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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 15 - Reactor Coolant Pressure Boundary (RCPB) - RAI Numbers 5.2-1 S01, 5.2-1 S02, 5.2-2 S01, and 5.2-2 S02**

Enclosure 1 contains GEH's response to the subject NRC RAIs originally transmitted via the Reference 1 letter and supplemented by a first and second NRC request for clarification.

If you have any questions or require additional information, please contact me.

Sincerely,

Kathy Sedney for

James C. Kinsey
Project Manager, ESBWR Licensing

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NRO

Reference:

1. MFN 06-102, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 15 Related to ESBWR Design Certification Application*, March 30, 2006

Enclosure:

1. MFN 06-085 Supplement 2 - Response to Portion of NRC Request for Additional Information Letter No. 15 - Related to ESBWR Design Certification Application - Reactor Coolant Pressure Boundary (RCPB) - RAI Numbers 5.2-1 S01, 5.2-1 S02, 5.2-2 S01, and 5.2-2 S02

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Enclosure 1

MFN 06-085 Supplement 3

Response to Portion of NRC Request for

Additional Information Letter No. 15

Related to ESBWR Design Certification Application

Reactor Coolant Pressure Boundary (RCPB)

RAI Numbers 5.2-1 S01, 5.2-1 S02, 5.2-2 S01, and 5.2-2 S02

NRC RAI 5.2-1:

DCD Section 5.2.5 Item (3) indicates that the system is equipped with indicators and alarms for each leak detection system in the control room, and permits "qualitative" interpretations of such indicators. However, DCD Section 5.2.5.8 indicates that the monitoring instrumentation is designed to detect leakage rates of 1 gpm within one hour, satisfying Regulatory Guide (RG) 1.45, Position C.5. Leakage from unidentified sources inside drywell is collected in the floor drain sump to detect leakage of 1 gpm, thus satisfying RG. 1.45, Position C.2. Furthermore, DCD Section 5.2.5.8 indicates that the limit established for alarming unidentified leakage is 5 gpm, and the Technical Specification (TS) limit specified in Limiting Conditions for Operation (LCO) 3.4.2 for unidentified RCPB leakage is 5 gpm. The above DCD statements appear to be inconsistent in meeting 1 gpm guidance in RG 1.45. The following are the specific questions.

a. *Why does the system permit only "qualitative" rather than "quantitative" interpretations of such control room indicators? Qualitative control room indicators are not adequate in meeting RG 1.45.*

b. *Explain how the proposed TS limit and alarm limit for the unidentified leakage of 5 gpm, which is consistent with neither the design capability of 1 gpm nor Positions C.2 and C.5 of RG 1.45, is justified?*

GEH Response:

a. The term "qualitative" was quoted directly from SRP 5.2.5 Rev. 1 ("Area of Review") to provide acknowledgement that the design of the Leak Detection and Isolation system (LDIS) will be compliant with the guidance of the SRP in terms of information presented to the main control room operator. This information would be used for "interpretation" as the SRP implies. Nevertheless, the information presented to the main control room operator will be "quantitative" in the context that the operator can convert the various readings to an equivalent leakage rate. The sentence will be modified to indicate that information, which is "quantitative" in nature, will be provided.

b. The proposed TS limit is not considered to be inconsistent with either position C.2 or C.5 of RG 1.45. Position C.2 is interpreted as providing guidance as to the "accuracy" of the measurement of unidentified leakage and not the TS limit. i.e., the "accuracy" of a device is not necessarily equivalent to the total quantity allowed by TS for the monitored parameter.

   Position C.5 of RG 1.45 recommends that the "sensitivity and response time" of various instruments "employed for unidentified leakage should be adequate to detect a leakage rate, or its equivalent, of one gpm in less than one hour." Similar to this discussion above for C.2, the "sensitivity" of a detection method, does not necessarily imply, nor require, that it be the same as the limiting condition (or actionable TS limit) for the monitored parameter. The sensitivity of these detection methods to a specific leakage amount, i.e. tolerance of the instrument, is different from the value that is calculated to be significant in regards to the total leakage amount.

   There is a long history of leakage detection/alarm limits as related to the BWRs. Early BWRs are designed and operated with instruments with a 1 gpm sensitivity and 5 gpm alarm limit, similar to what is included within the ESBWR design application. Given that earlier

BWRs contain materials susceptible to IGSCC, a rate of change technical specification limitation was included, as required by Generic Letter 88-01, to detect increases in unidentified leakages inside of containment. The ESBWR however, does not use materials susceptible to IGSCC, therefore, the ESBWR technical specifications do not require a similar rate of change limitation.

