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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 34 - Emergency Core Cooling Systems - RAI Numbers 6.3-10 S01 and 6.3-16 S01**

Enclosure 1 contains GE's response to the subject NRC RAIs originally transmitted via the Reference 1 letter and supplemented by NRC requests 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 06-198, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 34 Related to ESBWR Design Certification Application*, June 22, 2006

Enclosure:

1. MFN 06-241 Supplement 3 - Response to Portion of NRC Request for Additional Information Letter No. 34 - Related to ESBWR Design Certification Application - Emergency Core Cooling Systems - RAI Numbers 6.3-10 S01 and 6.3-16 S01

| | | |
|---|---|---|
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**Enclosure 1**

**MFN 06-241 Supplement 3**

**Response to Portion of NRC Request for**

**Additional Information Letter No. 34**

**Related to ESBWR Design Certification Application**

**Emergency Core Cooling Systems**

**RAI Numbers 6.3-10 S01 and 6.3-16 S01**

**NRC RAI 6.3-10:**

*DCD Tier 2, Section 6.3.2.1*

*(a) It is stated that "[t]he starting signal for the ECCS comes from independent and redundant sensors of low reactor water level." Please address the drywell high pressure sensors and a delay timer, in this section of the DCD.*

*(b) Can the GDCS timer be over-ridden?*

*(c) It is recommended that the following statement be revised from "[b]ecause ECCS flow is gravity driven, NPSH is not a concern" to "[b]ecause GDCS flow is gravity driven, NPSH is not a concern." The SLCS is not gravity driven, therefore the entire ECCS is not gravity driven.*

**GE Response:**

(a) The first paragraph in DCD Tier 2, Section 6.3.2.1 will be modified as follows.

"The starting signal for the ECCS comes from independent and redundant sensors~~ of low reactor water level~~as per Table 6.3-1, item B.1. The ECCS is actuated automatically and requires no operator action during the first 72 hours following the accident."

(b) The GDCS timer cannot be over-ridden.

(c) The last paragraph in DCD Tier 2, Section 6.3.2.1 will be modified as follows.

"Because ~~ECCS~~GDCS flow is gravity driven, NPSH is not a concern."

**NRC RAI 6.3-10 S01:**

*In DCD Tier 2, Revision 1, Table 6.3-1, the following ECCS initiation signals were shown:*

*Level 1.5 plus High Drywell Pressure*
*or*
*Level 1.5 plus Delay Timer ( 15 Minutes) Timed out*
*or*
*Level 1 Maximum Allowable Time Delay to Confirm ECCS-LOCA Signal - 10 seconds*

*In DCD Tier 2, Revision 2, Table 6.3-1, the ECCS initiation signals are shown as:*

*Level 1*
*Maximum Allowable Time Delay to Confirm ECCS-LOCA Signal - 10 seconds*

*(a) Explain in detail why the level 1.5 plus drywell high pressure and the level 1.5 plus delay timer initiation signals were removed from the ECCS logic. Discuss the impact of the change on safety margin for LOCA events, including consideration of the change in initiation signal diversity.*

*(b) The current logic may result in a delay in the initiation of ECCS for some scenarios. For example, for a small steam line break, there could be slow depressurization and level swell such that the level 1 setpoint may not be reached. Demonstrate that ECCS initiation from the*

*level 1 setpoint alone will be sufficient to maintain adequate core cooling for the full spectrum of break sizes and locations.*

(c) *Provide details on the control logic used to model the level 1 setpoint in TRACG. Justify that the TRACG model adequately represents the instrumentation in the plant. Explain how measurement uncertainty is considered in TRACG, and justify that it is treated in a bounding way.*

**GE Response:**

(a) The removal of the level 1.5 plus high drywell pressure and the level 1.5 plus delay timer initiation signals from the Emergency Core Cooling System (ECCS) logic is the result of the simplification of Automatic Depressurization System (ADS) trip control logic. This simplification is not due to any safety issues, but will provide improved operator flexibility. There is no impact on the safety margins for loss-of-coolant accident (LOCA) events as a result of this simplification.

In DCD Tier 2, Revision 1, Table 6.3-1, the initiating signals for ADS trip are (a) Level 1.5 + high drywell pressure, or (b) Level 1.5 + 900 second delay time, or (c) Level 1, where Level 1.5 is 13.0 m and Level 1 is 11.0 m from the reactor pressure vessel (RPV) bottom. Under these initiating signals, the water level for the station blackout (SBO) event will drop below Level 1.5 for more than 900 seconds and activate the ADS trip. The water level for the loss of all feedwater (LOFW) event drops below Level 1.5 for a short time period and the water level recovers to above Level 1.5 with the high-pressure control rod drive (CRD) flow to avoid the ADS trip. There are no safety issues with these transient events.

The objective of the simplification of ADS trip control logic is to provide improved operator flexibility. This simplification avoids the ADS trip for the SBO and LOFW events. It combines the Level 1.5 and Level 1 into one new Level 1 (at 11.5 m). It also eliminates the requirement of high drywell pressure signal for ADS initiation, the 900 second delay timer on Level 1.5, and the old Level 1 (at 11.0 m). The simplification also includes a design change to the isolation condenser (IC) drain line to increase the water volume by 9 $m^3$ per IC drain line. This increased water inventory offsets the effect of lowering the ADS setpoint from 13.0 m to 11.5 m.

