MITSUBISHI HEAVY INDUSTRIES, LTD.
16-5, KONAN 2-CHOME, MINATO-KU
TOKYO, JAPAN

April 30, 2009

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Attention: Mr. Jeffery A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-09185

Subject: MHI's Response to US-APWR DCD RAI No. 209-1803

References: 1) "Request for Additional Information No. 209-1803 Revision 1, SRP Section: 03.09.03 – ASME Code Class 1, 2, and 3 Components, Application Section: DCD, Tier 1 – Section 3.9.3," dated 2/25/2009.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Response to Request for Additional Information No. 209-1803 Revision 1."

Enclosed are the responses to questions 1 through 23, all 60-day responses, of the RAI (Reference 1).

Please contact Dr. C. Keith Paulson, Senior Technical Manager, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of this submittal. His contact information is provided below.

Sincerely,

Y. Ogata

Yoshiki Ogata,
General Manager- APWR Promoting Department
Mitsubishi Heavy Industries, LTD.

Enclosures:

1. Response to Request for Additional Information No. 209-1803, Revision 1

CC: J. A. Ciocco
C. K. Paulson

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NRO

Contact Information

C. Keith Paulson, Senior Technical Manager
Mitsubishi Nuclear Energy Systems, Inc.
300 Oxford Drive, Suite 301
Monroeville, PA 15146
E-mail: ck_paulson@mnes-us.com
Telephone: (412) 373-6466

Enclosure 1

UAP-HF-09185
Docket No. 52-021

Response to Request for Additional Information No. 209-1803, Revision 1

April, 2009

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

4/30/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 209-1803 REVISION 1**
SRP SECTION:	**03.09.03 - ASME Code Class 1, 2, and 3 Components**
APPLICATION SECTION:	**03.09.03**
DATE OF RAI ISSUE:	**02/25/09**

QUESTION NO. RAI 03.09.03-1:

To ensure that ASME components meet the service level stress and functionality requirements, the ASME Code, Section III, NCA-3000 requires that design specifications and corresponding design reports be prepared for ASME Code, Section III, Class 1, 2, and 3 components. In DCD Tier 2 (Rev. 1) Section 3.9.3, MHI states that the design specifications for ASME Code, Section III, Class 1, 2, and 3 components, supports, and appurtenances are prepared under administrative procedures that meet or exceed the ASME Code, Section III rules. The ASME Code also requires a design report for safety-related components, to demonstrate that the component design meets the requirements of the relevant ASME design specification and the applicable ASME Code, Section III requirements. MHI states that the licensee, or the licensee's authorized agent, is responsible for developing design specifications and design reports in accordance with the responsibilities outlined under the ASME Code, Section III rules. In order for the staff to reach a reasonable assurance finding based on the requirements of 10 CFR 52.47, however, certain information is required during the NRC review of the design certification application. The staff requests that MHI commit to provide the certified design specifications of risk-significant mechanical components, as a minimum, for NRC audit. This is to ensure that the components are ready for procurement, and to verify that the DCD design methodologies and criteria are adequately reflected in the associated component design specifications. As for the design reports, the staff requests that MHI discuss in the DCD its plan and schedule of making the design reports of US-APWR major mechanical components available for NRC audit, e.g., through an ITTAC, to ensure that MHI has established a procedure for verifying the completion of the US-APWR component design.

ANSWER:

MHI will prepare the certified design specifications of risk-significant mechanical components during the procurement stage, which is assured through ITAAC as reflected in Table 2.3-2 of DCD Tier 1. Design reports will be prepared in accordance with the design completion plan provided in Table 1 of MHI Letter UAP-HF-08123 (Ref. ML082030589, dated July 14, 2008). Technical Report UAP-HF-09139 was submitted to the Staff in March 2009 (Ref. ML091030073, dated March 31, 2009] which summarized the stress analysis and design specifications of major components and piping. Design completeness will be verified during the reconciliation of the "as-built" plant against pertinent design documents as committed in the system specific ITAAC.

