Supplemental Request for Information on Responses to RAIs for ESBWR DCD, Tier 2, Chapter 3

Comment on response to RAI 3.9-35:

In ESBWR RAI 3.9-35, the staff requested that the applicant discuss the effects of the additional flexibility between the building nodal points and the pipe support in the piping analysis model. In its response dated November 22, 2006, the applicant stated that with the exception of snubber, pipe clamp and pipe support steel, the support is demonstrated to be dynamically rigid in the seismic analysis to preclude amplification. Though reflecting a common industry practice of assuming rigid and fixed attachments between the seismic subsystems (i.e., equipment and piping) and the supporting seismic systems (i.e., structures), this response may allow the influence of the anchorage system stiffness on the dynamic response to be neglected, as stated in SRP 3.9.2, Section III.2.A. The staff, therefore, requests that the applicant provide supplemental information to address the following issues:

(1) Discuss the effects of the dynamic characteristics of the support anchorages to the building structure, including anchor base plate and anchor bolts or through-bolts, on the seismic and dynamic response of piping , equipment, and components, especially heavy equipment. Verify that appropriate assumptions have been made with regard to the stiffness of the subsystem anchorage in the seismic and dynamic analyses. In light of IE Bulletin 79-02 requirements, discuss how base plate flexibility may cause the anchorage system stiffness to be different from the assumed rigid condition. Discuss how the reduction of natural frequencies, as a result, would potentially affect the seismic and dynamic response calculations for the piping, equipment, and components.

(2) Certain degree of anchor bolt torque relaxation may occur after years of operation causing reduction in the natural frequencies of piping, equipment, and components. This, in turn, may lead to higher seismic responses of the piping , equipment, and components than originally analyzed. Provide the plant-specific compensatory measures or quality control/quality assurance program to be relied on prior to, during, and after the installation of the anchorage systems, in order to alleviate the effects of anchor bolt torque relaxation.

(3) Discuss the statement made in the response to RAI 3.12-31(1), where it is stated that expansion anchor bolts shall not be used for any safety-related system components. Provide a sample list of such safety-related system components, and their associated loading environments.

Comment on response to RAI 3.9-149 (MFN 07-238):

The its response to RAI 3.9-149 in a letter dated April 30, 2007, the applicant states that, according to ASME Code, Section II, Part D, Appendix I, the allowable stress intensity value, S_m, for austenitic stainless steel is 90% of the minimum yield strength at temperature. The applicant has selected the minimum strain, ε, just before yielding of irradiated stainless steel to represent the strain corresponding minimum yield strength at temperature. The applicant states that the magnitude of the minimum strain, ε, is based on experimental data from industry.

The applicant defines the deformation limits in terms of minimum strain, ε, and the safety factors, SF_{min}, defined in Section 3.9.5.4 of ESBWR DCD, Tier 2, Rev. 1, January 2006. The deformation limits can be expressed as,

$$(P + Q)/E \leq (0.9/SF_{min}) \cdot \varepsilon$$

For Service Levels A to D, according to Section 3.9.5.4, safety factors, SF_{min}, vary from 2.25 to 1.125.

In response to RAI 3.9-149, the applicant further states that when experimental data from the actual material are used, the general deformation limit $1.00/SF_{min}$ instead of $0.9/SF_{min}$, as shown in Table 3.9-4 (b) may be used. The staff needs the following additional information to complete the review:

(a) The applicant is requested to provide a reference for the industry data for irradiated stainless steel as mentioned in its response. In addition, the applicant is requested to provide a summary of this industry data, especially the neutron fluence and irradiation temperature for the irradiated steel considered here. Also, please provide the end-of-the-life neutron fluence for the vessel internals that will be subject to deformation limits.

(b) The applicant is requested to provide technical basis for the safety factors defined in Section 3.9.5.4 of ESBWR DCD, Tier 2, Rev. 1, January 2006.

(c) The applicant is requested to explain the increase in the general deformation limit from $0.9/SF_{min}$ to $1.0/SF_{min}$ when experimental data from the actual material are used. The applicant is also requested to identify any codes or standards that support such increase in the general deformation limit.

