



GE Energy

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Subject: **Response to Portion of NRC Request for Additional Information
Letter No. 70 Related to ESBWR Design Certification Application –
Testing Programs – RAI Numbers 14.2-22, 14.2-23, 14.2-26, 14.2-29
through 14.2-32, 14.2-35, and 14.2-40**

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,

James C. Kinsey
Project Manager, ESBWR Licensing

Reference:

1. MFN 06-382, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 70 Related to ESBWR Design Certification Application*, October 10, 2006

Enclosure:

1. MFN 07-096 – Response to Portion of NRC Request for Additional Information Letter No. 70 Related to ESBWR Design Certification Application – Testing Programs – RAI Numbers 14.2-22, 14.2-23, 14.2-26, 14.2-29 through 14.2-32, 14.2-35, and 14.2-40

cc: AE Cubbage USNRC (with enclosures)
GB Stramback GE/San Jose (with enclosures)
eDRFs 0062-8015, 0062-5175

Enclosure 1

MFN 07-096

Response to Portion of NRC Request for

Additional Information Letter No. 70

Related to ESBWR Design Certification Application

Testing Programs

**RAI Numbers 14.2-22, 14.2-23, 14.2-26,
14.2-29 through 14.2-32, 14.2-35, and 14.2-40**

NRC RAI 14.2-22

It is stated in DCD Tier 2, Revision 1, Section 14.2.8.1.42, that thermal expansion testing during the pre-operational phase is limited to those systems that are expected to be heated up significantly above their normal ambient temperatures. The applicant is requested to identify the specific systems for which thermal expansion testing would be performed during the pre-operational phase.

GE Response

The system piping that is designated for thermal expansion testing are those listed in Subsection 14.2.8.2.9 of DCD Tier 2.

Affected Documents

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

NRC RAI 14.2-23

It is stated in DCD Tier 2, Revision 1, Section 14.2.8.1.42, that vibration testing is performed during critical steady-state operating modes and during transients such as pump starts and stops, valve stroking, and significant process flow changes. The applicant is requested to identify the specific steady state operating modes, operational transients and the process flow changes during which pre-operational vibration testing would be performed.

GE Response

Table 14.2-1 (Power Ascension Test Matrix) provides various testing modes of certain piping systems. Additionally, preoperational vibration test procedures/acceptance criteria as applicable are part of the detail design phase. DCD Tier 2 Subsection 14.2.8.2.10 (titled: Description) states that various modes of operations would be considered during the performance of the vibration monitoring.

Affected Documents

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

NRC RAI 14.2-26

DCD Tier 2, Revision 1, Section 14.2.8.2.9, does not contain sufficient information relative to the design performance and test procedures for the staff to assess the adequacy of the development of the systems expansion test procedures. The applicant is requested to provide the type and source of design performance information that will be, or is being, used in the development of detailed systems expansion test procedures.

GE Response

DCD Tier 2 Subsection 14.2.8.2.9 describes the prerequisites and the acceptance criteria conditions for the thermal expansion testing. Additional detail and special requirements for a thermal expansion test will be performed in accordance with the test procedure that would be developed and evaluated against acceptance criteria. The DCD will be revised to include test procedure requirements.

Affected Documents

DCD Tier 2, Subsection 14.2.8.2.9 will be revised as noted in the attached markup.

NRC RAI 14.2-29

DCD Tier 2, Revision 1, Section 14.2.8.2.9, does not contain sufficient information relative to the test program schedule and sequence for the system expansion test phase. The applicant is requested to provide additional information regarding the system expansion test program schedule, and sequence for conducting the tests planned for the system expansion test phase. Also provide the time available between approval of testing procedures and their intended use.

GE Response

Table 14.2-1 provides the test matrix for various systems. DCD Tier 2 Subsection 14.8.2.2 states that the power ascension test phase procedures will be made available to the NRC 60 days prior to the fuel loading. In addition, to insure the tests are conducted in accordance with the established methods and acceptance criteria, the associated plant testing specification(s) is made available to the NRC.

Affected Documents

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

NRC RAI 14.2-30

DCD Tier 2, Revision 1, Section 14.2.8.2.9, does not contain sufficient information regarding the special test which will be conducted to monitor the effects of thermal stratification in the feedwater discharge piping to establish the functional adequacy of this piping. The applicant is requested to provide additional information to include acceptance criteria and conformance with applicable regulatory guides regarding the special test which will be conducted to monitor the effects of thermal stratification in the feedwater discharge piping.

GE Response

DCD Tier 2 Subsection 14.2.8.2.9 will be revised to add a requirement to include the acceptance criteria for the effects of thermal stratification in the test procedure for the feedwater discharge piping.

Affected Documents

DCD Tier 2, Subsection 14.2.8.2.9 will be revised as noted in the attached markup.