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

4/30/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 209-1803 REVISION 1**
SRP SECTION:	**03.09.03 - ASME Code Class 1, 2, and 3 Components**
APPLICATION SECTION:	**03.09.03**
DATE OF RAI ISSUE:	**02/25/09**

QUESTION NO. RAI 03.09.03-2:

In DCD Tier 2 (Rev. 1) Section 3.9.3.1, MHI states, "This subsection establishes the criteria for the selection and definition of design limits and loading combinations associated with normal operation, postulated accident, and specified seismic and other transient events for the design of other safety-related ASME Code, Section III components." It is not clear what MHI means by stating that this section is applicable to OTHER safety-related components. The staff requests that MHI address the following:

(a) Clarify what other safety-related components are referenced in the above statement.

(b) Clarify if the design of Quality Group D (per RG 1.26: for systems not part of the RCPB, but may contain radioactive materials) components satisfy the ASME B31.1 or any other industry Code/Standard requirements.

ANSWER:

(a) In DCD Subsection 3.9.3.1, first paragraph, first sentence, the word "other" was inadvertently included. The referenced subsection pertains to all safety related components and therefore the word "other" will be deleted.

(b) The industry code and standard requirements for Quality Group D components will be reflected in the design specifications to be developed.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2 Section 3.9, Revision 2 changes to be incorporated.

- Change the first sentence in the first paragraph in Subsection 3.9.3.1 to the following: "This subsection establishes the criteria for the selection and definition of design limits and loading combinations associated with normal operation, postulated accidents, and specified seismic and other transient events for the design of safety-related ASME Code, Section III (Reference 3.9-1) components."

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

4/30/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	NO. 209-1803 REVISION 1
SRP SECTION:	03.09.03 - ASME Code Class 1, 2, and 3 Components
APPLICATION SECTION:	03.09.03
DATE OF RAI ISSUE:	02/25/09

QUESTION NO. RAI 03.09.03-3:

In DCD Tier 2 (Rev. 1) Section 3.9.3.1, MHI states that the number of cycles for seismic events considered is based on equivalent of usage factor where 300 cycles at 1/3 SSE stress range equals the same usage factor as 20 cycles of SSE stress range, consistent with Appendix D of IEEE Standard 344-2004. MHI made a reference to Reference 3.9- 34 for the guidance. The staff requests MHI to clarify the following in regard to the SSE loading consideration:

(a) There appears to be a typographical error at the end of section 3.9.3.1 on page 3.9- 33. There, the reference is made to reference number 3.9-33 when it should be 3.9-34.

(b) There appears to be typographical errors in parentheses in the third sentence in Note 3 on page 3.9-34.

(c) Note 3 on DCD page 3.9-34 states that in certain cases for non-standard SSCs, the 1/3 SSE may be adjusted higher for plant specific site as justified for site-specific design as permitted by SECY 93-087. Clarify what non-standard SSCs at US-APWR perform safety-related functions and explain why the use of an adjusted higher than 1/3 plant-specific SSE is limited to non-standard SSCs per SECY 93-087.

ANSWER:

(a) The typographical error "Reference 3.9-33" in Subsection 3.9.3.1 will be corrected in DCD Revision 2 to "Reference 3.9-34."

(b) The statements of note continuation identified within the parentheses "(continued on next page) (continued from previous page)" are no longer applicable, and will be corrected in DCD Revision 2.

(c) Note 3 within Subsection 3.9.3.1.1 will be clarified by removing the reference to SECY 93-087, which does not specifically address adjusting the OBE based on site specific information. The OBE values that will be used will be chosen by the COL Applicant and may be higher than

1/3 SSE based on the site specific seismic information. For the standard US-APWR design, the OBE is 1/3 of the SSE and, therefore, no explicit analysis or design is required for the DCD.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2 Section 3.9, Revision 2 changes to be incorporated.

- Change the last sentence of the second paragraph in Subsection 3.9.3.1 to the following: "The number of cycles considered are based on equivalent of usage factor where 300 cycles at 1/3 SSE stress range equals the same usage factor as 20 cycles a SSE stress range (see Reference 3.9-34)."

