-203

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 markup(s) may not be fully developed and approved for inclusion in DCD Revision 5.

NRC RAI 14.3-163

Clarify RPS functional arrangement.
DCD Tier 1, Table 2.2.7-1 (same concern applies to Tables 2.2.13-1 & 2.2.14-1) reactor protection system (RPS) Functional Arrangement stated that RPS logic is designed to provide a trip initiation by requiring a coincident trip of at least two divisions to cause a trip output. This design is to prevent inadvertent trip. However, if the system digressed to a level that only one division functional, would this statement preclude the system from tripping one out of one?

GEH RESPONSE

The RPS is designed to provide reliable, single-failure proof capability to automatically or manually initiate a reactor scram while maintaining protection against unnecessary scrams resulting from single failures. This protection is accomplished by the combination of fail-safe design, redundant sensor division trip logic, and redundant two-out-of-four trip systems output scram logic. The RPS functional block diagram is provided in DCD Tier 2, Chapter 7, Figure 7.2-1.

RPS and SSLC/ESF are physically designed such that the coincident division trip logic cannot be reduced further than two-out-of-three, as only one division can physically be bypassed or out-of-service at any one time. For both RPS and SSLC/ESF, manually placing a division into bypass excludes that division from the voting process and reduces the scram logic to a two-out-of-three trip. Loss of communication with the bypass switch is interpreted as a "no bypass" signal. RPS scrams the reactor on two-out-of-four or two-out-of-three trips; therefore RPS cannot digress to one-out-of-one level.

Although there are four divisions of RPS instrumentation for each function, only three divisions of RPS are required to be OPERABLE as per Technical Specification 3.3.1.1. The single failure criterion is met with three OPERABLE RPS divisions. Any failure of an active (in-service) division during a time when one of four divisions is out of service (or bypassed) does not prevent the system from performing its safety-related protection functions because of the two-out-of-four logic. The RPS system design allows for, and technical specifications require, placing the failed division in the tripped mode, resulting in a situation where any trip in either of the remaining two divisions will cause the initiation of a reactor trip. The RPS logic continues to provide the requisite two divisions to initiate the protective action. In all cases, the RPS function arrangement is designed such that the RPS initiates a reactor trip if any of the two remaining divisions exceed their trip value.

SSLC/ESF resides in four redundant divisions of sensors, trip logics, and actuators and performs two-out-of-four trip decisions. The SSLC/ESF logic is energized to trip and fails to a state where the associated component remains "as is". The functional block diagram of the SSLC/ESF system is provided in DCD Tier 2, Chapter 7, Figure 7.3-4. SSLC/ESF is designed to initiate a trip with any two non-faulted divisions of actuation logic.

DPS provides automatic backup to RPS and SSLC/ESF. DPS includes diverse monitoring of RPS and SSLC/ESF trip conditions, automatic initiation of alternate rod insertion scrams, and automatic initiation of ECCS functions.

DCD IMPACT

No DCD change will be made in response to this RAI.

NRC RAI 14.3-165

NRC Summary:
Tier 2 Section 7.7.3.2 needs to be updated to support Tier 1 statement

NRC Full Text:
DCD Tier 1, Table 2.2.3-2 has listed functions "Reduce speed of other FW pumps" when FW flow High, and "Perform FW Runback" when FW temperature Low. These two functions are not addressed in Tier 2 DCD. DCD Tier 2 should be updated to support the information provided in Tier 1.

GE RESPONSE

For consistency, DCD Tier 2 Rev 5, Subsection 7.7.3.2.2 will add the following paragraph:

> The worst case of a FW Pump ASD controller failure in the FW system would cause a run-out of one FW pump to its maximum capacity. In the event of one pump run-out (detected by FW flow high), the FWCS would respond by reducing the demand to the other pumps, automatically compensating for the excessive flow from the failed pump.

