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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 284 - Related To ESBWR Design Certification Application – RAI Number 21.6-69 Supplement 2**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) response to the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) sent by the Reference 1 NRC letter. GEH response to RAI Number 21.6-69 Supplement 2 is addressed in Enclosure 1. DCD markups associated with this response are provided in Enclosure 2

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

Sincerely,

Charles W. Bagnal
for

Richard E. Kingston
Vice President, ESBWR Licensing

Reference:

1. MFN 08-972, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request For Additional Information Letter No. 284 Related To ESBWR Design Certification Application*, dated December 11, 2008.

Enclosures:

1. MFN 09-165 – Response to Portion of NRC Request for Additional Information Letter No. 284 - Related To ESBWR Design Certification Application – RAI Number 21.6-69 S02
2. MFN 09-165 – Response to Portion of NRC Request for Additional Information Letter No. 284 - Related To ESBWR Design Certification Application – RAI Number 21.6-69 S02 – DCD Markup

cc:	AE Cubbage	USNRC (with enclosures)
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Enclosure 1

MFN 09-165

Response to Portion of NRC Request for

Additional Information Letter No. 284

Related to ESBWR Design Certification Application

RAI Number 21.6-69 S02

NRC RAI 21.6-69 S02

Addition of the Evaluation of TRACG Nodalization for Feed Water Line Break (FWLB) in the DCD

DCD, Tier 2, Revision 5, Appendix 6B documents the evaluation of TRACG nodalization for Main Steam Line Break (MSLB), but it does not document the corresponding Main Feed Water Line Break (FWLB) results. The staff requested GEH in Part C of RAI 21.6-69 S01 to include the evaluation of TRACG nodalization for FWLB in DCD or NEDE-32176P (TRACG Model Description), as background information for the short and long-term containment analyses. The staff considered the documentation to be necessary due to the design and modeling changes, such as the removal of the T-component in the lower drywell (DW) (see Figure 7-43, NEDE-32176P, Rev.3), and using the wider interconnecting pathways between the lower and upper dry well. In GEH's response to RAI 21.6-69 S01, it was implied that the required evaluation would not be needed because the containment responses for the MSLB and FWLB cases are very similar. However, the Staff found that the predicted distributions of non-condensables in dry well and GDCS are vastly different for the MSLB (Figure 6.2-14d1) and FWLB (Figure 6.2-13d1) cases. Non-condensables are significantly higher in DW and GDCS, for MSLB than for FWLB.

In this backdrop, the staff expects GEH to include either the corresponding FWLB nodalization evaluation in DCD, say in Appendix 6B, or explain within the DCD why it is not included. GEH is expected to document that the different containment responses for non-condensables for MSLB and FWLB are not caused by any differences in nodalization. The reason behind different non-condensable responses and why they still lead to comparable overall containment pressures, should also be documented in the DCD.

GEH Response

Applicability of MSLB Nodalization Evaluation to FWLB

A Feedwater Line Break (FWLB) nodalization evaluation as background information for the short and long-term containment analyses in DCD will not be included in this response nor in DCD Tier 2. The rationale for this is summarized below, and explained later in the response:

a) Nodalization optimized for the MSLB is applicable to and covers the FWLB event.

b) The dominant phenomena driving the predicted pressure profiles for both the MSLB and the FWLB events are similar.

c) The containment response for the MSLB and the FWLB events are very similar in nature during the blow down period, the Gravity Driven Cooling System (GDCS) period and the long-term Passive Containment Cooling System (PCCS) cooling period.

The Main Steam Line Break (MSLB) nodalization impact was established in DCD Tier 2, Revision 4, Appendix 6B and updated in Revision 5, including Table 6A-1, Item 1. Appendix 6B provides nodalization impact and background information for the short and long-term containment analyses. The impact due to nodalization has been demonstrated by performing comparisons among different nodalizations: Model COMB-5, Model COMB-6 and tie back calculation MSLB–NL2_V40. The impact was established using the MSLB event as a common event. The use of a common event rather than using different events provided a better understanding of the effects of TRACG nodalization.

The main conclusions from the combined TRACG nodalization evaluations discussed in DCD Tier 2, Appendix 6B, indicate the following responses and effects:

1. The downcomer response is milder and more accurate compared to the base case.
2. The long term Drywell (DW) pressure is higher than that in the base case due to higher suppression pool (SP) temperature.
3. The SP surface temperature is higher than that for the base case due to slightly more energy discharging to the SP.
4. The time period for purging DW non-condensable gases (NC) into the Wetwell (WW) is reduced.
5. The effect of purging time period on the long term DW peak pressure is small.

In general, the calculations using the combined TRACG nodalization compared well with those using the base cases and the differences are judged to be small by comparing them to margins.

The FWLB combined TRACG nodalization evaluation is considered not necessary. This consideration is based on two main developments.

First, the MSLB nodalization evaluation included in DCD Tier 2, Appendix 6B provides the background information for the short and long term containment analyses.