- Change Note 3 within Subsection 3.9.3.1.1 to the following:

  "[3] OBE as used in Table 1 of SRP 3.9.3, Appendix A and in ASME Code, Section III for stress evaluation subject to fatigue is 1/3 SSE with SSE damping. The earthquake inertial and anchor movement loads used in the Level B stress intensity range and alternating stress calculation is taken as 1/3 of the peak SSE inertial and anchor movement loads. In this case, the number of cycles to be considered for earthquake loading is 300 as derived in accordance with Appendix D of IEEE Standard 344-2004 (Reference 3.9-34). In certain cases for non-standard SSCs, the 1/3 SSE may be adjusted higher for site-specific design since the site-specific value of OBE is determined by the COL Applicant as discussed in "OBE" of Subsection 3.7.1.1. If used, the COL Applicant is to demonstrate that applicable stress, strain, and deformation limits are satisfied based on the site-specific OBE selected."

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

4/30/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	NO. 209-1803 REVISION 1
SRP SECTION:	03.09.03 - ASME Code Class 1, 2, and 3 Components
APPLICATION SECTION:	03.09.03
DATE OF RAI ISSUE:	02/25/09

QUESTION NO. RAI 03.09.03-4:

In DCD Tier 2 (Rev. 1) Section 3.9.3.1.1, MHI states that due to the low probability of occurrence of a SSE (less than 10% of plant operation time), the SSE is analyzed in combination with only those operating modes that occur greater than 10 percent of the time. One of the conditions for combining SSE with other transient loads assumed that a simultaneous loss of offsite power (LOOP) and a single failure of a safety-related system occur as a result of an SSE event. The staff requests that MHI clarify certain aspects of these criteria:

(a) Provide the technical basis for combining SSE with only those operating modes that occur greater than 10% of the plant operation time.

(b) The staff noted that an occurrence of a SSE is measured with respect to plant operation time, while a system transient is measured with respect to its system operating time. Since the system operating time may not be the same as the plant operating time for all safety-related systems, clarify how the SSE during operational modes occurring less than 10% of plant operation time correlate to the system operating mode that occurs greater than 10 percent of the time of the system operating mode.

(c) In accordance with RG 1.53, the safety systems must perform all safety functions required for a design basis event in the presence of any single detectable failure within the safety system. The second bullet on DCD page 3.9-34 states that for combining SSE with other transient loads, it is assumed that a simultaneous loss of offsite power (LOOP) and a single failure of a safety-related system occur as a result of an SSE event. Clarify the meaning of a single failure of a safety-related system in the light of RG 1.53 definition of a single failure within the safety system.

(d) The third bullet on DCD page 3.9-34 states that the SSE duration is considered as 22 seconds. Explain how this SSE duration of 22 seconds is established for US-APWR.

(e) On DCD page 3.9-35 it is stated that in order to assure an adequate safe-shutdown margin, the SSE loads are combined concurrently with several specific loads based on past precedents and regulatory guidelines. Examples of these past precedent and regulatory guideline loading conditions include (i) SSE is combined with postulated pipe rupture loads, (ii) SSE is combined with containment design pressures, and (iii) Polar crane and associated rigging equipment are qualified to withstand an SSE event. Note that for Service Level D, SRP Section 3.9.3, Table 1 requires that SSE should be combined with LOCA (e.g., pipe break loads), irrespective of their occurrence frequency in a plant life. Since the three cases cited in the DCD are considered as examples of past precedence and regulatory guidelines loading conditions, discuss if there are other loads that will be included in the US-APWR design.

ANSWER:

(a) SRP 3.9.3 Appendix A provides the loads that are combined with SSE for the faulted condition. In accordance with SRP 3.9.3, the design includes the sustained loads and LOCA loads in combination with SSE loads. MHI treats the loads associated with normal operating condition (e.g. thermal load and dead weight) as a sustained load. Modes occurring greater than ten percent of the plant operating time is used to distinguish normal loads from those that are considered transient or dynamic loads. MHI will delete the associated fourth paragraph in Subsection 3.9.3.1.1 since the information provides unnecessary detail. In addition, the statement "therefore" in the first sentence in the fifth paragraph is no longer applicable.

