AUDIT TRIP REPORT

Purpose: Audit of GE's Economic Simplified Boiling Water Reactor (ESBWR) Piping Design Criteria, Sample Analyses, Design Procedures and Specifications; and Discussion of RAI Responses

Location: GE Nuclear Energy, Wilmington, NC

Dates: May 22-26, 2006

NRC Participants: John Fair (NRC), Larry Rossbach (NRC), Mark Lesser (NRC/RII - for Monday), Paul Kaufman (NRC/RI - for Monday-Wednesday), Mano Subudhi (BNL), Joe Braverman (BNL) - (See Attachment 1)

GE Participants: David Hinds, Rick Kingston, Jerry Deaver, Henry Hwang, Kirti Doshi, Teresa Dominguez (Empresarios Agrupados-Spain), Pedro Santiago (EA-Spain), Tomas Romero (EA-Spain) - (See Attachment 1)

I. PURPOSE AND SCOPE

The purpose of this audit was to review the General Electric (GE) proposed piping design criteria and sample analyses for the Economic Simplified Boiling Water Reactor (ESBWR). The staff is performing this review as part of the 10 CFR Part 52 design certification process for the ESBWR.

In reviewing the ESBWR piping design criteria, the staff had identified a number of areas for which GE did not provide design and engineering information that was consistent with current staff positions or at a level of detail reviewed by the staff in reaching a final safety determination for the ABWR. As a result, the staff issued a request for additional information (RAI) regarding the information submitted by GE in the ESBWR Design Control Document (DCD). During the audit, the staff provided comments on GE's response to the RAI.

During the audit, the staff requested GE to provide the piping design procedures and two sample calculations of the main steam (MS) piping system which demonstrate the implementation of the DCD design criteria and the GE piping design procedures. In addition, the staff requested the validation and verification records for computer codes used in piping analysis and design. GE provided specification documents for piping system analysis and design methods and two sample pipe stress reports for staff review. The staff and its consultants from Brookhaven National Laboratory (BNL) concentrated on reviewing the design procedures, acceptance criteria and sample calculations. This included identification of additional documents needed to complete the review. Also, information needed to perform confirmatory analyses of the sample piping system by BNL was requested.

II. SUMMARY OF EFFORTS

The audit items covered and discussed during this audit are presented in Appendix A. The audit began on Monday morning with introductory comments by NRC staff members, John Fair (ESBWR Piping Design Lead) and Larry Rossbach (ESBWR PM). Also attending the audit were Mark Lesser from NRC Region II (for Monday only) and Paul Kaufman from NRC Region I (for Monday thru Wednesday). John stated that the goals of this audit were to (1) discuss GE's RAI responses, (2) review GE design procedures, and (3) identify information needed for BNL to perform an independent confirmatory analysis of a piping system.

The audit proceeded with GE staff presenting and explaining their design criteria document. The audit team discussed all request for additional information (RAI) issues and GE's responses to these RAIs sent to the staff in a letter dated May 3, 2006. Also, new questions were raised and discussed on issues as they came up while reviewing the documents provided by GE. Audit item sheets were used to document and track specific questions and concerns that were raised and discussed (see Appendices B and C). A total of 37 RAIs on the DCD and 8 additional audit items were discussed and technical agreement was reached in many cases. GE will prepare written responses and proposed changes to the DCD for staff evaluation at a later date. The audit team spent most of the first day discussing the staff's concerns on the 37 RAI responses. During the next two days, the audit team reviewed GE analysis methods, design specifications, analysis reports, design related documents and the two sample piping calculations of the MS piping system. On Thursday, the staff discussed and evaluated GE's proposed resolution of all 37 RAIs and 8 audit items. This continued next day until the exit meeting at 10 AM.

GE was not able to provide all of the design record files (DRFs - containing calculations, assumptions and input information) for each of the two MS piping analyses, although GE did provide all computer input and output and additional backup information. GE engineers and its consultants from the Empresarios Agrupados, Spain were available to discuss and respond to technical questions from the reviewers.

At the conclusion of the audit, the staff conducted an exit briefing in a public meeting and discussed the overall findings, highlighting the significant issues.

III. QUESTIONS AND CONCERNS

The following is a summary of the questions and concerns raised by the audit team. They are documented in the RAI and audit item sheets in Appendices B and C, respectively. A summary of discussions and GE commitments is included where applicable.

1. RAI RESPONSES (See Appendix B)

Prior to the audit, the staff evaluated the design acceptance criteria for the ESBWR piping system design documented in the DCD, Tier 2 (Rev. 01), submitted by GE. A total of 37 RAIs were sent to GE to address various design aspects of the ESBWR piping and pipe supports. These include clarifying some statements in the DCD, missing criteria, and providing technical justification for those criteria which deviate from NRC regulatory guidance documents and current staff positions. In a letter dated May 3, 2006, GE provided responses to the RAIs, and the staff reviewed and assessed them prior to this audit. Based on this, it was necessary for

the staff to have a face-to-face discussion with the GE staff in order to resolve them satisfactorily. During the audit, the NRC staff discussed each RAI with the GE staff and a summary of the final status is given below.

• Resolved RAIs	1
• RAI response accepted based on GE proposed commitment	18
• Need revised and/or a complete response to the RAI	11
• Unresolved and considered significant RAIs	7
Total:	37 RAIs

GE agreed to resubmit all responses to the RAIs at a later date after revising them. Out of 37 RAIs, only one RAI was completely resolved based on the GE response and proposed changes to the DCD (Rev. 02) submitted in GE's letter dated May 3, 2006. The staff accepted the explanations and technical justifications provided during the audit on 18 RAIs and GE will include them in the appropriate sections of the DCD. The remaining 18 RAIs need revisions to the original response and some of them need a complete response to NRC's original RAI. A formal submittal of the RAI responses (except the one resolved RAI) is needed for staff review before the RAIs can be considered resolved. The 7 unresolved/significant RAIs consist of items that may require technical justification for deviating from the current staff position, require completion of documentation identified during this audit, or will become a COL or ITAAC item.

2. AUDIT ISSUES (See Appendix C)

During the audit, the following documents were not available in their final forms for review:

- Design record files - for two MS piping problems including the SRV discharge lines routed to the suppression pool.
- Computer manuals for PISYS07 and ANSI713 - in an auditable form.
- Final report on benchmark problems for the computer code PISYS07 using NUREG/CR-6049.
- Final reports for validation and verification of computer codes ANSI713, RVFOR01, and TSFOR06.
- Input and output information for the MS piping problem including RPV nozzles 2 and 3 for BNL to perform the independent confirmatory analyses.

GE was requested to send the input and output information for the MS piping problem as soon as possible so that BNL could initiate its effort to develop a mathematical model of the piping system for confirmatory evaluation of the piping computer code PISYS07.

The staff also found that the sample piping analyses for the MS system do not include the contributory weight of pipe supports in the piping model. GE was requested to evaluate the impact of excluding pipe support mass on the overall piping responses and provide technical justification for not including them in the model. Later, GE confirmed that these two problems will be reanalyzed with the contributory pipe support weights included and the results will be provided to the staff for review.

In addition to the RAIs, the following audit items were provided to the GE staff for a satisfactory response. Some of them will be audited during the second audit this fall and GE should make them available at that time in order to complete the review process. These audit items are summarized below.

Audit Question 1: The staff requested GE to verify that the design specifications for the MS piping system define all loading conditions to be considered in the piping analyses and specify all those that are missing, including the cold temperature of the SRV discharge lines.

Audit Question 2: The DCD load tables and MS/SRV discharge lines do not include the direct loading of SRV discharge and LOCA on submerged components in the suppression pool.

Audit Question 3: The staff requested GE to provide technical justification for not considering the depressurization valve (DPV) actuation loads in the MS piping analyses. Also, the test report on the DPV actuation is based on the SBWR application. The staff requested GE to ensure that the DPV actuation load for the ESBWR is bounded by the SBWR test results.

Audit Question 4: The staff requested GE carefully review Design Specifications B21-4010 and B21-4020 because a few editorial and technical corrections were identified during the audit.

Audit Question 5: The staff requested GE to finalize the draft benchmark document for the PISYS07 against NUREG/CR-6049 and provide the final report for staff review.

Audit Question 6: The staff requested GE to prepare the final validation and verification documents for the computer codes ANSI713, RVFOR06 and TSFOR01 for review by the staff.

Audit Question 7: GE has been using the turbine stop valve (TSV) closure analysis using flow rate and pipe diameter data from the Lungmen plant. The staff requested GE to justify this assumption for the ESBWR MS piping design.

3. INPUT/OUTPUT DATA FOR BNL CONFIRMATORY ANALYSES

The staff decided to perform the confirmatory analyses of the MS piping system that connects to RPV nozzles 2 and 3. In order to develop an independent model of the piping system, the staff requested GE to provide all relevant information as listed below.

Audit Question 8: GE is requested to provide the following in order for BNL to perform an independent evaluation of the piping system and compare GE's results with the BNL analysis:

a. Pipe isometric drawings showing nodes, pipe components, support types and their locations, pipe equipment, and other relevant information in order to develop a mathematical model similar to that used in GE's piping analyses.
b. P&ID, and/or building/floor drawings of the system to verify that all essential elements of the piping system are appropriately modeled.
c. Computer input and output data used in the PISYS code. Include both Class 1 and Class 2 piping sections.
d. All loading conditions considered for the piping model. Include floor response spectra for both seismic and hydrodynamic loads. Also, time histories for the SRV discharge and TSV closure loads.

IV. MAJOR TECHNICAL ISSUES

The seven more significant technical issues are:

- RAI 3.12-3: ISM method of analysis is not consistent with the staff position given in NUREG-1061. GE is requested to provide technical justifications for every deviation from the staff position given in NUREG-1061.

- RAI 3.12-11: The validation documents for the computer codes PISYS07, ANSI713, RVFOR01, and TSFOR06 were not available during this audit. Therefore, the staff expects these documents will be available later or during the second audit. (See also RAI 3.12-14 and audit questions 5 and 6).

- RAI 3.12-17: Justification for the use of SRSS in load combination tables needs to be demonstrated by showing that the non-exceedance probability (NEP) of 84 percent or higher is satisfied as required in NUREG-0484.

- RAI 3.12-21: Use of non-linear analysis methods in the piping design. GE was contemplating to make this a COL item, in case the COL applicant decides to use this method.

- RAI 3.12-22: A draft regulatory guide on environmental effects in the fatigue calculations of Class 1 piping will be issued soon; GE should provide its position on this issue.

- RAI 3.12-25: Thermal stratification in feedwater piping is required to be considered as a COL item (during a plant startup) to confirm that the ABWR thermal load definition is conservative for ESBWR.

- RAI 3.12-27: SRSS combination of the inertial and SAM responses for USM method of analysis is not consistent with the staff position in the SRP. GE is requested to provide technical justification for this inconsistency.

In summary, most items identified during the audit are either already included in the RAIs or relate to documents that were not available in an auditable form for staff to review during the audit. All documents listed above under item 2 in section III are needed soon in order to complete the design certification process.

V. EXIT MEETING

A public exit meeting was held on Friday at 10 AM. Staff from NRC, GE, BNL and EA-Spain were present. No public participants were present in the meeting. David Hinds, the ESBWR engineering manager, was connected through a telephone. The staff described the purpose, scope, and major findings of this audit. The staff indicated that the audit went well and that GE piping personnel were very helpful in resolving many concerns raised by the staff. However, there were a number of concerns that would require additional information from GE. Twelve of the RAIs were highlighted during the exit meeting of which seven were identified as more significant. It was noted that a number of GE reports and design record files were not available during this audit, although GE stated that they are present at its San Jose Office.

VI. GE DOCUMENTS REVIEWED

Selected sections of the following GE documents were reviewed during the audit:

5. ESBWR MS Lines 1 and 4, Pipe Stress Analysis Results, PISYS07/ANSI713 computer code input and output, dated May 2006.

6. ESBWR MS Lines 2 and 3, Pipe Stress Analysis Results, PISYS07/ANSI713 computer code input and output, dated May 2006.

7. Nuclear Boiler System, ESBWR Design Specification, MPL No. B21-4010, GE 26A6600, rev.0, 7-27-05.

8. ASME Code Section III, Class 1 MS Piping System, ESBWR Design Spec. MPL No. B21-4020, GE 26A6910, rev.0, 5-17-2006.

9. Advanced LWR Plants, SBWR Program, Depressurization Valve Development Test Program, final report, GEFR-00879, Class II, DRF A00-03007, October 1990.

