October 10, 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. 67 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 enclosure to this letter. This RAI, containing questions 3.9-3 through 3.9-175, concerns mechanical systems and components as described in Section 3.9, Revision 1, of the ESBWR design control document.

To support the review schedule, you are requested to respond to this RAI by November 22, 2006.

If you have questions or comments concerning this matter, please 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
ESBWR/ABWR Projects Branch
Division of New Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 52-010

Enclosure: As stated

cc: See next page

October 10, 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. 67 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 enclosure to this letter. This RAI, containing questions 3.9-3 through 3.9-175, concerns mechanical systems and components as described in Section 3.9, Revision 1, of the ESBWR design control document.

To support the review schedule, you are requested to respond to this RAI by November 22, 2006.

If you have questions or comments concerning this matter, please 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
ESBWR/ABWR Projects Branch
Division of New Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 52-010

Enclosure: As stated

cc: See next page
ACCESSION NO. ML062760404

OFFICE	NESB/PM	NESB/BC(A)
NAME	LRossbach	JColaccino
DATE	10/04/2006	10/10/2006

OFFICIAL RECORD COPY

Distribution for DCD RAI Letter No. 67 dated October 10, 2006

Hard Copy
PUBLIC
NESB R/F
ACubbage
LRossbach

E-Mail
MGavrilas
JDanna
ACRS
OGC
KWinsberg
JColaccino
ACubbage
LRossbach
LQuinones
MBarillas
JGaslevic
TKevern
DAllen
MHartzman
JRajan
ALee
KPoertner
PYChen
TScarbrough
JHuang
GHammer
GBedi

Requests for Additional Information (RAIs)
ESBWR Design Control Document (DCD), Revision 1

Section 3.9.1, Special Topics for Mechanical Components

RAI Number	Reviewer	Question Summary	Full Text
3.9-3	Hartzman M	Section 3.9.1: why isn't Appendix S listed?	In DCD Tier 2, Section 3.9.1, provide justification for not listing Title 10 of the *Code of Federal Regulations,* Part 50, Appendix S as one of the requirements that form the basis for staff acceptance.
3.9-4	Hartzman M	Table 3.9-1: clarify if events equals cycles.	In DCD Tier 2, Table 3.9-1, provide clarification if the term "No. of Events" is synonymous with "cycles".
3.9-5	Hartzman M	Table 3.9-1: basis for events and number of events.	Discuss the basis for the Plant Operating Events and corresponding "number of events" listed in DCD Tier 2, Table 3.9-1.
3.9-6	Hartzman M	Table 3.9-1 Events 3 and 9: difference between 180 startups and 172 shutdowns.	Discuss the difference between the Event 3, Startup, events (180) and Event 9, Shutdown, events (172) in DCD Tier 2, Table 3.9-1.
3.9-7	Hartzman M	Table 3.9-1: basis for Dynamic Loading Events.	Discuss the basis of the "Dynamic Loading Events" in DCD Tier 2, Table 3.9-1.
3.9-8	Hartzman M	Table 3.9-1 Event 13: basis for 2 events/10 cycles.	Discuss the basis of "2 events/10 cycles per event" for Event 13 in DCD Tier 2, Table 3.9-1.
3.9-9	Hartzman M	Table 3.9-1 Event 14: basis for 1 cycle.	Discuss the basis for selecting 1 cycle for Event 14 in DCD Tier 2, Table 3.9-1.

Enclosure

RAI Number	Reviewer	Question Summary	Full Text
3.9-10	Hartzman M	Table 3.9-1 Event 16: basis for 1 event.	Discuss the basis for selecting 1 event for Event 16 in DCD Tier 2, Table 3.9-1.
3.9-11	Hartzman M	Table 3.9-1: confirm if for 60 years operation.	Provide confirmation that the transients in DCD Tier 2, Table 3.9-1 are valid for 60-year operation.
3.9-12	Hartzman M	Appendix 3D: provide information for each computer program.	In accordance with Standard Review Plan Section 3.9.1, provide the following information for each computer program listed in DCD Tier 2, Appendix 3D: 1) The author, source, dated version and facility, 2) the extent and limitation of its application, and 3) the method used to demonstrate its applicability and validity.
3.9-13	Hartzman M	Appendix 3D: verify if environmental effects included.	In DCD Tier 2, Appendix 3D verify that all computer programs used for calculating stresses and cumulative usage factors for Class 1, 2, and 3 components include staff endorsed environmental effects on the fatigue curves.
3.9-14	Hartzman M	Section 3.9.1.4: what computer program was used to evaluate stresses?	For each of the components listed in DCD Tier 2, Section 3D, provide the computer program that was used to evaluate the stresses for determining that the American Society of Mechanical Engineers Code Section III, Appendix F, limits were met.
3.9-15	Hartzman M	Section 3.9.1.4: describe inelastic analysis of control rod drive housing blowout.	Provide a description of the application of inelastic analysis in DCD Tier 2, Section 3.9.1.4 to demonstrate the acceptability of a postulated blowout of a control rod drive housing caused by a weld failure.
3.9-16	Hartzman M	Section 3.9.1.4: where were inelastic Service Level D limits met?	Identify the components where the inelastic Service Level D limits were met, under these postulated events in DCD Tier 2, Section 3.9.1.4.

Section 3.9.2, Dynamic Testing and Analysis of Systems, Components, and Equipment

RAI Number	Reviewer	Question Summary	Full Text
3.9-17	Rajan J	List high and moderate energy piping systems covered by the vibration and dynamic effects testing program and those exempted from it. Provide bases for these exemptions.	Provide a listing of the high and moderate energy piping systems which are covered by the vibration and dynamic effects testing program described in the DCD Tier 2, Section 3.9.2.1.1 and those that are exempted from it. Also provide the bases for these exemptions.
3.9-18	Rajan J	Identify which measurement technique (visual, local measurements, or remotely monitored/recorded measurements) will be used on each of the piping systems in the vibration and dynamic effects testing program.	In DCD Tier 2 Section 3.9.2.1.1, it is stated that there are essentially three methods available for determining the acceptability of steady state and transient vibration for the affected systems. These are visual observation, local measurements, and remotely monitored/recorded measurements. The technique used depends on a number of factors stated in the application. The staff finds this information inadequate to determine which specific measurement technique will be used for a particular system. Provide a listing of the systems to identify which measurement technique (visual observation, local measurements, or remotely monitored/recorded measurements) will be used on each of the piping system covered by the vibration and dynamic effects testing program.

3.9-19	Rajan J	Explain how the Level 1 and Level 2 criteria stated DCD Tier 2, Section 3.9.2.1.1 envelop all the piping systems, piping configurations, environments and materials.	It is stated in DCD Tier 2, Section 3.9.2.1.1 that for steady state vibration, the Level 1 criteria are based on 68.95 MPa (10,000 psi) maximum stress to assure no failure from fatigue over the life of the plant. The corresponding Level 2 criteria are based on one half the 68.95 MPa (10,000 psi) or 34.5 MPa (5,000 psi). Provide a detailed discussion to explain how these stress levels envelop all the piping systems, configurations, environments and materials. Alternately, provide a reference document which describes the vibration monitoring program.
3.9-20	Rajan J	Discuss in greater detail to explain how remote measurements are regularly checked during tests to verify compliance with acceptance criteria.	The discussion under 'Reconciliation and Corrective Actions' in DCD Tier 2, Section 3.9.2.1.1, does not clearly explain how remote measurements during testing would ensure compliance with the acceptance criteria. Discuss in greater detail to explain how remote measurements are regularly checked during tests to verify compliance with acceptance criteria. The discussion should cover the vibration measurement and analysis methodology including the approximate number of locations monitored, the specific systems covered by this monitoring, basis for selection of systems and locations as well as the instrumentation/analyzers used for such monitoring. Alternately, provide a reference document which describes the vibration/condition monitoring program.
3.9-21	Rajan J	Provide details of the piping system stress analysis methods used to determine acceptable thermal expansion limits. Identify and discuss the computer codes used.	Under 'Test and Evaluation Criteria' in DCD Tier 2, Section 3.9.2.1.2, it is stated that acceptable thermal expansion limits are determined after completion of piping system stress analysis and provided in piping test specification. No details are provided regarding the analytical methodology. Discuss methods used to anticipate piping movements and deflections. Also identify and discuss any computer codes used in the analysis and indicate whether or not these codes have been benchmarked or approved by the NRC. Alternately provide a reference document which describes the piping system stress analysis methodology.

3.9-22	Rajan J	List the different flow modes of operation and transients such as pump trips, valve closures, etc., to which the components will be subjected during the test.	There is insufficient information in DCD Tier 2, Section 3.9.2.1.1, relative to the flow modes of operation and transients. Therefore the applicant is requested to provide a listing of the different flow modes of operation and transients (such as pump trips, valve closures, etc.) to which the components will be subjected during the test. For example, the transients associated with the reactor coolant system heatup tests should include, but not necessarily be limited to: (1) Reactor coolant pump start (2) Reactor coolant pump trip (3) Operation of pressure-relieving valves (4) Closure of a turbine stop valve
3.9-23	Rajan J	List selected piping system locations for visual inspections and measurements during the tests. For each location provide the deflection (peak-to-peak) or other appropriate criteria, to be used.	There is insufficient information in DCD Tier 2, Section 3.9.2.1.1, relative to the visual inspections and measurements. Therefore the applicant is requested to provide a list of selected locations in the piping system at which visual inspections and measurements will be performed during the tests. For each of these selected locations, the deflection (peak-to-peak) or other appropriate criteria intended to be used to show that the stress and fatigue limits are within the design levels, should be provided.
3.9-24	Rajan J	COL applicant identify snubbers which experience enough thermal movement to measure snubber travel from cold to hot position.	A list of snubbers on systems which experience sufficient thermal movement to measure snubber travel from cold to hot position should be provided as part of the testing program, when the piping analysis is completed. This item should be identified as an action item for the Combined Operating License (COL) applicant and included in the list of action items to be completed by the COL applicant in the DCD Tier 2.

3.9-25	Rajan J	Describe the thermal motion monitoring program in more detail (verification of snubber movement, etc.) including acceptance criteria and how motion will be measured.	Provide a more detailed description of the thermal motion monitoring program for verification of snubber movement, adequate clearances and gaps, including acceptance criteria and how snubber motion will be measured. Alternately the applicant may provide a reference document which contains details of the thermal motion monitoring program.
3.9-26	Rajan J	Provide detailed information relative to corrective restraints, if vibration is noted beyond acceptable levels or no motion is observed at stations where large motion is predicted.	There is insufficient information in DCD Tier 2,Section 3.9.2.1.1 relative to the corrective restraints. In accordance with Standard Review Plan (SRP) 3.9.2, Draft Revision 3, April 1996, if vibration is noted beyond the acceptance levels, corrective restraints should be designed, incorporated in the piping system analysis, and installed. If during the test, piping system restraints are determined to be inadequate or are damaged, corrective restraints should be installed and another test should be performed to determine that the vibrations have been reduced to an acceptable level. If no snubber piston travel is measured at those stations where large motion is predicted, a description should be provided to address the identified discrepancy. Provide detailed information relative to corrective restraints.
3.9-27	Lee A	Provide a detailed discussion on the methods and criteria used for the design of the seismic Category I electrical raceway (cable trays, conduit and HVAC) supports.	In DCD Tier 2, Section 3.9.2, sufficient information is not provided for the qualification of Seismic Category I cable tray and conduit supports. Section 3.10.3.2 provided only limited information for loadings that are used for their design and analysis. Provide a detailed discussion on the methods and criteria used for the design of the seismic Category I electrical raceway (cable trays, conduit and heating, ventilation and air conditioning (HVAC)) supports, including the applicable codes, standards, and specifications used for the design. Also explain how the design would conform to the requirements of SRP 3.7.3.

