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Subject: **Response to RAI Letter No. 22 for the ESBWR Design Certification Application – Component and Subsystem Design – RAI Numbers 5.4-14 through 5.4-18**

Enclosure 1 contains GE responses to the subject NRC RAIs transmitted via the Reference 1 letter. This completes GE's response to RAI Letter No. 22.

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

Sincerely,

Kathy Sedney for

David H. Hinds
Manager, ESBWR

DO68

Reference:

1. MFN 06-117 - Letter from U.S. Nuclear Regulatory Commission to David H. Hinds, *Request for Additional Information Letter No. 22 Related to ESBWR Design Certification Application,* April 25, 2006

Enclosure:

1. MFN 06-151 – Response to RAI Letter No. 22 for the ESBWR Design Certification Application – Component and Subsystem Design – RAI Numbers 5.4-14 through 5.4-18

cc:	WD Beckner	USNRC (w/o enclosures)
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Enclosure 1

MFN 06-151

Response to RAI Letter No. 22

for the ESBWR Design Certification Application

Component and Subsystem Design

RAI Numbers 5.4-14 through 5.4-18

NRC RAI 5.4-14

One function of the RWCU system is to prevent thermal stratification in the reactor vessel lower head. If the system stops functioning, and "overboarding" cannot be done, a stratified layer of cold water may begin to build up in the vessel lower head. This condition could have the effect of lowering the overall driving head for natural circulation in the vessel.

(a) How will stratification affect normal natural circulation flow in the reactor vessel?
(b) What impact would the stratification have on the operation of the safety systems, including the gravity-driven cooling system (GDCS) and Isolation condensers, in the event of a transient or an accident?

GE Response

During the reactor heatup and the early stage of startup operations, the total core flow (or the downcomer flow) develops from 0% and increases to about 25% of the nominal operating core flow. The water in the vessel starts at nearly room temperature. Under these low core flow and initially cold conditions, the RWCU system removes cold water in the reactor lower head and to prevent thermal stratification, as the RPV is heated by FW flow, and core heat.

During normal operation the total core flow is about 4 times of that for the feedwater, or about 400 times of the RWCU suction flow from the bottom head. The water in the vessel lower head will be more or less at uniform temperature and close to that in the downcomer during normal operation, there is no significant density difference to cause stratification. Under these high flow and initially same temperature as that in the downcomer, a sudden loss of the RWCU system is not expected to develop a significant and stratified layer of cold water in the bottom head.

During hot standby and startup, RWCU also performs "overboarding" to maintain reactor water level. During normal operation, the reactor water level is maintained by the Feedwater Control System (FWCS).

(a) If the RWCU system stops functioning during normal operation, no significant stratification is expected to develop. As a result, it is expected to have no significant impact on the normal natural circulation flow in the reactor vessel.
(b) Since there is no stratification developed, it is also expected to have no significant impact on the operation of the safety systems.

NRC RAI 5.4-15

Add 10 CFR 50.34(f)(2)(vi) related to TMI action plan item II.B.1 to DCD Tier 2, Section 5.4.12. Provide a discussion regarding how this requirement will be met.

GE Response:

ESBWR design meets the recommendations of TMI action plan item II.B.1 in 10 CFR 50.34(f)(2)(vi) regarding the capability of high point venting of noncondensable gasses from the reactor coolant system and operation of the appropriate systems from the control room. During reactor operation, continuous venting from the RPV head and the Isolation Condenser System (ICS) purge lines occurs and is driven by the differential pressure between the primary system pressure and a downstream steamline location where the gasses are swept to the main condenser and subsequently extracted. The head vent line valves and ICS purge line valves are operated from the control room. These lines are not required to assure natural circulation cooling. Statements will be added to DCD Tier 2, Section 5.4.12 as shown in the attached mark-ups. Additional discussion is provided in Table 1A-1 of DCD Tier 2.

NRC RAI 5.4-16

Add 10 CFR 50.49 as it relates to environmental qualification of electrical equipment necessary to operate the reactor coolant vent to DCD Tier 2, Section 5.4.12. Provide discussion as to how these requirements will be met.

GE Response:

GE will add 10 CFR 50.49 with respect to environmental qualification of electrical equipment necessary to operate the reactor coolant vent system to DCD Tier 2, Section 5.4.12. Environmental Qualification and reference to 10 CFR 50.49 is described in DCD Tier 2, Section 3.11, "Environmental Qualification of Mechanical and Electrical Equipment". Section 3.11 addresses Equipment Identification, Environmental Condition Requirements and Qualification Program, Methods and Documentation. Therefore, the addition of this requirement to Section 5.4.12 will make reference to Section 3.11 for a description of the details for environmental qualification of the reactor coolant head vent electrical equipment. Statements will be added to DCD Tier 2, Section 5.4.12 as shown in the attached mark-ups.