10. User's Manual for PISYS07, NEDE-32352, Class 2, 2-1998.

11. User's Manual for ANSI713D, NEDE 23518, Rev.1, 9-2000.

12. ESBWR Turbine Stop Valve Closure Analyses, GENE-0000-0051-9296-R0, 3-17-2006.

13. ESBWR MS SRV Discharge Analyses, GENE-0000-0053-2413-01, 4-18-2006.

14. Engineering Computer Program PISYS07D, DRF A12-00144, 1-6-1999. Conversion of ECP PISYS07D from the HP workstation to the DEC Alpha/Unix platform. (Software Test Plan and Test Report, DRF A12-001444, 1-1998).

15. TSFOR01D Engineering Computer Program, Software Test Plan and Test Report, DRF A12-00146, December 1997.

16. RVFOR06D Engineering Computer Program, Software Test Plan and Test Report, DRF A12-00145, January 1998.

17. ANSI713D Engineering Computer Program, Software Test Plan and Test Report, DRF A12-00166, June 2000.

18. Dynamic Response Analysis of Containment Loads, MPL-A25-5030-26A6681A, Doc. # 092-134-F-C-00006, Issue 2, 5-19-2006.

APPENDIX A

ESBWR Piping
Design Acceptance Criteria
Key Audit Topics

NRC Audit of GE at Wilmington, NC on
ESBWR Piping Design Criteria and Confirmatory Analyses
May 22-26, 2006

Review Procedures and Documents

s. Design Specifications and Design Reports
b. Small Bore Handbook
c. Benchmark Calculations
d. Potential COL Items
   ASME Code Class 1, 2 and 3 piping and pipe supports
   t. Code Cases
   u. Design specifications and design reports
   v. Piping analysis benchmark
   w. Damping values used in the analysis
   x. InterSystem LOCA - TS for pressure isolation valves
   y. Computer Code Validation and Verification
   z. Use of energy absorbers and limit stops
   aa. Pipe support stiffness (rigid and non-rigid)

e. Potential ITAAC Items
   bb. Satisfy the ASME Class, Seismic Category and Quality Group
   b. 60 years life: Class 1 - CUT; Class 2/3: 7000 cycles
   c. Pipe mounted equipment and attachment interface allowable loads, acceleration and stresses
   d. Analytical methods
      Mathematical models of piping, supports and pipe mounted equipment
      (29) Damping
      (30) Cut-off frequency
      (31) High frequency modes
      (32) Group combination (ISM)
      (33) Mode combination
      (34) SAM plus Inertia

Review of Design Criteria

a. Code classification of all seismic Category I piping and pipe supports, and their jurisdiction boundaries

   (5) Class 1 Piping
   (6) Class 2 and 3 Piping
   (7) Pipe Supports

b. Design Loads

   (1) Operating transients
      • major pressure and thermal cycles
      • emergency transients

- thermal stratifications and stripings
- suppression pool hydrodynamics

(2) Seismic (w/o OBE)
(3) Guidance to distinct primary and secondary loads
(4) Load combinations

c. Analysis Methods

(1) Thermal analysis
- for expansion under operating thermal cycles
- for local effects of thermal stratification

(2) Dynamic analysis
- for seismic
- for hydrodynamic events
  - responses to suppression pool dynamics

(3) Fatigue evaluations

d. Acceptable Limits

Allowables established by Code for piping and support design under various service levels

e. Other Considerations

(1) Criteria to ensure protection of seismic Category I piping and supports against possible failure of non-seismic components and structures
(2) Criteria to ensure application of good engineering practices in pipe support design

Audit of sample calculations and documents for pipe stress analysis

Stress analysis of the following piping systems:

1. Main steam
2. SRV discharge line to wetwell

Discuss additional information needed by NRC for conducting confirmatory analyses

a. Documents/Calculations
b. Review Results
c. List of Outstanding Issues

APPENDIX B

Resolution Sheets for RAI 3.12-1 through 37

**Discussion of GE's RAI Responses (Dated May 3, 2006)
and
GE's Action Items to Resolve NRC's Concerns**

NRC Audit of GE at Wilmington, NC on
ESBWR Piping Design Criteria and Confirmatory Analyses
May 22-26, 2006

AUDIT ITEM NO.	RAI 3.12-1	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

DCD Tier 2, Table 1.9-22, identifies that the 2004 edition of the ASME Code, Section III, is applicable to the ESBWR piping design. Explain how the requirements of 10 CFR 50.55a(b) will be satisfied.

GE RESPONSE

DCD Tier 2, Table 1.9-22 will be revised to identify the 2001 edition of the ASME Code, including Addenda through 2003, as being applicable to the ESBWR design. This change makes the DCD basis consistent with 10 CFR 50.55a(b) and the basis for Regulatory Guide 1.84, Revision 33, and Regulatory Guide 1.147, Revision 14, which discuss the applicability of specific ASME Codes cases.

The same change will also be made to DCD Tier 2 Tables 3.8-6 and 3.8-9.

Markups of the affected DCD pages are attached.

STAFF EVALUATION

Unresolved

Demonstrate how this change would make the DCD consistent with 10 CFR 50.55a(b). Include a discussion of how all the limitations and modifications specified in the 10 CFR 50.55a(b)(1) will be implemented and specify this in the DCD and applicable tables.

CONCLUSION

GE indicated that they will state that all limitations and modifications specified in the 10 CFR 50.55a(b)(1) for the 2001 edition of the Code through 2003 addenda will be satisfied. GE will also verify if these required positions would have any effect on the ASME piping design criteria currently used in the computer code ANSI713.

Unresolved, pending GE’s revised response to the RAI and revised DCD.

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ESBWR Piping Design Criteria and Confirmatory Analyses
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AUDIT ITEM NO.	RAI 3.12-2	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

(a) DCD Tier 2, Table 5.2-1, Sections 3.7 and 3.9 include the following ASME Code Cases which have been annulled by the ASME as noted in the current Regulatory Guides (RGs) 1.84 and 1.147: –247, –411-1, –420, –463-1, –476, –479-1 and –608. Discuss what alternatives are being considered to address the issues contained in these Code Cases.

(b) The staff approved, in RG 1.84, Code Cases –71-18, –122-2, and –416-3 that are the revised versions of these Code Cases referenced in the DCD. Describe the changes in these revised Code Cases that may impact the design criteria presented in the DCD and how they were addressed.

(c) The staff's acceptance status of several Code Cases in DCD Tier 2, Table 5.2-1, have been changed. (I) The DCD indicates that Code Cases –318-5 and –416-2 were conditionally accepted, but they are now unconditionally endorsed by the staff. Note that Code Case –416-3, not its previous revision, has been currently endorsed by the staff. (ii) The DCD also indicates that Code Case –491-2 was not listed in RG 1.147, but it is now endorsed by the staff. Since the acceptance status of these Code Cases given in the DCD has been changed, address the changes in the applicability of these Code Cases in the DCD for ESBWR piping design.

GE RESPONSE

(a) GE agrees to review the applicable code cases cited in RAI 3.12-2(a), but cannot accomplish this review effort by the 4/28/06 due date. Evaluation of the applicability of these ASME Code Cases will be completed by 7/1/06, with a revised RAI 3.12-2 response provided at that time.

(b) Code Case –71-18 is for "Additional Material for Subsection NF, Class 1, 2, 3 and MC Supports Fabricated by Welding Section III, Division I". Since there is no additional material used in the ESBWR design, this Code Case does not impact the design criteria presented in the DCD.

Code Case –122-2 provides the Procedure for the Design of Rectangular Cross Section Attachment on Class 1 Piping. The revised Code Case reduced the stress indices of CT, CL and CN by 50 percent as compared to the previous version. The design results using the previous Code Case are conservative for lug attachment analysis. Therefore, this Code Case does not impact the design criteria presented in the DCD.

Code Case –416-3 provides Alternative Test Requirement for Weld Repair. It does not impact the design criteria presented in the DCD. Revision 2 of the DCD will be revised to –122-2.

(c) DCD Tier 2, Table 5.2-1 will be changed to allow unconditional use of Code Cases –318-5, –416-3 and –491-2 in DCD Revision 2.

STAFF EVALUATION

(a) Unresolved

This is important for the current review of the DAC, audit of calculations, and procedures, because it will most likely affect the staff's review process.

(b) 1st Para: Technically Resolved

Code Case –71-16 through 18 contain conditions for welding, alternate materials requirements, welding qualifications, and related areas. For example, one such criterion is "welding is not permitted on carbon steels containing more than 0.35% carbon." Provide reasons why this Code Case is not applicable in the ESBWR piping design.

(b) 2nd Para: Technically Resolved

Provide which criteria (Rev. 1 or 2) will be used in the ESBWR piping design. Also, the Code Case Section 3.2 states that analysis complying with the Code Case shall be included in the Design Report for the piping system. Hence, indicate in the DCD if this criteria is included in the design report.

(b) 3rd Para: Unresolved

Explain why this does not impact the design criteria (pressure test in lieu of hydro test) presented in the DCD. Why is the statement "Revision 2 of the DCD will be revised to –122-2" placed under this Code Case. [Should this be –416 Rev. 3 ? see below.]

(c) Unresolved

Explain how the changes in the revised Code Case N416-3 affect the design [see above in (b)].

CONCLUSION

GE will revise this RAI response after completing its assessment of all ASME Code Cases identified in the DCD against the current staff positions in the Regulatory Guides 1.84, rev. 33 and 1.147, rev.14. This assessment will be available to the staff sometime in July 2006.

Unresolved, pending GE's revised response to the RAI and revised DCD.

AUDIT ITEM NO.	RAI 3.12-3* (significant issue)	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

The current staff position for the ISM method of analysis is presented in Volume 4, Section 2 of NUREG-1061, "Report of the US NRC Piping Review Committee." Some differences were noted between the ISM method of response combinations presented in the DCD Tier 2, Section 3.7.3.9, and the method given in NUREG-1061 (e.g., the SRSS method in the DCD and absolute sum method in NUREG-1061 for combining group responses for a given direction). Indicate whether all of the provisions contained in NUREG-1061 for the ISM method of analysis will be followed or provide the technical justification for any alternatives.

GE RESPONSE

NUREG-1503 paragraph 3.9.2.2, page 3-62 provides the guidelines for ISM analysis method.

As an alternative to the enveloped response spectrum method, GE chose to use the multiple-support excitation analysis method. When this method is used, the staff's position is that the response resulting from motions of supports between two or more different support groups may be combined by the SRSS method if a support group is defined by supports that have the same time history input. This usually means all supports located on the same floor or portion of a floor in a structure.

DCD Revision 2 will be revised to incorporate this guideline.

STAFF EVALUATION

Unresolved

NUREG-1503 refers to ABWR. Why is this being referenced? ESBWR DCD is a stand-alone document.

Original RAI needs to be addressed. Indicate whether all of the provisions contained in NUREG-1061 for the ISM method of analysis will be followed for piping systems supported at different floors and/or different buildings where the time histories are different. Provide the technical justification for any alternatives.

CONCLUSION

The current staff positions on combination methods for groups, modes, directions, and dynamic-static responses for the ISM method of analysis are delineated in NUREG-1061.

During the meeting, GE indicated that the proposed SRSS combination among groups, which is not consistent with the staff's position of absolute sum, has been accepted by the staff for the ABWR design. The NRC indicated that the technical basis for accepting the SRSS method among support groups needs to be established. GE will try to determine the technical justification developed earlier for the ABWR.

Also, GE will revise the RAI response to address the current staff positions on <u>all</u> combination methods presented in NUREG-1061 applicable to the ISM method of analysis. Any deviation from the staff position will be technically justified.

Unresolved, pending GE's revised response to the RAI with technical justifications for those combination methods that deviate from current staff positions.

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AUDIT ITEM NO.	RAI 3.12-4	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

In a time history analysis, the numerical integration time step, ªt, must be sufficiently small to accurately define the dynamic excitation and to ensure stability and convergence of the solution up to the highest frequency of significance. DCD Tier 2, Section 3.7.2.1.1, indicates that for the most commonly used numerical integration methods, the maximum time step is limited to one-tenth of the shortest period of significance. An acceptable approach for selecting the time step, ªt, is that the ªt used shall be small enough such that the use of ½ of ªt does not change the response by more than 10%. Indicate whether this is part of the analysis requirements or provide a technical justification for not considering this criterion along with the other criterion described above for seismic and hydrodynamic loading analyses.

