Enclosure 1

MFN 15-062, Supplement 2

GEH Response and Supplemental Response #2

To RAI 02.05.04-1

(Please note that below is GEH's original response and supplemental response #1 to RAI 2.05.04-1 for convenience)

NRC Request for Additional Information 2.05.04-1

10 CFR 52.59(a) (2015) requires, in pertinent part, a finding of compliance with the regulations in effect at the time of the original certification in order to issue a renewed design certification. In 1997, 10 CFR 52.47(a)(1)(iii) required design certification applicants to provide postulated site parameters, and an analysis and evaluation of the design in terms of such parameters. Also, as relevant to the ABWR design, Appendix A to 10 CFR Part 100, section V.(d) requires that each applicant determine other design conditions, which include soil stability under the Safe Shutdown Earthquake.

The ABWR DCD Tier 1 Table 5.0 "ABWR Site Parameters" and Tier 2 Table 2.0-1 "Envelope of ABWR Standard Plant Site Design Parameters" provided some standard design site parameters, but no dynamic bearing capacity and differential settlement site parameters are specified. Dynamic bearing capacity is an important site parameter that requires that the soil under the foundation be able to withstand, with certain safety margins, the foundation dynamic pressure resulting from the combination of all possible loadings, including seismic loading corresponding to the site SSE. In some cases, the maximum foundation dynamic pressure can be several times the static foundation pressure, therefore a site which meets the static bearing capacity requirement may not be stable under dynamic loading conditions. Also, the requirement of differential settlement of the foundation not to exceed certain limits under the combination of all possible loadings is another important site parameter needed to maintain foundation and structural integrity, and the normal operation of nuclear power plant facilities. Because the ABWR design is certified for plants founded on soil deposits up to 91.5 m (300 ft), in addition to rock sites, there is a potential that larger differential settlements may occur for a deep soil site due to the geologic variation of subsurface materials and non-uniform loading distribution. Therefore, the NRC requests the applicant to provide the following information or justify how its alternative approach complies with NRC regulations:

1. *Clearly define the dynamic bearing capacity (based on the maximum foundation pressure on foundation with adequate safety margin) and differential settlement requirements for safety related structures in proper sections and tables of the ABWR DCD to ensure foundation stability and safety of the structures for sites applying the ABWR technology. Associated COL information items should be specified in the DCD.*

2. *Provide details on how the dynamic bearing capacity and differential settlement requirements are determined, including the model(s), assumptions and input parameters used in analyses, calculations and justifications for site parameter determination.*

GEH Response:

There are three seismic category 1 buildings that make up the ABWR; Reactor Building, Control Building, and Radwaste Building Foundation. Of these three, the Reactor Building is the heaviest. The current ABWR interface requirement for static bearing capacity is based on the calculated static bearing pressure of the Reactor Building times a factor of safety. To stay consistent with that methodology the ABWR interface requirement for dynamic bearing pressure will also be based on the Reactor Building dynamic bearing pressure times a factor of safety.

The ABWR Reactor Building calculated dynamic bearing pressure is 2336kPa and can be found in ABWR DCD Tier 2 Section 3H.1.5.6.

GEH will revise Tier 1 Table 5.0-1 and Tier 2 Table 2.0-1 to add 2700 kPa as the minimum dynamic bearing capacity as an ABWR standard plant site parameter. This will provide approximately 15% margin over the calculated value. GEH will revise COL Action Item 2.3.1.2 (2) to add a confirmation of the dynamic bearing capacity.

Buildings that are constructed of Reinforced Concrete on a mat or raft foundation can tolerate total settlements on the order of 125mm without damage (Reference 1 and 2). In commercial buildings to prevent problems with interfacing components that connect to a building the total allowable settlement is usually limited to 50mm (Reference 1 and 3). If a building is allowed to settle prior to installing the interfacing components a larger allowable total settlement can be used.

Based on ABWR construction experience with an aggressive 39 month construction schedule (first safety concrete to fuel load), mechanical and electrical components are installed at least 12 months after the completion of the basemat. This allows sufficient time for the building to settle justifying the relaxation of the allowable total settlement value.

Based on the above discussion, GEH will add a total long term (post construction) settlement of 75mm to Tier 1 Table 5.0-1, and Tier 2 Table 2.0-1. GEH will add an additional COL Action Item 2.3.1.2 (3) to add a confirmation of the total long term (post construction) settlement.

Angular distortion is another important foundation criterion that is needed to prevent damage to a building founded on soil. Angular distortion in this context is defined as the slope between two adjacent column lines. Buildings that are constructed of reinforced concrete on a mat foundation can tolerate angular distortion on the order of 1/500 (Reference 1, 2 and 3). For buildings that contain machinery sensitive to settlement, it is recommended that angular distortion be limited to 1/750 (Reference 1).