Also, note that the Section 5.2.5.8 of the DCD addresses compliance to positions C.2 and C.5 of RG 1.45, specifically in regards to the 1 gpm limit. As noted in the evaluation against Criterion 30 (DCD Section 3.1.4.1), the allowable leakage rates have been based on the predicted and experimentally determined behavior of cracks in pipes, the ability to provide makeup water to the RCS, the normally expected background leakage due to equipment design, and the detection capability of the various sensors and instruments. The proposed TS limit of 5 gpm for unidentified leakage is considered acceptable, because, as noted in DCD Section 5.2.5.5, it is sufficiently low so that, even if the entire leakage rate were coming from a single crack in the nuclear system process barrier, corrective action could be taken before barrier integrity is threatened. Additional rationale for the proposed TS limit is included in the Bases discussion for LCO 3.4.2, which is provided in DCD Chapter 16B.

Also, it is worth noting that the initial ABWR design included a 1 gpm limit. However, the sensitivity and accuracy of available measuring equipment is +/- 1 gpm. Therefore, to assure proper system functionality, the limit was changed from 1 gpm to 5 gpm for current ABWR design, which is under construction at Lungmen site. Any future ABWR plants will also use the 5 gpm limit.

NRC RAI 5.2-1 S01:

Comments on response to RAI 5.2-1:

The response indicated that the sensitivity and accuracy of available leakage monitoring equipment is +/- 1 gpm. Based on the information in NUREG/CR-6861, "Barrier Integrity Research Program," it would appear that there are instruments available that could detect leakage at levels less than 1 gpm. Provide the basis for the +/- 1 gpm accuracy, and address whether all available leakage monitoring technologies have been explored.

The response indicated that the proposed technical specification limit of 5 gallons per minute (gpm) for unidentified leakage is considered acceptable because it is sufficiently low so that even if the entire leakage rate were coming from a single crack in the nuclear system process barrier, corrective action could be taken before barrier integrity is threatened. Please provide the technical basis for this conclusion. Include in the response how the critical flaw size was determined for the range of materials and geometries used in the reactor coolant system.

DCD Section 5.2.5.8, states that the monitoring instrumentation of the drywell floor drain sump, the air particulate radioactivity, and the drywell air cooler condensate flow rate are designed to detect leakage rates of 3.8 liters/min (1 gpm) within one hour, thus satisfying RG 1.45, Position C.5. How is this capability demonstrated?

NRC RAI 5.2-1 S02:

In RAI 5.2-1(b), the staff asked GE to explain how the proposed Technical Specification (TS) limit and alarm limit for the unidentified leakage of 5 gpm are consistent with the 1 gpm criterion specified in Positions C.2 and C.5 of RG 1.45. In GE's RAI response, MFN 06-085, and in a conference call on January 16, 2007, GE maintained its position for the TS limit and alarm limit being specified as 5 gpm based on its historical leakage detection/alarm limits being specified for BWRs. GE stated that Positions C.2 and C.5 only specified the "sensitivity" of the instrument rather than the TS limit or alarm limit, and stated that the ESBWR instrument has the sensitivity of 1 gpm. RG 1.45 (page 1.45-2) provides guidance on the "detector sensitivity," and states that "sumps and tanks used to collect unidentified leakage and air cooler condensate should be instrumented to alarm for increases of from 0.5 to 1.0 gpm." The sensitivity of 1 gpm, claimed by ESBWR design, is not demonstrated in the alarm set point, or in the TS limit, and is not explicitly shown being used by operators under any procedures. The staff believes that the alarm limit needs to be set as low as practicable to provide an early warning signal to alert operator taking actions. The current ESBWR alarm limit of 5 gpm is not acceptable because it is not consistent with RG 1.45 stated above, nor it serves the intended function to alert operator taking actions before the TS limit is reached.

Provide and justify a revised alarm limit for the unidentified leakage. Revise the DCD, Tier 2, Section 5.2.5.4, accordingly.

