March 30, 2006

Mr. David H. Hinds, Manager, ESBWR
General Electric Company
P.O. Box 780, M/C L60
Wilmington, NC 28402-0780

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 16 RELATED TO ESBWR DESIGN CERTIFICATION APPLICATION

Dear Mr. Hinds:

By letter dated August 24, 2005, General Electric Company (GE) submitted an application for final design approval and standard design certification of the economic simplified boiling water reactor (ESBWR) standard plant design pursuant to 10 CFR Part 52. The Nuclear Regulatory Commission (NRC) staff is performing a detailed review of this application to enable the staff to reach a conclusion on the safety of the proposed design.

The NRC staff has identified that additional information is needed to continue portions of the review. The staff's request for additional information (RAI) is contained in the attachment to this letter. This RAI concerns piping design as discussed primarily in Chapter 3 of the ESBWR design control document. These questions were sent to you via electronic mail on February 21, 2006, and were discussed with your staff during a telecon on March 16, 2006. You agreed to respond to these RAIs by April 28, 2006.

If you have any questions or comments concerning this matter, you may contact me at (301) 415-2863 or lwr@nrc.gov or you may contact Amy Cubbage at (301) 415-2875 or aec@nrc.gov.

Sincerely,

/RA/

Lawrence Rossbach, Project Manager
New Reactor Licensing Branch
Division of New Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 52-010

Attachment: As stated

cc w/att: See next page

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The NRC staff has identified that additional information is needed to continue portions of the review. The staff's request for additional information (RAI) is contained in the attachment to this letter. This RAI concerns piping design as discussed primarily in Chapter 3 of the ESBWR design control document. These questions were sent to you via electronic mail on February 21, 2006, and were discussed with your staff during a telecon on March 16, 2006. You agreed to respond to these RAIs by April 28, 2006.

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ACCESSION NO. ML060880224

OFFICE	NRBA/PM	NRBA/BC
NAME	LRossbach	LDudes
DATE	03/30/2006	03/30/2006

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Distribution for DCD RAI Letter No. 16 dated March 30, 2006

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Requests for Additional Information (RAIs)
ESBWR Design Control Document (DCD) Piping Design

RAI Number	Reviewer	Summary	Full Text
3.12-1	Fair J	ASME Code Editions and Addenda	DCD Tier 2, Table 1.9-22, identifies that the 2004 edition of the ASME Code, Section III, is applicable to the ESBWR piping design. Explain how the requirements of 10 CFR 50.55a(b) will be satisfied.
3.12-2	Fair J	ASME Code Cases	(a) DCD Tier 2, Table 5.2-1, Sections 3.7 and 3.9 include the following ASME Code Cases which have been annulled by the ASME as noted in the current Regulatory Guides (RGs) 1.84 and 1.147: –247, –411-1, –420, –463-1, –476, –479-1 and –608. Discuss what alternatives are being considered to address the issues contained in these Code Cases. (b) The staff approved, in RG 1.84, Code Cases –71-18, –122-2, and –416-3 that are the revised versions of these Code Cases referenced in the DCD. Describe the changes in these revised Code Cases that may impact the design criteria presented in the DCD and how they were addressed. (c) The staff's acceptance status of several Code Cases in DCD Tier 2, Table 5.2-1, have been changed. (I) The DCD indicates that Code Cases –318-5 and –416-2 were conditionally accepted, but they are now unconditionally endorsed by the staff. Note that Code Case –416-3, not its previous revision, has been currently endorsed by the staff. (ii) The DCD also indicates that Code Case –491-2 was not listed in RG 1.147, but it is now endorsed by the staff. Since the acceptance status of these Code Cases given in the DCD has been changed, address the changes in the applicability of these Code Cases in the DCD for ESBWR piping design.