3.9-28	Lee A	Discuss the methods used to calculate the representative snubber stiffness for each size, type, and design of snubbers.	DCD Tier 2, Section 3.7.3.3.1, states that the equivalent linear stiffness of the snubbers is based on actual dynamic tests performed on prototype snubber assemblies or on data provided by the vendor. Discuss the methods used to calculate the representative snubber stiffness for each different size, type, and design of snubbers.
3.9-29	Lee A	Revise the statements made in Section 3.7.3.3.2, fourth bullet, regarding conservative modeling for dynamic loads, or provide justification for the statements made.	DCD Tier 2, Section 3.7.3.3.2, fourth bullet, states that locating a mass at a point where the maximum displacement is expected to occur would tend to lower the natural frequencies of the equipment. It states that it is conservative because the equipment frequencies are in the higher spectral range of the response spectra. While these statements may be generally true for a seismic excitation, which has a predominant frequency content around 2 to 10 Hz, it may not be true for the equipment response under hydrodynamic loads, which typically have much higher frequency content. Similar concerns apply also to the statements made for the case of live loads and variable support stiffness. Revise the above statements or provide justification for the statements made.
3.9-30	Lee A	Provide supplementary information relating to several aspects of modeling consideration for the RPV and its major components.	DCD Tier 2, Section 3.7.2.3, states that the reactor pressure vessel (RPV), including its major internal components, is analyzed together with the primary structure using a coupled RPV and supporting structural model, as shown in Figure 3A.7-4 of DCD Tier 2. Provide the following information concerning the adequacy of the modeling for RPV and its internal components: (1) a detailed modeling consideration for each floor and/or nodal point of RPV and its major components, and sample calculations of lumped masses and stiffness properties; (2) considering that projected Safe Shutdown Earthquake (SSE) ground motion estimates in several future sites in the United States will likely possess high-frequency accelerations, as depicted in the ESBWR ground spectra, justify that the models are detailed enough (i.e., having sufficient dynamic degrees of freedom) to amplify high frequency inputs at 33 Hz to as high as 100 Hz; (3) address the concern in item (2) above considering the effects of suppression pool hydrodynamic loads; (4) the natural frequencies and mode shapes for the RPV and its major internal components generated from the seismic analysis,

			including the graphic representation of the mode shapes; (5) discuss the natural frequencies and mode shapes generated, and, based on that, justify the adequacy of the modeling; and (6) discuss any differences in dynamic modeling for the RPV and its internal components, between the ESBWR application and the Advanced Boiling Water Reactor (ABWR) design.
3.9-31	Lee A	Discuss in detail the modifications involved, and the acceptability of the modeling and analytical methodology used. Describe the Regulatory Guide 1.84 information to be provided to the NRC.	DCD Tier 2, Section 3.7.3.3.3, states that when the special engineered supports, described in Section 3.9.3.7.1(6), are used, modifications to the linear-elastic piping analysis methodology used with conventional pipe supports are needed to account for greater damping of the energy absorbers and the non-linear behavior of the limit stops. Discuss in detail the modifications involved, and the acceptability of the modeling and analytical methodology used. In addition, describe the information required by Regulatory Guide 1.84, Revision 33, August 2005, that shall be provided to the NRC for review.
3.9-32	Lee A	To simulate the dynamic effects of the non-Category I systems attached to Seismic Category I systems, clarify the design of the first anchor of the non-Category I system, beyond the interface.	DCD Tier 2, Section 3.7.3.8, states that to simulate the dynamic effects of the non-Category I systems attached to Seismic Category I systems, the attached non-Category I systems, up to the first anchor beyond the interface, are also designed in such a manner that during an earthquake of SSE intensity it does not cause a failure of the Seismic Category I system. Clarify that this designated first anchor is designed as a six-way restraint in the specific non-Category I system.

3.9-33	Lee A	Clarify what the "conservative manner" implicates in considering the effects of support displacements, and how it would be compared to the criteria of SRP 3.7.3.II.9.	In DCD Tier 2, Section 3.7.3.9, in regard to the effects of relative support displacements on the overall response of multi-supported systems (equipment and piping), the application states that the support displacements are imposed on the supported systems in a conservative manner and static analysis is performed for each orthogonal direction. Clarify what this "conservative manner" implicates, and how it would be compared to the criteria of SRP 3.7.3.II.9, which requires that the support displacements be imposed on the supported item in the "most unfavorable combination" using static analysis procedures.
3.9-34	Lee A	Explain how the subsystems, which are anchored and restrained to floors and walls of buildings, will be analyzed for both inertia response and the response due to differential anchor movements.	In DCD Tier 2, Section 3.7.3.12, for the effect of differential building movements, sufficient information is not provided for the analysis methodology of subsystems which are anchored and restrained to floors and walls of buildings that may experience relatively large differential displacements between separate buildings at a high seismic activity site. Explain how the subsystems will be analyzed for both inertia response and the response due to differential anchor movements.
3.9-35	Lee A	Discuss the effects of the additional flexibility between building model nodal point and the corresponding pipe support on the amplified response spectra, considering different varieties of pipe supports.	In DCD Tier 2, Section 3.7.2.3, for seismic analysis modeling, the amplified response spectra are generally specified at discrete building nodal points. No discussion is provided for the incorporation of any additional flexibility between these points and the pipe support (e.g., supplementary steel) in the piping analysis model. Provide a general discussion on the effects of this additional flexibility on the amplified response spectra, considering different varieties of pipe supports.

3.9-36	Lee A	In seismic analysis, when piping terminates at non-rigid equipment, discuss how the flexibility and mass effects of the equipment are incorporated into the analytical model.	In DCD Tier 2, Sections 3.7.2.3 and 3.9.2.2.2, for the seismic analysis of piping systems, no discussion is provided for the situations when piping terminates at non-rigid equipment (e.g., tanks, pumps, or heat exchangers), and how the piping analytical model would consider the flexibility and mass effects of the equipment. Discuss how the flexibility and mass effects of the non-rigid equipment attached to the piping are incorporated in the analytical model.
3.9-37	Lee A	Provide responses to questions regarding the acceptable criteria for decoupling small branch pipes from the analytical model used for the analysis of the main run pipe.	DCD Tier 2, Section 3.7.3.16, states the acceptable criteria for decoupling small branch pipes from the analytical model used for the analysis of the main run piping to which the branch lines are attached. Address the following questions: (1) the basis of using the ratio of run to branch pipe moment of inertia of 25 to 1 as one of the decoupling criteria; (2) since the "Suggested Piping Support Spacing" as tabulated in Table NF-3611-1 is for horizontal straight runs of standard and heavier piping, confirm that the small branch pipes in question are indeed all laid out horizontally; (3) since the above suggested pipe span is derived based on the assumption that there are no concentrated loads (such as flanges, valves, specialties, etc.) existing between supports, and that it is aimed to ensure that the pipe stress and deflection remain within allowable limits, explain how the suggested support span would ensure an adequate measure of branch line flexibility; (4) explain why the branch line would still offer sufficient flexibility to the main run pipe, if a concentrated mass, such as valve, is placed at the first one-half span length from the main run pipe, as stated in the DCD;

			(5) explain how the small branch line would still have adequate flexibility if its first anchor or restraint to movement is at one-half pipe span from the main run pipe, as stated in the DCD; (6) provide the basis of using one-half pipe span as the criteria for flexibility; and (7) demonstrate that the small branch pipe so designed will indeed offer adequate flexibility, in all three orthogonal directions, to the response of the main run pipe.
3.9-38	Lee A	Provide the criteria for decoupling small, Seismic Category II piping directly attached to Seismic Category I piping.	DCD Tier 2, Section 3.7.3.17, states that where small, Seismic Category II piping is directly attached to Seismic Category I piping, it can be decoupled from Seismic Category I piping. Provide the decoupling criteria.
3.9-39	Lee A	Explain how the 20 percent limit of composite damping was derived and how it can be justified.	DCD Tier 2, Section 3.7.2.13, states that the composite modal damping can be obtained either as stiffness-weighted or mass-weighted, and is limited to 20 percent. Explain how this 20 percent limit of damping was derived and how it can be justified.
3.9-40	Lee A	Revise the damping value used for the cable tray system.	In DCD Tier 2, Table 3.7-1 and Figure 3.7-36, a damping value of 20 percent is proposed for cable tray system (including supports) which are 50 percent to fully loaded. This is not consistent with the provisions of Regulatory Guide 1.61, Revision 0, October 1973. Revise the table and DCD Tier 2, Section 3.7.1.2, regarding the acceptable damping value for the cable tray system, including a detailed justification if the provisions of Regulatory Guide 1.61, Revision 0, October 1973, for damping are not met.

3.9-41	Lee A	Provide the analytical methodologies and criteria used for the design of the Seismic Category C-I and C-II buried piping and components. Clarify if buried piping will be in contact with the soil or routed in tunnels.	DCD Tier 2, Section 3.7.3.13, outlines information for the analysis of Seismic Category C-I or C-II buried piping, conduits, tunnels, and auxiliary systems. Provide the analytical methodologies and criteria used for the design of the buried piping and components, including references, codes, and standards used. Also, clarify whether the buried piping within the scope of design certification will be in contact with the soil or routed in tunnels.
3.9-42	Lee A	Identify all relevant codes and standards, and discuss their applicability for the seismic and dynamic qualification of all major mechanical equipment. Identify equipment to be seismically qualified by GE and available for staff audit.	DCD Tier 2, Section 3.9.2.2.1, "Tests and Analysis Criteria and Methods," does not discuss the codes and standards used for the seismic and dynamic qualification of mechanical equipment. Identify all relevant codes and standards, including their editions, and discuss their applicability for the seismic and dynamic qualification of all major mechanical equipment covered under Section 3.9.2.2.2. Also, identify the equipment that will be seismically qualified by GE and available for staff audit.

3.9-43	Lee A	Discuss the mathematical model of the CRD housing (including CRD) and the computer code used. Discuss the codes and standards used, stress limits, and input loading. Describe dynamic test model used for verification.	DCD Tier 2, Section 3.9.2.2.2, "Qualification of Safety-Related Mechanical Equipment," states that the qualification of the control rod drive (CRD) housing (with enclosed CRD) is done analytically, and the stress results of the analysis establish the structural integrity of these components. Discuss the mathematical model of the CRD housing (including CRD), and the computer code used for the analysis. Discuss the codes and standards used, the stress limits, and the input loading considered. For the verification of the control rod drive during a dynamic event, describe the dynamic test model used for the verification.
3.9-44	Lee A	Provide the combined RRS for each major building floor, and for each major safety-related mechanical equipment. Discuss how these combined RRS are derived.	In relation to DCD Tier 2, Section 3.9.2.2.2, "Qualification of Safety-Related Mechanical Equipment," for a dynamic loading event which involves both seismic and other reactor building vibration loads due to loss-of-coolant accident (LOCA) and safety relief valve (SRV) discharge, provide the combined required response spectra (RRS) for each major building floor, and for each major safety-related mechanical equipment. Discuss how these combined RRS are derived.
3.9-45	Lee A	For the case of equipment having supports with different dynamic motions, revise the statement made which stated that the most severe floor response spectrum is applied to all of the supports.	DCD Tier 2, Section 3.9.2.2.2, states that for the case of equipment having supports with different dynamic motions, the most severe floor response spectrum is applied to all of the supports. This is not consistent with the general guidance provided in SRP 3.9.2, Draft Revision 3, April 1996, Section II.2.g, where an upper bound envelop, instead of the most severe, of all the individual response spectra is required to calculate maximum inertial responses of multiply-supported items. Revise the statement accordingly.

3.9-46	Rajan J	Identify each of the major reactor internal component within the vessel that would be subjected to flow induced vibration testing.	It is stated in DCD Tier 2, Section 3.9.2.3 that the major reactor internal components within the vessel are subjected to extensive testing, coupled with dynamic system analyses, to properly evaluate the resulting flow-induced vibration phenomena during normal reactor operation and from anticipated operational transients. However, a complete listing of the major components has not been provided. Provide this listing and identify each of the major reactor internal component within the vessel that would be subjected to flow induced vibration testing.
3.9-47	Rajan J	Discuss GE's detailed analytical methodology to determine vibration forcing functions for obtaining operational flow transients and steady state conditions.	It is stated in DCD Tier 2, Section 3.9.2.3 that in general, the vibration forcing functions for operational flow transients and steady-state conditions are not predetermined by detailed analysis. Discuss GE's detailed analytical methodology to determine vibration forcing functions for obtaining operational flow transients and steady state conditions.
3.9-48	Rajan J	Provide details of the special analysis of the measured response signals from plants with similar reactor internals design to obtain amplitude and modal contributions in the vibration responses.	It is stated in DCD Tier 2, Section 3.9.2.3 that special analysis of the response signals measured from reactor internals of many similar designs is performed to obtain the parameters, which determine the amplitude and modal contributions in the vibration responses. Identify the specific parameters which are used to determine amplitude and modal contributions and explain with typical diagrams how these parameters are used in the special analysis.