<u>Comment on response to RAI 3.2-34 Supplement 1 (MFN 06-308):</u>

The response to RAI 3.2-34 Supplement 1 revised DCD Table 3.2-2 to show the minimum design requirements for each individual safety class and clarified that it was prudent for GE to upgrade the quality group and seismic classification for the nonsafety-related RWCU/SDC piping outside containment. For Safety Class N, Table 3.2-2 shows Quality Group D as the minimum requirement with a provision to optionally design such nonsafety-related SSCs to Quality Group B or C requirements. It is not clear if selecting the option to design these components as Quality group B or C and the ASME Section III Code represents a commitment to also construct to the ASME Section III Code and perform Inservice Inspection to the ASME Section XI Code for such nonsafety-related SSCs designed to Section III. The applicant is requested to clarify if all systems that are optionally designed to ASME Section III are also constructed to ASME Section III and subject to all ASME Section XI Inservice Inspection requirements. If selecting this optional upgrade does not represent a commitment to construct to Section III, including N stamping, and inspect to Section XI, the applicant is requested to clarify what supplemental construction and inspection requirements, if any, are imposed to upgrade the quality and inservice inspection of such SSCs. Also include a detailed description of the difference between the supplemental construction requirements and inservice inspection requirements compared to the requirements of ASME Sections III and XI. The applicant is also requested to clarify if upgraded nonsafety-related SSCs in systems such as RWCU and TMSS are to be included as RTNSS candidates.

Comment on response to RAI 3.2-3, Supplement 1 (MFN 06-308):

Regarding 3.2-3b, the response acknowledges that GE is aware of the withdrawn status of ANS 58.14 and that the NRC has not endorsed this standard. Until this standard is revised and submitted for NRC endorsement, the application of this document to ESBWR can not be endorsed by the NRC. This remains an open item that may be resolved by a licensing commitment to submit the ANS accepted standard for NRC endorsement.

Comment on response to RAI 3.2-7 Supplement 1 (MFN 06-308):

The response to RAI 3.2-7 S01 identified ITAAC commitments in DCD Tier 1 to confirm that the as-built system configuration is consistent with the simlified P&IDs and Tier 1 descriptions of the system. The response also refers to DCD Tier 2 Subsection 19.5.6 for the same action for the COL applicant, that was referred to in the RAI as a functional arrangement inspection, identified in the AP1000 DCD . These ITAAC commitments are appropriate to assess the as-built configuration for classifications. However, the RAI response does not address a licensing commitment or action item to identify the specific version or revision number of the detailed P&IDs used to develop the simplified diagrams included in the DCD. This information is necessary to assist in the NRC assessment, including audits, of future design changes and completeness of design.

To resolve this classification open item concerning design changes and completeness of design relative to P&IDs, the NRC staff proposes that the applicant identify the detailed P&IDs and their revision numbers used for development of the DCD simplified diagrams and include a licensing commitment such as a COL action item or license condition to confirm that, upon completion of the final design configuration, the version of the final P&IDs used for construction will be identified and any design changes that impact the level of detail shown in the simplified diagrams will be identified to the NRC and submitted for NRC review. As an alternative, the applicant may also choose to identify a licensing commitment to submit the actual P&IDs that were used to develop the simplified diagrams included in the DCD and a commitment to submit the actual P&IDs at the COL phase and again when final design is complete, but prior to the as-built certification.

Comment on response to RAI 3.2-1 Supplement 1 (MFN 06-308):

In the response to RAI 3.2.1 Supplement 1, GE clarified that the nonsafety-related Quality Group B Main Steam piping and components downstream of the seismic interface restraint is not required to be code stamped. This is identified in the DCD Tier 2 Table 3.2-1 notes for N11 Item 1 and it is further noted that this piping does not require ASME authorized inspection.

The practice to not Code stamp or apply ASME authorized inspection to this Quality Group B piping is contrary to the requirement in 10 CFR 50.55a relative to Quality Group B components and the guidance included in Regulatory Guide 1.26, Rev. 4 that specifically identifies that components classified Quality Group B must meet the requirements for Class 2 components in Section III of the ASME Boiler and Pressure Vessel Code. The basis for requiring N stamping is further explained in NRC RIS 2005-17 which clarifies that compliance with 10 CFR 50.55a is expected to be a Tier 1 requirement. The applicant is requested to review Tier 1 and Tier 2 commitments relevant to 10 CFR 50.55a and modify their position or explain and justify why such piping and components are not to be N stamped and inspected by an authorized ASME inspector. Specific information necessary to evaluate a proposed alternative position should include:

(1) An explanation as to why the applicant does not consider ASME N stamping and authorized inspection to be feasible. Any explanation should include factors such as hardship or unusual difficulty without compensating increase in the level of quality and safety, precedence, available N stamp suppliers, a cost-benefit analysis, alternative stamping and inspection provisions.

(2) A demonstration that the proposed alternative approach for stamping and inspection would provide an acceptable level of quality and safety equivalent to the ASME required code certification activities.