GEH will modify the DCD Tier 1, Rev 5, Table 2.2.3-2 from " FW flow high" to "FW flow high on one FW Pump run-out". The function "Perform FW runback" and the initiator "FW temperature low" will be removed from Table 2.2.3-2 because there is no design basis in the DCD Tier 2, Rev 5, Chapter 15 Safety Analyses.

DCD IMPACT

DCD Tier 1, Table 2.2.3-2, will be revised as noted in the attached markup.
DCD Tier 2, Subsection 7.7.3.2.2, will be revised as noted in the attached markup.

NRC RAI 14.3-203

NRC Summary:
GDCS Pool Injection line check valve

NRC Full Text:
DCD Tier 1, Section 2.4.2, GDCS, Table 2.4.2-1, GDCS Mechanical Equipment

It is shown that GDCS Pool injection check valve (V-1) is not remotely operated. It is our understanding that the check valve is a testable check valve and hence can be operated from control room for testing. Clarify how the testing is done.

GEH RESPONSE

DCD Tier 2, Subsection 6.3.2.7.2, Revision 4 describes the GDCS Injection Line Check Valve testing. A test line downstream of the check valves can be used to pressurize the system and remotely exercise the check valves during a refueling outage. Check valve movement is monitored utilizing check valve position indication located in the Main Control Room. DCD Tier 2 Figure 6.3-1, GDCS Configuration, shows these check valves are remotely exercised (RE), meaning that they can be tested using the test line as described above.

DCD IMPACT

No DCD changes will be made in response to this RAI.

Table 2.2.3-1

~~Feedwater Control Modes~~FWCS Functional Arrangment

FWCS is nonsafety-related.
FWCS ~~is a~~uses triple-redundant, fault tolerant digital controllers (FTDC)

Table 2.2.3-2

FWCS Automatic Functions, Initiators, and Associated Interfacing Systems

Functions	Initiators	Interfacing System
Perform FW runback	RPV water level high (Level 8)	NBS
~~Send signal to N-DCIS to initiate SCRRI / SRI function~~	~~FW temperature low.~~	~~RC&IS~~
Reduce speed of other FW pumps	FW flow high on one FW pump run-out.	-
Start standby reactor feed pump.	Reactor feed pump trip.	-
Open the steam line condensate drain valves	Steam flow less than predefined value of rated flow.	-
~~Perform FW runback.~~	~~FW temperature low~~	-
Trip all FW pumps.	RPV water level high-high (Level 9)	-
~~Perform FW runback.~~	~~RPV water level high (Level 8)~~	-
Perform FW runback and close the LFCV and the RWCU/SDC overboard flow control valve.	ATWS trip signal	~~DICS~~DPS

inputs and compared with the position speed demands sent by the FWCS. If an FTDC channel detects a discrepancy between the field voter output and the FTDC channel output, a "lock-up" signal is sent to a "lock-up" voter that maintains the valve position and activates an alarm in the MCR. Refer to Section 10.4 for drawings of the feedwater system, feedwater heater, pump and valve configuration.

7.7.3.2.2 Operation Modes (Level Control)

The following modes of RPV waterfeedwater flow provide level control are provided.:

- **Single Element Control** - At less than 25% of rated reactor powers, the FWCS uses single-element control based on RPV water level. In this mode the conditioned level error from the master level (proportional + integral, or PI) controller is used to determine the demand to either the Low Flow Control Valve (LFCV) or to an individual feed pump ASD. The ASDs control feed -pump -motor -speed and thus feedwater flow rate. In addition, the FWCS can regulate the RWCU/SDC system Overboard Control Valve (OBCV) flow demand to counter the effects of density changes and purge flows into the reactor during heatup when the steam flow rate is low.