3.9-49	Rajan J	Provide a listing of the plants which GE considers to have reactor internals similar to the ESBWR design.	It is stated in DCD Tier 2, Section 3.9.2.3 that response signals measured for reactor internals of many similar designs is performed to obtain the parameters, which determine the amplitude and modal contributions in the vibration responses. However, the specific plants which GE considers to be similar to the ESBWR design have not been specifically identified. Provide a listing of the plants which GE considers to have reactor internals similar to the ESBWR design and on what bases. Discuss the dissimilarities if any. Also discuss what impact they may have on the predicted results.
3.9-50	Rajan J	Discuss any differences between analytical models being used in the dynamic analysis of major components and subassemblies, and models used for Seismic Category 1 structures.	It is the staff's understanding that the models used for the dynamic analysis of the reactor internals are similar to the analysis models used for Seismic Category I structures outlined in DCD Tier 2, Section 3.7.2. Discuss any differences that may exist between the analytical models being used in the dynamic analysis of major components and subassemblies, and the models used for Seismic Category 1 structures in Section 3.7.2 of the DCD Tier 2, document.
3.9-51	Rajan J	Provide the extent of the variation in the response amplitude, in BWRs of differing size and design.	It is stated in DCD Tier 2, Section 3.9.2.3 that data from previous plant vibration measurements are assembled and examined to identify predominant vibration response modes of major components. In general, response modes are similar but response amplitudes vary among boiling water reactors (BWRs) of differing size and design. Provide the extent of the variation in the response amplitudes, in BWRs of differing size and design for selected typical major reactor internals components.

3.9-52	Rajan J	Identify all the parameters which are expected to influence vibration response amplitudes among the reference plants. Also discuss the relative significance of each parameter.	It is stated in DCD Tier 2, Section 3.9.2.3 that parameters are identified which are expected to influence vibration response amplitudes among the several reference plants. These include hydraulic parameters such as velocity and steam flow rates and structural parameters such as natural frequency and significant dimensions. Identify all the parameters which are expected to influence vibration response amplitudes among the reference plants. Also discuss the relative significance of each parameter.
3.9-53	Rajan J	Discuss the development of the correlation functions for the major components and response modes.	It is stated in DCD Tier 2, Section 3.9.2.3 that correlation functions of the variable parameters are developed such that, when multiplied by response amplitudes, they tend to minimize the statistical variability between plants. A correlation function is obtained for each major component and response. Discuss the development of the correlation functions for the major components and response modes with typical specific examples to show how multiplication by the response amplitude tends to minimize the statistical variability.
3.9-54	Rajan J	Explain how the predicted amplitude takes into account the degree of statistical variability.	It is stated in DCD Tier 2, Section 3.9.2.3 that the predicted amplitude for each dominant response mode is stated in terms of a range, taking into account the degree of statistical variability in each of the correlations. The predicted mode and frequency are obtained from the dynamic modal analyses. Explain with typical analytical data that the predicted amplitude takes into account the degree of statistical variability.
3.9-55	Rajan J	Demonstrate that dynamic loads caused by FIV from feedwater jet impingement have no significant impact on the steam separator assembly.	DCD Tier 2, Section 3.9.2.3 states that the dynamic loads caused by flow-induced vibration (FIV) from the feedwater jet impingement have no significant effect on the steam separator assembly. Analysis is performed to show that the impingement feedwater jet velocity is below the critical velocity. However no analytical methodology or quantitative data is provided. Provide quantitative analytical or test data to demonstrate that dynamic loads caused by FIV from the feedwater jet impingement have no significant impact on the steam separator assembly.

3.9-56	Rajan J	Show that the excitation frequency of the steam separator skirt is substantially different from the natural frequency of the skirt.	It is stated in DCD Tier 2, Section 3.9.2.3 that it can be shown that the excitation frequency of the steam separator skirt is very different from the natural frequency of the skirt. No additional rationale or analysis has been provided to demonstrate the validity of this statement. Provide the analysis or test data to show that the excitation frequency of the steam separator skirt is substantially different from the natural frequency of the skirt.
3.9-57	Rajan J	Provide drawings of the core support structures, the reactor vessel internals including the steam dryer, chimney, etc. Identify locations where stresses would be computed.	No drawings of the ESBWR reactor vessel internals, core support structures, steam dryer and chimney showing locations where predicted stress and displacements would be calculated, has been provided in DCD Tier 2, Section 3.9.2. Provide drawings of the core support structures, the reactor vessel internals including the steam dryer, chimney and other individual steam dryer components. Identify the locations where stresses would be computed.
3.9-58	Rajan J	Discuss the acoustic and computational fluid dynamic analyses to predict stresses at the locations to be monitored in the steam dryer.	There is no discussion in DCD Tier 2, Section 3.9.2.3 relative to the acoustic and computational fluid dynamic analyses to predict stresses at the locations to be monitored in the steam dryer. The applicant is requested to discuss the acoustic and computational fluid dynamic analyses to predict stresses at the locations to be monitored in the steam dryer.
3.9-59	Mulcahy T	Provide the FIV evaluations for the internal components.	FIV evaluation analyses are required for all components with significantly different features and loading conditions, per Regulatory Guide 1.20, Revision 2, May 1976, and SRP Section 3.9.2, Draft Revision 3, April 1996. Provide detailed descriptions of each of the components, their structural boundary conditions and finite element method modeling (including assumed damping), the flow conditions, the FIV load definitions, the modal characteristics, and results of the response analyses, including acceptance criteria.

3.9-60	Rajan J	Provide a list of the steady state and transient conditions of the natural circulation flow operation which are evaluated.	It is stated in DCD Tier 2, Section 3.9.2.4 that vibration measurements are made during reactor startup at conditions up to 100 percent rated flow and power. Steady state and transient conditions of natural circulation flow operation are evaluated during the initial startup testing. However, the steady state and transient conditions of the natural circulation flow operation have not been provided. Provide a complete list of the steady state and transient conditions of the natural circulation flow operation which are evaluated.
3.9-61	Rajan J	Clarify whether or not instrumentation will be mounted directly on the steam dryer at significant locations including the outer hood, skirt and all potential high stress locations.	It is stated in DCD Tier 2, Section 3.9.2.4 that accelerometers are provided with double integration signal conditioning to give a displacement output. A partial list of the sensor locations has been provided. It is not clear from the list whether or not instrumentation will be mounted directly on the steam dryer at all significant locations including the outer hood, skirt and all potential high stress areas. Provide this additional information.
3.9-62	Rajan J	Provide a discussion to demonstrate that the instrumentation mounted on the steam dryers provides sufficient information for stress analysis of all steam dryer and main steam system components.	The discussion provided in DCD Tier 2, Section 3.9.2.4 does not specifically address the steam dryer instrumentation and its capabilities. There is also no discussion on what data would be obtained from these sensors for a stress analysis of the steam dryer and main steam system components. Provide a discussion to demonstrate that the instrumentation mounted directly on the steam dryers shall provide sufficient information to perform an accurate stress analysis of all steam dryer and main steam system components and would include appropriate pressure sensors, strain gauges, and accelerometers.

3.9-63	Rajan J	Provide a discussion to demonstrate how the main steam lines in the ESBWR shall be instrumented in order to identify the presence of acoustic resonances.	The discussion provided in DCD Tier 2, Section 3.9.2.4 does not specifically address how the main steam lines in the ESBWR would be instrumented in order to identify the presence of acoustic resonances. Provide a discussion to demonstrate how the main steam lines in the ESBWR shall be instrumented to collect data to determine steam pressure fluctuations in order to identify the presence of acoustic resonances. Also discuss how the pressure fluctuations would be analyzed to determine steam dryer loading and stresses.
3.9-64	Rajan J	Discuss how the steam dryer data would be used to calibrate the main steam line instrumentation.	The discussion provided in DCD Tier 2, Section 3.9.2.4 does not specifically address how the steam dryer data would be used to calibrate the main steam line instrumentation and data analysis prior to the removal or failure of the steam dryer instrumentation. Provide a discussion to address this concern.
3.9-65	Rajan J	Clarify whether the steam, feedwater, and condensate lines and associated components shall be instrumented during the initial startup testing.	The discussion provided in DCD Tier 2, Section 3.9.2.4 does not specifically state that the steam, feedwater, and condensate lines and associated components shall be instrumented during the initial startup testing. Clarify whether these lines and associated components, including safety relief valves and power operated valves and their actuators will be instrumented to measure vibration during testing. Also discuss how this data would be used to demonstrate that short term and long term limits would not be exceeded for the piping and individual components.
3.9-66	Rajan J	Verify that the startup test procedure will include the stress limit curve to be applied for evaluating steam dryer performance.	The discussion provided in DCD Tier 2, Section 3.9.2.4 does not specifically state that the startup test procedure will include the stress limit curve to be applied for evaluating steam dryer performance. Verify that this curve would be included in the startup test procedure. Also provide the details of the stress limit curve which would be applied for the ESBWR steam dryer components.

3.9-67	Rajan J	Verify that during the ESBWR startup tests the procedures will include specific hold points for interaction with the NRC staff.	The discussion provided in DCD Tier 2, Section 3.9.2.4 does not specifically state that the startup test procedure will include specific hold points for interaction with the NRC staff. Verify that during the ESBWR startup tests the procedures will include specific hold points for interaction with the NRC staff. The activities to be accomplished during the power ascension should also be specified and the hold points should be of sufficient duration to accomplish those activities.
3.9-68	Rajan J	With respect to the steam, feedwater and condensate systems and components, discuss the plant parameters to be monitored during the hold points.	The discussion provided in DCD Tier 2, Section 3.9.2.4 does not specifically state which plant parameters will be monitored during the hold points on the steam, feedwater and condensate systems and components. Discuss the plant parameters which would be monitored during the hold points with respect to the steam, feedwater and condensate systems and components.
3.9-69	Rajan J	With respect to the steam, feedwater and condensate systems and components, discuss the methods which would be used for trending the parameters.	The discussion provided in DCD Tier 2, Section 3.9.2.4 does not specifically state how the ESBWR plant parameters would be trended. With respect to the steam, feedwater and condensate systems and components, discuss the methods which would be used for trending the plant parameters during the ESBWR startup tests.
3.9-70	Rajan J	Discuss the acceptance criteria for monitoring, trending and conducting the walkdowns and inspections relating to	The discussion provided in DCD Tier 2, Section 3.9.2.4 does not provide specific information on the acceptance criteria for monitoring, trending and inspection of the steam, feedwater, and condensate systems during ESBWR startup testing. The staff considers this information highly pertinent in evaluating the potential adverse flow effects, particularly on steam dryers and main steam system components. Discuss the acceptance criteria for monitoring, trending, and

		the steam, feedwater, and condensate systems during ESBWR startup tests.	conducting the walkdowns and inspections relating to the steam, feedwater, and condensate systems during ESBWR startup tests. Also discuss the actions to be taken if acceptance criteria are not satisfied.
3.9-71	Rajan J	Provide a discussion to clearly explain how the predicted and allowable amplitudes are obtained for the steam dryer at all significant locations including the outer hood, skirt and all potential high stress areas.	The discussion provided in DCD Tier 2, Section 3.9.2.4 does not specifically state how the predicted and allowable amplitudes are obtained for the steam dryer components at significant locations. Provide a discussion to clearly explain how the predicted and allowable amplitudes are obtained for the steam dryer at all significant locations including the outer hood, skirt and all potential high stress areas.
3.9-72	Mulcahy T	Provide a comprehensive DCD on the FIV evaluation of reactor internals.	GE's FIV evaluation program for the reactor internals is incomplete and difficult to comprehend, because the FIV program information is spread over DCD Tier 2, Sections 3.9.5, 3.9.2, Appendix 3L and a supplemental report (MFN 06-012, NEDE-33259P). Also, the different documents are not cross referenced and, clearly, additional reports are planned. Provide a revised and comprehensive DCD on the FIV evaluation of reactor internals.
3.9-73	Mulcahy T	Specify the instrumentation, the internals responses, and the flow conditions during startup testing.	In accordance with the guidance provided in Regulatory Guide 1.20, Revision 2, May 1976, and the SRP Section 3.9.2, Draft Revision 3, April 1996, the specifics of the instrumentation, the expected response, and the flow conditions for all components that will be instrumented during startup FIV testing, should be identified. Therefore the applicant is requested to provide the following additional information: (a) identify each component which is being instrumented and explain why it is being instrumented