GE RESPONSE

The convergence criterion of using ½ ªt to result in no more than a 10% change in response is part of the requirement for time history analysis. DCD Tier 2, Section 3.7.2.1.1 will be updated accordingly. Markups of the affected DCD pages are attached.

STAFF EVALUATION

Technically Resolved

The proposed changes in the DCD Tier 2, Section 3.7.2.1.1 should indicate that this approach applies to seismic and hydrodynamic loads.

The proposed wording in the markup of the DCD - "An acceptable approach...." suggests that alternate methods may be used. If this is the case, then explain what alternate methods will be used.

CONCLUSION

GE's changes to DCD page 3.7-6 attached to the RAI responses, dated May 3, 2006, are acceptable. However, GE will revise the RAI response as follows: (a) the proposed changes in the DCD Tier 2, Section 3.7.2.1.1 will indicate that this approach applies to seismic and hydrodynamic loads, and (b) the word "acceptable" in the proposed changes will be deleted.

Unresolved, pending GE's revised response to the RAI and revised DCD.

NRC Audit of GE at Wilmington, NC on
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AUDIT ITEM NO.	RAI 3.12-5	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

DCD Tier 2, Section 3.7.2.1.1, states that for the frequency domain solution, the dynamic excitation time history is digitized with time steps no larger than the inverse of two times the highest frequency of significance. It appears that this criterion is related to the Nyquist frequency for selection of the appropriate time step. Provide the technical justification why this approach is sufficiently accurate to capture the piping system response at the Nyquist frequency.

GE RESPONSE

Frequency domain solution is not used in the piping system response analysis. This analysis methodology applies to structural evaluations.

STAFF EVALUATION

Technically Resolved

This statement must be included in the DCD.

CONCLUSION

During the meeting, GE provided the proposed text to be added at the end of the DCD Section 3.7.2.1.1. The proposed changes to the DCD are acceptable.

Unresolved, pending revision of the DCD.

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AUDIT ITEM NO.	RAI 3.12-6	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

When developing seismic floor response spectra for use in a response spectrum analysis for piping and equipment analysis, the peaks of the spectra obtained from a time history analysis are generally broadened by plus and minus 15% to account for modeling uncertainties. When performing a time history analysis of piping and equipment for seismic and hydrodynamic loads, describe how the uncertainties in the material properties of the structure/soil and in the modeling techniques used in the analysis to develop the loading are accounted for in the time history analysis. Indicate whether the digitized time history is adjusted to account for the material/modeling uncertainties. Describe all of the dynamic loads for which the time history will be adjusted to account for modeling uncertainties and provide the basis for the amount of the adjustment. Also, indicate how the hydrodynamic building spectra are broadened to account for the modeling uncertainties.

GE RESPONSE

When the calculated floor acceleration time history is used in the time history analysis of piping and equipment, the uncertainties in the time history are accounted for by expanding and shrinking the time history within 1/(1±0.15) so as to change the frequency content of the time history within ±15%. Alternatively, a synthetic time history that is compatible with the broadened floor response spectra may be used. The methods of peak broadening are applicable to seismic and other building dynamic loads. DCD Tier 2, Section 3.7.2.9 will be updated accordingly and markups of the affected DCD pages are attached.

STAFF EVALUATION

Resolved

CONCLUSION

GE's markups to the DCD page 3.7-15 attached to the RAI responses, dated May 3, 2006, are acceptable.

Resolved.

AUDIT ITEM NO.	RAI 3.12-7	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

DCD Tier 2, Section 3.7.2.1.3, provides a description of the static coefficient method of analysis. It states that the response loads are determined statically by multiplying the mass value by a static coefficient equal to 1.5 times the maximum spectral acceleration at the appropriate damping value of the input response spectrum. Indicate whether the use of the static coefficient method in the DCD also requires that (a) justification be provided that the system can be realistically represented by a simple model and the method produces conservative results and (b) the design and associated simplified analysis account for the relative motion between all points of support, as prescribed in SRP 3.9.2. If not, provide the technical justification.

GE RESPONSE

The use of the static coefficient method satisfies SRP 3.7.2 and 3.9.2 requirements. DCD Tier 2, Section 3.7.2.1.3 will be updated accordingly and markups of the affected DCD pages are attached.

STAFF EVALUATION

Technically Resolved - for original RAI concerns.

Unresolved - Follow-up RAI
However, new technical criteria has been introduced in the markups of DCD Section 3.7.2.1.3 as follows: "If the fundamental frequency of the structure is known, the spectral acceleration value at this frequency can be multiplied by a factor of 1.5 to determine the response." This approach may be unconservative when the fundamental frequency falls between spectral peaks or to the soft side of the spectral peak. In view of this, provide technical justification for this alternate approach.

CONCLUSION

GE's markups to the DCD page 3.7-9 attached to the RAI responses, dated May 3, 2006, are acceptable to address the original RAI. However, to address the staff's concern with the new technical criteria that were added, GE indicated they will revise the text that describe the selection of the acceleration value at the fundamental frequency of the structure/piping system.

Unresolved, pending revision of the DCD.

AUDIT ITEM NO.	RAI 3.12-8	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

The DCD did not provide any information on the use of inelastic analysis methods for the ESBWR piping design, except that discussed in DCD Tier 2, Section 3.9.1.4, for design of whip restraints against a postulated gross piping failure. Indicate if any ESBWR piping design, other than the whip restraints, includes any inelastic analysis method. Also, if such a method could be used, provide details of the analysis approach, its acceptance criteria, scope and extent of its application.

GE RESPONSE

Inelastic analysis methods are not used in the ESBWR piping design and analysis.

STAFF EVALUATION

Technically Resolved

This statement must be included in the DCD. Clarify how the load due to a high energy pipe break is defined and included in DCD Table 3.9-2 on load combination.

CONCLUSION

During the meeting, GE provided the proposed text to be added under the “Inelastic Analysis Methods” of the DCD Section 3.9.1.4. The proposed changes to the DCD are acceptable.

Unresolved, pending revision of the DCD.

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AUDIT ITEM NO.	RAI 3.12-9	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

DCD Tier 2, Section 3.7.3.13, did not give details on the analysis method and how the criteria are to be applied in the design of buried piping. Based on the criteria presented in DCD Tier 2, Section 3.7.3.13, describe the analysis method and design requirements that are used for buried piping. The design procedure should include the load components, categorization of seismic stresses in the Code evaluation, and allowable stress limits.

GE RESPONSE

There is no buried seismic Category I piping in the ESBWR design.

STAFF EVALUATION

Technically Resolved

Clarify if there is no Cat I buried piping because it is located within buried tunnels. If this is the case, provide the analysis and design criteria for these piping systems. All statements must be included in the DCD.

CONCLUSION

GE stated that there is no buried pipe between the nuclear island and other surrounding structures. During the meeting, GE also provided a markup for DCD section 3.7.3.13 which contains the statement. The proposed changes to the DCD are acceptable.

Unresolved, pending revision of the DCD.

NRC Audit of GE at Wilmington, NC on
ESBWR Piping Design Criteria and Confirmatory Analyses
May 22-26, 2006

AUDIT ITEM NO.	RAI 3.12-10	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

DCD Tier 2, Section 3.7.3, refers to the guidelines in Appendix N of the ASME Code, as being applicable to design/analysis of ESBWR subsystems. The NRC staff has not explicitly endorsed Appendix N in its entirety. Identify all Appendix N guidance used in the ESBWR piping design/analysis that differs from the guidance provided in the current SRPs and RGs. If any differences exist and are used in the ESBWR piping design/ analysis, then provide technical justification for using the Appendix N guidance.

GE RESPONSE

For ESBWR analyses, the NRC SRPs and RGs are the first priority to use. Reference to Appendix N will be deleted from DCD Tier 2, Section 3.7.3 in Revision 2.

STAFF EVALUATION

Technically Resolved

Reference to Appendix N must be deleted from all applicable sections of the DCD (e.g., DCD Section 3.7.2.9).

CONCLUSION

GE will delete all references to Appendix N throughout the DCD.

Unresolved, pending revision of the DCD.

AUDIT ITEM NO.	RAI 3.12-11* (significant issue)	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

DCD Tier 2, Appendix 3D, provides a description of the major computer programs used in the analysis and design of safety-related components, equipment, and structures. According to this appendix, the quality of these programs and computer results is controlled. The programs are verified for their application by appropriate methods, such as hand calculations, or comparison with results from similar programs, experimental tests, or published literature, including analytical results or numerical results to the benchmark problems. To facilitate the staff review of the computer programs used in the ESBWR design, provide the following additional information:

(a) Identify which computer programs will be used during the design certification phase and which programs may be used in the future during the COL application phase.

(b) Identify which programs have already been reviewed by the NRC on prior plant license applications. Include the program name, version, and prior plant license application. As stated in SRP 3.9.1, this will eliminate the need for the licensee to resubmit, in a subsequent license application, the computer solutions to the test problems used for verification.

(c) Confirm that the following information is available for staff review for each program: the author, source, dated version, and facility; a description, and the extent and limitation of the program application; and the computer solutions to the test problems described above.

GE RESPONSE

(a) The programs used in the certification phase are:

PISYS07 It is a computer code for analyzing piping systems subjected to both static and dynamic piping loads.

ANSI713 The program is for calculating stresses and cumulative usage factors for Class 1, 2 and 3 piping components in accordance with articles NB, NC and ND-3650 of ASME Code Section III. ANSI7 is also used to combine loads and calculate combined service levels A, B, C and D load on piping supports and pipe-mounted equipment.

All of the programs in Appendix 3D.4 may also be used in the future during the COL application phase.

(b) PISYS05 has been benchmarked against NRC piping models. The results are documented in GE report NEDO 24210, dated August 1979 (Reference 3D 1 of Appendix 3D), for mode

shapes and uniform support motion response spectrum analysis (USMA) options. The independent support motion response spectrum analysis (ISMA) option has been validated against NUREG/CR 1677.

The PISYS05 computer program has been reviewed by NRC, and the results are benchmarked with NUREG/CR-6049. PISYS07 USMA and ISMA analyses are the same as PISYS05. It has been benchmarked with NUREG/CR-6049.

(c) The computer programs listed in Appendix 3D are available for staff review. These programs are Level 2 programs. The author, source, dated version, and facility; a description, and the extent and limitation of the program application; and the computer solutions to the test problems are contained in the design record file of each program.

STAFF EVALUATION

(a) Resolved

(b) Technically Resolved

To be confirmed by BNL (during audit).

(c) Technically Resolved

What is meant by a Level 2 program? The documentation in the design record file needs to be available for staff review during the audit.

CONCLUSION

During the audit, the computer codes PISYS07, ANSI713, RVFOR and TSFOR were selected for review. PISYS07 is a computer code for analyzing piping systems subjected to both static and dynamic piping loadss. ANSI713 calculates stresses and cumulative usage factors for Class 1, 2, and 3 piping components in accordance with the requirements of ASME Section III, Subsection NB, NC and ND. RVFOR computes the time history forcing function and resultant pipe forces at the time of relief valve opening and uses the method of characteristics. Finally, TSFOR computes the time history forcing function in the main steam piping due to turbine stop valve closure.

(1) The V/V documents for these four computer codes were not available in auditable format and hence, will be considered as an audit followup item.

(2) A Draft copy of the report summarizing the benchmark of the PISYS code against NUREG/CR-6049 was available. Since the report is still draft, it was not reviewed during the audit. The review of the final report is identified as an audit followup item.

(3) GE's Level 2 computer programs are the official version of the code typically used in the design certification (Level 1 - origin of the code, Level 3 - new methods added, and Level 4 - code retired).

Unresolved. An audit followup item.

AUDIT ITEM NO.	RAI 3.12-12	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

DCD Tier 2, Section 3.7.3.3.2, provides criteria to model lumped-masses for equipment in a dynamic analysis. Clarify whether these criteria are also applied to the development of piping system mathematical models. If not, provide the criteria used for the piping system mathematical models.

GE RESPONSE

The lumped-masses for equipment are modeled and included in the mathematical model when the effect on the piping cannot be uncoupled from the piping. For this case, the equivalent equipment properties with the associated lump masses are included in piping models.

STAFF EVALUATION

Unresolved

Original RAI needs to be addressed.