Requests for Additional Information (RAIs)
ESBWR Design Control Document (DCD) Piping Design

RAI Number	Reviewer	Summary	Full Text
3.12-3	Fair J	Independent Support Motion (ISM) method of analysis	The current staff position for the ISM method of analysis is presented in Volume 4, Section 2 of NUREG-1061, "Report of the US NRC Piping Review Committee." Some differences were noted between the ISM method of response combinations presented in the DCD Tier 2, Section 3.7.3.9, and the method given in NUREG-1061 (e.g., the SRSS method in the DCD and absolute sum method in NUREG-1061 for combining group responses for a given direction). Indicate whether all of the provisions contained in NUREG-1061 for the ISM method of analysis will be followed or provide the technical justification for any alternatives.
3.12-4	Fair J	Time history analysis time step	In a time history analysis, the numerical integration time step, Δt, must be sufficiently small to accurately define the dynamic excitation and to ensure stability and convergence of the solution up to the highest frequency of significance. DCD Tier 2, Section 3.7.2.1.1, indicates that for the most commonly used numerical integration methods, the maximum time step is limited to one-tenth of the shortest period of significance. An acceptable approach for selecting the time step, Δt, is that the Δt used shall be small enough such that the use of ½ of Δt does not change the response by more than 10%. Indicate whether this is part of the analysis requirements or provide a technical justification for not considering this criterion along with the other criterion described above for seismic and hydrodynamic loading analyses.
3.12-5	Fair J	Frequency domain analysis procedure	DCD Tier 2, Section 3.7.2.1.1, states that for the frequency domain solution, the dynamic excitation time history is digitized with time steps no larger than the inverse of two times the highest frequency of significance. It appears that this criterion is related to the Nyquist frequency for selection of the appropriate time step. Provide the technical justification why this approach is sufficiently accurate to capture the piping system response at the Nyquist frequency.

Requests for Additional Information (RAIs)
ESBWR Design Control Document (DCD) Piping Design

RAI Number	Reviewer	Summary	Full Text
3.12-6	Fair J	Time history analysis uncertainty	When developing seismic floor response spectra for use in a response spectrum analysis for piping and equipment analysis, the peaks of the spectra obtained from a time history analysis are generally broadened by plus and minus 15% to account for modeling uncertainties. When performing a time history analysis of piping and equipment for seismic and hydrodynamic loads, describe how the uncertainties in the material properties of the structure/soil and in the modeling techniques used in the analysis to develop the loading are accounted for in the time history analysis. Indicate whether the digitized time history is adjusted to account for the material/modeling uncertainties. Describe all of the dynamic loads for which the time history will be adjusted to account for modeling uncertainties and provide the basis for the amount of the adjustment. Also, indicate how the hydrodynamic building spectra are broadened to account for the modeling uncertainties.
3.12-7	Fair J	Static coefficient method of analysis	DCD Tier 2, Section 3.7.2.1.3, provides a description of the static coefficient method of analysis. It states that the response loads are determined statically by multiplying the mass value by a static coefficient equal to 1.5 times the maximum spectral acceleration at the appropriate damping value of the input response spectrum. Indicate whether the use of the static coefficient method in the DCD also requires that (a) justification be provided that the system can be realistically represented by a simple model and the method produces conservative results and (b) the design and associated simplified analysis account for the relative motion between all points of support, as prescribed in SRP 3.9.2. If not, provide the technical justification.

Requests for Additional Information (RAIs)
ESBWR Design Control Document (DCD) Piping Design