			(b) provide the modal response characteristics and the specific locations and orientation of the sensors (c) describe the sensors, including their sensitivities and frequency responses (d) provide the expected response of the sensor for the flow conditions to be tested, as well as the test acceptance criteria for each sensor; and (e) justify the use of the sensor and its placement.
3.9-74	Mulcahy T	Clarify the reference to Section 3.9.7.1 regarding the information to be provided by the COL applicant.	It is stated in DCD Tier 2, Section 3.9.2.4, that the information that will be provided to the NRC by the COL applicant on the Startup FIV Program, is provided in Section 3.9.7.1 of DCD Tier 2. However it is the staff's understanding that this information is really provided in section 3.9.9 -COL Information, Section 3.9.9.1 - Reactor Internals Vibration Analysis, Measurement and Inspection Program. The applicant is requested to clarify this discrepancy and amend DCD Tier 2 accordingly.
3.9-75	Mulcahy T	Make revisions to DCD 3.9.9.1 terminology and information.	The use of the terms prototype and non-prototype in DCD Tier 2, Section 3.9.9.1 and GE Report MFN 06-012, NEDE-33259P are contradictory. Using Regulatory Guide 1.20, Revision 2, May 1976, revise DCD Tier 2, Section 3.9.9.1, including the information on startup testing that will be provided to the NRC.
3.9-76	Mulcahy T	Further justify lack of additional evaluations for the Sparger and Guide Rod.	In accordance with Regulatory Guide 1.20, Revision 2, May 1976, and SRP 3.9.2, Draft Revision 3, April 1996, guidelines, differences between the valid prototype and the non-prototype reactors will have no significant effects on the vibratory response of <u>any</u> of the components. The applicant is requested to identify and describe the structures and flow conditions in the valid prototype which correspond to the ESBWR Feedwater Sparger and the Chimney-Head and Steam-Dryer Guide Rod, and provide additional evaluation and evidence to show that the differences, if any, have no significant effects on the vibratory response. This information is considered pertinent in determining whether or not the ESBWR reactor internals can be classified as non-prototype Category II, in

			accordance with Regulatory Guide 1.20, Revision 2, May 1976, and SRP 3.9.2, Draft Revision 3, April 1996, guidelines.
3.9-77	Mulcahy T	Further justify lack of additional evaluations for the Top Guide Assembly.	In accordance with Regulatory Guide 1.20, Revision 2, May 1976, and SRP-3.9.2, Draft Revision 3, April 1996, guidelines, differences between the valid prototype and the non-prototype reactors will have no significant effects on the vibratory response of any of the components. The applicant is requested to describe the modifications made to the vibration analysis of the ABWR Top Guide Assembly used to predict the response of ESBWR's Guide. Demonstrate that the FIV response of ESBWR's Guide is not significantly modified by the structural differences with the ABWR's. In particular, discuss the modifications made to account for the differences in any cutout patterns in the Guides' plate, their diameters, and their attachments to the Shroud, and the Chimney or the Shroud Head. This information is considered pertinent in determining whether or not the ESBWR reactor internals can be classified as non-prototype Category II, in accordance with Regulatory Guide 1.20, Revision 2, May 1976, and SRP 3.9.2, Draft Revision 3, April 1996, guidelines.
3.9-78	Mulcahy T	Further justify lack of additional evaluations for the Core Plate	In GE Report MFN 06-012, NEDE-33259P, it is stated that the ESBWRs Core Plate requires no further evaluation for flow-induced vibrations (FIV), because it is similar to the ABWR's Core Plate which GE contends is a valid prototype of the ESBWR design. Show how the vibration analysis of the ABWR's Core Plate was modified to account for the structural differences with the ESBWR's Plate. Demonstrate that the ESBWR's FIV response is not significantly modified from the ABWR's. In particular, discuss the modifications made to account for any differences in the cutout patterns in the Core Plates, their diameters, and their attachments to the Shroud. The response should be in accordance with the guidelines of Regulatory Guide 1.20, Revision 2, May 1976, and SRP 3.9.2, Draft Revision 3, April 1996, which include that differences between the valid prototype and the non-prototype reactors will have no significant effects on the vibratory response of any of the components.

3.9-79	Mulcahy T	Further justify lack of additional evaluations for the CRDH, CRGD, ICMH, and the ICMGT.	Comparing ESBWR's DCD Tier 2, Fig. 3.9-3 and ABWR's DCD Tier 2, Fig. 3.9-2, the character and distribution of the flow below the core can be expected to be different because of the lack of Jet Pumps and the presence of 12 separate Shroud Supports. Explain these flow differences and how they will not have a significant effect on the FIV response of these ESBWR safety related components. In particular, include a discussion of the potential effects of organized wake flows downstream of the Shroud Supports. This information is considered pertinent in determining whether or not the ABWR reactor internals design is a valid prototype of the ESBWR design in accordance with Regulatory Guide 1.20, Revision 2, May 1976, and SRP 3.9.2, Draft Revision 3, April 1996, guidelines.
3.9-80	Mulcahy T	Further justify lack of additional evaluations for the ICMHs and the ICMGTs.	There appears to be a discrepancy between GE Report MFN 06-012, NEDE-33259P, and GE Report MFN 05-116, DCD Tier 2, Appendix 3L, as to the need for additional evaluations of the In-Core Monitor Housings (ICMH) and the In-Core Monitor Guide Tubes (ICMGT) of the ESBWR, both of which are safety-related components. The Appendix 3L recommends modeling the components as a continuously connected structure to accurately predict the vibration characteristics. GE Report MFN 06-012, NEDE-33259P treats the components as individual tubes, both for determination of vibration characteristics as well as for fluid loading (a single tube in crossflow). Clarify the vibration characteristics and fluid loading on the ICMHs, the ICMGTs, and the Stabilizer Bar Network. Explain how the FIV response of the ESBWR's components will not be significantly different from those of the ABWR. This information is considered pertinent in determining whether or not the ESBWR reactor internals can be classified as non-prototype Category II, in accordance with Regulatory Guide 1.20, Revision 2, May 1976, and SRP 3.9.2, Draft Revision 3, April 1996, guidelines.

3.9-81	Rajan J	Summarize analytical results that demonstrate no significant dynamic amplification of the loads on the reactor internals core support structures due to a main steam or feedwater line break.	It is stated in DCD Tier 2, Section 3.9.2.5 that the reactor internal pressure differentials due to an assumed break in main steam or feedwater line are determined by analysis as described in DCD Tier 2, Section 3.9.5.3. In order to assure that no significant dynamic amplification of load occurs as a result of the oscillatory nature of the blowdown forces during an accident, a comparison is made of the periods of the applied forces and the natural periods of the core support structures being acted upon by the applied forces. These periods are determined from a comprehensive vertical dynamic model of the reactor pressure vessel (RPV) and internals. Provide a summary of the analytical results that demonstrate no significant dynamic amplification of the loads on the reactor internals core support structures as a result of the postulated break in main steam or feedwater lines.
3.9-82	Rajan J	Explain how the presence of water is accounted for in the modeling of the reactor pressure vessel and internals.	It is stated in DCD Tier 2, Section 3.9.2.5 that the response of the RPV internals and core support structures to applied loads is determined from a comprehensive dynamic model of the RPV and internals. Besides the real masses of the RPV and core support structures, account is made for the water inside the RPV. Provide a discussion to explain how the presence of water is accounted for in the modeling of the reactor pressure vessel and internals.
3.9-83	Rajan J	Explain how the fluid-structure interaction effects are accounted for in the modeling of the reactor internals and dynamically related piping, pipe supports, components.	It is stated in DCD Tier 2, Section 3.9.2.5 that except for the nature and locations of the forcing functions, the dynamic model and the dynamic analysis method are identical to those for seismic analysis. The resulting loads on the reactor internals are shown in DCD Tier 2, Table 3.9-1. However, there is no discussion of the basis for the assumptions employed in the development of the dynamic reactor internals model. Provide a discussion to explain how the fluid-structure interaction effects are accounted for in the modeling of the reactor internals and dynamically related piping, pipe supports, components. In addition, describe with typical diagrams the basis for the assumptions employed in the development of the model.

3.9-84	Rajan J	Justify that the dynamic reactor internals model is representative of system structural characteristics.	It is stated in DCD Tier 2, Section 3.9.2.5 that the dynamic model and the dynamic analysis methods are identical to those for seismic analysis. Dynamic analysis is performed by coupling the lumped-mass model of the reactor vessel and internals with the building seismic model to determine the system natural frequencies and mode shapes. The loads on the reactor internals due to faulted event SSE are obtained from this analysis. However, there is no discussion relating to the reactor internals system characteristics such as mass inertia effect and damping. Provide a discussion to justify that the dynamic reactor internals model is representative of system structural characteristics, such as the flexibility, mass inertia effect, geometric configuration, and damping (including possible coexistence of viscous and Coulomb damping).
3.9-85	Rajan J	Discuss and provide justification for any system structural partitioning and directional decoupling employed in the dynamic system modeling of the reactor internals.	It is stated in DCD Tier 2, Section 3.9.2.5 that the dynamic model and the dynamic analysis methods for the reactor internals are similar to those described in DCD Tier 2, Sections 3.9.1.2 and 3.7. Dynamic analysis is performed by coupling the lumped-mass model of the reactor vessel and internals with the building seismic model to determine the system natural frequencies and mode shapes. However, there is no discussion regarding structural partitioning and directional decoupling that may have been employed. Discuss and provide justification for any system structural partitioning and directional decoupling employed in the dynamic system modeling of the reactor internals.
3.9-86	Rajan J	Explain how effects of flow upon the mass and flexibility properties of the system are incorporated in the lumped-mass model of the reactor vessel and internals.	It is stated in DCD Tier 2, Section 3.9.2.5 that the dynamic model and the dynamic analysis methods for the reactor internals are similar to those described in DCD Tier 2, Sections 3.9.1.2 and 3.7. Dynamic analysis is performed by coupling the lumped-mass model of the reactor vessel and internals with the building seismic model to determine the system natural frequencies and mode shapes. However, there is no discussion regarding any effects of flow upon the mass and flexibility properties of the system as described in SRP Section 3.9.2, Draft Revision 3, April 1996, Section II.5. Provide a discussion to explain how effects of flow upon the mass and flexibility properties of the system are incorporated in the lumped-mass model of the reactor vessel and internals.

3.9-87	Rajan J	Provide (a) Typical diagrams and the basis for postulating the pipe break-induced forcing function, etc. (b) Tests for determining flow coefficients, and any semi-empirical formulations and scaled model flow testing.	It is stated in DCD Tier 2, Section 3.9.2.5 that an assumed break of the main steam line, the feedwater line or the reactor water cleanup/shutdown cooling line at the reactor vessel nozzle results in jet reaction and impingement forces on the vessel and asymmetrical pressurization of the annulus between the reactor vessel and the shield wall. These time-varying pressures are applied to the dynamic model of the reactor vessel system. However, the discussion to explain the basis for developing the forcing function is inadequate. Therefore, the applicant is requested to provide the following: (a) Typical diagrams and the basis for postulating the pipe break-induced forcing function, including a description of the governing hydrodynamic equations and the assumptions used for flow path geometries, and, (b) Tests for determining flow coefficients, and any semi-empirical formulations and scaled model flow testing for determining pressure differentials or velocity distributions.
3.9-88	Rajan J	Describe the methods and procedures used for dynamic system analyses including the governing equations of motion and the computational scheme used to derive results.	It is stated in DCD Tier 2, Section 3.9.2.5 that the relative displacement, acceleration, and load response is determined by either the time-history method or the response-spectrum method. The loads on the reactor internals due to faulted event SSE are considered in combination with various LOCA loads. However the methods and procedures used in the dynamic system analysis have not been described in sufficient detail. Therefore, the applicant is requested to describe the methods and procedures used for dynamic system analyses including the governing equations of motion and the computational scheme used to derive results.
3.9-89	Rajan J	Identify the locations in the reactor internals where the stress, deformation and fatigue are highest. Also identify the loading combination.	It is not clear from the discussion in DCD Tier 2, Section 3.9.2.5 which subassemblies of the reactor internals experience the highest stress, deformation or fatigue under the faulted condition loadings. Therefore, the applicant is requested to identify the locations in the reactor internals where the stress, deformation and fatigue are determined to be highest. Also identify the corresponding loading combination.

3.9-90	Rajan J	Describe how the stability of the elements in compression such as the core barrel and control rod guide tubes, under pipe rupture loadings was investigated.	In DCD Tier 2, Section 3.9.2.5 there is no discussion regarding the stability of elements in compression under faulted condition loads. Therefore, the applicant is requested to describe how the stability of the elements in compression such as the core barrel and control rod guide tubes, under pipe rupture loadings was investigated.
3.9-91	Rajan J	Provide a comparison of the measured response frequencies with the analytically obtained natural frequencies of the reactor internals of the plant which GE considers to be similar to the ESBWR design.	It is stated in DCD Tier 2, Section 3.9.2 that the knowledge gained from previous vibration tests has been used in the generation of the dynamic models for the ESBWR plant to predict vibration amplitudes, natural frequencies and mode shapes. Therefore, the applicant is requested to provide a comparison of the measured response frequencies with the analytically obtained natural frequencies of the reactor internals of the plant which GE considers to be similar to the ESBWR design, for possible verification of the mathematical model used in the analysis.
3.9-92	Rajan J	Provide a comparison of the analytically obtained mode shapes with the shape of measured motion from the plant which GE considers to be similar to the ESBWR design.	It is stated in DCD Tier 2, Section 3.9.2 that the knowledge gained from previous vibration tests has been used in the generation of the dynamic models for the ESBWR plant to predict vibration amplitudes, natural frequencies and mode shapes. Therefore, the applicant is requested to provide a comparison of the analytically obtained mode shapes with the shape of measured motion from the plant which GE considers to be similar to the ESBWR design, for possible identification of the modal combination or verification of a specific mode.