Comparable safety margin in the events such as LOCA, SBO, and LOFW is well maintained between the two DCD revisions, and meanwhile much simpler ADS trip control logic is achieved. For SBO transient and safety analysis results, please refer to DCD Tier 2, Revision 3, Figures 15.5-10a through 15.5-10e, and for LOFW, refer to DCD Tier 2, Revision 3, Figures 15.2-16a through 15.2-16g. As for LOCA, DCD Tier 2, Revision 3, Table 6.3-5 summarizes the ECCS-LOCA performance for both the nominal and bounding conditions, and it can be seen that the margin of the minimum chimney collapsed level to top of active fuel (TAF) is larger than 1.0 m even for the limiting case. Results show that there is no compromise of safety margin from the simplification of ADS trip control logic.

(b) Six main steam line (MSL) break spectrum cases including 100%, 80%, 60%, 40%, 20% and 10% break sizes have been analyzed, with each case considering the single failure of one depressurization valve (DPV). These cases focus on the ECCS performance and the RPV water level responses following a LOCA.

The calculated key minimum water level responses for the MSL break spectrum study with one DPV failure are summarized below. The results show that the minimum chimney static head levels are well above the TAF level of 7.453 m for all break sizes. Therefore, there is no core uncovery in any of the break spectrum cases and it is concluded that ECCS initiation from Level 1 setpoint is sufficient to maintain adequate core cooling for the full spectrum of break sizes.

| Parameter | 100% | 80% | 60% | 40% | 20% | 10% |
|---|---|---|---|---|---|---|
| Break Size, $m^2$ ($ft^2$) | 0.098320 (1.05831) | 0.078656 (0.84665) | 0.058992 (0.63498) | 0.039328 (0.42332) | 0.019664 (0.21166) | 0.009832 (0.10583) |
| Minimum Chimney Static Head Level Above Vessel Zero, m (ft), at sec | 8.9072 (29.22) 721 sec | 9.1728 (30.09) 828 sec | 9.0257 (29.61) 941 sec | 9.0854 (29.81) 1327 sec | 8.9443 (29.34) 1502 sec | 8.9228 (29.27) 2212 sec |
| Minimum Downcomer Collapsed Water Level Above Vessel Zero, m (ft), at sec | 7.6892 (25.23) 664 sec | 7.9455 (26.07) 747 sec | 7.7141 (25.31) 875 sec | 7.9225 (25.99) 1065 sec | 8.0933 (26.55) 1447 sec | 8.1099 (26.61) 2142 sec |
| Level 1 Setpoint Reached, sec | 497 sec | 553 sec | 644 sec | 773 sec | 1102 sec | 1769 sec |

(c) The control logic used to model Level 1 setpoint in TRACG is a pure time delay, where the performance specified time delay for the installed control logic and the confirmation time delay are considered in TRACG analysis. The water level setpoint used in the LOCA analysis is an analytical limit. It is conservatively lower than the nominal trip setpoint. The instrument uncertainty is considered in establishing the nominal trip setpoint using the GE BWR setpoint methodology, NEDO-31336. See also the response to RAI 7.2-36 S01.

**DCD Impact:**

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

**NRC RAI 6.3-16:**

*DCD 6.3.5 Instrumentation Requirements, Page 6.3-24*

*It is recommended that "[t]he GDCS is automatically initiated on low reactor water level" be changed to "[t]he GDCS is automatically initiated on low reactor water level plus high drywell pressure."*

**GE Response:**

The level needed to initiate only on reactor water level must be lower than the level needed with high drywell pressure or delay timer. See Table 6.3-1 for values associated with the different levels and initiating signals. A reference to Table 6.3-1 will be added to the last paragraph of DCD Tier 2, Section 6.3.5.

**NRC RAI 6.3-16 S01:**

*In DCD Tier 2, Revision 1, Table 6.3-1, the following ECCS initiation signals were shown:*

*Level 1.5 plus High Drywell Pressure*
*or*
*Level 1.5 plus Delay Timer ( 15 Minutes) Timed out*
*or*
*Level 1 Maximum Allowable Time Delay to Confirm ECCS-LOCA Signal - 10 seconds*

*In DCD Tier 2, Revision 2, Table 6.3-1, the ECCS initiation signals are shown as:*

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*(a) Explain in detail why the level 1.5 plus drywell high pressure and the level 1.5 plus delay timer initiation signals were removed from the ECCS logic. Discuss the impact of the change on safety margin for LOCA events, including consideration of the change in initiation signal diversity.*

*(b) The current logic may result in a delay in the initiation of ECCS for some scenarios. For example, for a small steam line break, there could be slow depressurization and level swell such that the level 1 setpoint may not be reached. Demonstrate that ECCS initiation from the level 1 setpoint alone will be sufficient to maintain adequate core cooling for the full spectrum of break sizes and locations.*

*(c) Provide details on the control logic used to model the level 1 setpoint in TRACG. Justify that the TRACG model adequately represents the instrumentation in the plant. Explain how measurement uncertainty is considered in TRACG, and justify that it is treated in a bounding way.*

**GE Response:**

See response to RAI 6.3-10 S01.

**DCD Impact:**

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