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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 50 Related to ESBWR Design Certification Application – Initial Test Program – RAI Numbers 14.2-6 and 14.2-8**

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

If you have any questions about the information provided here, please let me know.

Sincerely,

Kathy Sedney for

David H. Hinds
Manager, ESBWR

D068

Reference:

1. MFN 06-300, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 50 Related to ESBWR Design Certification Application,* August 16, 2006

Enclosure:

1. MFN 06-413 – Response to Portion of NRC Request for Additional Information Letter No. 50 Related to ESBWR Design Certification Application – Initial Test Program – RAI Numbers 14.2-6 and 14.2-8

cc: AE Cubbage USNRC (with enclosures)
GB Stramback GE/San Jose (with enclosures)
eDRFs 0000-0059-3273 and 0000-0059-3300

# ENCLOSURE 1

# MFN 06-413

## Response to Portion of NRC Request for

## Additional Information Letter No. 50

## Related to ESBWR Design Certification Application

## Initial Test Program

## RAI Numbers 14.2-6 and 14.2-8

**NRC RAI 14.2-6**

*Section 1.b.(3) of RG 1.68 states that the initial test program should include testing of the standby liquid control (SLC) system in its pre-operational phase, including testing to verify redundancy and electrical independence. Also, verification of the operability of heaters used to control the solution temperature is required. The pre-operational test description of the SLC system does not include verification of electrical independence and redundancy for the Class 1E electrical system. Also, testing of the heater installed in the mixing drum is not addressed in the test description.*

*Consistent with the above RG:*

*(a) Specify whether the redundancy and electrical independence of the SLC system will be verified; and*

*(b) Specify whether the heater installed in the mixing drum will be tested to verify its proper operation.*

*If these tests will be performed, please provide the appropriate test descriptions in the DCD Tier 2, Section 14.2.8.1.3. Otherwise, provide adequate justification for not performing the tests.*

**GE Response**

(a) The redundancy and electrical independence of the SLC system will be verified through inspection, analysis and/or preoperational tests. The SLC system requires no active equipment for operation under design conditions and the system only requires firing of one of the two squib valves in each train. If only one of the two valves was to actuate and critical system parameters (accumulator pressure and level) were normal then injection would occur. Therefore redundancy and electrical independence, as it applies to the ESBWR design, is associated with the squib valves, critical instrumentation, and initiating logic channels as detailed in ESBWR DCD/Tier 2, Document 26A6642AW, Rev. 1, Chapter 7 "Instrumentation and Control Systems" Subsection 7.4.1.3.3:

> *"This system has two redundant and parallel squib-type valves, only one of which is required for the safety-related function of SLC system."*

And Subsection 7.4.1.2.1, which states:

> *"Divisional assignments are made to ensure independence of redundant components."*

ESBWR DCD/Tier 2, Document 26A6642BN, Rev. 1, Subsection 14.2.8.1.3, covers the testing that supports the above statement in the item:

> *"Proper operation of instrumentation and equipment in the required combinations of logic and instrument channel trip."*

These statements are consistent with the requirements of RG 1.68. Specifically both the proper operation of instrumentation and equipment in the required combinations of logic

and instrument channel trip and the proper operation of the squib type injection valves are addressed. The combination of these tests in conjunction with the construction tests ensures that the requirement for redundancy and electrical independence is met.

Therefore, no DCD change will be made in response to RAI 14.2-6 item (a).

(b) The SLC system mixing drum heater does not require an independent test to verify its operation. The mixing drum is non-safety-related and only used for initial system fill and periodic make up.