CONCLUSION

During the meeting, GE provided proposed text to be added to the DCD Section 3.7.3.3.1. The proposed text “in accordance with subsection 3.7.3.3.2" for additional criteria used to lump masses should apply to the entire subsection 3.7.3.3.1, and not just “concentrated weights on the piping systems, such as the valves, pumps, and motors, ...”

Unresolved, pending revised response and revised DCD.

AUDIT ITEM NO.	RAI 3.12-13	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

DCD Tier 2, Section 3.7.3.3.3, states that if special engineered pipe supports are used, the modeling and analytical methodology shall be in accordance with methodology accepted by the regulatory agency at the time of certification or at the time of application, per discretion of the applicant. Clarify whether the statement means that the modeling and analytical methodology will be determined at the COL application stage and will be submitted for review and approval by the staff. If this is the case, the DCD should be revised accordingly. Otherwise, additional clarification of this statement is needed.

GE RESPONSE

The use of special engineered pipe supports is exceptional, unless specified otherwise. The need to use it during the COL phase is not foreseen. If its use should be essential at any point during the development of detailed engineering, the modeling and analytical methodology will be adequately determined in accordance with methodology accepted by the regulatory agency at the time of certification or at the time of application, per discretion of the applicant.

STAFF EVALUATION

Unresolved

Original RAI needs to be addressed, instead of repeating what was already stated in the DCD.

CONCLUSION

During the meeting, GE provided proposed text to be added at the end of the DCD Section 3.7.3.3.3. The proposed changes to the DCD are acceptable.

Note that Code Case N-420 on linear energy absorbing supports was unconditionally accepted by the staff and now has been annulled by the ASME. This may be considered as one of the COL items.

Unresolved, pending revision of the DCD.

AUDIT ITEM NO.	RAI 3.12-14	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

DCD Tier 2, Section 3D.4.1 of Appendix 3D, indicates that the PISYS program has been benchmarked against NRC piping models. The results are documented in GE report NEDO-24210, dated August 1979 (Reference 3D-1 of Appendix 3D), for mode shapes and uniform support motion response spectrum analysis (USMA) options. The independent support motion response spectrum analysis (ISMA) option has been validated against NUREG/CR-1677. With regard to the benchmarking of the PISYS program, provide the following information:

(a) The version of the PISYS program used for the ESBWR analysis should be benchmarked against NUREG/CR-6049, "Piping Benchmark Problems for the GE ABWR." The piping benchmark problems in NUREG/CR-6049 are more recent and more representative of the current piping systems in the ESBWR. If NUREG/CR-6049 will not be used to benchmark the piping computer code used by COL applicants, then provide an explanation.

(b) Indicate where the requirement for the COL applicant to benchmark the use of any piping analysis program(s) in accordance with the current DCD validation methods is located.

GE RESPONSE

(a) Appendix 3D paragraph 3D.4.1 last paragraph will add the following in DCD Revision 2:

"Subsequently, the PISYS07 program, which is used for ESBWR piping analysis, has been benchmarked against NUREG/CR-6049. If applicable, COL applicants are also required to benchmark piping computer codes against NUREG/CR-6049.

(b) Appendix 3D paragraph 3D.4.1 last paragraph will be modified in DCD Revision 2 as shown in the (a) response.

STAFF EVALUATION

(a) Unresolved

To be confirmed by BNL (during audit). Need to review GE document that compares PISYS07 against NUREG/CR-6049. The last sentence of the response needs clarification: under what circumstances is the COL applicant required to benchmark the PISYS07 or other computer codes.

(b) Technically Resolved

This statement must be included in the DCD.

CONCLUSION

GE is currently finalizing the draft benchmark report verifying the PISYS code results against the piping models given in NUREG/CR-6049.

Unresolved, pending completion of the draft report. This is an audit followup item (see RAI 3.12-11).

AUDIT ITEM NO.	RAI 3.12-15	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

DCD Tier 2, Section 3.7.3.17, indicates that where small, Seismic Category II piping is directly attached to Seismic Category I piping, it can be decoupled from Seismic Category I piping. However, the DCD did not describe how the small branch piping will be analyzed in the piping design for both inertial and Seismic Anchor Motion (SAM) responses (e.g., small bore handbook or like other (larger) piping, equivalent static method or dynamic analysis). Describe the seismic analysis methods and procedures, including the input floor response spectrum and input SAM displacements, that apply to the small branch piping design. The description should also describe how any amplification effects and SAM effects, from the main run pipe at the attachment to the small branch pipe, are considered.

GE RESPONSE

The non-safety related piping and components whose structural failure due to an SSE could hinder the operation of the safety-related piping components, shall be designed to withstand the SSE without loss of piping integrity. The load combination and acceptance criteria are as follows.

The load combination and criteria are as follows.

Seismic Category	**Description**	**Load Combination**	**Acceptance Criteria**
II	Sustained Loads	PD + WT	EQ 8 # 1.5 Sh
	Occasional Loads	PD + WT + RV2I	EQ 9 # 1.8 Sh or 1.5 Sy
	Thermal Range	TE	EQ 13 # SA+ f(Sh - SL)
	Structural Integrity	PD + WT + SSEI PD + WT + [(CHUGI)2 + (RV2I)2]1/2 PD + WT + [(CONDI)2 + (RV2I)2]1/2 PT + WT + API	ND 3600 EQ 9 < 3Sh and no greater than 2.0 Sy and Meet NUREG 1367

For dynamic and SAM analyses,

1. Decouple criteria is 25 to 1 in the ratio of "moment of inertia" of run pipe to branch pipe.

2. Linear spectrum with accelerations from the seismic and dynamic analyses used in the large bore piping analysis (run pipe) are applied to this interface point for the small branch piping design, as well as the seismic and dynamic displacements at the connection point.

3. Formal analysis methods and procedures similar to the main pipe should be used, or more conservative handbook analysis may also be used.

STAFF EVALUATION

The load combination table included in the response corresponds to Class 2 piping components. GE should define the SRV and LOCA loads consistent with the DCD Table 3.9-2.

Follwup RAI: Provide design and analysis criteria for seismic Category I branch piping that decouple from larger piping.

Original RAI not fully addresses.

Explain the term linear spectrum and how amplification of the run pipe is considered.

CONCLUSION

GE states in DCD Section 3.7.3.16 that small branch lines (50 mm and less nominal pipe size) decoupled from larger size piping may be designed using small bore handbooks in lieu of a system flexibility analysis. The criteria presented in this section for the piping handbook are acceptable. However, GE has not developed any such handbook to be used for the design certification and will not have such a document during the second audit sometime next fall. Therefore, this will be a COL action item.

When decoupled piping is not designed using small bore handbooks, GE discussed the use of a linear spectrum for the response spectrum analysis and linear displacements for the SAM analysis in the design of the small branch lines. The linear spectrum or the linear displacement is defined as the interpolated values of the building spectra or SAM displacements on either side of the branch connection. The staff did not accept GE’s proposed criteria for cases where the larger size main run piping has some dynamic amplification effects at the attachment to the small branch pipe. GE agreed to develop a criteria for this case and will provide necessary changes to be included in the DCD for staff review.

Note that the decoupling criteria are applicable to both seismic Category I and Category II branch piping.

Unresolved, pending GE’s revised response to the RAI and revised DCD.

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AUDIT ITEM NO.	RAI 3.12-16	DATE/TIME	5-25-06
AUDITED BY	MS/JB/JF	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

DCD Tier 2, Section 3.9.3.3, indicates that the main steam ASME Class 1 piping thermal loads are less than 2.4 Sy per Equation 12 of NB-3600. Describe how the stress of 2.4 Sy satisfies the ASME Code Equation 12 allowable limit of 3 Sm.

GE RESPONSE

It is a typo. The last sentence of the first paragraph of 3.9.3.3 should read:

"The Main Steam ASME Class 1 piping stress range due to thermal loads per Equation 12 of NB-3600 are less than 2.4 Sm, and are more limiting than the dynamic loads that are required to be analyzed per Equation 13 of NB-3600."

Likewise, in 3.9.3.4 under the "ASME Class 1,2 and 3 Piping" heading, Sy will be changed to Sm.

The purpose of specifying this limit is to satisfy the pipe break criteria of MEB 3-1. The ASME Code for Equation 12 specifies an allowable limit of 3 Sm.

These corrections will be made in DCD Revision 2.

STAFF EVALUATION

Technically Resolved

This statement must be included in the DCD.

CONCLUSION

During the meeting, GE provided the proposed text in DCD Sections 3.9.3.3 and 3.9.3.4. The proposed changes to the DCD are acceptable.

Also, GE will correct the acceptance criteria in DCD Table 3.9-9 for Service Level A and B applicable to Fatige - NB-3653 for Eq. 12 and 13 # 2.4 Sm and U < 0.1. The criteria in the existing Table 3.9-9 is inconsistent with GE's design criteria of 0.8 x 3 Sm allowable for Eq. 12 and 13, and usage factor to be less that 0.1 (See GE's response to RAI 3.12-18 for Main Steam piping design).

Unresolved, pending revision of the DCD.

AUDIT ITEM NO.	RAI 3.12-17* (significant issue)	DATE/TIME	5-25-06
AUDITED BY	MS/JB/JF	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

Note 3 to DCD Tier 2, Table 3.9-2 indicates that the method used in the combination of dynamic responses of piping loadings is in accordance with NUREG-0484, Revision 1. Table 3.9-9 specifies a number of load combinations that specify an SRSS load combination. Describe how the NUREG-0484 criteria were satisfied for the Service Level D load combinations.

GE RESPONSE

The technical approach is a linear elastic analysis for Level D. According to that established criteria in Section 5 of NUREG-0484, SRSS combination specified in Table 3.9-9 is suitable for earthquake combinations with LOCA.

STAFF EVALUATION

Further NRC evaluation is needed.

CONCLUSION

The staff accepts the use of the SRSS method for combination of LOCA and SSE. However, for combinations of other dynamins loads, GE needs to provide technical justification for the use of the SRSS methods. As noted in NUREG-0484, rev.1, the use of the SRSS method is acceptable when it is shown that a non-exceedance probability (NEP) of 84% or higher is achieved. GE has not demonstrated that all SRSS combinations in DCD Table 3.9-9 satisfy this criterion.

Unresolved. Need technical justification for SRSS load combinations.

AUDIT ITEM NO.	RAI 3.12-18	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

Note 12 to DCD Tier 2, Table 3.9-2 provides a modification to the ASME Class 2 and 3 criteria to address SSE seismic anchor motion stresses. However note 12 did not include any additions/changes to the Class 1 piping requirements of ASME Code Section III, Subsection NB-3600, for equations 10, 11 and 12 (similar to the additions/changes made for Class 2 and 3 piping). Clarify whether there are any additions or changes for the Class 1 piping requirements and what earthquake level (for inertia and SAM) will be used to satisfy the ASME Code equations.

GE RESPONSE

Table 3.9-2 specifies SSE load. This includes the inertia and the anchor motion effect.

This is the same designation as other dynamic loads. The SAM is included in Equation 10, 12, 13 and 14 evaluations. The piping design specification for Service Level A&B is shown below as an example.

Table 2. Main Steam Piping System

Condition	**Load Combination for All Terms(1)(2)(3)**	**Acceptance Criteria(7)**
Service Levels A & B	PP, TE, ΔT1(4), ΔT2(5), TA-TB(6), RV1, RV2I , RV2D, TSV, SSEI, SSED	Eq 12 & 13 #2.4 Sm Fatigue - NB-3653 U < 0.1

STAFF EVALUATION

Unresolved

The load combination table included in the response corresponds to Class 2 piping components. GE should define the SRV and LOCA loads consistent with the DCD Table 3.9-2.

Original RAI needs to be addressed. According to Table 3.9-2, the term SSE does not appear to include SAM. SAM is only addressed in note 12 for Class 2 and 3 piping systems.

CONCLUSION

During the meeting, GE provided the proposed text to be added in note 12 of DCD Table 3.9-2. The proposed changes to the DCD are consistent with the staff position and hence are acceptable.

Unresolved, pending revision of the DCD.