3.9-93	Rajan J	Provide a comparison of the response amplitude time variation and the frequency content obtained from test and analysis conducted on the plant which GE considers to be similar to the ESBWR design.	It is stated in DCD Tier 2, Section 3.9.2 that the knowledge gained from previous vibration tests has been used in the generation of the dynamic models for the ESBWR plant to predict vibration amplitudes, natural frequencies and mode shapes. Therefore, the applicant is requested to provide a comparison of the response amplitude time variation and the frequency content obtained from test and analysis conducted on the plant which GE considers to be similar to the ESBWR design, for possible verification of the postulated forcing function.
3.9-94	Rajan J	Provide a comparison of the maximum responses obtained from test and analysis conducted on the plant which GE considers to be similar to the ESBWR design.	It is stated in DCD Tier 2, Section 3.9.2 that the knowledge gained from previous vibration tests has been used in the generation of the dynamic models for the ESBWR plant to predict vibration amplitudes, natural frequencies and mode shapes. Therefore, the applicant is requested to provide a comparison of the maximum responses obtained from test and analysis conducted on the plant which GE considers to be similar to the ESBWR design, for possible verification of stress levels.

3.9-95	Rajan J	Provide a comparison of the mathematical model used for dynamic system analysis under operational flow transients and under the combined LOCA and SSE loadings, for the similar plant to note similarities.	It is stated in DCD Tier 2, Section 3.9.2.6, that the knowledge gained from previous vibration tests has been used in the generation of the dynamic models for the ESBWR plant to predict vibration amplitudes, natural frequencies and mode shapes. Therefore, the applicant is requested to provide a comparison of the mathematical model used for dynamic system analysis under operational flow transients and under the combined LOCA and SSE loadings, for the similar plant to note similarities.
3.9-96	Rajan J	Identify the differences in the tests that were conducted on the plant which GE considers to be similar to the ESBWR design and the ones that GE proposes to do on the first ESBWR plant.	It is stated in DCD Tier 2, Section 3.9.2.4 that the first ESBWR plant will be instrumented for testing. However, it can be subjected to startup flow testing only to demonstrate that the flow induced vibrations similar to those expected during operation do not cause damage. The applicant is requested to explain why the testing for the first ESBWR plant is restricted only to those aspects that are perceived to demonstrate that the flow induced vibrations expected during operation do not cause damage. Identify the differences in the tests that were conducted on the plant which GE considers to be prototypical of the ESBWR reactor internals design and those tests which GE proposes to conduct on the reactor internal of the first ESBWR plant. It is the staff's understanding that GE contends that ESBWR reactor internals fall in the classification of Non-Prototype Category II. Therefore, the applicant is requested to discuss how its testing program is consistent with the vibration assessment program delineated in Regulatory Position C.2.2 of Regulatory Guide 1.20, Revision 2, May 1976, associated with the testing program for Non-Prototype Category II reactor internals.

Section 3.9.3, ASME Code Class 1, 2, and 3 Components, Component Supports, and Core Support Structures

RAI Number	Reviewer	Question Summary	Full Text
3.9-97	Hartzman M	Explanation of how requirements in 10 CFR 50.55a(b) are met.	DCD Tier 2, Table 1.9-22, identifies the 2004 edition of the ASME Code, Section III, as applicable to the design of components, component supports and core support structures. Confirm that the requirements of 10 CFR 50.55a(b) will be met without exception.
3.9-98	Hartzman M	Justification for the exclusion of inertia loads in Table 3.9-2, footnote 12.	In DCD Tier 2 Table 3.9-2, footnote 12, provide justification for excluding seismic inertia loading in the calculation of ASME Code Sections NC/ND-3600 Equation (9), Service Levels A and B, and Equations (10) and (11).
3.9-99	Hartzman M	Basis for correlation between plant conditions and probability ranges.	In DCD Tier 2, Section 3.9.3.1.1, provide the basis for the correlation between the plant conditions and the associated probability ranges. Also indicate the application of these probabilities to the events listed under Plant Events.
3.9-100	Hartzman M	Analysis of the reactor pressure vessel.	Provide a listing and description of the computer programs and calculational procedures used for the analysis of the reactor pressure vessel and the reactor pressure vessel internals, including the core support structures.
3.9-101	Hartzman M	Confirmation that the stresses in main steam Class 1 piping meet the 3Sm criterion.	DCD Tier 2 Table 3.9-9 lists the acceptance criteria for Service Level A and B, Equations 12 and 13 as ≤ 3.0 Sm. In DCD Tier 2 Section 3.9.3.3, confirm that the stresses in the main steam Class 1 piping meet these criteria.

3.9-102	Hartzman M	Verification that all ESBWR safety related components are included in DCD Tier 2 Sections 3.9.3 and 3.9.4.	Provide verification that DCD Tier 2, Sections 3.9.3 and 3.9.4 address all ESBWR pressure boundary safety-related components and component supports.
3.9-103	Hartzman M	Confirmation of design criteria for components required to remain operational.	In DCD Tier 2, Section 3.9.3, provide a table similar to Table 3.9-9 showing the load combinations and acceptance criteria for safety related active valves and pressure relief devices. Provide confirmation that safety related components and component supports required to remain operational and to perform a safety function after a specified plant condition event are designed to lower ASME Section III service level stress criteria.
3.9-104	Hartzman M	Description of Section 4.4 of the GE environmental Qualification Program.	In DCD Tier 2, Section 3.9.3.5, provide a description of Section 4.4 of the GE Environmental Qualification Program. Indicate if this program has been reviewed and approved by the NRC.
3.9-105	Hartzman M	Confirmation that stresses in valve bodies do not exceed the elastic limit.	In DCD Tier 2, Section 3.9.3.5, provide confirmation that the stresses in active valve bodies and pump casings loading conform with the requirements in Standard Review Plan (SRP) Section 3.10, Draft Revision 3, April 1996, for faulted conditions.
3.9-106	Hartzman M	Dynamic load qualification of a representative active valve.	In DCD Tier 2, Section 3.9.3.5.2, provide a detailed description of the Dynamic Load Qualification that demonstrates the functionality and operability of a representative active valve.
3.9-107	Hartzman M	Documentation of safety-related valves.	In DCD Tier 2, Section 3.9.3.5, provide a list of the Design Reports documenting the qualification of the safety-related valves. Confirm that the Design Reports meet the requirements stated in ASME Section III NCA 3550.
3.9-108	Hartzman M	Verification of the design and installation of pressure relief devices.	In DCD Tier 2, Section 3.9.3.6, provide verification that the design and installation of pressure relief devices is in accordance with the provisions in SRP 3.9.3, Draft Revision 2, April 1996, Section II.2.

3.9-109	Hartzman M	TMI Action Item II.D.1 of NUREG-0737.	In DCD Tier 2, Section 3.9.3.6, provide a detailed description of the tests that are conducted to address the testing requirements in TMI Action Item II.D.1 of NUREG-0737, or provide a reference in DCD Tier 2 where this is discussed.
3.9-110	Hartzman M	Documentation of pressure relief devices.	In DCD Tier 2, provide a list of the Design Reports documenting the qualification of the pressure relief devices. Confirm that the Design Reports meet the requirements stated in ASME Section III NCA 3550.
3.9-111	Lee A	Provide the definition and the basis of such definition for the Seismic Category IIA pipe supports.	DCD Tier 2, Section 3.9.3.7, does not discuss Seismic Category IIA pipe supports. Clarify and discuss how the provisions of Regulatory Guide 1.29, Revision 3, September 1978, are addressed in regard to Seismic Category IIA pipe supports.
3.9-112	Lee A	Discussion on the kind of building structure component supports which are being designed in accordance with ANSI/AISC N690 or AISC Specification, and explain how these component supports correspond to those used for design of the supported pipe.	DCD Tier 2, Section 3.9.3.7.1, states that the building structure component supports designed in accordance with ANSI/AISC N690 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. Provide a discussion on the types of component supports which are being designed in accordance with the ANSI/AISC N690 or AISC Specification, and explain how these component supports correspond to those used for design of the supported pipe. In addition, since the staff accepts ANSI/AISC N690, 1994 Edition, for certain types of component supports, only if it is applied in conjunction with Supplement No. 2 to the standard, confirm that the correct edition and supplement are being used.

3.9-113	Lee A	Provide detailed information on the component support service stress limits, and the support deformation limits under both static and dynamic loadings.	In DCD Tier 2, Section 3.9.3.7, sufficient information is not provided for component support service stress limits and deformation limits under both static and dynamic loadings. Provide the following information: (1) for each loading combination considered for each component support, describe the designation of the appropriate service stress limit, and discuss its conformance to the criteria provided in Section II.3 and Appendix A of SRP 3.9.3, Draft Revision 2, April 1996, Section II.3, and Regulatory Guides 1.124, Revision 1, January 1978, and 1.130, Revision 1, October 1978; (2) discuss how the support deformation limits are incorporated into the operability assurance determination and seismic qualification program of the components; (3) provide examples of the deformation limits considered for the supports, considering the types of supports, their characteristics (such as stiffness), and the components or structures that they are attached to; and (4) clarify whether the above design criteria also apply to snubbers used as supports for active components.
3.9-114	Lee A	Discuss snubber end fitting clearance and lost motion, their effect on the calculations of snubber reaction loads and stresses, the potential impact of end fitting clearance and lost motion, and load sharing of multiple snubber supports.	In DCD Tier 2, Section 3.9.3.7.1(3), sufficient information is not provided for potential snubber end fitting clearance and lost motion. Discuss how snubber end fitting clearance and lost motion are managed, and how they affect the calculations of snubber reaction loads and stresses using a linear analysis methodology. In multiple snubber applications where mismatch of end fitting clearance and lost motion exist, discuss their potential impact on the synchronism of activation level or release rate, and, consequently, the assumption of the load sharing of multiple snubber supports.

3.9-115	Lee A	Provide a detailed discussion on the characterization of effective stiffness for the snubber support assembly (i.e., the snubber plus clamp, transition tube extension, back-up support structure, etc.) used in the analytical model.	In DCD Tier 2, Section 3.9.3.7.1(3), sufficient information is not provided for the characterization of snubber mechanical properties (i.e., spring rates) in the analytical model. Provide a detailed discussion on the characterization of effective stiffness for the snubber support assembly (i.e., the snubber plus clamp, transition tube extension, back-up support structure, etc.) used in the analytical model, both during the initial estimation and the refined piping analysis.
3.9-116	Lee A	Discuss the design rule for snubbers. Discuss in detail how the load capacity for both mechanical and hydraulic snubbers will be calculated and examined for design, normal, upset, emergency and faulted conditions.	In DCD Tier 2, Section 3.9.3.7.1(3), sufficient information is not provided for the specific design rules of Subsection NF used for snubbers. Provide such design rules for snubbers, namely, the rules for design by analysis, by experimental stress analysis, or by load rating. Discuss in detail how the load capacity for design, normal, upset, emergency and faulted conditions will be calculated and examined for both mechanical and hydraulic snubbers.
3.9-117	Lee A	(1) discuss the production test and the qualification test programs, for both the mechanical and hydraulic snubbers; (2) discuss how the criteria are met in the testing; and (3) provide the codes and standards used for the programs.	In DCD Tier 2, Section 3.9.3.7.1(3)c(ii), certain test requirements are provided for snubbers to ensure that they can perform as required under all pertinent loading conditions. In connection with the stated test requirements, (1) discuss the procedure and scope of production test and the qualification test programs, separately, for both the mechanical and hydraulic snubbers, of different sizes and manufacturers; (2) discuss how the criteria of each pertinent snubber functional parameters are met in the testing; and

			(3) provide the codes and standards used for the programs.
3.9-118	Lee A	Explain how the force or displacement versus time are related to the velocity and acceleration parameters measured in a snubber testing. Also explain how displacements are measured to determine the performance characteristics specified in the test.	DCD Tier 2, Section 3.9.3.7.1(3)c(ii), states that snubbers are subjected to force or displacement versus time loading at frequencies within the range of significant modes of the piping system. Clarify how the force or displacement versus time loading as stated are related to the velocity and acceleration parameters measured in a snubber testing. Also explain how displacements are measured to determine the performance characteristics specified in the test.
3.9-119	Lee A	COL holders should verify the operability of essential snubbers by verifying proper installation and by performing visual inspections and measurements of cold and hot positions of the snubbers.	In conformance with DCD Tier 2, Section 3.9.3.7.1, COL holders should verify the operability of essential snubbers by verifying the proper installation of the snubbers, and by performing visual inspections and measurements of the cold and hot positions of the snubbers as required during plant heat-up to verify that the snubbers are performing as intended. This issue is not currently addressed in Section 3.9.9 of the DCD Tier 2. Provide the rationale for the exclusion of this item from the listing of COL action items.
3.9-120	Lee A	Confirm that snubber pre-service examination requirements meet the intent of the design Code of record Clarify that during initial system heat-up and cool-down, snubber thermal movements will be verified according to Code.	In DCD Tier 2, Section 3.9.3.7.1(3)e, there is no reference to the codes and standards used, and there is no regulatory basis provided. Confirm that the snubber pre-service examination requirements meet the intent of the design Code of record incorporated by reference in 10CFR 50.55a. Also, clarify that during initial system heat-up and cool-down, snubber thermal movements will be verified according to an acceptable Code requirement.