In the ESBWR design the SLC system heaters, air spargers (tank) and heat tracing specifically mentioned in RG 1.68, Appendix A. 1.b.(3) used to control and maintain solution temperature, and used in previous BWR designs, have been eliminated. The ESBWR DCD/Tier 2 Document 26A6642AY, Rev. 1, Chapter 9 "Auxiliary Systems," Subsection 9.3.5.2, provides a detailed system description regarding heating requirements for the SLC system specifically:

> *"Electrical heating of the accumulator tank and the injection line is not necessary because the saturation temperature of the solution is less than 15.5°C (60°F) and the equipment room is maintained above that value at all times when SLCS injection is required to be operable."*

Furthermore, ESBWR DCD/Tier 2, Document 26A6642BN, Rev. 1, Chapter 14 "Initial Test Program" Subsection 14.2.8.1.3 currently provides adequate requirements to test the SLC system design as implemented in the ESBWR consistent with RG 1.68.

Therefore, no DCD change will be made in response to RAI 14.2-6 item (b).

**NRC RAI 14.2-8**

*Section 1.c of RG 1.68 states that the initial test program should include the testing of the reactor protection system and engineered safety feature actuation (RPS/ESF) systems in its pre-operational phase. The pre-operational test description should include the testing of the response time of each of the protection channels, including sensors. The pre-operational test description of the SSLC does not include testing for channel response time or sensor calibration/testing. Consistent with the above RG, specify whether the channel response time and sensor calibration and testing will be performed during the SSLC pre-operational test.*

*If these tests will be performed, provide the appropriate test descriptions in the DCD Tier 2, Section 14.2.8.1.6. Otherwise, provide adequate justification for not performing the test.*

GE Response

The operability of the SSLC functional logic shall be demonstrated during a series of overlapping preoperational tests. The SSLC preoperational tests are described in DCD/Tier 2, 26A6642BN Rev 1, Subsection 14.2.8.1.6. After these tests are conducted the testing of the response time and calibration/testing of each of the safety-related channels, including sensors is performed as part of the tests of following safety-related systems.

Preoperational tests of the RPS/ESF response times are performed as part of the tests described in DCD/Tier 2, Subsection 7.9.1.4; these tests flow down from DCD/Tier 1, Table 2.2.10-1, Item 4. Specifically, DCD/Tier 2, Subsection 7.9.1.4, states:

> *"Because the E-DCIS functions are closely interfaced with the SSLC functions, the integrated hardware and software functions of the E-DCIS and SSLC including network parameters and data status are checked and tested. Some of the key diagnostics include the CPU status check, parity checks, watchdog timer status, voltage level in controllers, data path integrity and data validation checks, and data cycling time and system signal response time."*

E-DCIS channel response times are tested in accordance with DCD/Tier 2, Subsection 14.2.8.1.7:

> *"Verify the ability to transmit and receive data from interfacing systems within specified response times and data rate requirements"*

The RPS channel response times are tested in accordance with DCD/Tier 2, Subsection 14.2.8.1.9:

> *"Acceptability of instrument channel response times, as measured from each applicable process variable (except for neutron sensors and suppression pool temperature sensors) to the deenergization of the scram pilot valve solenoids."*

The ESF comprises the Gravity Driven Cooling System (GDCS), the Automatic Depressurization System (ADS), the Passive Core Cooling System (PCCS), the Isolation Condenser System (ICS), Standby Liquid Control System (SLCS) and the Leak Detection and Isolation System (LD&IS). Channel response time is not applicable to the PCCS because the PCCS does not rely on instrumentation to function. ESF channel response times for the ICS, GDCS, and ADS are tested in accordance with DCD/Tier 2, Subsections 14.2.8.1.63 (ICS), 65 (GDCS), and Subsection 14.2.8.1.1 (ADS). To clarify that channel response times are tested, the following bulleted item will be added to Subsections 14.2.8.1.63 and 65, and 14.2.8.1.1:

*"Acceptability of instrument channel response times, as measured from each applicable process variable input signal to the applicable process actuator confirmation signal"*

ESF channel response times for the LD&IS are tested in accordance with DCD/Tier 2, Subsection 14.2.8.1.8. To clarify that channel response times are tested, the following bulleted item will be added to Subsection 14.2.8.1.8:

*"Acceptability of instrument channel response times, as measured from each applicable process variable input signal to the applicable process actuator confirmation signal"*