AUDIT ITEM NO.	RAI 3.12-19	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

DCD Tier 2, Section 3.7.1.2 and Table 3.7-1 specify damping values to be used in the seismic analysis of SSCs. The DCD indicates that ASME Code Case N-411-1 may be used as permitted by RG 1.84 in place of Regulatory Guide 1.61 damping values. As indicated in RAI 3.12-2, Code Case N-411 has been annulled by the ASME. The DCD also indicates that ASME Code Case N-411-1 damping cannot be used for analyzing linear energy absorbing supports designed in accordance with ASME Code Case N-420. Indicate whether the damping values, corresponding to Code Case N-411-1 and meeting the conditions listed in Table 4 of RG 1.84, Rev. 33, will be used for the independent support motion (ISM) method. If the Code Case N-411-1 will be used, then provide the technical basis for using these damping values with the ISM method.

GE RESPONSE

References to ASME Code Case N-411-1 are being deleted from Section 3.7 in DCD Revision 2. To maintain this option in the ESBWR design, N-411-1 damping curve and associated conditions permitted by RG 1.84, including the limitations for use with the ISM method, will be explicitly described. Markups of the affected DCD pages are attached.

STAFF EVALUATION

Technically Resolved

Provide changes that should be made in the DCD Section 3.7.1.2 and Table 3.7-1.

Also, need further clarification for Note (4) associated with Figure 3.7-37. Since Code Case N-420 is annulled by the ASME, what criteria will be used for the design of linear energy absorbing supports mentioned in this note?

CONCLUSION

GE will update the RAI response, dated May 3, 2006, consistent with all conditions stated in the RG 1.84 for Code Case N-411.

Unresolved, pending revised response to the RAI and revised DCD.

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AUDIT ITEM NO.	RAI 3.12-20	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

In DCD Tier 2, Section 3.7.2.7, the cutoff frequency for modal responses is defined as the frequency at which the spectral acceleration approximately returns to the ZPA of the input response spectrum. Define this cutoff frequency quantitatively for seismic and other building dynamic loads applicable to the piping analysis for the ESBWR.

GE RESPONSE

The ZPA cutoff frequency for modal response analysis of subsystems for seismic and other building dynamic loads is 100 Hz or the rigid frequency as defined as f2 in DG-1127, Proposed Revision 2 of Regulatory 1.92. DCD Tier 2, Section 3.7.2.7 will be updated accordingly and markups of the affected DCD pages are attached.

STAFF EVALUATION

Technically Resolved (may be)

Clarify why 33hz is not applicable to locations where hydrodynamic loads do not exist. See RAI 3.12-21 for further clarification.

Delete all references to 33 hz for seismic and 60 hz for hydrodynamic ZPA in the DCD (e.g., 3.9.1.4, 3.9.2.2.1 if applicable)

CONCLUSION

For piping analysis, GE proposes to use 100 hz as the cutoff frequency. However, while reviewing the load definition document used in the Main Steam piping analyses it was noted that several of the hydrodynamic spectra are at their peaks even at 100 hz, and the main steam piping analyses considered frequencies above 100 hz cutoff value in their response spectrum analyses. Since the contributions from these high frequencies are not significant and missing mass is still included, the staff finds this acceptable. However, GE has agreed to revise its RAI response, dated May 3, 2006, as discussed during the audit.

GE also agreed to review and make necessary changes, if applicable, to all references to 33 hz for seismic and 60 hz for hydrodynamic ZPA in the DCD.

Unresolved, pending revised response to the RAI and revised DCD.

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AUDIT ITEM NO.	RAI 3.12-21* (significant issue)	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

For the analyses of vibratory loads (other than seismic) with significant high-frequency input (e.g., above 33 Hz), describe:

(a) the modal combination method to be used for the high frequency modes above the cutoff frequency for vibratory loads.

(b) the nonlinear analysis method to be used to account for large gaps between the pipe and its supports.

GE RESPONSE

(a) The modal combination to be used for the high frequency modes above the cutoff frequency for vibratory loads is performed according to Appendix A of SRP 3.7.2.

(b) In general, the clearance of the supports considered in the piping analysis is sufficiently small so that a non-linear analysis is not needed. If this case should happen, a detailed analysis would be carried out with finite elements using the appropriate evaluation tools.

STAFF EVALUATION

(a) Resolved pending resolution of RAI 3.12-20.

(b) Unresolved

Clarify the second sentence whether it meant to say "If this is not the case, a detailed..." Is this a COL action item or provide a description of the "appropriate evaluation" methods.

COL action item or provide a description of the "appropriate evaluation" methods.

CONCLUSION

GE is not sure if nonlinear analysis will ever be performed in the ESBWR piping design. GE will confirm if this will be considered as a COL action item; otherwise, GE will provide appropriate method of nonlinear analysis to be included in the ESBWR piping design.

Unresolved, pending revised response to the RAI.

AUDIT ITEM NO.	RAI 3.12-22* (significant issue)	DATE/TIME	5-25-06
AUDITED BY	MS/JB/JF	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

DCD Tier 1, Section 3.1, "Piping Design," states that Class 1 piping systems will be analyzed for fatigue with environmental effects. Provide the analysis and design methods that will be used to perform the fatigue evaluation, including the environmental effects, for the ESBWR Class 1 piping systems.

GE RESPONSE

Requirements contained in ASME III NB-3653. The load combinations contained in Table 3.9-9, and the plant event cycles contained in Table 3.9-1 of the DCD, define the design conditions that are inputs to the fatigue analysis.

Additionally, GE has additional design criteria for carbon steel and stainless steel materials that are intended to address environmental issues that have been applied to prior BWR applications, and are likewise being applied to the ESBWR piping design. Additionally, class 1 piping using a fatigue limit of 0.1 instead of the ASME Code acceptance limit of 1.0 in conjunction with a stress ratio limit of 0.80 for Equations 12 and 13 of the ASME Code in order to limit the number of pipe whip restraints within the containment. DCD paragraphs 3.9.3.3 and 3.9.3.4 will be revised in DCD Revision 2 to reflect this commitment as follows:

"Additionally, a fatigue usage limit of 0.10 is used as a design criteria for all Class 1 piping." Evaluations have also determined that the ASME Code has conservative methods that provide additional margins. Specifically, the ASME Code adds stresses that include P, Ma, Mb, Mc, DT1, DT2, and Dtab by absolute sum when in actuality the direction and signs of the stresses are different. Reference (1) has performed a detail finite element analysis to compare against the results of a NB-3600 analysis and found that the fatigue usage based on NB-3600 is about 10 times more conservative.

This design criteria that is being used for ESBWR is consistent with the design methods used on previous BWR product lines that have successfully operated for the last 40 years without piping fatigue issues. Data from fatigue usage monitors from operating plants have also confirmed that the design criteria specified by GE in the original plant design was conservative.

The simplified NB-3600 analysis has been used for last 40 years successfully. If newly developed environmental fatigue curves are used, high fatigue usage factors are predicted and pipe break locations will be postulated throughout the plant. The economical cost to the plant is huge, and any gain of safety is questionable.

It is recommended that the environmental fatigue design curves should not be used without

substantial simultaneous changes in analytical methodology and the ASME Code.

Ref.1. "Fatigue Usage Factor Evaluation For An Integrally Reinforced Branch Connection Using NB-3600 And NB-3200 Analysis Methods" by Henry L. Hwang, PE, General Electric Nuclear Energy, Jack R. Cole, PE, David M. Bosi, PE, Design Engineering, Washington Public Power Supply System. PVP Vol. 313-2, page 139 through 156.

STAFF EVALUATION

Unresolved

Further NRC evaluation is needed.

CONCLUSION

During the meeting, the NRC stated that a draft Regulatory Guide on the environmental effects of Class 1 piping fatigue evalution will be issued soon. The staff will present this position at the next ASME Code meeting. This will remain as an open item.

Unresolved, will remain as an Open Item.

AUDIT ITEM NO.	3.12-23	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

Provide the analysis method that will be used to perform the fatigue evaluation of ESBWR Class 2, 3, and Quality Group B piping systems that are subject to cyclic loadings. Also, discuss how the environmental effects are considered in the Code Class 2 and 3 piping for which a fatigue analysis is performed.

GE RESPONSE

The Class 2 and Class 3 fatigue analyses are performed in accordance with the indications in NC-3611.2. The allowable stress reduction coefficient, f, is in accordance with Table NC-3611.2-1.

STAFF EVALUATION

Unresolved

The response does not include the QG B piping systems. In addition, GE did not address the environmental effect applicable to Class 2, 3 and QG B piping systems.

CONCLUSION

GE's response on the Class 2 and 3 fatigue analyses using the 7000 cycle criteria in the Code is acceptable. However, GE will revise its RAI response to include the QG B piping system. In addition, in the case of a fatigue analysis for Class 2 or 3 piping system (e.g., FW - a Class 2 system) if GE elects to perform fatigue calculations similar to that of a Class 1 piping system, then the effects of environmental fatigue need to be considered.

Unresolved, pending revised RAI response and revised DCD.

AUDIT ITEM NO.	RAI 3.12-24	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

NRC Bulletin 88-08 addresses unisolable sections of piping connected to the RCS (including the RPV) that may be subjected to temperature oscillations induced by leaking valves. Identify unisolable piping segments directly connected to the RCS and describe the analysis method to mitigate problems identified in Bulletin 88-08, including supplements 1, 2 and 3.

GE RESPONSE

(1) NRCB 88-08 and NRCB, Supplement 1:

Theoretically, the problem of thermal fatigue in unisolable sections of piping connected to the RCS caused by cold water leaks through a normally closed block valve, with the pressure upstream of the valve greater than the RCS and the temperature upstream of the valve significantly lower than the RCS temperature,
could occur in the following cases:

1.1 Condensate Isolation Valves of the Isolation Condenser System (B32). In the ESBWR, the problem of thermal stratification has been reduced to a minimum by means of a loop seal by providing a reduction in the pipeline where the condensate block valves are installed of 0.5m minimum below the RPV nozzle elevation. The piping downstream of the condensate block valves are not insulated except for the horizontal piping directly connected to the RPV nozzle. In addition, temperature elements strapped or magnetically attached to the top and bottom surface of the horizontal pipe are provided to detect temperature stratification in the piping.

1.2 Standby Liquid Control System (C41) Squib Valves. In this case the problem of leaks does not exist due to the design of the squib valves.

(2) NRC 88-08, Supplement 3

The problem of injection of cold water through the stem seal connection of a normally closed gate valve could theoretically occur in the following cases:

2.1 Nuclear Boiling System (B21) RPV head vent piping drain line isolation valves. In the ESBWR globe type valves with bellow seals are provided.

2.2 The Gravity-Driven Cooling System (E50) squib valves do not have a seal line either. Therefore it can be concluded that initially the condensate return piping of the Isolation Condensate Systems could be affected by the problem mentioned in NRC Bulletin 88.08 and that the design of the system in the ESBWR has taken into account the necessary measures to reduce the risk of stratification and to detect it.

STAFF EVALUATION

Unresolved

The response to this RAI require drawings of the piping layout with respect to RPV connections. Also, the issue here is not thermal stratification, rather it is thermal oscillations induced by leaking valves in the unisolable section of the piping.

During audit, GE should demonstrate those piping which are exposed to this temperature oscillation and explain how this phenomenon is considered in the ESBWR piping design.

CONCLUSION

GE discussed all cases included in its RAI response with P&I drawings to illustrate the potential thermal oscillations that might occur in an unisolable section of piping connected to the RCS (including the RPV) induced by leaking valves.

1.1 Condensate Isolation Valves of the Isolation Condenser System (B32). This section of the piping can be isolated by the containment isolation valves and hence not subject to any thermal oscillations.

1.2 Standby Liquid Control System (C41) Squib Valves. GE showed design drawings of several types of squib valves and based on their designs these valves will not leak since their operation is controlled by explosive which knocks out the valve disc from its completely sealed position.

2.1 Nuclear Boiling System (B21) RPV head vent piping drain line isolation valves. These valves address the stem leaking aspect of the Bulletin 88-08. GE showed a design of such a valve with bellows, which prevents any leaking through the valve stem. This section of the piping may also be subject to thermal oscillation depending on its actual routing. GE provided proposed text for this concern and the commitments delineated are acceptable.

2.2 The Gravity-Driven Cooling System (E50) squib valves do not have a seal line either. GE reviewed this system again to ensure that thermal oscillation would not occur in this section of the piping. GE will address this in its revised response to this RAI.

GE will further investigate this phenomenon for the ESBWR piping design and will revise its RAI response. Since actual routing of piping is important for examining this concern, GE may consider this as a COL action item. In the mean time NRC will check the MRP guidelines for the screening criteria to address the adequacy of GE's response to the thermal oscillation issue.