3.9-121	Lee A	Provide a detailed discussion on snubber pre-service testing requirements, including the codes and standards used and the specific test parameters considered.	In DCD Tier 2, Section 3.9.3.7.1, sufficient information is not provided for snubber pre-service testing. Provide a detailed discussion of snubber pre-service testing requirements, including the codes and standards used and the specific test parameters considered.
3.9-122	Lee A	COL holders should provide the necessary information regarding snubber surveillance programs.	In conformance with DCD Tier 2, Section 3.9.3.7.1, COL holders should provide the following snubber surveillance information: (1) the scope of the snubber in-service examination program, including the codes and standards used and the specific examination parameters considered; (2) the scope of the snubber in-service testing program, including the codes and standards used and the specific test parameters considered; and (3) a detailed discussion on the accessibility provisions for maintenance, in-service examination and testing, and possible repair or replacement of snubbers consistent with the requirements of SRP Section 3.9.3, Draft Revision 2, April 1996. The above information is currently not included in Section 3.9.9 of DCD Tier 2. Provide the rationale for the exclusion of the information from the listing of COL action items.
3.9-123	Lee A	Demonstrate that the plant-specific design specification will include adequate snubber information. Confirm that the snubber manufacturer will be submitting its quality assurance and assembly quality control procedures.	To ensure that the plant-specific snubber programs will be readily available for a site audit, demonstrate , such as by a COL action item, that the plant-specific design specification will include the following specific snubber information: (i) the general functional requirement, (ii) operating environment, (iii) applicable codes and standards,

			(iv) materials of construction and standards for hydraulic fluids and lubricants, (v) environmental, structural, and performance design verification tests, (vi) production unit functional verification tests and certification, (vii) packaging, shipping, handling, and storage requirements, and (viii) description of provisions for attachments and installation. In addition, confirm that the snubber manufacturer will be submitting its quality assurance and assembly quality control procedures for review and acceptance by the purchaser.
3.9-124	Lee A	COL holders should provide a table in FSAR which contains and identifies all safety-related components utilizing snubbers in their support systems.	DCD Tier 2, Section 3.9.3.7.1, should say that COL holders should provide, consistent with the requirements of SRP 3.9.3, Draft Revision 2, April 1996, Subsection II.3.b(7), a table in the FSAR which contains all safety-related components utilizing snubbers in their support systems, and includes (i) identification of the systems and components in those systems which utilize snubbers; (ii) the number of snubbers utilized in each system and on components in that system; (iii) the type(s) of snubber (hydraulic or mechanical) with the corresponding supplier identified; (iv) specify whether the snubber was constructed to the rules of ASME Code Section III, Subsection NF, or others as specified; (v) state whether the snubber is used as a shock, vibration, or dual purpose snubber; and (vi) for snubbers identified as either dual purpose or vibration arrester type, indicate if both snubber and component were evaluated for fatigue strength. This item is not included in Section 3.9.9 of DCD Tier 2. Provide rationale for excluding this item from the listing of COL action items.

3.9-125	Lee A	Provide sufficient information concerning the design of frame-type pipe supports.	DCD Tier 2, Section 3.9.3.7.1(5), does not provide sufficient information regarding the design of frame-type pipe supports. Discuss the following: (1) the hot and cold gaps to be used between the pipe and the frame-type support, (2) the coefficients of friction used for different pipe and support material combinations, and the calculation of friction forces induced by the pipe on the support; and (3) how the seismic excitation of a large frame-type support structure itself is considered in the design of the support anchorage.
3.9-126	Lee A	Discuss the analytical models and the methods of analysis used for all major ASME Code Class 1 component supports, including snubbers.	In DCD Tier 2, Section 3.9.3.7, provide a discussion of the analytical models and the methods of analysis used for all major ASME Code Class 1 component supports, including snubbers.

Section 3.9.4, Control Rod Drive (CRD) System

RAI Number	Reviewer	Question Summary	Full Text
3.9-127	Poertner K	Revise HCU Quality Group requirements	The Hydraulic Control Unit (HCU) and subcomponents are identified as Quality Group D. However, consistent with SRP 3.2.2, Revision 1, July 1981, and Draft Revision 2, April 1996, and Regulatory Guide 1.26, Revision 3, February 1976, guidance regarding components designed for reactor shutdown, these should be Quality Group B components. It is the staff position that, because of the safety importance of the reactivity control function, all HCU assemblies and subcomponents, must be designated Quality Group B components. Please revise the DCD accordingly.
3.9-128	Poertner K	Clarify design requirements for non-pressure retaining portions of FMCRD	The pressure retaining portions of the Fine-Motion Control Rod Drive (FMCRD) are identified as Quality Group A components. FMCRD internals are not identified as either Quality Group A, B, or C. Please provide information on the quality group criteria, design criteria, and allowable stress criteria used for the FMCRD non-pressure retaining components.
3.9-129	Poertner K	Clarify magnetic coupling capabilities/testing	The FMCRD incorporates an electro-mechanical brake keyed to the motor shaft and a magnetic coupling. The magnetic coupling is designed so that its maximum coupling torque exceeds the maximum torque of the motor unit to prevent decoupling or slippage due to motor torque. Please provide data/testing requirements that ensure that the magnetic coupling will meet the 49 N-m (minimum) braking torque of the electro-mechanical brake.

3.9-130	Poertner K	Clarify FMCRD design, design life, and life cycle program	The ESBWR FMCRD appears to be similar in design to the Advanced Boiling Water Reactor FMCRD. Please provide a description of the mechanical differences between the two FMCRDs. Please provide information on the design life of the ESBWR FMCRD and an overview of the FMCRD life cycle maintenance program.
3.9-131	Poertner K	Clarify ESBWR FMCRD developmental activities.	Please provide a description of the ESBWR FMCRD developmental process/tests that demonstrate ESBWR FMCRD performance under actual Boiling Water Reactor operating conditions.

Section 3.9.5, Reactor Pressure Vessel Internals

RAI Number	Reviewer	Question Summary	Full Text
3.9-132	Chen PY Scarbrough T	Provide detailed descriptions of some reactor internal components, and FIV analysis for those components.	As discussed in DCD Tier 2, Appendix 3L (GE Report MFN 05-116), related to flow-induced vibration (FIV), GE indicated that many of the reactor internal components require additional analysis to demonstrate their design adequacy. Further, FIV evaluation analyses are required for all components with significantly different features and loading conditions from valid prototype reactor internals, per Regulatory Guide 1.20, Revision 2, May 1981, and SRP Section 3.9.5, Draft Revision 3, April 1996. GE is requested to provide detailed descriptions of the components, their boundary conditions, the load definitions, design criteria, bias errors and uncertainties, and the evaluation analyses for the ESBWR's Shroud/Chimney assembly, the Chimney Head/Steam Separator Assembly, the Standby Liquid Control lines, the Control Rod Guide Tubes and Housings, the In-Core Monitor Guide Tubes and Housings, the Chimney Partition, and the Steam Dryer.
3.9-133	Chen PY Scarbrough T	Clarify the instrumentation that will be installed on the steam dryer, MSLs, and steam system components.	It is not clear whether GE has committed to install instrumentation on the steam dryer in the prototype ESBWR plant for FIV response during power ascension. Although test and instrumentation plans are described in the report for some components, and GE lists the differences between the ESBWR and past BWR dryers in DCD Tier 2, Section 3L.5.5.1.3, stating that 'these differences warrant a detailed vibration analysis and test monitoring'; Item 5 in DCD Tier 2, Section 3L.2.1 (page 3L-4) implies that GE might submit a supplemental report asserting that 'FIV will not be an issue' for various components, which might include the steam dryer. Also, DCD Tier 2, Table 3L-4 lists many sensors that might be installed on the prototype steam dryer, and includes several caveats in the last column stating 'if problem occurs'. GE is requested to clarify the instrumentation that will be installed on the steam dryer, the main steam

			lines (MSLs), and steam system components, in the ESBWR prototype plant for FIV response during the startup power ascension. Also, GE is requested to clarify whether data for all equipment listed in DCD Tier 2, Table 3L-4 will be acquired during testing.
3.9-134	Chen PY Scarbrough T	Describe the design of the ESBWR SRV standpipes, justify the frequency limit for FIV testing based on the SRV standpipe design, and submit a list of instrumentation planned for the SRVs and MSLs.	GE states that most recent BWR steam dryer fatigue failures have been caused by ‘strong narrow-band pressure loads’ at frequencies between 120 and 200 Hz that emanate from acoustic resonances in the safety relief valve (SRV) standpipes (DCD Tier 2, Section 3L.4.4, page 3L-8), and that ‘the ESBWR SRV standpipe design is intended to reduce or eliminate acoustic resonances in these branch lines’. a. GE is requested to describe the design of the ESBWR SRV standpipes summarizing (1) dimensions of the SRVs, standpipes, and the MSLs; (2) expected steam flow speeds near the SRV standpipes; (3) plant power levels at which acoustic resonances in the standpipes might be strongly excited, along with the frequencies of the resonances and their expected amplitudes; and (4) the proximity of various SRVs to each other on individual MSLs. b. GE plans to limit the data acquisition, signal processing, and data interpretation of all FIV testing during prototype ESBWR power ascension to frequencies below 200 Hz (and, in some cases, below 100 Hz), as shown in DCD Tier 2, Tables 3L-5 and 3L-6, and described in DCD Tier 2, Section 3L.5.4. GE is requested to justify this frequency limit based on submission of complete SRV standpipe ESBWR design criteria in part (a). c. In addition to the instrumentation for the steam dryer in the prototype ESBWR for FIV testing, GE is requested to submit a list of instrumentation planned for the SRVs and MSLs, and justification where such instrumentation will not be installed.