NRC RAI 5.4-17

Add GDC 17 ,19 and 36 to DCD Tier 2, Section 5.4.12. Provide discussion as to how these criteria will be met.

GE Response:

GE will add GDC 17 and GDC 19 and address how these criteria are met in DCD Tier 2, Section 5.4.12 as shown in the following mark-ups. The RPV vent system is not part of the ECCS and is not required to assure natural circulation core cooling. Therefore, GDC 36 is not applicable. GE will add a statement that addresses this in DCD Tier 2, Section 5.4.12 as shown in the attached mark-up.

NRC RAI 5.4-18

The following features specified by in standard review plan (SRP) Section 5.4.12, Revision 0, July 1981, are not addressed in DCD Tier 2, Section 5.4.12. Please address these criteria and identify any deviations:

(a) The SRP states that "The vent system shall be designed with sufficient redundancy to assure a low probability of inadvertent or irreversible actuation." The SRP also states: "A single failure of a vent valve, power supply, or control system shall not prevent isolation of the vent path." In the ESBWR design, there is only one RPV vent line. Justify why redundancy is not required for the ESBWR. Describe how the vent system satisfies the single failure criterion. Describe the failure modes of the valve train.

(b) Specify the location, size, discharge capacity, functions, and discharge areas of the vent system.

(c) Perform supporting LOCA analyses for breaks in the vent line (Refer to DCD Tier2 Section 6.3) to demonstrate compliance with 10 CFR 50.46.

(d) Describe the procedure(s) for using (or not using) the vent system, and the bases for these procedures. (This may be a combined operating license (COL) action item).

(e) Describe the information available to the operator (i.e. instrument indications) related to vent system operation, the procedures for initiating and terminating vent system operation, and the bases for these procedures.

GE Response:

(a) GE will address this criterion by adding statements to DCD Tier 2, Section 5.4.12 as shown in the attached mark-ups. When the RPV is in an isolated condition, redundancy for venting the reactor coolant system is provided by the RPV head vent line and the Safety Relief Valves (SRVs). For RCPB isolation purposes during reactor power operation, redundancy is provided by the use of two motor operated valves in series in the piping that vents the RPV to the Equipment and Floor Drain sump. Either or both valves isolate the piping. Failure modes of the valve train consist of loss of power supply, failure of the control system and mechanical failure in the valve. In the event that one of the valves experiences a failure, there is the second valve in series that performs the isolation function.

(b) GE will address this criterion by adding statements to DCD Tier 2, Section 5.4.12 as shown in the attached mark-ups. There is a connection at the RPV flange area that connects the internal integral head vent piping to the external RPV head vent piping. The head vent piping is 2 inches in diameter, which is consistent with that used in current operating BWRs and the Lungmen ABWR design. Discharge capacity is not a criterion that has been considered when sizing the head vent piping in current operating BWRs and the Lungmen ABWR design and, therefore is not used for ESBWR. The vent piping directs air and non-condensable gases from the RPV to either the Equipment and Floor Drain Sump or one of the main steamlines. The head vent piping permits air to be released from the RPV so that the vessel can be filled with water for hydrostatic testing, vents air and non-condensable gases during reactor operation and reactor shutdown and provides the upper tap for RPV level measurement during reactor shutdown.

(c) The vent line is much smaller than a main steamline. Therefore, a break in the vent line is bounded by a main steam line break and no additional analysis is performed for this specific line. Will add a statement in DCD Tier 2, Section 5.4.12 as shown in the attached mark-ups that describes this and makes reference to Section 6.3, which addresses a main steamline break.

(d) Typically, the use of the RPV head vent system is addressed in a plant Integrated Operating Instruction (IOI). Prior to reactor startup, deaeration of the reactor water may be performed. This requires closing the two valves in the vent piping leading to the Equipment and Floor Drain Sump and opening the valve in the vent piping to the main steamline. During reactor shutdown and after the plant reaches cold shutdown conditions, the two valves in the vent piping leading to the Equipment and Floor Drain Sump are opened and the valve in the vent piping to the main steamline is closed. Will add a new sub-section 5.4.12.1, which describes the procedure to operate the RPV head vent system, to DCD Tier 2 as shown in the attached mark-up.

(e) The procedures for initiating and terminating vent system operation are addressed in item (d) above and are based upon the procedures in use at current operating BWRs and the Lungmen ABWR design. Open and close position indication for the motor operated valves and temperature in the piping downstream of the second motor operated isolation valve are available in the control room. This provides indication to the operator of valve status and any leakage past both of the isolation valves. Will add a statement in DCD Tier 2, Section 5.4.12 as shown in the attached mark-ups that describes this information.