Unresolved, pending GE's revised response to this RAI and revised DCD.

NRC Audit of GE at Wilmington, NC on
ESBWR Piping Design Criteria and Confirmatory Analyses
May 22-26, 2006

AUDIT ITEM NO.	RAI 3.12-25* (significant issue)	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

The effects of thermal stratification have been observed in both BWR and PWR feedwater piping as discussed in NRC Information Notice (IN) 84-87 and NRC IN 91-38. Describe the method of analysis used in the ESBWR feedwater piping design to include the thermal stratification effects.

GE RESPONSE

IN 84-87 and IN 91-38 deal with the thermal stratification in Washington Nuclear Plant Unit 2, WNP-2 (BWR) and in Beaver Valley Unit 1, BV-1 (PWR). As indicated in IN 91 38, the three-loop design of BV 1 is especially prone to global thermal stratification in the feedwater pipes, which typically include long horizontal sections. Additionally, BWR plants are sensitive to the stratification effect during start-up when cold water is fed through preheated pipes.

The ABWR feedwater piping circumferential temperatures has been measured at various locations during startup and shutdown tests. The testing also included various designed operation transients. These test data, plus conservatisms, have been incorporated into the design duty cycle diagrams. Therefore, all the stratifications data are parts of the feedwater design requirements.

PISYS computer program has been written to calculate the piping forces and moments due to stratification. The solution has been benchmarked with ANSYS computer program results and exact solution by hand calculation for simple cases. The results of the stratification are included in the thermal cases. For ABWR feedwater piping analyses, there are 46 thermal cases calculated. Therefore, the thermal stratification effects have been incorporated in Equations 10 through 14 of NB-3650.

Furthermore, ESBWR have been designed to minimize the thermal stratification. In the case of WNP-2 (IN 84-87), an unusual design feature of the WNP-2 plant allows the feedwater system to be heated by the reactor water cleanup system (RWCU). The RWCU return lines join two 24-inch feedwater lines upstream from two isolation check valves, but downstream from normally open motor-operated valves. In many boiling water reactors, the RWCU enters the feedwater system between the inboard and outboard isolation check valves so that reverse flow of the RWCUS into the feedwater system is impossible. In the case of the ESBWR, the RWCU/SDC feeds water into the Nuclear Boiler System (NBS) in the feedwater section between two check valves (Figure 5.1-2 Nuclear Boiler System Schematic Diagram), so reverse flow of the RWCU/SDC into the feedwater system is impossible. {See NEDC-33084P Revision 1 page 3.1-27, GE proprietary information}.

In the case of the BV-1 (IN 91-38), the longest horizontal section in the ESBWR design is of approximate 50 ft. In addition, this section has the anti-stratification RWCU/SDC connection. Furthermore, within the containment, the feedwater line has seven direction changes before the connection to the RPV.

STAFF EVALUATION

Unresolved

The response to this RAI require drawings of the piping layout with respect to specific piping configuration. The response concentrates on WNP-2 and BV-1 situations rather than the criteria for the ESBWR.

During audit, GE should demonstrate those piping which is vulnerable to thermal stratification and explain how this phenomenon is considered in the ESBWR piping design.

CONCLUSION

Based on the discussion with GE, the ESBWR FW line from the RWCU return line connection at the FW line to the vessel nozzle may be subject to thermal stratification. GE has used the Japanese test data simulating the ABWR piping transients in the design of the ESBWR FW line. GE will provide technical justification that the ABWR data (both thermal conditions and transients) are conservative for its use in the ESBWR FW piping design.

Even though the ESBWR FW line is considered as ASME Class 2 piping, GE will perform an ASME Code Class 1 stress and fatigue evaluation of the FW piping. The two thermal stratification cases will include the piping at the RPV nozzle and FW header piping. GE will also provide additional justification and guidance (e.g., methodology, loading conditions, minimum temperature gradient from top to bottom) to be used in the FW piping design.

GE should specify that a verification test should be performed as part of the startup program to monitor the conditions and effects of thermal stratification in sections of the FW piping where stratification is anticipated. The purpose of this test is to confirm the conservatism of the ABWR stratification test data that is used in the ESBWR design. The test program will measure temperatures around the pipe circumference, strains at points of high stress, and pipe displacements, which are due to bowing caused by stratification. This will be considered as a COL action item.

Unresolved, pending GE’s revised response to this RAI.

AUDIT ITEM NO.	RAI 3.12-26	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

Describe the SRV design parameters and criteria that will need to be specified to the COL applicant to ensure that the specific piping configuration and SRVs purchased and installed at the COL applicant stage will match the test and design parameters used at the design certification stage. An example is the minimum rise time for the SRV valve operation; this can greatly affect the transient loads imposed on the piping system analysis. Also, any change in the discharge piping system configuration may affect the SRV loadings.

GE RESPONSE

GE & BWR owner has performed SRV tests at Wyle in Huntsville, Alabama in August, 1981. The forces due to SRV discharge had been measured. It confirms that 20 msec opening time should be used. The results were presented in a paper "Comparison of the Performances of the Strut and Snubber Subject to Dynamic Load", by H. L. Hwang and E. O. Swain, Proceedings of International Nuclear Power Plant Thermal Hydraulics and Operations Topical Meeting, page J1 to J10. Taipei, Taiwan, Republic of China, October 22-24, 1984."

The computer program, RVFOR, is described in Appendix 3D paragraph 3D.4.4.1. This program is available for COL applicant to use whenever needed. Example input and output will be also available in the User's manual.

STAFF EVALUATION

Unresolved

Original RAI needs to be addressed. Are tested SRVs similar to ESBWR SRVs.

During the meeting, GE should demonstrate and explain how the SRV design parameters are considered in the ESBWR piping design.

CONCLUSION

GE provided a revised response to this RAI and indicated that DCD Section 3.9.3.6 will be updated to include this revised information.

Unresolved, pending revised response to the RAI and revised DCD.

AUDIT ITEM NO.	RAI 3.12-27* (significant issue)	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

DCD Tier 2, Section 3.7.3.12, discusses the effect of differential building movement on piping systems that are anchored and restrained to floors and walls of buildings that may have differential movements during a dynamic event. SRP 3.9.2 Section II.2.g states that the responses due to the inertial effect and relative displacement for multiply-supported equipment and components with distinct inputs should be combined by the absolute sum method. Provide the combination methods that are to be used in the design of ESBWR piping systems for the inertial responses and SAM responses caused by relative displacements for all analysis methods (including ISM).

GE RESPONSE

DCD Tier 2, Section 3.7.3.12, discusses the effect of differential building movement on piping systems that are anchored and restrained to floors and walls of buildings that may have differential movements during a dynamic event. In general, the piping systems are anchored and restrained to floors and walls of buildings that may have differential movements during a seismic event. The movements may range from insignificant differential displacements between rigid walls of a common building at low elevations to relatively large displacements between separate buildings at a high seismic activity site.

Piping system is different from multiply- supported equipment. For piping system, the induced displacements in compliance with NB 3653 are treated differently than the inertia displacements. The SRSS method is a standard industrial practice to combine the inertial responses and SAM responses caused by relative displacements.

STAFF EVALUATION

Unresolved

For piping: It is acceptable. However, explain why is the SRSS method introduced in the response for the piping if the inertial and SAM stresses are treated separately per NB-3653.

For pipe supports: SRP 3.9.2 requires absolute sum for USM and SRSS for ISM. Clarify the ESBWR design criteria and include the criteria in the DCD.

CONCLUSION

GE has been using the SRSS load combination of inertial and SAM responses in the ESBWR piping design using USM method of analysis. The staff position as described in SRP 3.9.2 is

the absolute sum method. If GE utilizes an alternative method to the absolute sum approach, then technical justification needs to be provided.

Unresolved, pending technical justification for using SRSS or following SRP 3.9.2 guidance.

NRC Audit of GE at Wilmington, NC on
ESBWR Piping Design Criteria and Confirmatory Analyses
May 22-26, 2006

AUDIT ITEM NO.	RAI 3.12-28	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

The DCD did not indicate whether piping thermal analyses of piping systems will be performed for all temperature conditions above ambient. If this is not the case, then provide the minimum temperature at which an explicit piping thermal expansion analysis would be required. Also, provide the technical basis for the selected minimum temperature.

GE RESPONSE

For Class 1 piping, all the operating temperatures above ambient or below ambient are included in the fatigue analysis. Even the ambient temperature is included as a load set with defined cycles. The stress free state of a piping system is defined as a temperature of 21ºC (70ºF). For Class 2, 3 or B31.1 piping, no thermal expansion analysis will be performed for piping with system operating temperature of 65ºC (150ºF) or less.

STAFF EVALUATION

Technically Resolved

Clarify if the stress free state of Class 2 and 3 piping system is also defined as a temperature of 21ºC (70ºF).

CONCLUSION

During the meeting, GE provided a proposed revision to the RAI response. The staff considered the response technically acceptable, provided the information is included in the DCD.

Unresolved, pending revised RAI responses and revised DCD.

NRC Audit of GE at Wilmington, NC on
ESBWR Piping Design Criteria and Confirmatory Analyses
May 22-26, 2006

AUDIT ITEM NO.	RAI 3.12-29	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

DCD Tier 2, Appendix 3K, Section 3K.2, acknowledges that, as part of the resolution of the intersystem LOCA issue, the staff requires in addition to other requirements, that periodic surveillance and leak rate testing of the pressure isolation valves via Technical Specifications, as part of the ISI program. Indicate where in the DCD is the requirement that the COL applicant must perform this periodic surveillance and leak rate testing.

GE RESPONSE

DCD Tier 2 Appendix 3K, Section 3K2 describes NRC positions related to the design of low pressure piping system that interface with reactor coolant pressure boundary. These positions, which were developed during NRC review of ABWR, were taken into consideration in the development of ESBWR design.

The statement describes an NRC requirement on surveillance and leak rate testing of the pressure isolation valve between reactor coolant pressure boundary and a low pressure system. Because there is no such kind of pressure isolation valves identified in ESBWR, this NRC requirement is not applied in the ESBWR design.

For clarification, the following statement will be added in Section 3K2 of the next revision of DCD Tier 2. "The periodic surveillance and leak rate testing requirements for high-pressure to low-pressure isolation valves are not applicable to the ESBWR, because, as shown in this appendix, the ESBWR design does not contain a pressure isolation valve between the reactor coolant pressure boundary and a low pressure piping system."

STAFF EVALUATION

Technically Resolved

During the audit, GE should demonstrate and explain this issue discussed in DCD Appendix 3K. The summary of this Appendix in Section 3K.11 states that certain piping system thicknesses are considered for ISLOCA. Confirm that none of these piping systems is required to install a pressure isolation valve for separating the high pressure piping from the low pressure piping.

CONCLUSION

In DCD Appendix 3K, GE discusses the resolution of ISLOCA issue applicable to ESBWR piping design based on the requirements stated in SECY 93-087. Provided ESBWR piping does not contain any pressure isolation valves, the staff finds that the criteria presented in this

Appendix is acceptable. The issue of ISLOCA is subject to further review by the reactor systems reviewers. However, the proposed changes included in the RAI response are acceptable to resolve the concern identified in the RAI.

Unresolved, pending revision of the DCD.

NRC Audit of GE at Wilmington, NC on
ESBWR Piping Design Criteria and Confirmatory Analyses
May 22-26, 2006

AUDIT ITEM NO.	RAI 3.12-30	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

DCD Tier 2, Section 3.9.3.7.1, states: "The building structure component supports are designed in accordance with ANSI/AISC N690, Nuclear Facilities-Steel Safety-Related Structures for Design, Fabrication and Erection, or the AISC specification for the Design, Fabrication, and Erection of Structural Steel for buildings, correspond to those used for design of the supported pipe." Clarify what this sentence means, particularly the phrase "correspond to those used for design of the supported pipe." Also, identify the edition of these specifications because the titles do not match the corresponding specifications given in Tables 3.8-6 and 3.8-9 of the DCD.

GE RESPONSE

The paragraph "The building structure… supported pipe" will be modified in DCD Revision 2 as shown below.

"Supports and their attachments for ASME Code Class 1, 2 and 3 piping are designed in accordance with Subsection NF[1] up to the interface of the building structure, with jurisdiction boundaries as defined by Subsection NF. The loading combinations for various operating conditions correspond to those used for design of the supported pipe."

STAFF EVALUATION

Unresolved

What does "[1]" after NF signify?