RAI Number	Reviewer	Summary	Full Text
3.12-8	Fair J	Inelastic analysis methods	The DCD did not provide any information on the use of inelastic analysis methods for the ESBWR piping design, except that discussed in DCD Tier 2, Section 3.9.1.4, for design of whip restraints against a postulated gross piping failure. Indicate if any ESBWR piping design, other than the whip restraints, includes any inelastic analysis method. Also, if such a method could be used, provide details of the analysis approach, its acceptance criteria, scope and extent of its application.
3.12-9	Fair J	Buried piping criteria	DCD Tier 2, Section 3.7.3.13, did not give details on the analysis method and how the criteria are to be applied in the design of buried piping. Based on the criteria presented in DCD Tier 2, Section 3.7.3.13, describe the analysis method and design requirements that are used for buried piping. The design procedure should include the load components, categorization of seismic stresses in the Code evaluation, and allowable stress limits.
3.12-10	Fair J	ASME Code Appendix N criteria	DCD Tier 2, Section 3.7.3, refers to the guidelines in Appendix N of the ASME Code, as being applicable to design/analysis of ESBWR subsystems. The NRC staff has not explicitly endorsed Appendix N in its entirety. Identify all Appendix N guidance used in the ESBWR piping design/analysis that differs from the guidance provided in the current SRPs and RGs. If any differences exist and are used in the ESBWR piping design/analysis, then provide technical justification for using the Appendix N guidance.

Requests for Additional Information (RAIs)
ESBWR Design Control Document (DCD) Piping Design

RAI Number	Reviewer	Summary	Full Text
3.12-11	Fair J	Verification of computer codes	DCD Tier 2, Appendix 3D, provides a description of the major computer programs used in the analysis and design of safety-related components, equipment, and structures. According to this appendix, the quality of these programs and computer results is controlled. The programs are verified for their application by appropriate methods, such as hand calculations, or comparison with results from similar programs, experimental tests, or published literature, including analytical results or numerical results to the benchmark problems. To facilitate the staff review of the computer programs used in the ESBWR design, provide the following additional information: (a) Identify which computer programs will be used during the design certification phase and which programs may be used in the future during the COL application phase. (b) Identify which programs have already been reviewed by the NRC on prior plant license applications. Include the program name, version, and prior plant license application. As stated in SRP 3.9.1, this will eliminate the need for the licensee to resubmit, in a subsequent license application, the computer solutions to the test problems used for verification. (c) Confirm that the following information is available for staff review for each program: the author, source, dated version, and facility; a description, and the extent and limitation of the program application; and the computer solutions to the test problems described above.
3.12-12	Fair J	Modeling of lumped masses	DCD Tier 2, Section 3.7.3.3.2, provides criteria to model lumped-masses for equipment in a dynamic analysis. Clarify whether these criteria are also applied to the development of piping system mathematical models. If not, provide the criteria used for the piping system mathematical models.

Requests for Additional Information (RAIs)
ESBWR Design Control Document (DCD) Piping Design

RAI Number	Reviewer	Summary	Full Text
3.12-13	Fair J	Special engineered pipe supports	DCD Tier 2, Section 3.7.3.3.3, states that if special engineered pipe supports are used, the modeling and analytical methodology shall be in accordance with methodology accepted by the regulatory agency at the time of certification or at the time of application, per discretion of the applicant. Clarify whether the statement means that the modeling and analytical methodology will be determined at the COL application stage and will be submitted for review and approval by the staff. If this is the case, the DCD should be revised accordingly. Otherwise, additional clarification of this statement is needed.
3.12-14	Fair J	PISYS computer code benchmark	DCD Tier 2, Section 3D.4.1 of Appendix 3D, indicates that the PISYS program has been benchmarked against NRC piping models. The results are documented in GE report NEDO-24210, dated August 1979 (Reference 3D-1 of Appendix 3D), for mode shapes and uniform support motion response spectrum analysis (USMA) options. The independent support motion response spectrum analysis (ISMA) option has been validated against NUREG/CR-1677. With regard to the benchmarking of the PISYS program, provide the following information: (a) The version of the PISYS program used for the ESBWR analysis should be benchmarked against NUREG/CR-6049, "Piping Benchmark Problems for the GE ABWR." The piping benchmark problems in NUREG/CR-6049 are more recent and more representative of the current piping systems in the ESBWR. If NUREG/CR-6049 will not be used to benchmark the piping computer code used by COL applicants, then provide an explanation. (b) Indicate where the requirement for the COL applicant to benchmark the use of any piping analysis program(s) in accordance with the current DCD validation methods is located.