5.4.12 Reactor Coolant System High Point Vents

SRP 5.4.12 addresses 'Reactor coolant system high point vents provided to exhaust noncondensable gasses from the primary system that could inhibit natural circulation core cooling'. The ESBWR has an RPV head vent system that handles any noncondensable gas buildup at the high point inside the RPV head by sweeping the gasses through a main steamline and then ultimately to the condenser. Additionally, systems that are connected to the RPV and are stagnant during normal plant operation have lines that are sloped to prevent any buildup of noncondensable gasses. The ESBWR features that deal with noncondensable gasses meet the relevant requirements of the following regulations:

A. 10 CFR Part 50.55a and General Design Criteria 1 and 30 as they relate to the vent system components which are part of the reactor coolant pressure boundary being designed, fabricated, erected, and tested and maintained to high quality standards.

B. GDC 14, as it relates to the reactor coolant pressure boundary being designed, fabricated, erected and tested to have an extremely low probability of abnormal leakage, of rapidly propagating failure, and of gross rupture.

C. 10 CFR 50.46(b) as it relates to the long-term cooling of the core following any calculated successful initial operation of the ECCS to remove decay heat for an extended period of time.

D. 10 CFR 50.49 with respect to environmental qualification of electrical equipment necessary to operate the reactor coolant vent system.

E. GDC 17 with respect to the provision of normal and emergency power for the vent system components

F. GDC 19 with respect to the vent system controls being operable from the control room

The ESBWR meets the recommendations of TMI action plan item II.B.1 in 10 CFR 50.34(f)(2)(vi) regarding the capability of high point venting of noncondensable gases from the reactor coolant system. During reactor operation, the noncondensable gases that may collect in the reactor head and the IC steam lines are continuously drawn to the steamline through a vent line from the RPV head and a purge line from each of the ICs. Differential pressure between the reactor head and the downstream steamline location extracts the noncondensables. The noncondensables are swept from these lines to the condenser, where they are extracted. Position indication and controls for opening and closing the valves are provided in the control room. These vents and purge lines are not required to assure natural circulation core cooling. The procedure for operation of the RPV head vent system is discussed in the following subsection 5.4.12.1.

When the RPV is in an isolated condition, redundancy for venting the reactor coolant system is provided by the RPV head vent line and the SRVs. The vent line used to vent

the reactor head noncondensables following a refueling operation is isolated with two normally closed valves during reactor power operation. These valves are subjected to an Environmental Qualification program as described in Section 3.11.

GDC 17 is met by an on-site electric power system that provides normal and emergency power to permit operation of the RPV head vent line valves. GDC 19 is met by controls and indication that permit operation of the valves from the main control room. The RPV head vent system is not part of the ECCS and is not required to assure natural circulation core cooling. Therefore, GDC 36 is not applicable.

For RCPB isolation purposes during reactor power operation, redundancy is provided by the use of two motor operated valves in series in the piping that vents the RPV to the Equipment and Floor Drain Sump. Either or both valves isolate the piping. Failure modes consist of loss of power supply, failure of the control system and mechanical failure in the valve. In the event that one of the valves experiences a failure, there is the second valve in series that performs the isolation function. Indication of open and close position and temperature downstream of the second valve are available to operators in the control room.

There is a connection at the RPV flange area that connects the internal integral head vent piping to the external head vent piping. The piping is 2 inches in diameter. The vent piping directs air and non-condensable gases from the RPV to either the Equipment and Floor Drain Sump or one of the main steamlines. The vent piping permits air to be released from the RPV so that the vessel can be filled with water for hydrostatic testing, vents gases during reactor operation and reactor shutdown and provides the upper tap for RPV level measurement during reactor shutdown.

The diameter of the vent line piping is much smaller than the main steam line piping. Therefore, a break in this piping is bounded by a main steam line break, which is addressed in Section 6.3.

The isolation condensers also vent noncondensables to the suppression pool to maintain their performance; however, the ICs are isolable and not part of the primary system. The isolation condenser vents are discussed in Subsection 5.4.6.

5.4.12.1 Operation of RPV Head Vent System

Prior to reactor startup, deaeration of the reactor water may be performed. This requires closing the two motor operated valves in the vent piping leading to the Equipment and Floor Drain Sump and opening the motor operated valve in the vent piping connected to the main steamline. These valve positions are maintained during power operation. During reactor shutdown and after the plant reaches cold shutdown conditions, the two valves in the vent piping leading to the Equipment and Floor Drain Sump are opened and the valve in the piping connected to the main steamline is closed.