Also, some load combinations for pipe supports are different from the supported pipe (e.g., anchor movement + dynamic inertia; support self weight inertia; axial pipe load on support due to friction) . Therefore, define load combinations for pipe supports.

CONCLUSION

During the meeting, GE provided a revision to its RAI response. GE will incorporate the proposed text in the DCD and will also include the load combination tables for various support types. The staff found this acceptable.

Unresolved, pending revised RAI response and revised DCD.

AUDIT ITEM NO.	RAI 3.12-31	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

(1) DCD Tier 2, Section 3.9.3.7, states that concrete anchor bolts used in pipe supports are designed to the factors of safety defined in IE Bulletin 79-02, Revision 1 and pipe support base plate flexibility will be accounted for in accordance with IE Bulletin 79-02. Clarify that all aspects of the anchor bolt design (not just the factor of safety) will follow IE Bulletin 79-02, Revision 2 (not Revision 1).

(2) Indicate whether the design and installation of all anchor bolts will also be performed in accordance with Appendix B to ACI 349-01 - "Anchoring to Concrete," subject to the conditions and limitations specified in RG 1.199.

(3) Define the term Seismic Category IIA used in DCD Tier 2, Section 3.9.3.7, and explain how it differs from Category II.

GE RESPONSE

(1) Concrete expansion anchor bolts, with regard to safety factor and anchor plates flexibility, will follow all aspects IE Bulletin 79-02 Rev 2 dated November 8, 1979. Expansion anchor bolts shall not be used for any safety related system components.

(2) The design and installation of all other anchor bolts will be performed in accordance with Appendix B to ACI 349-01 "Anchoring to Concrete", subject to the conditions and limitations specified in RG 1.199.

(3) Seismic Category IIA does not exist. DCD will be changed from "IIA" to "II" in DCD Revision 2.

STAFF EVALUATION

(1) Technically resolved

However, does GE really want to exclude expansion anchor bolts for safety related system components with no exceptions? The IE Bulletin covers only expansion anchors.

Clarify the DCD Section 3.9.3.7 statement "Surface-mounted ..... floor slabs." The first and second phrases seem to contradict each other.

(2) Unresolved

Why is the term "all other anchor bolts" included in the response?

(3) Resolved

CONCLUSION

ESBWR piping design will not use expansion anchor bolts for safety related system components. However, for other applications GE will adapt all aspects of the IE Bulletin 79-02, Rev.2, dated November 8, 1979.

A discussion with GE staff (in San Jose office) on the DCD Section 3.9.3.7 statement "Surface-mounted ..... floor slabs." GE agreed to revise this paragraph to clarify the use of surface-mounted base plates for pipe support design.

Unresolved, pending revised RAI response and revised DCD.

AUDIT ITEM NO.	RAI 3.12-32	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

DCD Tier 2, Section 3.7.3.3.1, provides some limited information about modeling the stiffness of guides and snubbers by using representative stiffness values. Some additional information about snubbers is provided in DCD Tier 2, Section 3.9.3.7.1, which describes the procedures to ensure that the spring constant achieved by the snubber supplier matches the spring constant used in the piping system model. However, the DCD does not adequately describe how the representative stiffness values are developed for all supports other than snubbers. Therefore, describe (1) the approach used to develop the representative stiffness values, (2) the procedure that will be imposed to ensure that the final designed supports match the stiffness values assumed in the piping analysis, (3) the procedure used to consider the mass (along with the support stiffness) if the pipe support is not dynamically rigid, and (4) the same information [(1), (2), and (3) above] for the building steel/structure (i.e., beyond the NF jurisdictional boundary) and for equipment to which the piping may be connected to.

GE RESPONSE

(1) Standard practice is to consider the minimum stiffness values stated in Welding Research Council (WRC)-353. These are obtained in such a way that the support is a stiff point for the pipe in the restricted direction; in general, a minimum value of 200EI/L3 is accepted. For struts and snubbers, the stiffness to consider is the combine stiffness of Strut/Snubber, Pipe Clamp and piping support steel.

(2) Standard stiffness values developed for Lungmen project will be used. Pipe support will be designed to satisfy stiffness used in piping analysis.

(3) In general, pipe support component weights, which are directly attached to a pipe such as a Clamp, Strut, Snubber are considered in piping analysis.

(4) The stiffness for the building steel/structure (i.e., beyond the NF jurisdictional boundary) are not considered in pipe support overall stiffness because the stiffness is much higher than the pipe support steel.

STAFF EVALUATION

(1) Unresolved

If WRC 353 is used, the criteria and definition of the terms need to be specified in the DCD (WRC 353, section 2.3.2). Specific stiffness values in relation to pipe size need to be included in the design specification.

(2) Unresolved. The Lungmen criteria should be available during audit for review. Explain which approach (1) and/or (2) will be used and specify in DCD.

(3) Unresolved

Answer the RAI part (3) regarding supports that are not dynamically rigid (potential amplification).

(4) Unresolved

Answer the RAI part (4) regarding the case where the building steel/structure (i.e., beyond the NF jurisdictional boundary) are not dynamically rigid (potential amplification) and similarly for equipment to which the piping may be connected to.

CONCLUSION

For pipe support within NF Jurisdiction

(1) GE will delete the reference to the WRC-353 and will include the Lungmen project values that will be used for the ESBWR piping design. This is acceptable.

(2) GE did not provide the Lungmen stiffness values during the audit, but it is acceptable as long as the stiffness values used in the piping analyses correspond to the actual stiffness in the design.

(3) GE provided criteria for including pipe support component weights in its revised RAI response and after further discussion on the issue, GE agreed to revise the response to satisfy NRC's concerns.

For pipe support outside NF Jurisdiction

(4) GE will revise the RAI response to address the NRC's concerns on large and complex supporting structures. GE will evaluate this condition on a case-by-case basis and may include the supporting structure in the piping analyses.

Unresolved, pending GE's revised response to this RAI and revised DCD.

AUDIT ITEM NO.	RAI 3.12-33	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

DCD Tier 2, Sections 3.7.3 and 3.9.3 do not provide a description of the analysis methods or design requirements needed to evaluate the effects of seismic and other dynamic (support) self-weight excitation for ESBWR pipe supports. Provide this information which is especially important for the larger and more massive type supports. The description should consider these effects on the support structure and anchorage. In addition, the description should consider all loads transmitted from the piping to the support and the support internal loads caused by self-weight, thermal, and inertia effects due to the support mass.

GE RESPONSE

The ESBWR pipe supports meet WRC Bulletin 353 stiffness criteria to preclude selfweight excitation.

In general, pipe support weight, such as snubber clamp or strut clamp on the pipe, is considered in piping analysis. The larger and more massive type supports will be evaluated in detail.

STAFF EVALUATION

Unresolved

Original RAI needs to be addresses. Meeting WRC Bulletin 353 stiffness criteria does not address whether the design of support is performed for pipe loads and support selfweight times inertial acceleration.

Explain what do you mean by the larger and more massive type supports will be evaluated in detail (see above comment).

CONCLUSION

During the meeting, GE provided a revision to the RAI response. This response is acceptable except that the approach should be applied not just for larger or more massive type supports, but to all supports where this effect may be significant.

Unresolved, pending revised RAI response and revised DCD.

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AUDIT ITEM NO.	RAI 3.12-34	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

DCD Tier 2, Section 3.9.3.7, describes the criteria and design requirements for piping supports of ESBWR piping. However, the DCD does not describe how friction loads imparted on pipe supports, due to unrestrained thermal motion, will be considered in design. Provide the criteria and design approach that will be used to calculate pipe support friction loads.

GE RESPONSE

There are no sliding supports used for ESBWR.

The friction loads caused by unrestricted motion of the piping are considered to act on the support with a friction coefficient of 0.3, in the case of steel-to-steel friction. For stainless steel, Teflon, and other materials, the friction coefficient could be less. The friction stresses are not considered during seismic or dynamic loadings.

STAFF EVALUATION

Unresolved

Explain what is meant by no sliding supports are used?

Include all material combinations used in the ESBWR pipe support design where sliding might occur. Provide specific values to be used for friction coefficient values.

CONCLUSION

During the meeting, GE provided a proposed revision to the RAI response to address this concern. The staff considered the response technically acceptable.

Unresolved, pending revised RAI response and revised DCD.

AUDIT ITEM NO.	RAI 3.12-35	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

DCD Tier 2, Section 3.9.3.7, describes the criteria and design requirements for piping supports of ESBWR piping. The DCD does not provide any description of the development and specification of hot and cold gaps to be used between the pipe and the box frame type supports. Provide this information.

GE RESPONSE

Current industry practice is to limit the total gap on frame type pipe supports in the range of 1/8 in. depending on the location of the application. In general this gap will be adequate for the radial thermal expansion of the pipe to avoid any thermal binding. For large pipe with much higher temperature, this gap will be evaluated to assure no thermal binding.

STAFF EVALUATION

Unresolved

Provide the technical basis and a range needs to be provided.

CONCLUSION

During the meeting, GE provided a proposed revision to the RAI response to address this concern. The staff considered the response technically acceptable.

Unresolved, pending revised RAI response and revised DCD.

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AUDIT ITEM NO.	RAI 3.12-36	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

DCD Tier 2, Section 3.9.3.7, describes the criteria and design requirements for piping supports of ESBWR piping. However, the DCD does not provide any information on the analysis and design criteria for instrumentation line supports. Provide this information.

GE RESPONSE

The instrumentation lines will be supported taking into account the flexibility and thermal and dynamic motion requirements of the pipe to which they connect. The supports on the instrumentation lines are located/positioned by taking into account the characteristics of said lines (self weight, temperature, seismic or dynamic loads as a function of their location, etc.).

STAFF EVALUATION

Unresolved

The level of detail is insufficient. Indicate whether the analysis and design criteria for instrumentation line supports are the same as other pipe supports or what alternate will be used.

CONCLUSION

During the meeting, GE provided a proposed revision to the RAI response to address this concern. The staff considered the response technically acceptable.

Unresolved, pending revised RAI response and revised DCD.

AUDIT ITEM NO.	RAI 3.12-37	DATE/TIME	5-25-06
AUDITED BY	MS/JB	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi/Maria Dominguez

DESCRIPTION OF ISSUE

DCD Tier 2, Section 3.9.3.7, describes the criteria and design requirements for piping supports of ESBWR piping. The DCD indicates that maximum calculated static and dynamic deflections of the piping at support locations do not exceed the allowable limits specified in the "suspension design specification". The purpose of the allowable limits is to preclude failure of the pipe supports due to piping deflections. Provide an additional discussion of the "suspension design specification." Also, describe how the deflection limits are developed.

GE RESPONSE

Standard practice in calculating piping supports is to consider a deflection limit of 1.6 mm for erection and operation loadings, based on WRC-353 paragraph 2.3.2. For the consideration of loads due to SSE and in the cases of springs, the deflection limit is increased to 3.2 mm. "Suspension Design Specification" will be changed to "Piping Design Specification" in DCD Revision 2.

STAFF EVALUATION

Technically Resolved

GE should clarify if this standard practice is applicable to ESBWR piping design and should be included in the DCD. [Design spec should be reviewed during the audit.]

CONCLUSION

During the meeting, GE provided a proposed revision to the RAI response. The staff considered the response technically acceptable except for the editorial type corrections identified (e.g., replacing “Standard practice” with “For ESBWR”.

Unresolved, pending changes to the DCD.

APPENDIX C

Audit Item Sheets

Discussion of Design Reports and Specifications
and
Other Audit Items

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AUDIT ITEM NO.	Audit - 01	DATE/TIME	May 23, 2006
AUDITED BY	M. Subudhi	GE STAFF	Jerry Deaver/Henry Hwang/Kirti Doshi

DESCRIPTION OF AUDIT

Review of the piping system analyses of the ESBWR MS/SRV piping system using the computer code PISYS07. Two separate piping analyses were performed: one representing the MS lines 1 and 4 including all SRV lines routed to the suppression pool and the other representing the MS lines 2 and 3 including their all SRV lines routed to the suppression pool.

DOCUMENTS REVIEWED

1. ESBWR MS Lines 1 and 4, Pipe Stress Analysis Results, Doc.# 092-134-F-A-00008A, Issue 1, 5-22-06.

2. ASME Code Section III, Class 1 MS Piping System, ESBWR Design Spec. MPL No. B21-4020, GE 26A6910, rev.0, 5-17-2006.

3. Advanced LWR Plants, SBWR Program, Depressurization Valve Development Test Program, final report, GEFR-00879, Class II, DRF A00-03007, October 1990.