(3) Confirmation that, other than stamping and inspection, all other Code required design, material, fabrication, inspection, testing, quality assurance and documentation are in conformance with the ASME Section III Code Class 2 or equivalent alternative methods.

(4) Confirmation that inservice inspection and testing for these Quality Group B piping and components will be consistent with ASME Section XI or equivalent alternative methods. If inservice inspection (ISI) will not be performed according to ASME Section XI due to hardship or unusual difficulty, describe the hardship or unusual difficulty this presents and the alternative inspection approach including the technical justification.

(5) If the applicant prefers to change Tier 1 and Tier 2 commitments and designate this nonsafety-related piping as within scope of RTNSS with augmented design, fabrication, inspection and quality requirements, all supporting information to technically justify such an alternative classification should be presented for staff review.

Comment on response to RAI 3.2-21 Supplement 1 (MFN 06-308):

The response to RAI 3.2-21 Supplement 1 clarified that the classification of the Hydraulic Control Unit (HCU) is an exception to RG 1.26 and DCD Tier 2 Tables 1.9-21b and 17.1-1 will be revised accordingly. Although staff recognizes that the HCU classification has been standard industry practice, the applicant is requested to provide technical justification that this is an acceptable alternative to Quality Group B and ASME Section III Class 2 Code requirements identified in RG 1.26. Justification should include information such as alternative equivalent industry standards, supplemental NDE, inservice inspection, quality assurance practices and operating experience to demonstrate the reliability of the HCU pressure boundary.

Comment on response to RAI 3.2-63:

In response to NRC RAI 3.2-63 regarding medium voltage distribution system and low voltage distribution system (needed for recharging batteries) being classified as non-safety and non-seismic, GE indicated that these equipments are located in the electrical building and that the electrical building and the components within it that are needed to recharge the safety-related batteries will be designed to withstand seismic effects using methods permitted by the International Building Code (IBC), without formally classifying these components as Seismic Category I. However, the NRC staff notes that the method of seismic analysis referenced in Section 16.2.3 of the IBC is only applicable to building structures and not the electrical equipment. In view of the above, please identify the Standards or Codes that will be used to qualify the electrical equipment (switchgear) that will be used to recharge the safety-related batteries (after 72 hours) in the event of a seismic event to ensure their availability when required.

Comment on response to RAI 3.8-4 (MFN 06-298, Supplement 1):

The staff reviewed the latest supplemental response and finds that additional clarification is needed. The applicant stated that the entire Reactor Building is designed to both the ASME Section III, Division 2, Subsection CC code and the ACI 349-01 Code. Therefore, it is not clear to the staff why there is a need to demonstrate that the acceptance criteria in ASME, Section III, Division 2 are more conservative than the criteria in ACI 349. In addition, the RAI response does not appear to support that conclusion. The comparison between the codes is limited to the case of a member subjected to a combination of axial loading and bending. As indicated in the response, in the high axial force (compression) region the ASME allowable values are not more conservative. The limited comparison presented in the response does not constitute a technical basis for concluding that other acceptance criteria in the ASME Code are also more conservative than the ACI 349-01 Code. The staff requests the applicant to explain the purpose of the comparison, and clarify how ASME Section III, Division 2, Subsection CC and ACI 349-01 Code were used for the design of the RB.

Comment on response to RAI 3.8-5 (MFN 06-298, Supplement 1):

The staff notes that Regulatory Guide (RG) 1.136, Revision 3, entitled "Design Limits, Loading Combinations, Materials, Construction, and Testing of Concrete Containments," was officially issued in March 2007. This regulatory guide endorses the 2001 Edition of the ASME Code, Section III, Division 2, through the 2003 addenda, subject to the exceptions cited in Section C, Regulatory Position, of the RG. Since the staff has officially accepted the Code, through the 2003 addenda, the applicant needs to identify any applicable relaxations between the 2004 Code referenced for the ESBWR design and RG 1.136, Rev. 3, including the regulatory positions. The deviations will require technical justification for acceptability. As an alternative, to facilitate resolution, the applicant may reference RG 1.136, Rev. 3 directly, and thereby revise the applicable code for the ESBWR design to the 2001 Edition of the ASME Code, Section III, Division 2, through the 2003 addenda. If the applicable code edition is revised, it needs to be documented in the DCD.