Second, the information and results provided in DCD Tier 2 for the MSLB and FWLB events, including item (A9) of the response to RAI 21.6-69 S01 in letter MFN-08-631, establish that the dominant phenomena driving the predicted pressure profiles for both events are similar. These show that the containment response for the MSLB and FWLB events are very similar in nature during the blow down period, the Gravity Driven Cooling System (GDCS) period and the long-term Passive Containment Cooling System (PCCS) cooling period. The containment response results from the MSLB and FWLB events, noted in DCD Tier 2, Revision. 5, Figures 6.2-13a1 through Figures 6.2-13d3 and Figures 6.2-14a1 through Figures 6.2-14d3, also indicate such similarity in nature.

Therefore, based on the above findings, it is considered that the nodalization impact results on containment from the MSLB event evaluation stated in Appendix 6B of DCD Tier 2, Revision 5 are also applicable to the FWLB event, (see RAI 21.6-69 S01 response item (C)).

The MSLB background information for the short and long-term containment analyses provided in the nodalization evaluation in Appendix 6B, including the statement that the impact is judged to be small when compared to margins, is also applicable for the FWLB.

DCD Tier 2, Appendix 6B will be revised to include the conclusion that the MSLB nodalization evaluation results are valid and applicable to the FWLB event.

The results from the TRACG nodalization due to the addition of two pipes between the GDCS air space and the DW are discussed in the Non-Condensable Gases section below.

Non-condensable Gas Distribution in DW and GDCS Pools (MSLB vs. FWLB)

The NRC staff indicates that the predicted distribution of non-condensable gases in the DW and GDCS pools are vastly different for the MSLB and FWLB. This statement corroborates the information provided in DCD, Tier 2, Revision 5, Figures 6.2-13d1 through 6.2-13d3 and Figures 6.2-14d1 through 6.2-14d3.

The main reasons for different non-condensable gases migration responses to FWLB and MSLB is explained below.

- During the initial part of the FWLB event, the lower DW accumulates more water during the blowdown period than for the MSLB event, displacing the NC from the lower DW and forcing them to migrate faster to the WW area than for the MSLB event, see DCD Tier 2, Revision 5, Figures 6E-1 and Figure 6E-3.
- During the initial stages of the FWLB event relatively more NC migrate, than during the MSLB event. This is because of earlier and greater inventory drainage from the GDCS pool to the reactor pressure vessel, as shown in DCD Tier 2, Revision 5, Figures 6E-2, Figure 6E-4, Table 6.2-7d and Table 6.2-7e, and RAI 21.6-69 S01 response, (A9).

The results from the nodalization evaluation presented in DCD Tier 2, Appendix 6B indicates that the MSLB and FWLB NC migration is not significantly affected by the nodalization changes.

It is also noted that the results in DCD Tier 2, Section 6.2 reflect the added conservatism on the DW pressure calculation resulting from the inclusion of two pipes in the TRACG nodalization to simulate the connection between the GDCS air space and the drywell. Evaluation performed for the two pipes in the TRACG nodalization, located at levels L35 and L34 show that the DW pressure is maximized during the post-GDCS draindown period.

The effects of this nodalization on the MSLB indicate that there are essentially no NC remaining in the DW and GDCS spaces, therefore the DW pressure increased slightly from 380.0 kPa to 384.2 kPa (about 1%) when compared to the case with one pipe between the GDCS and DW air space, see RAI 6.2-53 S01 response, MFN-06-215-Supp-1.

These nodalization effects on the DW during FWLB event were found to show a DW pressure increase but different in magnitude. On the FWLB event the NC in GDCS air space are higher than in the MSLB, resulting in an increase of the DW pressure (at 72 hrs) of about 5% equivalent to pressure margin reduction from 19% to about 14%, see RAI 6.2-98 S01 response, part B, MFN-08-011.

Further analyses were performed to determine the impact of additional NC in the containment during the most bounding event from the gas dissolved in the sodium pentaborate solution and the resultant gas from the actuation of the containment safety/nonsafety related pneumatic valves including the bounding assumption that all the containment NC are relocated to the WW. The results of these analyses indicate that the DW pressure increased during the bounding MSLB to 1% from the design pressure, see DCD Tier 2, Table 6.2-5.

Based on the above discussion, it is inferred that initially the MSLB and FWLB were not significantly affected by the nodalization changes stated in DCD Tier 2, Appendix 6B, Revision 5. However, the two pipes nodalization change currently implemented makes the containment results on the DW pressure during the LOCA events more conservative. This impact reduces the DW pressure margin from 19% to about 14% for the FWLB and a bounding MSLB DW pressure maximum increase of about 1% due to the NC migration enhancement. This impact due to NC relocation is bounded when all the containment non-condensable gases, including those added to the containment during the corresponding LOCA event are assumed to relocate to the WW. DCD Tier 2, Appendix 6B will be revised to include the above main rationale regarding the impact of the two pipe TRACG nodalization change and the impact on the DW pressure due to FWLB and MSLB NC migration responses.