3.9-135	Chen PY Scarbrough T	Describe the load definition and stress analysis for ESBWR steam dryer, and confirm the same by using actual data during plant operation.	GE is requested to describe in detail (1) the source of the load definition of the ESBWR steam dryer, (2) the validation of the methodology used in developing the load definition, (3) the stress analysis performed using the load definition, (4) the error and uncertainties associated with the each aspect of the analysis, (5) the application of the error and uncertainties in the stress analysis, (6) the stress analysis results and comparison to acceptance criteria, and (7) the plans to confirm the steam dryer load definition and stress analysis using actual steam dryer data during plant operation.
3.9-136	Chen PY Scarbrough T	Submit the LIA method along with any data measured in the SMT for assessing the integrity of ESBWR steam dryer, and also submit the benchmarking information related to the prediction of frequency content of the forcing functions.	GE describes its procedure for assessing the integrity of the ESBWR steam dryer in Section 3L.4 of DCD, Tier 2, Appendix 3L. The procedure for defining the fluctuating pressure loads acting on the steam dryer is described in Section 3L.4.4, and uses a 'Load Interpolation Algorithm' (LIA) to compute a fine discretization of pressure time histories over the steam dryer surfaces based on measurements made in GE's scale model test (SMT) facility in Sunol, CA. The LIA includes acoustic finite element models as part of its load estimating process. (a) GE is requested to submit the LIA method for review (including the Acoustic Finite Element modeling (AFEM) procedures), along with any data measured in the SMT that substantiates the method. Also, the documentation of uncertainties and bias errors in the LIA and AFEM is requested. (b) GE asserts that the BWR/3 configuration of the SMT facility has been benchmarked against plant data acquired from an instrumented dryer that confirms its capability to predict steam dryer acoustic load definitions. Per SRP Section 3.9.2, Draft Revision 3, April 1996, GE is requested to submit this benchmarking information, along with an assessment of the SMT uncertainties and bias errors. Particular emphasis should be placed on confirming that the SMT can be used to predict the frequency content of the forcing

			functions associated with acoustic flow tones (or singing) caused by flow over the branch lines for MSL safety and relief valves.
3.9-137	Chen PY Scarbrough T	Discuss the planned impact hammer testing and the determination of the damping of the ESBWR steam dryer.	In Section 3.L.4.6 of DCD, Tier 2, Appendix 3L, GE describes potential steam dryer FIV measurements, including determination of the steam dryer as-built modal parameters. Impact hammer testing will be used to determine the natural frequencies, mode shapes, and damping of the steam dryer components. The data will be used to verify portions of the steam dryer analytical models. (a) GE is requested to discuss the planned impact hammer testing (e.g., will the testing be conducted outside the plant, or with the steam dryer installed in the plant, with the skirt partially immersed in water) for the purposes of determination of the steam dryer as-built modal parameters. (b) Per SRP Section 3.9.2, Draft Revision 3, April 1996, GE is requested to discuss the determination of the damping of the ESBWR steam dryer, and how the damping will be applied to their stress analysis models of the steam dryer.
3.9-138	Chen PY Scarbrough T	Describe the specific instrumentation for the ESBWR steam dryer and other reactor internal structures.	In Table 3L-4 of DCD, Tier 2, Appendix 3L, GE lists sensors that may be mounted to the steam dryer, the reactor dome, and other structures. Describe the specific instrumentation, including the number of sensors and locations, to measure pressure, strain, and acceleration of steam dryer components for the purpose of providing sufficient information to evaluate the performance of the ESBWR steam dryer and to assess its continued structural capability during plant operation. As part of this description, GE is requested to explain the instrumentation specifications, including the following:

			(a) How many accelerometers will be mounted to the steam dryer support ring and in what direction(s) will they be oriented? (b) How many accelerometers will be mounted to the steam dryer skirt, and how many in circumferential positions? (c) In what orientation(s) will the strain gages on the steam dryer hood, steam dryer drain channels, and steam dryer skirt be mounted? How many strain gages will be mounted at the above locations? (d) How many strain gages will be mounted to the shroud, in what orientation(s), and in how many circumferential positions? (e) Clarify the meaning of 'steam dryer FIV instrument post' for the pressure transducer to be mounted in the Vessel Dome Region.
3.9-139	Chen PY Scarbrough T	Explain the steam dryer instrument limits for each type of instrumentation and provide corrective action if the limits are exceeded.	In Section 3L.4 of DCD, Tier 2, Appendix 3L, GE explains how the steam dryer instrumentation (strain gages, accelerometers, and pressure transducers) will be monitored against established limits. (a) GE is requested to explain the determination of those limits for each type of instrumentation, particularly for the pressure transducers. (b) Per SRP Section 3.9.2, Draft Revision 3, April 1996, GE is requested to list the corrective actions to be taken if the limit curves are exceeded, and the steam dryer stresses are deemed not acceptable for higher plant power operation.
3.9-140	Chen PY Scarbrough T	Provide the details of the Chimney Partition evaluation analysis related to FIV.	Section 3L.3 of DCD, Tier 2, Appendix 3L describes how GE has assessed the structural integrity of the Chimney Partition assembly using scale model testing, computational flow analyses, and finite element modeling and stress analysis. GE computed a maximum stress of 41 MPa using static analyses (based on their determination of a 2 Hz

			pressure fluctuation in the partition flow), which is less than the allowable 68.95 MPa established by ASME design codes. Details of the Chimney Partition evaluation analysis were not presented. (a) GE is requested to provide the flow conditions for which the two-phase pressure measurements were made on the Chimney Partition and to provide the prototype conditions that they simulate, and describe the expected steam/water mixture flow rates and speeds through the Chimney Partitions. Also, provide the magnitude and frequency content of the associated loads. GE is requested to discuss how the loading conditions due to flow in the mixing chamber at the top of the chimney were included in the two-phase load definition on the partitions. (b) GE is requested to explain how fluid loading (due to exterior water, and interior steam/water mixture) was considered in their finite element model (FEM), and the effects of the fluid loading on the model response at 2 Hz. Also, discuss the damping assumed in the chimney FEM, including the damping due to the fluid loading. (c) GE is requested to describe the structural attachments and constraints of the Chimney Partitions and the Chimney, and to provide the justification for the modeling of the boundary conditions in the FEM analysis.
3.9-141	Chen PY Scarbrough T	Provide ABWR or other valid prototype steam dryer FIV data relevant to the ESBWR design criteria, and estimate any differences between the	In GE Report MFN 06-012 (NEDE-33259P), GE describes testing of the prototype ABWR plant in Japan, and provides a table of selected FIV parameters measured in the ABWR and estimated for the ESBWR. However, GE did not include steam dryer data in the table. To justify GE's classification of the ESBWR dryer as a Category II Non-Prototype (per Regulatory Guide 1.20, Revision 2, May 1981), GE is requested to provide ABWR or other valid prototype steam dryer FIV data relevant to the ESBWR design criteria, such as the presence of any strong tones in

		ABWR or other valid prototype, and ESBWR steam dryer FIV response.	the fluctuating pressure loads incident on the steam dryer surfaces. Also, GE is requested to estimate any differences between the ABWR or other valid prototype, and ESBWR steam dryer FIV response.
3.9-142	Chen PY Scarbrough T	Quantify expected fluctuating pressure loads (if any) from various RPV inlet and outlet nozzles.	GE is requested to explain what fluctuating pressure loads are expected to emanate from the various nozzles in the reactor pressure vessel adjacent to the chimney. This explanation should include the Reactor Water Cleanup and Shutdown Cooling (RWCU/SDC) nozzle, the Isolation Condenser (IC) return nozzle, and the Gravity-Driven Cooling System (GDCS) nozzle near the chimney side walls as shown in Figure 2 on page 15 of the GE report (NEDE-33259P).
3.9-143	Chen PY Scarbrough T	Assess the design adequacy of CRGT and CRDH subject to FIV in the event of failure of the weld at the nozzle in the bottom of the reactor vessel.	In Section 4.1.2.2 of the DCD Tier 2, GE stated that individual fuel assemblies in groups of four rest on orificed fuel supports that are mounted on top of the control rod guide tubes (CRGT). Each guide tube, with its orificed fuel support, bears the weight of four fuel assemblies and is supported on a CRD Housing (CRDH) penetration nozzle in the bottom of the reactor vessel. It appears that the weld at the nozzle is subjected to the weight of four fuel assemblies, orificed fuel support, CRGT and CRDH, and other vertical and horizontal loads. GE is requested to clarify the load path and ensure the weld at the nozzle is adequate to accommodate these loads. In the event of weld failure, GE is requested to assess the adequacy of the CRGT and the CRDH subjected to flow-induced vibrations, and the ability to insert the control rod, considering the boundary conditions at the top of the CRGT and failed weld, and the CRGT base coupling connection with the CRDH.

3.9-144	Chen PY Scarbrough T	Describe the power ascension plan for the ESBWR related to the FIV of ESBWR steam dryer and main steam systems.	A. Describe the power ascension plan for the ESBWR that includes the following aspects: (a) For initial startup, plant data at the ESBWR will be collected from instrumentation mounted directly on the steam dryer at significant locations (including the outer hood and skirt, and other potential high stress locations) to verify that the stress on individual steam dryer components is within allowable limits during plant operation. (b) The instrumentation directly mounted on the steam dryer will provide sufficient information to perform an accurate stress analysis of all steam dryer components, and will include pressure sensors, strain gages, and accelerometers. (c) The main steam lines in the ESBWR will be instrumented to collect data to determine steam pressure fluctuations in order to identify the presence of acoustic resonances and to allow the analysis of those pressure fluctuations to calculate steam dryer loading and stress. (d) The direct steam dryer data will be used to calibrate the MSL instrumentation and data analysis prior to the removal or failure of the steam dryer instrumentation. (e) The steam, feedwater, and condensate lines and associated components, including safety relief valves and power-operated valves and their actuators, will be instrumented to measure vibration during plant operation to demonstrate that short-term and long-term qualification limits are not exceeded for the piping and individual components.

			B. Describe the ESBWR startup test procedure that includes the following: (a) the stress limit curve to be applied for evaluating steam dryer performance; (b) specific hold points and their duration during power ascension with sufficient time intervals for interaction with NRC staff during power ascension; (c) activities to be accomplished during hold points that are of sufficient duration to accomplish those activities; (d) plant parameters to be monitored; (e) inspections and walkdowns to be conducted for steam, feedwater, and condensate systems and components during the hold points; (f) the method to be used to trend plant parameters; (g) acceptance criteria for monitoring and trending plant parameters, and conducting the walkdowns and inspections; and, (h) actions to be taken if acceptance criteria are not satisfied.
3.9-145	Chen PY Scarbrough T	Describe the validation of the TRACG computer code for determining reactor internals pressure differences.	As indicated in DCD Tier 2, Section 3.9.5.3, GE has identified loading conditions for reactor internals. GE states that it has used the TRACG computer code to determine pressure differences for reactor internals during the events under different operating conditions. GE is requested to describe the validation of this computer code in calculating the pressure differences for reactor internals during the events under normal, upset, emergency and faulted conditions.

3.9-146	Chen PY Scarbrough T	Describe the capability of the TRACG computer code to calculate the spatial pressure variation.	Table 3.9-3 of ESBWR Design Control Document, Tier 2, provides 11.2 kPaD (kilopascal differential) as the maximum pressure difference for the steam dryer. However, there is likely to be a significant pressure variation across the outer hood of the steam dryer. GE is requested to describe the capability of the TRACG computer code to calculate such spatial pressure variation.
3.9-147	Chen PY Scarbrough T	Explain how the fluid loading on the reactor internals are verified for FIV analysis and testing.	Since the natural circulation of the working fluid in the ESBWR is a new feature and only occurs when the fuel assemblies generate heat, GE is requested to justify that the flow velocities and their distribution over the reactor internals are verified for FIV analysis and testing, per SRP Section 3.9.2, Draft Revision 3, April 1996.
3.9-148	Chen PY Scarbrough T	Identify the Subsection NG paragraph from which the stress, deformation, and fatigue criteria are derived. Also, identify and justify the other criteria that are used as the basis to develop the stress, deformation, and fatigue criteria.	As indicated in DCD Tier 2, Section 3.9.5.4, GE stated that the design and construction of the core support structures are in accordance with the ASME Code, Subsection NG. GE is requested to identify the specific paragraphs of Subsection NG that are followed for the design and construction of the core support structures. In addition, in Tables 3.9-4 through 3.9-7 of DCD Tier 2, GE provides the stress, deformation, and fatigue criteria for safety-related reactor internals (except core support structures), which are based on the criteria established in applicable codes and standards for similar equipment, by manufacturers' standards, or by empirical methods based on field experience and testing. GE is requested to: (1) identify which specific paragraphs of Subsection NG from which these criteria are derived, or (2) if other than the ASME Code is used, identify and justify the other criteria (based on manufacturers' standards or empirical methods) that are used as the basis to develop the stress, deformation, and fatigue criteria for safety-related reactor internals.

3.9-149	Chen PY Scarbrough T	Provide the technical basis for the General Limit listed in Table 3.9-4.	Table 3.9-4 of the DCD, Tier 2, provides deformation limits for safety class reactor internal structures. GE is requested to provide the technical basis for the General Limit listed in the table.
3.9-150	Chen PY Scarbrough T	Explain how the calculated modal responses of the reactor internals will be verified.	Since there will be no preoperational FIV testing of the ESBWR because it operates in a natural recirculation mode (as noted in Section 3.9.2.4 of the DCD, Tier 2), GE is requested to discuss how the FEM's computed natural vibration modes (vibration predictions) of the reactor internal components will be correlated with test data, as specified in SRP Section 3.9.5, Draft Revision 3, April 1996, and SRP Section 3.9.2, Draft Revision 3, April 1996, Item 4.
3.9-151	Chen PY Scarbrough T	Describe the information that COL applicants need to provide related to the reactor internals, including steam dryer instrumentation.	GE is requested to describe the reactor internals vibration analysis, measurement and inspection information that the first COL applicant and the subsequent COL applicants need to provide, at the time of application, related to reactor vessel internals, including the core-support structures, beyond the information specified in Section 3.9.9.1 of DCD Tier 2. In addition, describe the plans for steam dryer instrumentation to confirm the stress analysis for ESBWRs to be constructed subsequent to the prototype.