Requests for Additional Information (RAIs)
ESBWR Design Control Document (DCD) Piping Design

RAI Number	Reviewer	Summary	Full Text
3.12-15	Fair J	Analysis of small Seismic Category II branch piping	DCD Tier 2, Section 3.7.3.17, indicates that where small, Seismic Category II piping is directly attached to Seismic Category I piping, it can be decoupled from Seismic Category I piping. However, the DCD did not describe how the small branch piping will be analyzed in the piping design for both inertial and Seismic Anchor Motion (SAM) responses (e.g., small bore handbook or like other (larger) piping, equivalent static method or dynamic analysis). Describe the seismic analysis methods and procedures, including the input floor response spectrum and input SAM displacements, that apply to the small branch piping design. The description should also describe how any amplification effects and SAM effects, from the main run pipe at the attachment to the small branch pipe, are considered.
3.12-16	Fair J	Allowable stress limit for main steam piping	DCD Tier 2, Section 3.9.3.3, indicates that the main steam ASME Class 1 piping thermal loads are less than 2.4 Sy per Equation 12 of NB-3600. Describe how the stress of 2.4 Sy satisfies the ASME Code Equation 12 allowable limit of 3 Sm.
3.12-17	Fair J	Combination of dynamic responses	Note 3 to DCD Tier 2, Table 3.9-2 indicates that the method used in the combination of dynamic responses of piping loadings is in accordance with NUREG-0484, Revision 1. Table 3.9-9 specifies a number of load combinations that specify an SRSS load combination. Describe how the NUREG-0484 criteria were satisfied for the Service Level D load combinations.

Requests for Additional Information (RAIs)
ESBWR Design Control Document (DCD) Piping Design

RAI Number	Reviewer	Summary	Full Text
3.12-18	Fair J	ASME Class 1 seismic anchor motion stress limits	Note 12 to DCD Tier 2, Table 3.9-2 provides a modification to the ASME Class 2 and 3 criteria to address SSE seismic anchor motion stresses. However note 12 did not include any additions/changes to the Class 1 piping requirements of ASME Code Section III, Subsection NB-3600, for equations 10, 11 and 12 (similar to the additions/changes made for Class 2 and 3 piping). Clarify whether there are any additions or changes for the Class 1 piping requirements and what earthquake level (for inertia and SAM) will be used to satisfy the ASME Code equations.
3.12-19	Fair J	ASME Code Case –411-1 damping values	DCD Tier 2, Section 3.7.1.2 and Table 3.7-1 specify damping values to be used in the seismic analysis of SSCs. The DCD indicates that ASME Code Case –411-1 may be used as permitted by RG 1.84 in place of Regulatory Guide 1.61 damping values. As indicated in RAI 3.12-2, Code Case –411 has been annulled by the ASME. The DCD also indicates that ASME Code Case –411-1 damping cannot be used for analyzing linear energy absorbing supports designed in accordance with ASME Code Case –420. Indicate whether the damping values, corresponding to Code Case –411-1 and meeting the conditions listed in Table 4 of RG 1.84, Rev. 33, will be used for the independent support motion (ISM) method. If the Code Case –411-1 will be used, then provide the technical basis for using these damping values with the ISM method.
3.12-20	Fair J	Modal analysis Zero Period Acceleration (ZPA) cutoff frequency	In DCD Tier 2, Section 3.7.2.7, the cutoff frequency for modal responses is defined as the frequency at which the spectral acceleration approximately returns to the ZPA of the input response spectrum. Define this cutoff frequency quantitatively for seismic and other building dynamic loads applicable to the piping analysis for the ESBWR.