GEH Response:

The RAI 5.2-1 combined Supplement 1 and 2 requests ask GEH to respond on four issues:

a. *Based on the information in NUREG/CR-6861, there are instruments available that could detect leakage at levels less than 1 gpm. Provide the basis for the +/- 1 gpm accuracy, and address whether all available leakage monitoring technologies have been explored.*

   Drywell leakage detection methods are outlined in DCD Tier 2, Revision 3, Subsection 5.2.5.1.1. The relevant information from NUREG/CR-6861, Section 5 "Leak Monitoring Systems," has been reviewed and the following is a summary of the recommendations contained therein:

   1) Visual monitoring. The method is not applicable to ESBWR containment leakage monitoring. As noted in NUREG/CR-6861, the emphasis is on observation of boron accumulation correlated to leak rates, which is not applicable for a pure-water BWR. Further, entry into the BWR containment during power operation is prohibited due to the nitrogen-inerted containment design.

   2) Humidity change detection. This method is not applicable to ESBWR containment leakage monitoring. The report notes that sensitivity "could be in the range of gallons per minute when used in large volume containments." Given the large open water pools inside the ESBWR containment, humidity change detection sensitivity is further inhibited.

   3) Temperature change detection. This method is not applicable to ESBWR containment leakage monitoring. The report notes that temperature change detection cannot meet the 1 gpm sensitivity goal. The ESBWR, as other BWR designs, does use temperature

change detection in certain closed-volume systems to detect the onset of leakage, for example, in the tail pipes of safety-relief valves, but not for quantification of leakage.

4) Containment pressure increase. This method is not applicable to ESBWR containment leakage monitoring. The report notes that a leak would have to be large to result in a detectable pressure change. Further, containment pressure can be influenced by several factors including cooling water system temperature change or pneumatic subsystem leakage.

5) Reactor coolant inventory change. This method is not applicable to ESBWR containment leakage monitoring. NUREG/CR-6861 notes that this method is specific to PWRs and does not apply to BWRs.

6) Continuous sump level change measurement. This method is used in the ESBWR design to monitor for the 5 gpm leak rate limit with instrumentation accurate to as low as 1 gpm leak rate equivalent level change.

   As an example, a typical sump may have a surface area of 16 ft^2. This results in a volume of nearly 10 gallons per inch of level. With just a 10-inch volume of water present in the sump, temperature changes in the closed-cooling water supplied to the sump heat exchanger, and the ambient drywell conditions could combine to cause a volume expansion of greater than one-tenth inch. As sump volume increases, the potential thermal expansion affect increases. This could result in a false 1 gpm increase indication on a frequent basis, an adverse condition as evaluated for control room human factors. An alarm set at the 5 gpm equivalent detected unidentified leakage, a half-inch level change in the example, provides adequate margin to avoid false alarms. Therefore, a 5 gpm leak rate equivalent setpoint provides greater assurance of correct operator response without significant impact on the early detection of a potential gross RCPB loss of integrity.

7) Airborne radioactive gas and radioactive particulate monitoring. Fission products radioactivity monitoring is an additional method used in the ESBWR design. The report notes some sensitivity issues with the methods, with a preference toward particulate monitoring. There are some factors affecting BWR coolant activity levels that are independent of leak rate, but leak rate change detection at a low value remains technically possible under sufficiently constrained conditions.

8) Sump flow rate change. This is an additional method employed in the ESBWR design. There can be maintenance problems, for example, sudden long pump run-times with little volume transfer measured can be caused by a failed open minimum flow line. Not withstanding such problems, flow measurement precision, accuracy and repeatability is sufficiently accurate to satisfy RG 1.45 Positions C.2 and C.5 as noted in the original response (see above). Detection capability permitting less than 1% accuracy is advertised for some devices, but is typically conditioned on flow purity and other requirements (e.g., long straight pipe run length for element installation, flow stability, thermal stability). A typical sump flow element full-scale (FS) range of 50-100 gpm and 1% FS accuracy provides detection within plus or minus 0.5-1.0 gpm of actual flow rate Depending on the total sensing system stability, the application of an alarm set for a

1 gpm change in flow rate could result in frequent alarm activation because the setpoint is in the tolerance band.

Selection of the type of flow element to use for containment unidentified leakage must consider factors other than specific accuracy and precision. Of concern are the affect on transmitter performance of varying environmental conditions, and sump thermal conditions. Also a concern is particulate size distribution and concentration in the flow. Flow element selection must be biased in favor of flow element types resistant to error or plugging due to the presence of radioactive contaminants. And flow element installation is generally not in an ideal pipe run, but requires compromises to accommodate the layout and configuration of other systems and components.