Comment on response to RAI 3.8-9 (MFN 06-298, Supplement 1):

In response to item (e), the applicant stated that ESBWR hydrodynamic loads are the same as the ABWR. The ABWR loads satisfy the 84-percentile non-exceedance (NEP) criteria of NUREG-0484, Rev. 1, as shown in the memorandum attached to the response that documents the applicability of the square root of sum of squares (SRSS) method for hydrodynamic loads. The staff could not confirm that the ESBWR hydrodynamic loads are the same as the ABWR. In addition, the memorandum attached to the response does not clearly establish that the NEP criteria was satisfied for ABWR. Therefore, the staff requests the applicant to provide additional information demonstrating that the ESBWR hydrodynamic loads satisfy the 84-percentile NEP criteria of NUREG-0484, Rev. 1.

Comment on response to RAI 3.8-17 S01 (MFN 06-407, Supplement 1):

A review of the figures provided in GE's response, which present the element forces and moments in the local finite element model, show in some cases a sudden change in response. As an example, the plot of moment versus elevation in Section A-A, presented in Figure

3.8-17(12), shows sudden changes in magnitude from approximately -8 to -10 and then +5 MNm/m over a change in elevation from about 16.5 to 17 and then 17.5 m. GE needs to explain this sudden change in element forces and whether this indicates that there may not be sufficient discretization (refinement) in the finite element model. In addition, as requested in the original RAI, a description summarizing the analysis, a figure showing the local finite element model, and figure(s) showing the reinforcement details provided in the GE response for this representative containment penetration should be included in the DCD.

Comment on response to RAI 3.8-25:

From the information provided in the response, it is not clear whether the comparative analysis between the small "DCD Model" and the "Contact Model" addresses this issue. The two models appear to be basically the same, except that each rigid link was replaced by a contact element. Therefore, it is not surprising that the liner strains are the same. The applicant should indicate whether the small DCD Model represents the exact concrete, liner, and rigid link modeling configuration used in the full DCD building model. This should include confirmation of the horizontal and vertical spacing of the rigid links and whether this model represents the most critical location (e.g., where spacings between rigid links are large). Also, from the information provided it is not clear that the existing contact model had a sufficient number of contact elements and liner plate elements (with additional nodes in the plate elements between the contact elements) to properly simulate the true design configuration that will be constructed. The comparison of responses should also include a tabulation of maximum strains (membrane and membrane plus bending) and reaction loads at key liner anchor locations.

Comment on response to RAI 3.8-28 S01 (MFN 06-407, Supplement 1):

The staff reviewed the applicant's proposed DCD changes and found them acceptable to address the design of typical mechanical and electrical penetrations. The staff confirmed that the proposed changes were incorporated in a formally submitted revision to the DCD. However, the staff is unclear how the typical design details will be implemented at the COL application stage. Therefore, the staff requests the applicant to identify and describe the COL action item to implement the typical mechanical and electrical penetration design details. This information needs to be documented in the DCD.

Comment on response to RAI 3.8-41:

Based on its review of the latest response, the staff requests the applicant to address the following:

(1) When 50% of the concrete stiffness was considered, the natural frequencies of the vent wall and the diaphragm wall increased 84% and 26%, respectively, compared to the original values. When 100% of the concrete stiffness was considered, the natural frequencies only increased an additional 8 to 10%. Based on the results obtained from considering 50% of the concrete stiffness, GE needs to explain how the natural frequencies could rise only 8 to 10% when 100% of the concrete stiffness values were utilized. For seismic loadings, GE indicated that differences were noted in the floor response spectra at certain locations when 50% of the concrete stiffness values were included. Therefore, GE stated that the results of the infill concrete stiffness parametric evaluation will be included in the site-envelope seismic design loads. In addition, GE indicated that additional parametric seismic analysis is being performed to address containment Loss of Coolant Accident flooding and the effect of updated modeling

properties of the containment internal structures. From a review of DCD Rev. 3, it is not clear whether the enveloping and updates of the modeling properties discussed above have been incorporated for the seismic loading.

(2) For evaluating the effects of the infill concrete on hydrodynamic response spectra generation, spectra were provided at representative locations for annulus pressurization, safety relief valve, chugging, and condensation oscillation loadings. However, there was no comparison to show how the spectra for the 50% infill concrete case differ from the original (no infill concrete) case, as was done for the seismic case.

(3) In addition to the effect of the infill concrete on the generation of floor response spectra, GE still has not confirmed whether the member design loads (for seismic and hydrodynamic loads) for the vent wall and diaphragm walls are affected by a shift in the natural frequencies of these two structures (i.e., could the accelerations increase due to a shift in frequency).