Requests for Additional Information (RAIs)
ESBWR Design Control Document (DCD) Piping Design

RAI Number	Reviewer	Summary	Full Text
3.12-21	Fair J	High frequency vibratory loads	For the analyses of vibratory loads (other than seismic) with significant high-frequency input (e.g., above 33 Hz), describe: (a) the modal combination method to be used for the high frequency modes above the cutoff frequency for vibratory loads. (b) the nonlinear analysis method to be used to account for large gaps between the pipe and its supports.
3.12-22	Fair J	Environmental fatigue analysis of Class 1 piping	DCD Tier 1, Section 3.1, "Piping Design," states that Class 1 piping systems will be analyzed for fatigue with environmental effects. Provide the analysis and design methods that will be used to perform the fatigue evaluation, including the environmental effects, for the ESBWR Class 1 piping systems.
3.12-23	Fair J	Fatigue analysis of Class 2, 3 and Quality Group D piping	Provide the analysis method that will be used to perform the fatigue evaluation of ESBWR Class 2, 3, and Quality Group D piping systems that are subject to cyclic loadings. Also, discuss how the environmental effects are considered in the Code Class 2 and 3 piping for which a fatigue analysis is performed.
3.12-24	Fair J	NRC Bulletin 88-08	NRC Bulletin 88-08 addresses unisolable sections of piping connected to the RCS (including the RPV) that may be subjected to temperature oscillations induced by leaking valves. Identify unisolable piping segments directly connected to the RCS and describe the analysis method to mitigate problems identified in Bulletin 88-08, including supplements 1, 2 and 3.

Requests for Additional Information (RAIs)
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3.12-25	Fair J	Thermal stratification in feedwater piping	The effects of thermal stratification have been observed in both BWR and PWR feedwater piping as discussed in NRC Information Notice (IN) 84-87 and NRC IN 91-38. Describe the method of analysis used in the ESBWR feedwater piping design to include the thermal stratification effects.
3.12-26	Fair J	Main steam SRV design parameters	Describe the SRV design parameters and criteria that will need to be specified to the COL applicant to ensure that the specific piping configuration and SRVs purchased and installed at the COL applicant stage will match the test and design parameters used at the design certification stage. An example is the minimum rise time for the SRV valve operation; this can greatly affect the transient loads imposed on the piping system analysis. Also, any change in the discharge piping system configuration may affect the SRV loadings.
3.12-27	Fair J	Combination of inertial and anchor motion responses	DCD Tier 2, Section 3.7.3.12, discusses the effect of differential building movement on piping systems that are anchored and restrained to floors and walls of buildings that may have differential movements during a dynamic event. SRP 3.9.2 Section II.2.g states that the responses due to the inertial effect and relative displacement for multiply-supported equipment and components with distinct inputs should be combined by the absolute sum method. Provide the combination methods that are to be used in the design of ESBWR piping systems for the inertial responses and SAM responses caused by relative displacements for all analysis methods (including ISM).
3.12-28	Fair J	Thermal analysis of piping systems	The DCD did not indicate whether piping thermal analyses of piping systems will be performed for all temperature conditions above ambient. If this is not the case, then provide the minimum temperature at which an explicit piping thermal expansion analysis would be required. Also, provide the technical basis for the selected minimum temperature.

Requests for Additional Information (RAIs)
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RAI Number	Reviewer	Summary	Full Text
3.12-29	Fair J	Intersystem LOCA	DCD Tier 2, Appendix 3K, Section 3K.2, acknowledges that, as part of the resolution of the intersystem LOCA issue, the staff requires in addition to other requirements, that periodic surveillance and leak rate testing of the pressure isolation valves via Technical Specifications, as part of the ISI program. Indicate where in the DCD is the requirement that the COL applicant must perform this periodic surveillance and leak rate testing.
3.12-30	Fair J	Building structure component supports	DCD Tier 2, Section 3.9.3.7.1, states: "The building structure component supports are designed in accordance with ANSI/AISC N690, Nuclear Facilities-Steel Safety-Related Structures for Design, Fabrication and Erection, or the AISC specification for the Design, Fabrication, and Erection of Structural Steel for buildings, correspond to those used for design of the supported pipe." Clarify what this sentence means, particularly the phrase "correspond to those used for design of the supported pipe." Also, identify the edition of these specifications because the titles do not match the corresponding specifications given in Tables 3.8-6 and 3.8-9 of the DCD.
3.12-31	Fair J	Concrete expansion anchor bolts	(1) DCD Tier 2, Section 3.9.3.7, states that concrete anchor bolts used in pipe supports are designed to the factors of safety defined in IE Bulletin 79-02, Revision 1 and pipe support base plate flexibility will be accounted for in accordance with IE Bulletin 79-02. Clarify that all aspects of the anchor bolt design (not just the factor of safety) will follow IE Bulletin 79-02, Revision 2 (not Revision 1). (2) Indicate whether the design and installation of all anchor bolts will also be performed in accordance with Appendix B to ACI 349-01 - "Anchoring to Concrete," subject to the conditions and limitations specified in RG 1.199. (3) Define the term Seismic Category IIA used in DCD Tier 2, Section 3.9.3.7, and explain how it differs from Category II.