(b) The load combinations provided with a SSE for the faulted condition is provided in SRP 3.9.3 and is independent of plant operating time. There is no change to the DCD necessary.

(c) The assumed single failure of a safety-related system described in the second bullet of the fifth paragraph in Subsection 3.9.3.1.1 was intended in a broad sense and is taken within a safety-related system in accordance with RG 1.53. This statement in Subsection 3.9.3.1.1 will be changed in DCD Revision 2 to improve consistency with the phrasing of RG 1.53.

(d) The duration of motion has been determined using random phase characteristics as stated in US-APWR DCD Subsection 3.7.1.1; subsection 'Duration of Motion' on page 3.7-8. A duration time of 22 seconds meets the requirements of SRP 3.7.1 of at least 20 seconds. There is no change to the DCD necessary.

(e) The examples of other loads that are combined with SSE loads at the end of Subsection 3.9.3.1.1 are considered inclusive. There are no other additional loads based on past precedence and regulatory guidelines in the US-APWR design. There is no change to the DCD necessary.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2 Section 3.9, Revision 2 changes to be incorporated.

- Delete the fourth paragraph in Subsection 3.9.3.1.1 in its entirety.
- Change the first sentence in the fifth paragraph of Subsection 3.9.3.1.1 to the following: "The SSE is considered combined under the following PCs:"
- Change the second bullet in the fifth paragraph of Subsection 3.9.3.1.1 to the following: "It is assumed that a simultaneous Loss of Offsite Power and a single failure within a safety-related system occur as a result of an SSE event. In addition, it is assumed that non safety-related systems are unavailable."

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

4/30/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	NO. 209-1803 REVISION 1
SRP SECTION:	03.09.03 - ASME Code Class 1, 2, and 3 Components
APPLICATION SECTION:	03.09.03
DATE OF RAI ISSUE:	02/25/09

QUESTION NO. RAI 03.09.03-5:

In DCD Tier 2 (Rev. 1) Table 3.9-3, MHI provides the minimum design loading combinations for ASME Code, Section III, Class 1, 2, and 3 and CS systems and components, and in Table 3.9-4 MHI provides the same information for ASME Code, Section III, Class 1, 2, and 3 supports in piping and components. The staff requests MHI to address the following on load combination criteria:

(a) DCD Table 3.9-3 does not address load combinations (if any) associated with test conditions for ASME Code, Section III, Class 1, 2, and 3 and CS systems and components. Provide these load combinations.

(b) Note 3 to DCD Table 3.9-3 and note 2 to DCD Table 3.9-4 state that loadings generated by static displacement of the concrete containment vessel and building settlement are added to the loading combinations for ASME Code, Section III, Class 2 and 3 systems. Explain why this is not applicable to Class 1 systems and components?

(c) Note 4 to DCD Table 3.9-3 states that when determining appropriate load combinations involving external mechanical load (LEM), a determination of the timing sequence and initiating conditions that occur between pressure (PM) and LEM are considered. Also, notes 7, 8 and 9 to Table 3.9-3 and notes 4, 7 and 8 to Table 3.9-4 indicate similar statements. Explain each of these notes in relation to NUREG-0484 requirements for combining two or more dynamic loads.

(d) Note 5 to both DCD Tables 3.9-3 and 3.9-4 states that pressurizer safety valve discharge and associated load is classified under an emergency service condition (i.e., service level C). Provide the technical basis for this load combination limited to service level C loads.

(e) Identify the load in DCD Table 3.9-3 to which note 10 is applicable.

(f) Note 12 to DCD Table 3.9-3 and note 10 to DCD Table 3.9-4 state that if a loading is considered negligible or is non- existent, it is ignored in the service level combinations. Identify these loads and provide the criterion for assessing them to be negligible.

(g) Note 6 to DCD Table 3.9-4 states that SE is self weight excitation of the support caused by seismic building inertial loads. SSEI, SSEA, and SE are combined using absolute summation.