(4) For the thermal loading condition, GE indicated that the normal operating temperature is much lower than design bases accident (DBA) and no thermal ratios were used for normal operating conditions, which is conservative. Does this imply that the DBA thermal loading is used for all load combinations, even those that specify the normal operating condition? If not, then GE needs to explain why neglecting the thermal ratios is conservative.

Comment on response to RAI 3.8-64**:**

Regarding the use of BC-TOP-9A to evaluate an automobile tornado missile, as indicated in the RAI response, the staff notes that DCD Section 3.5.3 does not specify the use of BC-TOP-9A. While BC-TOP-9A has been added as Reference 3.5-9 in DCD Section 3.5.5, there is no reference to it in DCD Section 3.5.3. If BC-TOP-9A is used for the evaluation of the RB/FB exterior walls for the automobile tornado missile, DCD Section 3.5.3 needs to be revised accordingly, and accepted by the staff. If not accepted by the staff, GE needs to provide an evaluation of the RB/FB exterior walls for the automobile tornado missile using the procedures currently referenced in DCD Section 3.5.3.

Comment on response to RAI 3.8-76 S01 (MFN 06-407, Supplement 1)**:**

The applicant's response regarding welding of reinforcing bars is too limited since it only adds a sentence under ESBWR DCD Section 3.8.4.6.4 Quality Control that states: "For welding of reinforcing bars, inspection and documentation requirements conform to ASME Code Section III, Division 2 also." The staff's position is that welding of reinforcing bars should comply with all the applicable sections of the ASME Section III, Division 2, Code, not just those associated with inspection and documentation. This position applies to all seismic Category I concrete structures inside and outside containment. DCD Sections 3.8.3 and 3.8.4 need to be revised to address this position.

Comment on response to RAI 3.8-79 S01 (MFN 06-407, Supplement 1)**:**

The applicant stated that the Radwaste Building (RW) has a height of 12 m above grade and is at least 10 m away from the RB (measured corner to corner). The RW building is designed to RG 1.143 (Category RW-IIa), which exceeds NS requirements for seismic design. Therefore, potential failure of the RW building under full Safe Shutdown Earthquake will have negligible impact on C-I or C-II structures.

The staff determined that this exception was not identified in DCD Tier 2 Section 3.7, and has not been reviewed by the staff for acceptability. Given the possibility that the RB may be impacted by collapse of the RW building, the staff requires a detailed technical evaluation to support the conclusion that there would be no unacceptable damage to the RB. This information needs to be documented in the DCD.

Comment on response to RAI 3.8-80 S01(MFN 06-407, Supplement 1)**:**

The DCD Section 3.8.4 introductory paragraph discusses the RW building as if it is part of the design certification scope. In its response to RAI 3.8-79, the applicant identified the RW building height above grade, its distance from the RB, and the potential for impact of the RB if the RW should collapse in a seismic event. However, during the December 2006 audit discussion, the applicant indicated that it does not need to be designed as part of the design certification nor identified as a COL action item. Consequently, the staff is unclear about the status of the RW building, with respect to design certification or COL applicant responsibility. The staff requests the applicant to clearly define the design responsibility for this essential building, in accordance with RG 1.143. This information needs to be documented in the DCD.

Comment on response to RAI 3.8-91**:**

The applicant's supplemental response addressed the questions raised by the staff during the audit. However, to eliminate any uncertainty in the staff's interpretation of the tabulated load data, in combining the individual loads, and in applying the combined loads to selected critical elements, the staff requests the applicant to provide the following additional information for the most critical basemat element and the most critical wall element (i.e., whose stress ratios for concrete and steel reinforcement are the highest, recognizing that a different element and different load combination may govern for the concrete versus the steel):

The individual loads, combined loads, and a hand calculation performed in accordance with the design Code for the concrete and steel reinforcement (for flexure and membrane forces, and for the corresponding shear forces).

Please also provide the results of the SSDP analysis for the same two elements, which will allow a direct comparison to the hand calculation results.

Comment on response to RAI 3.8-93 (MFN 06-407, Supplement 2) :

The staff requests the applicant to address the following:

(1) It is noted that the settlement values in DCD Tier 2 Table 2.0-1 are the same as those specified in DCD Tier 1 Table 5.1-1. The DCD should clearly state that the COL applicant must estimate the settlement by an analysis using actual site conditions and show that they are acceptable when compared to the values specified in DCD Tier 1 Table 5.1-1.