NRC RAI 14.2-31

It is stated in the DCD Tier 2, Revision 1, Section 14.2.8.2.10, that piping vibration will be verified during steady state and anticipated operational occurrences. The applicant is requested to identify the anticipated operational occurrences.

GE Response

Refer to DCD Tier 2 Chapter 15 and Table 14.2-1 for analyzed Anticipated Operational Occurrences (AOOs).

Affected Documents

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

NRC RAI 14.2-32

DCD Tier 2, Revision 1, Section 14.2.8.2.10, does not contain sufficient information relative to the design performance and test procedures for the staff to assess the adequacy of the development of the system vibration test procedures. The applicant is requested to provide the type and source of design performance information that will be, or is being, used in the development of detailed system vibration test procedures.

GE Response

The critical systems that would require vibration testing are identified in Subsection 14.2.8.2.10. This DCD Subsection will be revised to add requirements to the test procedure, as it would be deemed necessary and determined based on the preoperational walk-down. For ESBWR piping and components, past experience on vibration testing of the earlier BWR piping systems will be used as guidance to develop a test procedure and acceptance criteria.

Affected Documents

DCD Tier 2, Subsection 14.2.8.2.10 will be revised as noted in the attached markup.

NRC RAI 14.2-35

DCD Tier 2, Revision 1, Section 14.2.8.2.10, does not contain sufficient information relative to the system vibration test program schedule and sequence for the system vibration test phase. The applicant is requested to provide additional information regarding the system vibration test program schedule and sequence for conducting the tests planned for the system vibration test phase. Also provide the time available between approval of testing procedures and their intended use.

GE Response

Refer to the RAI 14.2-29 response.

Affected Documents

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

NRC RAI 14.2-40

Depressurization Valve (DPV) tests are not listed in the test plan. Even though GE might have completed the DPV tests, NRC recommends GE include DPV tests in DCD Tier 2, Chapter 14 for document completeness.

GE Response

Previously completed DPV tests will be included in the test plan. The “Prerequisites” portion of Subsection 14.2.8.1.1 will be revised to include the previously completed DPV engineering development tests and the DPV operability tests, which are performed by the manufacturer of the DPV.

Affected Documents

DCD Tier 2, Subsection 14.2.8.1.1 will be revised as noted in the attached markup.

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 DPV engineering development tests have been completed as described in Subsection 6.3.2.8.2. The DPV factory operability tests, including response tests and flow tests, have been completed. 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

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.

14.2.8.2.9 System Expansion

Purpose

The purpose of the thermal expansion test is to confirm that the pipe suspension system is working as designed, and the piping is free of obstructions during power changes. The measured and observed pipe expansion is in accordance with design, the piping returns to its approximate cold condition after cooldown.

Prerequisites

The preoperational tests have been completed and plant management has reviewed the test procedures and approved the initiation of testing. For each scheduled testing iteration, the plant shall be in the appropriate operational configuration with the specified prerequisite testing complete. The applicable instrumentation shall be checked or calibrated as is appropriate.

Description

The thermal expansion tests consist of measuring displacements and temperatures of piping during various operating modes. The power levels used to heat and hold the system at a constant temperature shall be as low as practicable. The Plant Automation System can be used to control the rate of heatup and hold the temperature constant. Thermal movement and temperature measurements shall be recorded for at least the following test points (following a suitable hold period to assure steady-state temperatures):

- During reactor pressure vessel heatup at least one intermediate temperature (between 121°C/250°F and 177°C/350°F) prior to reaching normal operating temperature, including an inspection of the piping and its suspension for obstructions or inoperable supports;
- Following reactor pressure vessel heatup to normal operating temperature;
- Following heatup of other piping systems to normal operating temperature (those systems whose heatup cycles differ from the reactor pressure vessel); and
- Subsequent heatup/cooldown cycles, as specified, at the applicable operating and shutdown temperatures, to measure possible shakedown effects.

Thermal expansion shall be conducted on plant systems of the following systems:

- **Main Steam Piping:** Steam lines between the RPV nozzles and the outboard main steam isolation valves (MSIVs), and steam lines downstream of the outboard MSIVs shall be tested;
- **Relief Valve Discharge Piping:** The piping attached to the main steam lines and bounded by the SRV discharge flange and the quencher in the wetwell shall be within the scope of the test;
- **Feedwater Piping:** The feedwater discharge piping downstream of the butt welds, located nominally one meter of piping outside of the reactor building boundary up to the RPV feedwater nozzles, shall be within the scope of this test;

- Isolation Condenser Piping: The steam supply and condensate return piping shall be within the scope of this test;
- RWCU/SDC Piping: The RWCU pumps suction and discharge piping is within the scope of the test;
- RPV Head Vent Piping: RPV Head Vent piping shall be tested; and
- Piping Inside Drywell: Major piping systems inside the drywell including the GDCS and SLC discharge piping are within the scope of the test and subject to inspection.