9) Air-cooler condensation flow rate. This is also a method employed in the ESBWR design. Condensation will occur due to pool evaporation removed by the air-coolers. Packing leaks can also result in significant steam releases although there is no impairment of RCPB integrity. A 1 gpm condensation on the air-coolers would be a leak rate of about 497 lbm/hr of steam (assuming none of the condensate is deposited in any of the pools). The accuracy of the flow element and signal transmitting system is otherwise similar to that for sump flow measurement devices.

Further, data presented in Figure 20 of NUREG/CR-6861 show that about 80% of leaks used to develop the report were identified using methods not applicable to the ESBWR. Methods 6 through 9 reviewed above provide the ESBWR with sufficiently accurate detection of unidentified leak rate flow changes within the currently proposed ESBWR Technical Specification (TS) limit of 5 gpm.

b. *Please provide the technical basis for the conclusion that the proposed technical specification limit of 5 gallons per minute (gpm) for unidentified leakage is acceptable. Include in the response how the critical flaw size was determined for the range of materials and geometries used in the reactor coolant system.*

In review, a 5 gpm leak rate can be reverse calculated using Moody tables to approximate the equivalent break size. If the leak rate is measured at 100°F, the fluid density is 62 lbm/ft^3 and the mass flow can be found to be 0.69068 lbm/sec. This would equate to a saturated steam break opening of about 0.24 inch diameter, a size comparable to some instrumentation porting. A liquid break in the RCPB of equivalent flow is a smaller opening area than the saturated steam break due to the greater mass flux for liquid breaks. Pipe cracks bounding these sizes have been studied, as noted in the original response, demonstrating that the 5 gpm limit is conservative.

In Section 4 of NUREG/CR-6861 under subheading "Basis for RCS Leakage Monitoring Requirements," it is noted that one of the earliest established plant TS limits for leak rate was at the Monticello (BWR3/Mark I) plant in 1969. The TS limits were set at 1.6 kg/sec (25 gpm) for identified leakage and 0.32 kg/sec (5 gpm) for unidentified leakage. These values were established for BWR designs based upon reactor coolant makeup capability. The authors note that "The total allowed limit (identified plus unidentified) appears to be based on the inventory makeup capability and sump capacity rather than RCS integrity." However, the NUREG/CR-6861 authors also conclude about the current BWR leakage monitoring that "for many piping systems these limits provide significant margin against gross failure of reactor piping to sustained stress loads." This conclusion supports the original design basis of the BWR plants. Around circa 1969, the emphasis for plant licensing was placed on the ability to respond to a deterministically postulated (i.e., assumed without reference to any initiating or causative mechanism) double-ended guillotine pipe rupture of the BWR recirculation loop piping. Thus, reliance on assured RCS integrity was not the primary licensing basis.

The ESBWR plant design continues to use the same basis, rather than the alternative basis of leak-before-break (LBB). NUREG/CR--6861 contains several references indicating that the emphasis on RCS integrity is from the viewpoint of licensing on the LBB design basis. LBB requires analysis of critical flaw size, crack growth pattern and rate, and the correlation between crack size and growth and unidentified leak rate and leak rate change. The objective of LBB design is to assure detection of RCS leakage at very low values to provide early crack detection such that RCS pressure integrity is always assured. The ESBWR design is conversely based on being capable of responding within regulatory limits to a postulated RCPB bounding failure event. Therefore, calculations and analyses required to support LBB have not been performed. The leakage limits originally established for BWRs licensed on the basis of a deterministic RCPB failure response analysis remain valid for the ESBWR.

c. *DCD Section 5.2.5.8, states that the monitoring instrumentation is designed to detect leakage rates of 3.8 liters/min (1 gpm) within one hour. How is this capability demonstrated?*

This requirement is implemented through the "ITAAC for the Containment Monitoring System," DCD Tier 1, Revision 3, Table 2.15.7-1, Item No. 9. The ITAAC permits "Inspection, test, and/or analysis ... to verify that all the setpoints ... are in conformance with the design requirements."