(2) DCD Tier 1 Table 5.1-1 and DCD Tier 2 Table 2.0-1 now requires that the ratio of the largest to the smallest shear wave velocity over the mat foundation width at the foundation level should not exceed 1.7. Clarify that this requirement is imposed to ensure that the bending moments on the basemat do not exceed the design allowable for horizontal soil spring variations that may vary by a factor of 3 from the basemat center to the basemat edge. Also describe how such a

variation in shear wave velocity over the mat foundation was considered in the seismic analysis of the RB/FB and Control buildings. If this variation was not considered in the seismic soil structure interaction (SSI) analysis provide the appropriate criteria for the permissible variation in shear wave velocity to be used by the COL applicant, along with the technical bases for the criteria. The criteria in DCD Tier 1 Table 5.1-1 and DCD Tier 2 Table 2.0-1 should be revised accordingly.

(3) In response to this RAI, the applicant has studied several construction sequences and concluded that they have no effect on the basemat design. However, it is difficult to conclude that the worst loading condition has been considered. The criteria in DCD Tier 1 Table 5.1-1 and DCD Tier 2 Table 2.0-1 should require the COL applicant to review the construction sequences considered by GE in the design of the RB/FB and CB buildings. If the COL applicant proposes to use a construction sequence that is substantially different than that studied by GE, the COL applicant should be required to demonstrate that their proposed sequence does not cause a problem.

(4) Figure 3.8-93 (12)-d compares basemat moments resulting from differential settlement that are higher than the moments used for the DCD design condition. Explain why these higher moments are acceptable.

(5) As stated by the applicant in the response, Figure 3.8-93(16)-c indicates that the Softx3 case exceeds the base case (DCD) under the “Hard Spot” condition. The applicant states that for the design allowable, slightly less than 3x soft or hard conditions is used. However, Figure 3.8-93(16)-d indicates that the Softx2 case exceeds the base case (DCD) under the “Hard Spot” condition with results that appear to be identical to those in Figure 3.8-93(16)-c. Clarify what is meant by “slightly less than 3x soft or hard conditions is used.” Also compare the moments shown in these two figures with the basemat moment design capacities in both directions across the entire basemat and provide the technical justification for predicted moments that are higher than the design allowable.

<u>Comment on response to RAI 3.8-94 (MFN 06-407, Supplement 2):</u>

The staff requests the applicant to address the following:

(1) The bearing stresses reported in DCD Tier 2 Table 3G.1-58 for soft, medium and hard site conditions are 2.7 MPa (56.4 ksf), 7.3 Mpa (152.6 ksf) and 5.4 MPa (112.9 ksf). These values are extremely large compared to known soil and rock capacities. Explain how the COL applicant will satisfy this criteria. Also explain why the bearing stress reported for the medium site condition (7.3 MPa) is higher than the hard site condition (5.4 MPa).

(2) Explain how the COL applicant is to use the maximum bearing pressures reported in DCD Tier 2 Table 3G.1-58 and Table 3G.2-27 when conditions for a specific site fall between the tabulated values for soft, medium and hard site conditions.

(3) Footnote 7 to DCD Tier 2 Table 2.0-1 references DCD Tier 2 Subsections 3G.1.5.5, 3G2.5.5 and 3G.3.5.5 for the minimum dynamic bearing capacities for the Reactor, Control and Fuel Building, respectively. However, Footnote 7 to the corresponding DCD Tier 1 Table 5.1-1 only states “At foundation level of Seismic Category I structures.” Explain why the minimum dynamic bearing capacities are not clearly specified as Tier 1 information.

(4) The response to RAI 3.8-94 states that variations in the horizontal soil spring were considered and concludes that the maximum soil bearing pressures of the nonuniform soil condition are similar to those of the uniform soil condition. Results for maximum bearing pressure under non-uniform soil conditions are presented in Table 3.8-94(3). To complete the response, for the nonuniform soil conditions considered in Table 3.8-94(3), provide comparisons of the bending moments across the basemat in both directions that demonstrate that the DCD design moments bound the moments for the nonuniform soil condition.

Comment on response to RAI 3.8-96 (MFN 06-407, Supplement 2):

The applicant has not used a consistent set of criteria to determine the safety factor against sliding and also needs to provide the technical bases for some of the parameters used in the analysis results that are presented. The staff requests the applicant to address the following:

(1) The fourth bullet in the list of items that comprise the sliding resistance is identified as "passive soil pressure on walls." This terminology is misleading since the information included under this item is the elastic lateral soil pressure. If passive soil pressures are being credited to provide sliding resistance, explain how these pressures are calculated and confirm that the walls are designed to resist these forces. If elastic lateral soil pressures on the walls are being credited to provide sliding resistance, it is not consistent to use these elastic soil pressures with the passive soil pressures at the basemat side surface. Also, explain how the passive soil pressures are calculated for the basemat side surface.