ESF channel response times for the SLCS are tested in accordance with DCD/Tier 2, Subsection 14.2.8.1.3. To clarify that channel response times are tested, the following bulleted item will be added to Subsection 14.2.8.1.3:

*"Acceptability of instrument channel response times, as measured from each applicable process variable input signal to the applicable process actuator confirmation signal"*

Sensors are calibrated as part of the system to which they are associated. RPS sensors are calibrated in accordance with DCD/Tier 2, Subsection 14.2.8.1.9:

*"Calibration of primary sensors"*

ICS, GDCS sensors are calibrated in accordance with DCD/Tier 2, Subsection 14.2.8.1.63 and 65:

*"Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip"*

LD&IS sensors are calibrated in accordance with DCD/Tier 2, Subsection 14.2.8.1.8. To clarify that the instrumentation and controls are properly installed and calibrated, the following bulleted item will be added to Subsection 14.2.8.1.8:

*"Proper installation and calibration of all instrumentation and controls;"*

SLCS sensors are calibrated in accordance with DCD/Tier 2, Subsection 14.2.8.1.3:

*"Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip"*

DCD changes will be made in response to RAI 14.2-8 as indicated.

**14.2.8.1.1 Nuclear Boiler System Preoperational Test**

***Purpose***

To verify that the valves, actuators, instrumentation, trip logic, alarms, annunciators, and indications associated with the Nuclear Boiler System (NBS) function as specified.

***Prerequisites***

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. The reactor pressure vessel (RPV) and main steam lines (MSL) can accept water during the test. The nitrogen gas and instrument air are available to support operation of MS valves. Electrical power is available to support main steam (MS) valves, instrumentation, and system operation. To the extent necessary, the interfacing systems are available to support the specific system testing and the appropriate system configurations.

***General Test Methods and Acceptance Criteria***

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Verification that the sensing devices respond to actual process variables and provide alarms and trips at specified values;
- Proper operation of system instrumentation and any associated logic, including that of the automatic depressurization system (ADS);
- Proper operation of MSIVs and main steamline drain valves, including verification of closure time in the isolation mode;
- Verification of SRV and MSIV accumulator capacity;
- Proper operation of SRV air piston actuators and discharge line vacuum breakers;
- Verification of the acceptable leak tightness and overall integrity of the reactor coolant pressure boundary via the leakage rate and/or hydrostatic testing as described in Section 5.2.
- Proper operation of Depressurization Valves (DPV) and SRV
- Acceptability of instrument channel response times, as measured from each applicable process variable input signal to the applicable process actuator confirmation signal.

Other checks shall be performed, as appropriate, to demonstrate that design requirements, such as those for sizing or installation, are met via as-built calculations, visual inspections, review of qualification documentation or other methods. For instance, SRV setpoints and capacities shall be verified from certification or bench tests consistent with applicable requirements.

**14.2.8.1.3 Standby Liquid Control System Preoperational Test**

***Purpose***

To verify that the operation of the Standby Liquid Control (SLC) system, including accumulator, tanks, control, logic, and instrumentation, is as specified.

***Prerequisites***

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. The reactor vessel shall be available for injecting demineralized water. Required interfacing systems shall be available, as needed, to support the specified testing and the appropriate system configurations.

***General Test Methods and Acceptance Criteria***

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in the required combinations of logic and instrument channel trip;
- Proper functioning of instrumentation and alarms used to monitor system operation and availability;
- Proper operation of system valves, including timing, under expected operating conditions;
- Proper operation of the nitrogen pressurization system;
- Proper system flow paths and discharge (with demineralized water substituted for the neutron absorber mixture);
- Proper operation of interlocks and equipment protective devices in valve controls;
- Proper operation of the squib type injection valves; and
- Proper volume and concentration of the neutron absorber solution (refer to Subsection 9.3.5).
- Acceptability of instrument channel response times, as measured from each applicable process variable input signal to the applicable process actuator confirmation signal.