There are standard calibration tests for flow and level instruments, and these may be performed either at the installed location or on a calibration test bench, depending on the type of instrument and installation method used. There are also standard calibration sources and calibration test methods for radiation detection based unidentified leakage monitoring instruments. It may also be feasible to conduct some form of in-place simulated leakage test for flow or level measurement instrumentation. However, such testing for radiation detectors involves considerable risk.

d. *The current ESBWR alarm limit of 5 gpm is not acceptable because it is not consistent with RG 1.45. The staff believes that the alarm limit needs to be set as low as practicable to provide an early warning signal to alert operator taking actions. Provide and justify a revised alarm limit for the unidentified leakage. Revise the DCD, Tier 2, Section 5.2.5.4, accordingly.*

GEH disagrees, as noted in the original response, that the 5 gpm limit is in any way not consistent with RG 1.45. RG 1.45 does not explicitly take a position on the relationship of leakage alarm setpoint limits to leakage detection sensitivity and response time. The setpoint of 5 gpm is as low as practical without incurring the adverse Human Factors Engineering (HFE) condition of frequent spurious and nuisance control room alarms. This is due to the characteristics of a pressure-suppression containment and pure-water primary coolant system of all BWR designs including the ESBWR. The setpoint is also sufficiently low to provide a large margin prior to a gross pressure boundary failure, as pointed out in NUREG/CR-6861.

A lower setpoint is not required because the ESBWR design is predicated on the deterministic assumption of a large pipe rupture occurring as the bounding RCPB integrity failure, and not on prevention of such pipe ruptures by early detection under the LBB risk-informed design approach.

DCD Impact:

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

NRC RAI 5.2-2:

All certified advanced reactor designs (CE System 80+, AP600, AP1000, ABWR) have Technical Specification (TS) limit of 1 gpm or less for unidentified reactor coolant system (RCS) operational leakage to satisfy RG 1.45. Standard Technical Specifications for current operating GE BWRs have the limit of 5 gpm for unidentified RCS operational leakage. ESBWR TS LCO 3.4.2 specifies a limit of 5 gpm (the criterion used by the last generation BWR technology) for unidentified RCS operational leakage, even though it has the design capability of 1 gpm for unidentified leakage.

Why would ESBWR TS LCO 3.4.2 need a more relaxed limit (5 gpm) for RCPB leakage detection than ABWR (1 gpm)? The more relaxed limit indicates higher operating RCPB leakage rates, less RCPB leakage control, potentially more humid environment inside containment, increased probability of abnormal leakage.

a. *Evaluate the adverse effects to instrument and degradation effects (such as corrosion) to components caused by the additional humidity.*

b. *Specifying a leakage limit of 5 gpm instead of 1 gpm would allow a plant to operate in a potentially degraded condition longer. Provide compensatory measures to correct the degraded condition in accordance with the requirements of Criterion XVI of 10 CFR 50, Appendix B, as discussed in NRC Generic letter 91-18, Revision 1.*

GEH Response:

The equipment that is currently available can measure leakage with an accuracy of 1 gpm. It is considered to be unnecessarily restrictive with respect to plant operation and the avoidance of spurious alarms and presents an unnecessary hardship to the plant operator if the unidentified leakage limit is established at 1 gpm. Additionally, it should be noted that measures have been taken to reduce the likelihood of pipe cracks contributing to leakage. According to DCD section 3E.5, "the ESBWR plant design specifies use of austenitic stainless steel piping made of material (e.g., nuclear grade or low carbon type) that is recognized as resistant to Inter-Granular Stress Corrosion Cracking (IGSCC)". Therefore, the 5 gpm limit of ESBWR TS LCO 3.4.2 will provide detection in sufficient time to initiate corrective action.

a. An evaluation of the effects of relative humidity including that which is attributable to the proposed leakage limits up to 5 gpm would be included as part of equipment qualification requirements in the procurement of equipment. Because this value, i.e., 5 gpm, has been acceptable for operating BWRs, GE does not anticipate any additional adverse effects because current installed equipment in operating BWRs would already be qualified to that limit.

b. The BWR evolution has continued to reduce the likelihood of leaks because of Stress Corrosion Cracking (SCC) of austenitic stainless steels by reducing and limiting the use of austenitic stainless steel, eliminating large penetrations in the lower vessel region and using SCC resistant fabrication processes. Stainless steel piping continuously active during normal reactor operation is limited to the Reactor Water Cleanup System and the Isolation Condenser System return lines. Large penetrations in the lower vessel region have been avoided by the elimination of the external recirculation system and internal recirculation pumps and most vessel connections are above the core.