STAFF EVALUATION

The staff reviewed the computer output for the MS piping problem containing 1 and 4 MS nozzle connections. The analyses included dead weight, thermal, P&T transients, seismic, and building hydrodynamic loads. Each piping system was analyzed for 28 different analyses including the natural frequency and modal analysis. Only Class 1 portion of the piping responses included element displacements, forces, moments; support and nozzle loads; and natural frequencies without modal responses.

When the computer input data was compared with the MS line design specifications, the cold temperature of the SRV discharge lines was not found in the spec. Most other loading conditions were in accordance with the design spec. The dynamic loads due to the DPV actuation and due to SRV discharge on submerged components were not considered in the analysis. GE claims that the DPV is located near the RPV nozzle and has very insignificant dynamic load on the piping system. However, the RPV nozzle load should be able to withstand this dynamic effect.

CONCLUSION

Based on the audit findings, GE is requested to take the following actions:

Audit Question 1: The staff requested GE to verify that the design specifications for the MS piping system define all loading conditions to be considered in the piping analyses and specify

all those that are missing, including the cold temperature of the SRV discharge lines.

Audit Question 2: The DCD load tables and MS/SRV discharge lines do not include the direct loading of SRV discharge and LOCA on submerged components in the suppression pool.

Audit Question 3: The staff requested GE to provide technical justification for not considering the DPV actuation loads in the MS piping analyses. Also, the test report on the DPV actuation is based on the SBWR application. The staff requested GE to ensure that the DPV actuation load for the ESBWR is bounded by the SBWR test results.

Audit Question 8: The staff decided to perform the confirmatory analyses of the MS piping system that contains the RPV nozzles 2 and 3. GE is requested to provide the following in order for BNL to perform an independent evaluation of the piping system and compare GE's results with BNL study:

1. Pipe isometric drawings showing nodes, pipe components, support types and their locations, pipe equipment, and other relevant information in order to develop a mathematical model similar to that used in GE's piping analyses.

2. P&ID drawings of the system to verify that all essential elements of the piping system are appropriately modeled.

3. Computer input and output data used in the PISYS code. Include both Class 1 and Class 2 piping sections.

4. All loading conditions considered for the piping model. Include floor response spectra for both seismic and hydrodynamic loads. Also, time histories for the SRV discharge and TSV closure laods.

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AUDIT ITEM NO.	Audit - 02	DATE/TIME	May 23, 2006
AUDITED BY	M. Subudhi/J. Braverman	GE STAFF	Jerry Deaver/ Henry Hwang/Kirti Doshi

DESCRIPTION OF AUDIT

Review of the MS piping design specification against the piping analyses input.

DOCUMENT REVIEWED

ASME Code Section III, Class 1 MS Piping System, ESBWR Design Spec. MPL No. B21-4020, GE 26A6910, rev.0, 5-17-2006

STAFF EVALUATION

The staff compared the design specification data with the PISYS computer input data and found some minor discrepancies and editorial errors. GE agreed to correct all editorial errors and will make sure that all loading conditions used in the piping analyses will be specified in the design spec.

A review of selected sections of the design specification indicates that there are a number of editorial and technical items that need to be corrected. Examples are: (1) Section 5.3, 1. Dynamic analysis refers to requirements for time history, however no requirements are provided, (2) Section 2.2.2, Code Cases refers to N-411-1 for damping, but no references to the additional conditions specified in NRC RG 1.84 for this Code Case are provided, and (3) the design specification specifies that the weight of the piping system shall include pipe, in-line components, pipe support components and insulation, as applicable; however, the criteria for determining the mass contribution from pipe support components is not defined in the Design Specification nor the DCD. In the case of the main steam lines and SRV discharge lines, as an example, the contributory weight of snubbers were not included in the piping analyses.

CONCLUSION

Audit Question 1: The staff requested GE to verify that the design specifications for the MS piping system define all loading conditions to be considered in the piping analyses and specify all those that are missing, including the cold temperature of the SRV discharge lines.

Audit Question 4: The staff requested GE carefully review Design Specifications B21-4010 and B21-4020 because a few editorial and technical corrections were identified during the audit.

AUDIT ITEM NO.	Audit - 03	DATE/TIME	May 24, 2006
AUDITED BY	M. Subudhi	GE STAFF	Jerry Deaver/ Henry Hwang/Kirti Doshi

DESCRIPTION OF AUDIT

Review of the Depressurization Valve (DPV) design and its loads on the MS piping system

DOCUMENT REVIEWED

Advanced LWR Plants, SBWR Program, Depressurization Valve Development Test Program, final report, GEFR-00879, Class II, DRF A00-03007, October 1990.

STAFF EVALUATION

GE did not include the DPV actuation load in the piping analyses for the MS system. The staff requested GE to provide technical justification for not including this load in the load combination table. In response, GE stated that these valves are located very close to the RPV nozzles and will operate along with the ADS only when depressurization of the vessel will be required which are very rare events. The SBWR valve tests documented in the GE report indicate that the opening time for this valve is 0.3 seconds which is considered to be long enough not to exert any significant loads on the piping system. However, GE also stated that the load caused by the DPV actuation is included in the RPV nozzle load calculation.

The staff reviewed the test report and requested GE to provide in writing the technical justification for not including DPV load in the MS piping analyses. Also, the staff requested GE to ensure that the DPV actuation load for the ESBWR is bounded by the SBWR test results.

CONCLUSION

Audit Question 3: The staff requested GE to provide technical justification for not considering the DPV actuation loads in the MS piping analyses. Also, the test report on the DPV actuation is based on the SBWR application. The staff requested GE to ensure that the DPV actuation load for the ESBWR is bounded by the SBWR test results.

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AUDIT ITEM NO.	Audit - 04	DATE/TIME	May 24, 2006
AUDITED BY	M. Subudhi	GE STAFF	Jerry Deaver/ Henry Hwang/Kirti Doshi

DESCRIPTION OF AUDIT

Review of the user's manuals for the piping codes PISYS07 and ANSI713

DOCUMENTS REVIEWED

4. User's Manual for PISYS07, NEDE-32352, Class 2, 2-1998.
5. User's Manual for ANSI713D, NEDE 23518, Rev.1, 9-2000.

STAFF EVALUATION

The staff found that these user's manuals were not in an auditable form. There were mistakes and references to older version of computer codes. The staff pointed out to the GE staff certain editorial mistakes found in these documents. However, it seems that most content of these manuals are consistent with the computer program input information. The staff expects to get final copies of these documents during the next audit.

CONCLUSION

The staff concludes that the user's manuals are consistent with the computer output for the two MS piping analysis. In the next audit, the staff will audit these manuals again and other piping analyses of other ESBWR systems committed by GE in this design certification process.

AUDIT ITEM NO.	Audit - 05	DATE/TIME	May 25, 2006
AUDITED BY	M. Subudhi/J. Braverman	GE STAFF	Jerry Deaver/ Henry Hwang/Kirti Doshi

DESCRIPTION OF AUDIT

Review of ESBWR turbine stop valve closure analysis and SRV discharge analysis against the input loadings for the MS piping analyses..

DOCUMENTS REVIEWED

6. ESBWR Turbine Stop Valve Closure Analyses, GENE-0000-0051-9296-R0, 3-17-2006.
7. ESBWR MS SRV Discharge Analyses, GENE-0000-0053-2413-01, 4-21-2006.

STAFF EVALUATION

Section 3.7 of the Turbine Stop Valve Closure analysis report has an assumption that the main steam flow rate and pipe ID are the same as the Lungmen project. This may be unconservative since the ESBWR has a higher power rating. GE needs to justify this assumption. RAI 3.12-26 already addresses a similar issue related to SRV discharge loads.

CONCLUSION

Audit Question 7: GE has been using the turbine stop valve (TSV) closure analysis using flow rate and pipe diameter data from the Lungmen plant. The staff requested GE to justify this assumption for the ESBWR MS piping design.

AUDIT ITEM NO.	Audit - 06	DATE/TIME	May 25, 2006
AUDITED BY	M. Subudhi	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi

DESCRIPTION OF AUDIT

Review of the benchmark report for the PISYS07D.

DOCUMENTS REVIEWED

Engineering Computer Program PISYS07D, DRF A12-00144, 1-6-1999. Conversion of ECP PISYS07D from the HP workstation to the DEC Alpha/Unix platform. (Software Test Plan and Test Report, DRF A12-001444, 1-1998).

STAFF EVALUATION

The staff found this document in an incomplete form. The conclusion section states that NRC benchmark problems are matched, but there were no data to verify this conclusion. GE was requested to provide a complete version of this report during the next audit. In response, GE stated that the GE staff is now in the process of finalizing a draft report which analyzes benchmark problems given in NUREG/CR-6049 and will be available for staff review later.

CONCLUSION

Audit Question 5: The staff requested GE to finalize the draft benchmark document for the PISYS07 against NUREG/CR-6049 and provide the final report for staff review.

AUDIT ITEM NO.	Audit - 07	DATE/TIME	May 25, 2006
AUDITED BY	M. Subudhi	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi

DESCRIPTION OF AUDIT

Review of the computer program TSFOR01D for calculating turbine stop valve closure load definition.

DOCUMENT REVIEWED

TSFOR01D Engineering Computer Program, Software Test Plan and Test Report, DRF A12-00146, December 1997.

STAFF EVALUATION

The staff found this document incomplete. Missing front matters and several appendices were requested, but GE was unable to provide them during the audit. Also, the document was marked draft.

CONCLUSION

Audit Question 6: The staff requested GE to prepare the final validation and verification documents for the computer codes ANSI713, RVFOR06 and TSFOR01 for review by the staff.

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AUDIT ITEM NO.	Audit - 08	DATE/TIME	May 25, 2006
AUDITED BY	M. Subudhi	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi

DESCRIPTION OF AUDIT

Review of the computer program RVFOR06D for calculating SRV discharge load definition.

DOCUMENT REVIEWED

RVFOR06D Engineering Computer Program, Software Test Plan and Test Report, DRF A12-00145, January 1998.

STAFF EVALUATION

The staff found this document has incomplete sections and does not have the test report. However, in a Table on page 10, there were test data which were unconservative when compared with the analysis data. No explanation was given for this in the report. The staff requested GE to provide some explanation, but GE was unable to address the staff's concerns.

CONCLUSION

Audit Question 6: The staff requested GE to prepare the final validation and verification documents for the computer codes ANSI713, RVFOR06 and TSFOR01 for review by the staff.

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AUDIT ITEM NO.	Audit - 09	DATE/TIME	May 25, 2006
AUDITED BY	M. Subudhi	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi

DESCRIPTION OF AUDIT

Review of the computer program ANSI713D for calculating ASME Code stress calculations and fatigue evaluation.

DOCUMENT REVIEWED

ANSI713D Engineering Computer Program, Software Test Plan and Test Report, DRF A12-00166, June 2000.

STAFF EVALUATION

The staff found this document was missing Appendices A, B, and C. Also missing was the comparison of four parts mentioned in the report for the verification. GE could not provide a complete copy of this report. Some statements in the report were based on the previous version of this computer program (i.e., ANSI 712D dated 1-1998).

CONCLUSION

Audit Question 6: The staff requested GE to prepare the final validation and verification documents for the computer codes ANSI713, RVFOR06 and TSFOR01 for review by the staff.

AUDIT ITEM NO.	Audit - 10	DATE/TIME	May 24, 2006
AUDITED BY	J. Braverman	GE STAFF	Jerry Deaver/Henry Hwang/ Kirti Doshi

DESCRIPTION OF AUDIT

Review of the definition of floor response spectra and displacements for seismic and hydrodynamic loads generated from the dynamic analysis of containment.

DOCUMENT REVIEWED

Dynamic Response Analysis of Containment Loads, MPL-A25-5030-26A6681A, Doc. # 092-134-F-C-00006, Issue 2, 5-19-2006.

STAFF EVALUATION

The staff reviewed selected portions of this report to determine what are the seismic and hydrodynamic spectra and displacements that should be used as input to the piping analyses. This report included the mathematical models and building responses for seismic, SRV, LOCA, and AP.

CONCLUSION

This report provides an acceptable description of the dynamic building seismic, SRV, LOCA, and AP loads in terms of floor response spectra and displacements.