Requests for Additional Information (RAIs)
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RAI Number	Reviewer	Summary	Full Text
3.12-32	Fair J	Support stiffness	DCD Tier 2, Section 3.7.3.3.1, provides some limited information about modeling the stiffness of guides and snubbers by using representative stiffness values. Some additional information about snubbers is provided in DCD Tier 2, Section 3.9.3.7.1, which describes the procedures to ensure that the spring constant achieved by the snubber supplier matches the spring constant used in the piping system model. However, the DCD does not adequately describe how the representative stiffness values are developed for all supports other than snubbers. Therefore, describe (1) the approach used to develop the representative stiffness values, (2) the procedure that will be imposed to ensure that the final designed supports match the stiffness values assumed in the piping analysis, (3) the procedure used to consider the mass (along with the support stiffness) if the pipe support is not dynamically rigid, and (4) the same information [(1), (2), and (3) above] for the building steel/structure (i.e., beyond the NF jurisdictional boundary) and for equipment to which the piping may be connected to.
3.12-33	Fair J	Support self-weight excitation	DCD Tier 2, Sections 3.7.3 and 3.9.3 do not provide a description of the analysis methods or design requirements needed to evaluate the effects of seismic and other dynamic (support) self-weight excitation for ESBWR pipe supports. Provide this information which is especially important for the larger and more massive type supports. The description should consider these effects on the support structure and anchorage. In addition, the description should consider all loads transmitted from the piping to the support and the support internal loads caused by self-weight, thermal, and inertia effects due to the support mass.
3.12-34	Fair J	Friction loads on pipe supports	DCD Tier 2, Section 3.9.3.7, describes the criteria and design requirements for piping supports of ESBWR piping. However, the DCD does not describe how friction loads imparted on pipe supports, due to unrestrained thermal motion, will be considered in design. Provide the criteria and design approach that will be used to calculate pipe support friction loads.

Requests for Additional Information (RAIs)
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RAI Number	Reviewer	Summary	Full Text
3.12-35	Fair J	Box frame pipe supports	DCD Tier 2, Section 3.9.3.7, describes the criteria and design requirements for piping supports of ESBWR piping. The DCD does not provide any description of the development and specification of hot and cold gaps to be used between the pipe and the box frame type supports. Provide this information.
3.12-36	Fair J	Instrument line supports	DCD Tier 2, Section 3.9.3.7, describes the criteria and design requirements for piping supports of ESBWR piping. However, the DCD does not provide any information on the analysis and design criteria for instrumentation line supports. Provide this information.
3.12-37	Fair J	Suspension design specification	DCD Tier 2, Section 3.9.3.7, describes the criteria and design requirements for piping supports of ESBWR piping. The DCD indicates that maximum calculated static and dynamic deflections of the piping at support locations do not exceed the allowable limits specified in the "suspension design specification". The purpose of the allowable limits is to preclude failure of the pipe supports due to piping deflections. Provide an additional discussion of the "suspension design specification." Also, describe how the deflection limits are developed.

cc:

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