Overall Containment Pressure

RAI 21.6-69 S01 response to part A and DCD Figures 6.2-13a1 through 6.2-13a3 and 6.2-14a1 through 6.2-14a3 support the observation that the FWLB and MSLB containment DW, WW and reactor pressure vessel pressures are similar in nature during the blowdown period, the GDCS period and the long-term PCCS cooling period. The MSLB results in a higher DW pressure with about 5% margin to design pressure, while the FWLB DW pressure maintains a 14 % margin to design pressure, as seen in DCD Tier 2, Revision. 5, Table 6.2-5. Furthermore, the last paragraph of DCD, Tier 2, Revision 5, Appendix 6E, includes statements regarding the main causes for the higher DW pressure in the MSLB than FWLB.

<u>DCD Impact</u>

DCD Tier 2, Appendix 6B will be revised, as noted in the Enclosure 2 markup, to include the conclusion that the MSLB nodalization evaluation results are valid and applicable to the FWLB event.

Enclosure 2

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DCD Markup

removed from the input decks for both the ECCS / loss-of-coolant accident (LOCA) and Containment/LOCA analyses (for analyses performed after DCD Tier 2, Revision 3).

Summary

Main steam line breaks were simulated using the combined nodalization (with and without the TEE35 as the lower DW).

The downcomer level response for the cases using the combined nodalization is milder and more accurate compared to the base case, which is exaggerated because of the coarse nodalization for the RPV. The suppression pool surface temperature is about 4ºC (7.2ºF) higher than that for the base case, due to slightly more energy discharging to the suppression pool during the first 9 hrs. The long-term DW pressure is about 9 kPa (1.3 psia) higher than that in the base case, due to higher suppression pool surface temperature.

Modeling the lower DW with VSSL cells leads to shorter time period (21 hours for VSSL cells versus 54 hours for TEE35) for purging all DW noncondensable gases into the WW. However, the effect of purging time period on the peak, long-term DW pressure is small and is less than 2 kPa (0.3 psia) (Figure 6B-14). The relatively small effect is due to that the total PCC condensation power is greater than the decay heat after 9 ~ 10 hours. From that time on, the added energy to the suppression pool water due the movement of noncondensable gases from the DW to the WW is not significant because of the over-capacity in the PCCS. The DW pressure reaches the maximum value when all the noncondensable gases have been purged in the WW (Figure 6B-14). The difference in the timing for purging all noncondensable gases and the subsequent V/B openings show no significant impact on the peak value.

Results of this comparison show that the calculations using the combined TRACG nodalization compared well with those from the base cases, and the impacts due to nodalization changes on the minimum chimney static head level (+0.1 to -0.16 m (+4 to –6.3 in)) and on the long-term DW pressure (< 2 kPa (0.3 psia)) are judged to be small by comparing to the margins. Furthermore, considering that the MSLB and FWLB containment responses for these events are very similar in nature during the blow down period, the GDCS period and the long-term PCCS cooling period results, as noted in Figures 6.2-13a1 through Figures 6.2-13c3 and Figures 6.2-14a1 through Figures 6.2-14c3, are also applicable to the FWLB and with minimum impact to the respective non-condensable gas migration.

A slightly more noticeable and conservative impact due to nodalization changes is the inclusion of two pipes in the TRACG nodalization. These two pipes simulate the connection between the GDCS air space and the upper DW. This nodalization change increases the DW pressure as result of a more effective migration of non-condensable gases from the GDCS air space to the DW, and eventually to the WW. The current TRACG nodalization of the ESBWR Containment includes these changes as seen in Figure 6.2-7. These changes result in a MSLB DW pressure increase of about 1% when compared to a single pipe and a pressure margin reduction from 19% to about 14% for the FWLB.

The difference in the effect on DW pressure between these two events is attributed to their corresponding scenarios. During the initial part of the FWLB, the lower DW accumulates more water, displacing the non-condensable gases and forcing them to migrate faster to the WW area than during the MSLB; as seen in Figure 6.2-13d4 and Figure 6.2-14d4. During this period some amount of non-condensable gases migrate and hide in the GDCS drained volume by a greater amount and at faster rate than during the MSLB, due to earlier and greater inventory drainage from the GDCS pool to the RPV. At the same time this hideout is minimized by the carry over of non-condensable gases to the WW, thereby increasing the containment pressure, as seen in Figure 6.2-13d5, Figure 6.2-14d5, Table 6.2-7e and Table 6.2-7d.

These two main scenarios contribute to their different non-condensable gases migration pattern, such that the difference in non-condensable gases migration patterns is attributed mainly to different system event responses and not to nodalization changes.

Even though these two scenarios have a different non-condensable gas migration, the two-pipe nodalization stated above and the assumption that all DW non-condensable gases migrate to the WW airspace at 72 hours adds sufficient conservatism to their DW pressure. The addition of two pipes promotes migration of non-condensable gases from the DW to the WW resulting in a conservatively high DW pressure increase. Furthermore this migration enhancement is maximized when all the containment non-condensable gases, including those added to the containment from pneumatic supplies are assumed to relocate to the WW, see Appendix 6E.2.

6B.1 References

6B.1-1 GE Nuclear Energy, "TRACG Application for ESBWR," NEDC-33083P-A, Class III, (Proprietary), March 2005, and NEDO-33083-A, Class I (Non-proprietary), October 2005.