A test procedure and acceptance criteria will be developed on the basis of the test experience gained from the previous tests performed of the existing BWR units. The tests procedure will require to meet the applicable systems design specifications and thermal modes.

The system expansion test consists of measuring displacements and temperatures of piping systems using installed instruments or local measurements during various system and plant operating modes. A visual examination for evidence of obstruction or interference will be performed on the above mentioned system piping inside containment at appropriate hold points during reactor heatup to rated temperature and pressure conditions and after three heatup and cooldown cycles. In addition, visual observation will also be made by a system walkdown at accessible locations to determine acceptability of the system outside containment under the conditions existing during each specified system testing.

Thermal movement and temperature measurements shall be recorded inside the drywell and wetwell on the following piping: main steam, selected SRV discharge lines, IC steam piping, feedwater lines, and RWCU/SDC, at least at the following points during the power ascension phase of startup testing:

- Ambient temperature (for baseline data);
- 1.05 MPaG (150psig) reactor pressure;
- 4.14 MPaG (600 psig) reactor pressure;
- Approximately 7.07 MpaG (1025 psig); and
- 20-25%, 50%, 75% and 100% of rated thermal power.

Thermal movements will also be recorded at appropriate temperature increments up to the required test temperature for the feedwater, RWCU/SDC system piping when each system is placed in service during normal plant operation.

For applicable BOP system piping, cold baseline data will be initially recorded. During initial reactor heatup, measurement data will be obtained at specified temperature plateaus. Stop the heatup if any excessive movement is encountered. On completion of cooldown to ambient temperature, measurement data will again be collected.

Additionally, a special test procedure and acceptance criteria will be developed for the feedwater thermal stratification mode . Tests will be performed to monitor the conditions

and effects of temperature stratification that may exist on the feedwater discharge piping inside and outside of containment. This special test will be conducted during heatup, hot standby, post scram, during IC operation, and during reactor shutdown. During the performance of this test, thermal displacements, strains, and temperature measurements will be taken on at least one of the main feedwater headers inside and outside the containment, at selected feedwater riser piping, and at selected feedwater RPV nozzles to measure thermal cycling.

Criteria

The thermal expansion acceptance criteria are based upon the actual movements being within a prescribed tolerance of the movements predicted by analysis. Measured movements are not expected to precisely correspond with those mathematically predicted. Therefore, a tolerance is specified for differences between measured and predicted movement. The tolerances are based on consideration of measurement accuracy, suspension free play, and piping temperature distributions. If the measured movement does not vary from the predictions by more than the specified tolerance, the piping is expanding in a manner consistent with predictions and is therefore acceptable. Tolerances shall be the same for all operating test conditions. The locations to be monitored and the predicted displacements for the monitored locations in each plant are provided by the applicable testing specification.

14.2.8.2.10 System Vibration

Purpose

To verify that the vibration of critical plant system components and piping is within acceptable limits during normal steady-state power operation and during expected anticipated operational occurrences (AOOs).

Prerequisites

The applicable preoperational phase testing is complete and plant management has reviewed the test procedure(s) and approved the initiation of testing. Applicable systems have been walked through and verified complete to the extent required to conduct this test. Temporary hangers have been removed and replaced with permanently installed hangers for the systems involved, prior to starting the test on the particular system. For each scheduled test iteration the plant shall be in the appropriate operational configuration with all specified prerequisite testing complete. The required remote monitoring instrumentation shall be calibrated and operational.

Test procedures and acceptance criteria for ESBWR piping and components will be developed on the basis of the test experience gained from previous tests performed for earlier BWRs. Specific piping systems may be added to the vibration test program based on the results of the preoperational walkdown.

Description

Vibration testing during the power ascension phase is limited to those systems that could not be adequately tested during the preoperational phase. Systems within the scope of

this testing are therefore the same as mentioned in Subsection 14.2.8.1.42. However, the systems that remain to be tested are primarily of those exposed to and affected by steam flow and high rates of core flow. Because of the potentially high levels of radiation present during power operation, the testing is performed using remote monitoring instrumentation. Displacement, acceleration, and strain data is collected at various critical steady-state operating conditions and during significant anticipated operational occurrences (AOOs) such as turbine or generator trip, main steamline isolation, and SRV actuation.

Criteria

Criteria are calculated for those points monitored for vibration for both steady state and AOO cases. Two levels of criteria are generated, one level for predicted vibration and one level based on acceptable values of displacement and acceleration and the associated stress to assure that there are no failures from fatigue over the life of the plant. Failure to remain within the predicted levels of vibration shall be investigated but do not necessarily preclude the continuation of further testing. However, failure to meet the criteria based on stress limits requires prompt investigation and resolution while the plant or affected system is placed in a safe condition.