(2) Passive soil pressure at the basemat side surface is being credited to provide sliding resistance, which means that the static friction resistance at the bottom of the basemat is overcome. Therefore, explain why a dynamic coefficient of friction is not used to calculate the friction force at the basemat bottom surface.

(3) How has GE determined that there are sufficient soil sites that would have an angle of internal friction of 30 degrees or greater? What would a COL applicant be required to do if a site has a soil friction angle of less than 30 degrees?

(4) Provide a description of the formulations used to calculate the cohesion resisting forces and discuss how the material properties were determined for the analysis.

(5) Provide the technical basis for assuming that medium soils with an angle of internal friction of 30 degrees would also have the effective cohesion resisting forces reported in the analysis results in Table 3.8-96(1). Why is the cohesion value in Table 3.8-96(1) equal to zero for soft soils?

(6) Provide the technical basis for assuming that the hard soil/rock conditions have the effective cohesion resisting forces reported in the analysis results in Table 3.8-96(1).

(7) Why does the response indicate that the cohesion force contribution to total force is small when Table 3.8-96(1) shows that it is quite large for hard soils? For the RBFB medium soil condition, a small change in the cohesion force could result in a factor of safety of less than 1.1. In the light of these observations, further justification is needed to support the statement that "the reduction of the cohesion due to uplift has little impact on the total resistance."

(8) Describe the COL requirements for the backfill material for the gap shown in Figures 3G.1-

65 and 3G.2-15. Will the backfill material be required to have a stiffness defined by its shear wave velocity which is at least equal to the shear wave velocity of the surrounding insitu soil? If not, explain why not. Also, clarify that the backfill material will completely fill the gap above the concrete backfill to the grade level.

(9) The footnote in Table 3.8-96(1) implies that the 100-40-40 three directional combination method was used for the sliding evaluation. The data in the tables above the footnote, however indicate that a two dimensional (one horizontal and one vertical) check was made for calculating the factor of safety. In this evaluation the bottom friction force is derived based on the total vertical load consisting of dead weight minus the buoyancy effect minus 0.40 times the vertical seismic force. Since a simplified two dimensional approach (i.e., N-S & Vertical and then E-W & Vertical) is being used to demonstrate the factors of safety against sliding and overturning, the 100-40-40 rule is not considered to be appropriate. The typical approach that is utilized for checking sliding and overturning in accordance with the SRP 3.8.5 requirements is to use the dead load minus the buoyancy effect and then subtract the full vertical seismic load for the N-S & Vertical check and the E-W & Vertical check. If any other method is utilized, then GE needs to provide the technical justification for the approach. Note that 90% of the dead load (including the buoyancy effect) should be utilized as specified in footnote 1 of DCD Table 3.8-15, which is also in accordance with ACI 349 requirements.

Comment on response to RAI 3.8-101 S01 (MFN 06-407, Supplement 1)**:**

This RAI relates to the jurisdictional boundary between the containment and other Category I structures. This issue is discussed under RAI 3.8-4, which is currently unresolved. When resolved, DCD Section 3.8.5.2 will need to be revised to reflect the resolution.

Comment on response to RAI 3.8-102 S01 (MFN 06-407, Supplement 1)**:**

This RAI relates to the jurisdictional boundary between the containment and other Category I structures. This issue is discussed under RAI 3.8-4, which is currently unresolved. When resolved, DCD Section 3.8.5.3 will need to be revised to reflect the resolution.

Comment on response to RAI 3.8-103 S01 (MFN 06-407, Supplement 1)**:**

This RAI relates to the jurisdictional boundary between the containment and other Category I structures. This issue is discussed under RAI 3.8-4, which is currently unresolved. When resolved, DCD Section 3.8.5.5 will need to be revised to reflect the resolution.

Comment on response to RAI 3.8-107:

(a) The staff reviewed the numerical data provided in the supplemental response to RAI 3.8-107, and did not reach the same general conclusion as the applicant, concerning the conservatism of the DCD results, compared to the SRSS and the RG 1.92 100/40/40 methods for combining responses from 3 directions of motion. The applicant is requested to address the following questions:

(1) From review of the Fot values in Tables 3.8-107(2) and 3.8-107(7), both listed as element 1824, it appears that the calculation for combined loading uses different values for the DCD method and for the SRSS/RG1.92 100/40/40 methods. Of particular note is Nx, listed as 4.096 in Table 3.8-107(2) and 0.946 in Table 3.8-107(7). Please explain this apparent discrepancy, which would tend to show the DCD method is conservative. If this is an error, re-calculate the combined loading results using the correct Fot loads, and provide the revised comparison results.