Section 3.9.6, In-Service Testing of Pumps and Valves

RAI Number	Reviewer	Question Summary	Full Text
3.9-152	Huang J	Section 3.9.6-IST scope for pumps and valves	Identify the systems and associated pumps and valves that are required to perform a specific function in shutting down a reactor to the safe shutdown condition, in maintaining the safe shutdown condition, or in mitigating the consequences of an accident (including long term residual heat removal following an accident), and revise DCD Tier 2, Table 3.9-8 on In-Service Testing (IST) for pumps and valves accordingly.
3.9-153	Huang J	Section 3.9.6 design and qualification of safety-related pumps	Describe the method for the functional design and qualification of each safety-related pump for demonstrating the capacity of the pump to perform its intended safety function.
3.9-154	Huang J Poertner K	Section 3.9.6 - acceptance criteria for CV non-intrusive technique	The applicant stated in response to RAI 3.9-2 that during normal reactor operations the Gravity-Driven Cooling System (GDCS) bias-open check valve (CV) will be actuated remotely through the use of a non-intrusive magnetically coupled torque-motor. Describe the acceptance criteria and basis for the acceptance criteria to assess degradation and the performance characteristics of the CV. Discuss how the operation and accuracy of the diagnostic equipment and techniques will be verified during preoperational testing.
3.9-155	Huang J Poertner K	Section 3.9.6 - GDCS bias-open CV ΔP	Due to the thermal expansion of the water, pressure between the GDCS squib valve and bias-open CV will increase and, potentially cause the CV to close. Following the closure, the pressure will continue to increase to a higher value. Therefore, the DCD should provide the ΔP (both design and maximum expected) information for design and qualification of the CV.

3.9-156	Huang J Poertner K	Section 3.9.6 - GDCS bias-open CV design flow and minimum flow	The staff requested information (RAI 3.9-2) for the design flow for lifting the GDCS CV disc to the full open position and the minimum flow expected or available for holding the disc in a stable open position during the period when the valve is called upon to perform its safety function. This information is necessary during qualification and preservice tests for assuring that the valve and piping are adequately designed and installed to attain the minimum flow that will be required for maintaining the disc in a stable full open position.
3.9-157	Huang J Poertner K	Section 3.9.6 - GDCS bias-open CV hinge pin wear	As started in the response to RAI 3.9-2, hinge pin wear has been identified as major failure mode for the GDCS bias-open CV. Discuss the stability of the disc in its bias-open position during operation when flow oscillation may occur due to heat transfer and boiling effect of the water between the squib valve and check valve and also discuss a method of monitoring the condition of the hinge pin.
3.9-158	Huang J Poertner K	Section 3.9.6-all CVs	A. Describe how the test results will identify the flow required to open the valve and maintain the disc in a stable full open position. B. Describe the nonintrusive techniques and acceptance criteria (if different from that used for biased-open CV) used to periodically assess degradation and the performance of CVs.
3.9-159	Huang J	Section 3.9.6 - justification for RO test frequency for valves	In DCD Tier 2, Table 3.9-8 for IST, refueling outage (RO) test frequency is proposed for certain valves. The vendors for new reactors, for which the final designs are not complete, have sufficient time to include provisions in their valve and piping system designs to allow the Code-required quarterly testing. Therefore, the applicant should provide justifications for each valve as to why ESBWR can not be designed to accommodate the quarterly test.
3.9-160	Huang J	Section 3.9.6 - functional design and qualification test for squib valves	Describe the method for functional design and qualification including acceptance criteria for demonstrating that the squib valves will perform their function for a range of system pressure, pressure differential, temperature and ambient conditions from normal operating up to design-basis conditions.

3.9-161	Scarbrough T	Section 3.9.6 - functional design and qualification test for POVs	Describe the method for functional design and qualification for each power operated valve (POV) with safety-functions used in the ESBWR.
3.9-162	Scarbrough T	Section 3.9.6 - MOV testing requirements	DCD Tier 2, Section 3.9.6.1 states that the COL holder will meet the ISTC provisions for inservice testing (IST) of motor-operated valves (MOVs) in the ESBWR. Discuss the requirements for supplementing the MOV stroke-time provisions in Section ISTC of the ASME OM Code with a program for periodic verification of the design-basis capability of safety-related MOVs as indicated in 10 CFR 50.55a.
3.9-163	Scarbrough T	Section 3.9.6 - POV other than MOV testing requirements	Discuss the requirements to provide for periodic verification of the design-basis capability of POVs other than MOVs with safety functions in the ESBWR.
3.9-164	Hammer G	Section 3.9.6 - qualification of containment boundary valves	Identify any pressure relief devices which are part of the reactor containment boundary and verify that all of them are designed and qualified to meet ASME Section III requirements for Class 2 components. Also, verify that these devices are included in the IST program.
3.9-165	Hammer G	Section 3.9.6 - qualification of containment vacuum breakers	Provide information which demonstrates that the containment vacuum breaker valves and suppression pool vents have been designed, qualified, and capacity certified to meet ASME Section III requirements for Class 2 components. Verify that these devices are included in the IST program.
3.9-166	Hammer G	Section 3.9.6 - thermally-induced pressurization of containment isolation penetrations	Verify that all sections of containment penetration piping which may be isolated with trapped liquid are protected from thermally-induced pressurization by a pressure relief device. Verify that these devices are included in the IST program. Identify those sections of isolated piping which are protected from excessive pressurization by other methods and describe the methods. Verify that the resulting thermally-induced pressurization and resulting differential pressure loads on isolation valves do not exceed that for which the valves are qualified.

3.9-167	Hammer G	Section 3.9.3 - thermally-induced pressurization of piping and valves	Describe any non-containment isolation configurations where thermally-induced pressurization may be possible, and describe how excessive pressurization is prevented and how isolation valves remain operable, as necessary. Verify that any pressure relief devices are included in the IST program.
3.9-168	Hammer G	Section 3.9.6 - scope of valves designed to meet ASME Section III	Verify that all relief devices which perform a function of providing pressure relief to ensure the integrity of safety-related structures, systems, or components are designed, qualified, and capacity certified to meet all applicable requirements of ASME Section III and are included in the IST program. Specifically, in addition to any other systems which provide a safety-related function, provide this information for the following systems: the reactor coolant system, the main steam system, the facility and auxiliary pool cooling system, the shutdown cooling/standby liquid control system, the control rod drive system, the plant service water system, and the reactor building component cooling water systems.
3.9-169	Hammer G	Section 3.9.3 -piping and valve load interaction	For all relief devices which perform a function of providing pressure relief to ensure the integrity of safety-related structures, systems, or components, verify that all valve discharge fluid dynamic loads have been included in the analysis of the upstream and downstream piping. Also, verify that the fluid dynamic loads imposed by the piping onto the relief devices do not exceed those for which the valve has been qualified to open and close, as required.
3.9-170	Hammer G	Section 3.9.6 - specific valve information	Provide a list of all safety-related relief devices credited with providing pressure relief in the plant safety analysis. For these devices, please provide the associated system design pressures, the device design set pressures and tolerances, and the certified relief capacities.

3.9-171	Hammer G	Sections 5.2.2, and 6.3.2 - squib valve function	The depressurization valves and other squib valves employ squib explosives to actuate the valves open. The proper actuation depends on a high rate and high total amount of energy release to generate very localized heat and pressurization to break the tension bolt which normally holds the valve disk closed. Provide information regarding how the squib explosives are qualified to ensure proper rate and total amount of energy release for proper valve actuation, under limiting environmental and aging conditions. Are there a lower acceptable rate and total amount of energy release which ensure that the valves properly actuate, and could lower rates than these values result in melting or loss of pressure boundary integrity of upper valve parts, or would this simply result in failure of the valves to open? Provide information regarding the sample IST of the squib explosives which demonstrates that the rates and total amounts of energy release are acceptable.
3.9-172	Hammer G	Sections 5.2.2 and 6.3.2 - squib valve function	The squib valves have a piston which shears the disk to the open position when the valves are actuated. Below the piston is a travel space. Provide information regarding how the space below the piston is prevented from being pressure locked with liquid, either by leakage or diffusion. Are there provisions for draining or venting? Is this space monitored for presence of liquid?
3.9-173	Hammer G	Section 5.2.2 - S/RV rupture disk design and testing	Verify that the Safety/Relief Valve (S/RV) rupture disks meet ASME Section III requirements and are included in the IST program.

3.9-174	Bedi G	Section 3.9.6 - IST program for snubbers	ISTA-1000 of the OM Code provides preservice and IST requirements to be applied to dynamic restraints (snubbers) used in systems that perform a specific function in shutting down a reactor to the safe shutdown condition, in maintaining the safe shutdown condition, or in mitigating the consequence of an accident. Subsection ISTD of OM Code specifies IST requirements for snubbers. Provide detailed information or a program for implementing the IST requirements of snubbers.
3.9-175	Bedi G	Section 3.9.6 - functional design and qualification for snubbers	Describe the method for functional design and qualification for snubbers.

ESBWR Mailing List

cc:

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

Mr. George B. Stramback
Manager, Regulatory Services
GE Nuclear Energy
1989 Little Orchard Street, M/C 747
San Jose, CA 95125

Mr. David Lochbaum, Nuclear Safety Engineer
Union of Concerned Scientists
1707 H Street, NW., Suite 600
Washington, DC 20006-3919

Mr. Paul Gunter
Nuclear Information & Resource Service
1424 16th Street, NW, Suite 404
Washington, DC 20036

Mr. James Riccio
Greenpeace
702 H Street, Suite 300
Washington, DC 20001

Mr. Adrian Heymer
Nuclear Energy Institute
Suite 400
1776 I Street, NW
Washington, DC 20006-3708

Mr. Paul Leventhal
Nuclear Control Institute
1000 Connecticut Avenue, NW
Suite 410
Washington, DC 20036

Mr. Ron Simard
6170 Masters Club Drive
Suwanne, GA 30024

Mr. Brendan Hoffman
Research Associate on Nuclear Energy and Environmental Program
215 Pennsylvania Avenue, SE
Washington, DC 20003

Mr, Jay M. Gutierrez
Morgan, Lewis & Bockius, LLP
1111 Pennsylvania Avenue, NW
Washington, DC 20004

Mr. Glenn H. Archinoff
AECL Technologies
481 North Frederick Avenue
Suite 405
Gaithersburg, MD 20877

Mr. Gary Wright, Director
Division of Nuclear Facility Safety
Illinois Emergency Management Agency
1035 Outer Park Drive
Springfield, IL 62704

Mr. Charles Brinkman
Westinghouse Electric Co.
Washington Operations
12300 Twinbrook Pkwy., Suite 330
Rockville, MD 20852

Mr. Ronald P. Vijuk
Manager of Passive Plant Engineering
AP1000 Project
Westinghouse Electric Company
P. O. Box 355
Pittsburgh, PA 15230-0355

Mr. Ed Wallace, General Manager Projects
PBMR Pty LTD
PO Box 9396
Centurion 0046
Republic of South Africa

Mr. Russell Bell
Nuclear Energy Institute
Suite 400
1776 I Street, NW
Washington, DC 20006-3708

Ms. Sandra Sloan
Areva NP, Inc.
3315 Old Forest Road
P.O. Box 10935
Lynchburg, VA 24506-0935

Mr. Robert E. Sweeney
IBEX ESI
4641 Montgomery Avenue
Suite 350
Bethesda, MD 20814

Mr. Eugene S. Grecheck
Vice President, Nuclear Support Services
Dominion Energy, Inc.
5000 Dominion Blvd.
Glen Allen, VA 23060

Mr. George A. Zinke
Manager, Project Management
Nuclear Business Development
Entergy Nuclear, M-ECH-683
1340 Echelon Parkway
Jackson, MS 39213

E-Mail:
tom.miller@hq.doe.gov or
tom.miller@ nuclear.energy.gov
sfrantz@morganlewis.com
ksutton@morganlewis.com
jgutierrez@morganlewis.com
mwetterhahn@winston.com
whorin@winston.com
gcesare@enercon.com
jerald.holm@framatome-anp.com
erg-xl@cox.net
joseph_hegner@dom.com
mark.beaumont@wsms.com
steven.hucik@ge.com
patriciaL.campbell@ge.com
bob.brown@ge.com
david.hinds@ge.com
chris.maslak@ge.com
James1.Beard@ge.com
kathy.sedney@ge.com
mgiles@entergy.com
tansel.selekler@nuclear.energy.gov or
tansel.selekler@hq.doe.gov
Frostie.white@ge.com
David.piepmeyer@ge.com
george.stramback@gene.ge.com