**14.2.8.1.8 Leak Detection and Isolation System Preoperational Test**

***Purpose***

This test is to verify proper response and operation of the Leak Detection and Isolation System (LD&IS) logic.

***Prerequisites***

The construction tests have been successfully completed and the SCG has reviewed the test procedures and approved the initiation of testing. The required AC and DC electrical power sources shall be operational and the appropriate interfacing systems shall be available as required to support the specified testing.

***General Test Methods and Acceptance Criteria***

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper connection and calibration of all instrumentation and controls;
- Proper operation of instrumentation and controls in all combinations of logic and instrument channel trip;
- Proper functioning of indications, annunciators, and alarms used to monitor system operation and status;
- Proper operation of leakoff and drainage measurement functions such as those associated with the reactor vessel head flange and drywell cooler condensate;
- Proper interface with related systems in regard to the input and output of leak detection indications and isolation initiation commands; and
- Proper operation of bypass switches and related logic.
- Acceptability of instrument channel response times, as measured from each applicable process variable input signal to the applicable process actuator confirmation signal.

**14.2.8.1.63 Isolation Condenser System Preoperational Test**

***Purpose***

To verify that the operation of the Isolation Condenser (IC) system loops, including valves, logic and instrumentation is as specified.

***Prerequisites***

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. High-pressure nitrogen must be available to operate the spring-loaded condensate return valves, and nitrogen operated pneumatic rotary motor isolation valves. Electrical power is also required to operate valves and controls.

***General Test Methods and Acceptance Criteria***

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip;
- Proper functioning of instrumentation and alarms used to monitor system operation and availability;
- Proper operation of system valves, including timing;
- Verification that the steam flow paths from the IC/PCCS pools to the atmosphere are unobstructed;
- Verification that IC steam and condensate-return piping flow passages are unobstructed;
- Verification that IC system valves are in their operational readiness positions as required by design, and the IC pool is filled to normal level;
- Proper operation of IC/PCCS pool level control;
- Verification that the IC Pool subcompartment valves are locked open; and
- Proper isolation of IC containment isolation valves upon receipt of simulated isolation signals.
- Acceptability of instrument channel response times, as measured from each applicable process variable input signal to the applicable process actuator confirmation signal.

**14.2.8.1.64 Passive Containment Cooling System Preoperational Test**

***Purpose***

To verify the operation of Passive Containment Cooling Systems (PCCS) is as specified.

*Prerequisites*

The construction tests have been successfully completed and the integrated containment leak rate test has been completed successfully. Makeup Water System is available to support the proper level control of IC/PCCS pool. The SCG has reviewed the test procedure and approved this visual inspection.

***General Test Methods and Acceptance Criteria*** Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Verification that PCCS steam supply, drain and vent piping is unobstructed;
- Verification that PCCS condenser air flow versus differential pressure is within acceptable test limits;
- Verification that PCCS pool subcompartment valves are locked open;
- Proper operation of IC/PCCS pool level control; and
- Verification of the system interface with Fuel and Auxiliary Pools Cooling System for IC/PCCS pool cooling.

**14.2.8.1.65 Gravity-Driven Cooling System Preoperational Test**

*Purpose*

To verify that the operation of the four divisions of the Gravity-Driven Cooling System (GDCS), including valves, logic and instrumentation, is as specified.

*Prerequisites*

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. The reactor vessel shall be ready to accept GDCS flow. The required electrical power shall be available for squib type valve power supply. Instrument calibration and instrument loop checks have been completed.

*General Test Method and Acceptance Criteria*

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper operation of instrumentation and equipment in all combinations of logic and instrument channel trip;
- Proper functioning of instrumentation and alarms used to monitor system operation and availability;
- Proper operation of system valves, including timing;
- Verification that the flow passages from GDCS and Suppression Pool to reactor vessel are unobstructed;
- Verification that the flow passages to upper drywell are unobstructed; and
- Adequacy to provide required design flow rate.

- Acceptability of instrument channel response times, as measured from each applicable process variable input signal to the applicable process actuator confirmation signal.