(2) All comparisons presented in Figures 3.8-107(1) thru (12) show that the predicted stress does not exceed the allowable stress limit, for all 3 methods of spatial combination. The data presented is based on a limited subset of locations and two (2) load combinations that include SSE. Please identify any locations and load combinations where the allowable stress limit is exceeded by any of the 3 spatial combination methods. Quantify the degree of exceedance.

(3) Figures 3.8-107(6)(b) and (10)(b) show one point where the SRSS and RG1.92 100/40/40 methods of spatial combination produce results significantly higher (factor of 2.5 to 3) than the DCD method. Please explain this large difference, and provide the technical basis for considering this large difference to be acceptable.

(4) The RG 1.92, Rev.2, acceptable procedure for implementation of the 100/40/40 rule was intended to produce the most conservative estimates of response components due to 3 directions of seismic loading. Since the calculated response components are absolute values and seismic response is oscillatory, both the positive and negative sign must be considered when combining with response components due to other loads. This is completely analogous to implementation of the SRSS combination method. Studies conducted by the staff demonstrated the conservatism of this approach, compared to SRSS. The staff requires clarification why, for combined loading cases, the DCD method of combination (ASCE 4-98 implementation of the100/40/40 rule) produces higher results than the RG 1.92 implementation procedure for the 100/40/40 rule at approximately 50% of the locations in the comparison tables.

(b) The staff also reviewed the revised validation report for SSDP-2D, provided in the applicant's initial response to RAI 3.8-107. Based on this review, the staff requests the following clarifications:

(1) Table 7 and Table 8 present the transverse shear analysis and code check for ASME 2004 and ACI349-01, respectively. Table 7 lists the stress units as "MPa". Table 8 lists some units as "MPa" and some units as "psi". Please revise these tables as appropriate, to identify the correct units.

(2) The results presented in Tables 7 and 8 each show excellent correlation with hand calculations. However, comparing the results in Table 7 to the results in Table 8, row 1 and row 5 show differences between the 2 codes, while the remaining rows show consistency. Please explain the basis for the differences in rows 1 and 5.

(3) The applicant is requested to provide a copy of the journal article utilized for the membrane section force calculation in Section 4.1 of the validation report. For Section 4.2 of the validation report, the applicant is requested to identify the source of the equations utilized for the axial force and bending moment calculation, and provide a copy of the applicable pages. In addition, explain whether the hand calculations solve the same set of equations utilized in the SSDP computer code, or whether the hand calculations use an independent approach. If the hand calculations use an independent approach, please describe the method used in the SSDP computer code.

(c) The staff noted that the calculation of F_{OT}, used in demonstrating the combined loading comparisons, uses a unique "thermal ratio" for each individual internal force and moment resultant calculated by linear elastic thermal stress analysis using NASTRAN. For element 1824 used in the demonstration calculation, the "thermal ratio" varies as follows:

1.69 for Nx (1.981 goes to 3.348)
0.14 for Ny (-2.824 goes to -0.395)
1.0 for Nxy (0.082)
0.16 for Mx (-4.322 goes to -0.692)
0.29 for My (-7.438 goes to -2.157)
1.0 for Mxy (0.022)
-0.15 for Qx (-0.082 goes to 0.012)
0.24 for Qy (-1.354 goes to -0.325)

It is the staff's understanding that these ratios were obtained based on the results of two (2) ABAQUS/ANACAP analyses. The first was a linear elastic thermal stress analysis, and the second was a nonlinear thermal stress analysis that considered internal force and moment re-distribution due to concrete cracking and inelastic material behavior. The wide variation in the thermal ratios, and the significant reduction in the maximum elastically calculated results indicates that nonlinear behavior and re-distribution of internal forces and moments is very significant.

The staff has a concern that combining the nonlinear thermal stress analysis results with the elastically calculated results for other loads may not be appropriate. The correct approach, because of the significant nonlinear behavior evident in the ABAQUS/ANACAP thermal analysis, would be to apply all simultaneously occurring loads at the same time using the ABAQUS/ANACAP nonlinear model. In the presence of significant nonlinear behavior, linear superposition of results due to different applied load sets may lead to significant errors in the final combined loading response.

The staff requests the applicant to provide a detailed technical basis for the acceptability of its approach. Example comparisons for element 1824 and several other representative locations should be included in the response.