- **Three-Element Control** - During normal power range operation, the three-element control mode uses water level, total feedwater flow rate, total steam flow rate, and individual feed pump suction flow rate and pressure signals to determine the feed pump speed demand. The total feedwater flow rate is subtracted from the total steam flow rate signal to yield the vessel RPV flow rate mismatch. The flow rate mismatch signal is summed with the conditioned level error signal from the master level PI controller to provide the input signal for the master flow rate (PI) controller. The master flow rate controller provides the demand signal to the individual RFP loop trim controllers that use the discharge flow rate signals to balance RFP flow rates. The trim controllers provide the speed demand signal to the ASDs that control feed pump motor speed and thus feedwater flow rate.

- **Manual Feed Pump Control** - Each RFP can be controlled manually from the main control console through the FTDC by selecting the manual mode for that feed pump. In manual mode, the RFP speed demand signal that is sent directly to the ASD of the selected feed pump may be increased or decreased. Each feed pump is controlled manually at the manual/automatic transfer station. Each FBP can be started or stopped manually from the main control console through the FTDC by selecting the manual mode for the desired FBP.

The FWCS also provides interlocks and control functions to other systems. If the reactor water reaches Level 8, then the FWCS simultaneously activates a control room alarm and sends a zero-speed demand signal to the feed pump ASDs and trips two of the three operating FBPs. The remaining operating booster pump is placed into recirculation mode. At reactor water setpoint Level 8 the main turbine is tripped and at Level 9, a trip signal is sent to the feedwater pump ASD control breaker and the FBP motor breakers.

The worst case of a FW Pump ASD controller failure in the FW system would cause a run-out of one FW pump to its maximum capacity. In the event of a one pump run-out (detected by FW flow high), the FWCS would respond by reducing the demand to the other pumps, automatically compensating for the excessive flow from the failed pump. ~~Additional feedwater temperature controls, monitoring, and alarms are provided to assist in power maneuvering using the number seven high-pressure feedwater heater and bypass around the high pressure feedwater heaters. Refer to Section 10.4.~~

~~A loss of feedwater heating that results in a significant decrease in feedwater temperature generates a signal that FWCS sends to N-DCIS to initiate SCRRI and SRI functions. This interlock limits the consequences of a reactor power increase due to cold feedwater. The temperature difference between feedwater lines A and B is monitored and alarmed if excessive.~~

In addition, the FWCS initiates the signal to open the steam line condensate drain valves when steam flow rate falls below 40% of rated flow rate~~. ,Finally,~~and the FWCS sends a zero-flow demand signal to the feed pump ASDs on identification of an ATWS condition.

7.7.3.2.3 Operation Modes (temperature control)

The modes of feedwater temperature control are:

- Manual – the feedwater temperature setpoint is controlled by the operator, and
- Automatic – the feedwater temperature setpoint is provided by the PAS.

Both modes of feedwater temperature control use eight feedwater temperature measurements, four per feedwater line. These redundantly measured temperatures are compared to the temperature setpoint and the error signal used by a PID (proportional, integral, derivative) controller. The PID controller output range is between –100% to +100% depending on whether heating or cooling of the feedwater is required. The output signals are used to generate the position demands for the feedwater heater bypass valves and seventh feedwater heater steam heating valves.

Both modes of feedwater temperature control include the following features.

- Neither the operator nor the automation system can input a set point outside the area allowed by the ESBWR reactor power versus FW temperature operating map (Power-FWT Map) which is adjustable per fuel cycle and described in DCD subsection 4.4.4.3 .
- Neither the operator nor the automation system can change the effective set point faster than an allowable rate (nominally 100 °F per hour).
- No feedwater temperature control mode can be entered unless the controller has passed all its self-diagnostic tests and unless the operator has actively selected the control mode. Feedwater temperature control valves cannot be changed if any unbypassed ATLM has generated a feedwater temperature decrease block or if the feedwater temperature is not at set point within a predetermined time. Additionally the feedwater temperature setpoint cannot be changed unless the reactor power is above (an adjustable) level nor can a temperature be demanded outside the area allowed by the Power-FWT Map.. .