Additional measures taken in the ESBWR to reduce challenges to the 5 gpm unidentified leakage limit are use of SCC resistant materials for bottom head penetrations, CRD housings and in-core housings. The 5 gpm limit for unidentified RCS operational leakage is based on the behavior of pipe cracks. It has been shown that, for leakage even greater than 5 gpm, the probability is small that the associated imperfection or crack would grow rapidly. And, 5 gpm is a small fraction of the calculated flow from a critical crack in the primary system piping.

Additionally, pipe cracks are addressed in DCD Table 1.11-1. According to the resolution for Action Plan Item/Issue number A-42 in this table, the RCS piping in the ESBWR design complies with NUREG-0313, Rev. 2 and Generic Letter (GL) 88-01 through the selection of materials and processes that avoid sensitization or susceptibility to IGSCC. According to DCD Section 5.2.3.4.1, the RCS piping is designed to avoid sensitization and susceptibility to IGSCC through the use of reduced carbon content material and process controls. During fabrication, solution heat treatment is utilized. During welding, heat input is controlled. Austenitic stainless steels that have become sensitized or susceptible to cracking because of IGSCC are not used in the ESBWR design.

Historically, good operator practice plays a role in the event of an anomaly in unidentified leakage. The duties and responsibilities of the operating staff to regularly observe and record data, monitor trends in plant parameters and detect abnormal conditions during their shift provide a means to alert the plant staff to a condition that warrants further scrutiny and assessment. For example, if leakage is observed to be more than the normal expected leakage, yet less than the 5 gpm limit, the plant operators typically will be alerted to investigate, record, and track pertinent data, evaluate trends in the data and make an assessment of the cause for any change that could ultimately lead to a reactor shutdown to make a drywell entry to take further action to locate, assess and potentially repair the source of leakage. Therefore, this typical practice identifies that utilities have established measures for taking action before reaching the 5 gpm leakage limit.

Based on the above considerations, the proposed TS values and required actions are considered to be proper and adequate to assure plant safety and, therefore, operation in compliance with the proposed TS would not constitute a degraded or non-conforming condition requiring corrective action in accordance with Criterion XVI of 10 CFR 50, Appendix B, as discussed in NRC Regulatory Issue Summary 2005-20, September 26, 2005 (Note: RIS 2005-20 superseded NRC Generic Letter 91-18, Revision 1).

NRC RAI 5.2-2 S01:

Comments on response to RAI 5.2-2:

a. *The response states that "an evaluation of the effects of relative humidity including that which is attributable to the proposed leakage limits up to 5 gpm would be included as part of equipment qualification requirements in the procurement of equipment." Is this a commitment (COL action item)?*

b. The response discusses "good operator practice" would result in actions being taken before reaching a 5 gpm limit. Is this a commitment (COL Action Item) to address this in plant procedures?

c. Because there is no test data or operating experience of sufficient long term operation to eliminate the probability of the stress corrosion cracking, the concern of stress corrosion cracking is not completely resolved. Please discuss the extent to which comprehensive long term (e.g., 60 year) testing has been performed under the range of material and water chemistry conditions that could exist, given current NRC requirements pertaining to water chemistry and material selection, fabrication, and installation.

d. GE's response indicates that design improvements in ESBWR would reduce the likelihood of a leak. If this is the case, the development of leakage could indicate that something is not performing as expected (i.e., an unexpected or unanticipated condition). As indicated in the response, action is taken at many operating BWR plants before reaching the 5 gpm leakage limit (for similar reasons). In light of the above, the lowest possible leakage limit should be incorporated while limiting the potential for unnecessary plant shutdowns.

GE's response to RAI 5.2-2 stated that "An evaluation of the effects of relative humidity including that which is attributable to the proposed leakage limits up to 5 gpm would be included as part of equipment qualification requirements in the procurement of equipment." Which Equipment Qualification is GE referring to, and what leak duration would the qualification tests support? How is this leakage duration applied as a limit for a prolonged RCS leakage rate of up to 5 gpm?