Based on the above discussion, GEH will add an angular distortion (post construction) limit of 1/750 to Tier 1 Table 5.0-1, and Tier 2 Table 2.0-1. GEH will revise COL Action Item 2.3.1.2 (2) to add a confirmation of the angular distortion limit.

References:

1. EM 1110-1-1904, Engineering and Design Settlement Analysis, US Army Corps of Engineers, September 30, 1994.
2. Principles of Foundation Engineering - Seventh Edition, Das, Braja M., 2011
3. EN 1997-1, Eurocode 7: Geotechnical Design – Part 1: General Rules, 2004

Impact on DCD:

The DCD Tier 1 Table 5.0-1, DCD Tier 2 Table 2.0-1, and DCD Tier 2 Section 2.3.1.2 are revised as shown (in Enclosure 2 of MFN 15-062). The ABWR DCD Rev 5 marked up pages are provided in Enclosure 2 (of MFN 15-062).

NRC Request for Additional Supplemental Information to RAI 02.05.04-1

In an October 15 NRC teleconference; the NRC requested that the following supplemental information be provided:

- *NRC staff requests a "factor of safety" be used in determining the site specific allowable static and dynamic bearing pressure, consistent with the methodology for determining site-specific allowable static and dynamic bearing pressure found in the ESBWR, EPR and AP-1000 DCDs. Please review the ESBWR, EPR and AP-1000 DCD's and determine appropriate action for the ABWR DCD. Please refer to the factor of safety provided in AP-1000 DCD Table 5.0-1 on page 5.0-2; EPR DCD Tier 2 pages 2.5-8 and -9, Section 2.5.4.10.1; and ESBWR Tier 2, page 2.0-10 Notes for Table 2.0-1.*

- *Please provide a design value for the differential settlement between buildings in the ABWR DCD.*

GEH Supplemental Response # 1:

GEH will revise Subsection 2.3.1.2 (2) to include the following statements: "The maximum static bearing demand is compared with the site-specific allowable static bearing pressure, which is obtained by dividing the ultimate soil bearing capacity by a factor of safety appropriate for the design load combination. The maximum dynamic bearing demand is compared with the site-specific allowable dynamic bearing pressure, which is obtained by dividing the ultimate soil bearing capacity by a factor of safety appropriate for the design load combination."

Based on ABWR construction experience with an aggressive 39 month construction schedule (first safety concrete to fuel load), mechanical and electrical components are installed at least 12 months after the completion of the basemat. This allows sufficient time for the building to settle.

The ABWR Primary Containment penetrations sleeves are fixed and pipe positions cannot be adjusted after its construction. To avoid settlement problems, the ABWR Primary Containment shares a common basemat with the Reactor Building, whereas the ABWR Reactor Building and Control Building are on separate basemats. In normal reinforced concrete construction practice, openings are left in exterior walls to allow for the installation of pipe after construction of the wall. These openings are made large enough to account for expected settlement. A design value for the differential settlement between buildings does not need to be specified in the ABWR DCD because the maximum differential settlement is the same as the buildings maximum settlement value.

Impact on DCD:

The DCD Tier 2, Section 2.3.1.2 is revised as shown (in MFN 15-062 Supplement 1). The ABWR DCD Revision 5 marked up page is provided in Enclosure 2 of MFN 15-062 Supplement 1).

NRC Request for Additional Supplemental Information #2 to RAI 02.05.04-1

In a May 4, 2016 NRC/GEH telephone conversation, the NRC ABWR Certification Renewal Program Manager NRC identified a discrepancy between ABWR DCD Tier 1, Table 5.0-1 and ABWR DCD Tier 2 Subsection 2.3.1 versus ABWR DCD Tier 2 Table 2.0-1. Specifically, Table 5.0-1 and subsection 2.3.1 state "The site soil dynamic bearing capacity at the foundation level of the reactor and control building is 2700 kPa minimum", whereas Table 2.0-1 states "Maximum Dynamic Bearing Capacity is 2700 kPa".

GEH Supplemental Response # 2:

GEH will revise ABWR DCD Tier 2 Table 2.0-1 to state "Minimum Dynamic Bearing Capacity is 2700 kPa"

Impact on DCD:

The ABWR DCD Revision 6, Tier 2, Table 2.0-1 is revised to indicate Minimum Dynamic Bearing Capacity is 2700 kPa. The ABWR DCD Revision 6 marked up page is provided in Enclosure 2.