NRC RAI 5.2-2 S02:

In GEs response to RAI 5.2-2, MFN 06-085, GE stated that an evaluation of the effects of relative humidity including that which is attributable to the proposed leakage limits up to 5 gpm would be included as part of equipment qualification requirements in the procurement of equipment. The staff reviewed the current equipment qualification and found that it was not adequate to address the concern of long term leakage. Under current TS, the plant operators could continuously operate the plant for years with unidentified reactor coolant system (RCS) leakage of less than 5 gpm. In response to the RAI, GE stated that the design of ESBWR has been improved to reduce the likelihood of leaks resulting from stress corrosion cracking (SCC), and historically, good operator practice plays a role in the event of an anomaly in unidentified leakage. Typical operator practice will investigate, record, track, evaluate trends of the leakage, and take necessary measures to locate, assess, and repair the source of the leakage. The staff agreed that the material design improvement can reduce the likelihood of leaks resulting from SCC, but the improvement cannot eliminate all the possible leaks. The staff also agreed that good operator actions at low level leakage below the TS limit are acceptable measures to address the concern of long term leakage. To account for the good operator practice, every COL applicant should have operating procedures to manage the low level RCS leakage, and the alarm limit should be set as low as practicable to provide an early warning signal to the operators to implement the procedures. Therefore, it needs a new COL action item, and an appropriate alarm limit in the design.

In the conference calls, dated August 14, 2006, and January 16, 2007, the applicant agreed to add a COL holder item in Revision 3 of DCD Section 5.2.6. The COL holder item now states that "operators will be provided with procedures to assist in monitoring, recording, trending, determining the source of leakage, and evaluating potential corrective action." The staff find this statement unacceptable for the following reasons.

A. Revise the COL Holder item to state that "The COL Holder is responsible for the development of a procedure ..." rather than the current statement that the "Operators will be provided with procedures ..."

B. Revise the COL Holder item to indicate that the procedures are for low level unidentified leakage, (lower than the TS limit). {This RAI response is associated with the above RAI 5.2-1 supplement resolution as it needs an appropriate alarm limit in the design to provide an early warning signal to the operators to implement the procedures.}

GEH Response:

NRC RAI 5.2-2 S01, item a. Environmental qualification of components is addressed by an Inspection, Test, Analysis, and Acceptance Criteria (ITAAC) listed in DCD Tier 1, Revision 3, Table 2.15.7-1, Item No. 7. The environmental qualification of equipment and components is addressed in DCD Tier 2, Revision 3, Section 3.11 and Reference 3.11-3 "General Electric Environmental Qualification Program," NEDE-24326-1-P. Relative humidity is one parameter of environmental qualification.

NRC RAI 5.2-2 S01, item b. The original response using the phrase "good operator practice" is not a design commitment. The context is that the role expected of the operators is to carry out those activities as required under the surveillance requirements of plant Technical Specifications LCO 3.4.3. The issues of operating procedure and methodologies for evaluating detected leakage, with an associated COL commitment, has already been addressed in response to RAI 5.2-4 S02 (MFN 06-085 Supplement 2, submitted June 1, 2007, identified as resolved by NRC).

NRC RAI 5.2-2 S01, item c. In addition to laboratory testing, the existing world-wide operating BWR fleet represents a real-time accumulation of data and experience with the phenomenon of stress-corrosion cracking (SCC). That accumulation presently extends over 4 decades and will proceed to more than 6 decades due to the number of BWRS with license extensions, possibly achieving this milestone before the first ESBWR reaches 10 years of operating history. The selection of material, the selection of material processing, fabrication and post-fabrication treatment methods, and the water chemistry requirements and operating recommendations for the ESBWR are based upon the accumulated knowledge on SCC in addition to the regulatory guidance available.

NRC RAI 5.2-2 S01, item d. The ESBWR design is not predicated on an LBB risk-informed early detection of leakage. The reductions both of systems penetrating containment and of large penetrations below the top-of-active-fuel vessel elevation are primarily intended to reduce the severity of the postulated design base accidents and permit the passive Emergency Core Cooling System (ECCS) response of the ESBWR design. The design leakage limit for unidentified containment leakage remains at 5 gpm, which represents the lowest value without spurious alarm activations or plant shutdowns. The operating organization actions to be taken upon indication of a potential change in leak rate below the alarm limit are controlled under administrative procedures developed under the COL applicant's responsibility as per DCD Tier 2, Revision 3, Section 13.5.

NRC RAI 5.2-2 S02, items A and B. These requests are redundant to RAI 5.2-4 S02 (MFN 06-085 Supplement 2, submitted June 1, 2007, identified as resolved by NRC). The response to RAI 5.2-4 S02 was already in process to be transmitted to the NRC when this response to RAI 5.2-2 S02 was being prepared.

DCD Impact:

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