Explain and justify all combinations of SSEI, SSEA, and other dynamic loads (LDF) for Level B and Level D service conditions in DCD Table 3.9-4. Clarify if LDF for Level C and Level D service conditions should have been LDFE and LDFF, respectively.

ANSWER:

(a) DCD Table 3.9-3 does not identify the load combination of testing conditions for ASME Code, Section III, Class 1, 2, 3 and CS System and Components. DCD Table 3.9-3 will be changed in Revision 2 to include hydrostatic load combinations.

(b) The Class 1 systems and components are confined within the containment structure and will experience the same static settlement as the containment structure. Therefore, there is no effect of static displacement/settlement of the containment structure on Class 1 systems and components. Since Class 2 and 3 systems are not located solely within the containment structure, dissimilar displacements can be experienced. There is no change to the DCD necessary.

(c) The SRSS approach is used for combining SSE and accident loads. For loads which are not combining two or more dynamic loads, the use of SRSS or absolute summation is determined considering timing sequence and initiating conditions. This approach as stated in the notes for DCD Tables 3.9-3 and 3.9-4 is in accordance with the methodology of NUREG-0484. There is no change to the DCD necessary.

(d) Note 5 in DCD Tables 3.9-3 and 3.9-4 states that pressurizer safety valve discharge and the associated load is classified under emergency service condition Level C. However, pressurizer safety valve discharge is also classified under other service conditions, though not noted, as evidenced in Table 3.9-5. Since note 5 pertains to other emergency design loading conditions, it is unnecessary and will be deleted from Tables 3.9-3 and 3.9-4 during DCD Revision 2.

(e) DCD Table 3.9-3, note 10 is applied for the load combination of hydrostatic test conditions. The hydrostatic test load will be added to the table [as stated in part (a) above] with the applicable note. As stated in part (a) above, the DCD Table 3.9-3 will be changed in Revision 2.

(f) Loads sufficiently small compared to seismic, accident, thermal, dead weight and pressure loads are considered to be negligible and do not affect the overall plant design. Since note 12 is not pertinent to the design analyses, it will be deleted from the DCD during Revision 2.

(g) Dead Load (DL), Thermal Load (TH_i), External Load (L_{EM}), and Other Dynamic Load (L_{DF}) are combined using the absolute summation approach. DBPB and the total load of SSEI, SSEA, and SE are combined using the SRSS approach. These combinations are based on the guidelines for load combinations in SRP 3.9.3. As noted by the NRC Staff, L_{DF} for Level C and Level D service conditions in Table 3.9-4 should be L_{DFE} and L_{DFF} and will be corrected in the DCD during Revision 2.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2 Section 3.9, Revision 2 changes to be incorporated.

- Table 3.9-3 will be changed as follows:
  - The second column header will be changed to the following: "Design Loading Combinations(3)(6)"
  - The second column, third row will be changed to the following: "$P_M^{(1)}$ + DL + $L_{DFN}^{(7)}$ + $L_{EM}^{(7)}$ + TH_{TRN} + TH_{MTL}"
  - The second column, fourth row will be changed to the following: "$P_M^{(1)}$ + DL + $L_{EM}^{(7)}$ + TH_{TRN} + TH_{MTL} + SRSS(2) ((SSEI + SSEA)(11) + $L_{DFU}^{(7)}$)"
  - The second column, fifth row will be changed to the following: "$P_M^{(1)}$ + DL + $L_{DFE}^{(7)}$ + $L_{EM}^{(7)}$"
  - The second column, seventh row will be changed to the following: "$P_M^{(1)}$ + DL + $L_{DFF}^{(7)}$ + $L_{EM}^{(7)}$"
  - Insert the following as the last row of Table 3.9-3:

Hydrostatic Test	$H_{DL}^{(10)}$

  - Change Table 3.9-3 note 5 to the following: "Deleted.".
  - Note 12 of Table 3.9-3 is deleted in its entirety.
- Table 3.9-4 will be changed as follows:
  - The second column header will be changed to the following: "Design Loading Combinations(3)"
  - The second column, third row will be changed to the following: "DL + TH_i + L_{EM} + $L_{DFU}^{(4)}$"
  - The second column, fourth row will be changed to the following: "DL + TH_i + L_{EM} + $L_{DFE}^{(4)}$"
  - The second column, fifth row is deleted in its entirety.
  - The second column, ninth row will be changed to the following: "DL + TH_i + $L_{EM}^{(7)}$ + L_{DFS} + SRSS (DBPB + (SSEI + SSEA + SE))(6) +L_{DFF})(7)"
  - Change Table 3.9-4 note 5 to the following: "Deleted.".
  - Note 10 of Table 3.9-4 is deleted its entirety.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

4/30/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	NO. 209-1803 REVISION 1
SRP SECTION:	03.09.03 - ASME Code Class 1, 2, and 3 Components
APPLICATION SECTION:	03.09.03
DATE OF RAI ISSUE:	02/25/09

QUESTION NO. RAI 03.09.03-6:

In DCD Tier 2 (Rev. 1) Section 3.9.3.1.2, MHI discusses loads for ASME Code, Section III, Class 1, 2, and 3 components, CS, and component supports. Address the following:

(a) Under transient loading resulting from a postulated pipe break, MHI states that asymmetric blowdown load is discussed in DCD Tier 2 (Rev. 1) Section 3.9.2.5. The staff noted that DCD Tier 2 (Rev. 1) Section 3.9.2.5.2 discusses the pipe rupture analysis methodology and acceptance criteria, and uses MULTIFLEX computer code for the blowdown analysis. However, no discussion on the characterization of the asymmetric blowdown load is included. Discuss how the asymmetric blowdown load is characterized and included in the design of ASME Code, Section III, Class 1, 2, and 3 components, CS, and component supports.

(b) The LBB criteria are applied to RCL, specific RCS Class 1 branch lines, and main steam lines of the US-APWR. However, DCD Table 3B-2 lists ten lines subject to LBB evaluation. In addition to the lines identified above, LBB evaluation is also applied to accumulator system lines. Describe the LBB criteria applied to all lines listed in the Table, including the accumulator lines.

(c) Also, in DCD Section 3.9.3.1.4 for RCL piping model it is stated that external loads are applied to the RCS piping for connecting piping that does not meet the LBB criteria. Explain what types of pipe break loads are applied to the RCL piping at the branch connections and how these loads are determined. Also, clarify if only the lines satisfying LBB criteria are modeled as part of the RCL piping model, thus excluding all lines that do not satisfy the LBB criteria.

(d) MHI states that components and piping are evaluated for the dynamic response to transient loads as a static load subject to a dynamic load factor (DLF). Describe and technically justify the DLF to be used in this dynamic analysis.

(e) MHI states that the effects of two additional loading events (RCP locked rotor and heavy lift loads) on safety-related equipment are evaluated for local and global stress effects on a case-by-case basis and are not combined with any other Level C or D service condition. In case of RCP locked rotor, the stresses calculated are evaluated using Level D service limits for the immediately affected components and supports in the affected RCL and using Level B service limits for components in the other RCL. Explain above statements with technical justifications.

ANSWER:

(a) In the event of a postulated instantaneous pipe rupture in the primary coolant system, asymmetric depressurization due to the rapid hydraulic transients could take place, causing asymmetric hydraulic loads to act upon the reactor internals. This hydraulic load is termed "asymmetric blowdown load". The depressurization wave generated at the break point propagates through the primary coolant piping and extends into the reactor vessel (RV). The behavior of the depressurization in the RV depends upon the location of the postulated pipe rupture. The schematic diagrams of typical phenomenon of the depressurization wave propagation during LOCA are shown in Figure 1 of Reference 1 below.

In case of a cold leg break, the depressurization wave generated at the break point propagates through the inlet nozzle of the RV and extends into the annulus (downcomer) between the core barrel and the vessel. In the early phase of LOCA, decompression could take place on the side of the RV annulus nearest to the pipe rupture point before the pressure on the opposite side of RV changes. This instantaneous differential pressure across the core barrel could induce lateral loads both on the core barrel and on the RV, see Figure 1 of Reference 1 below.

The asymmetric blowdown loads due to postulated piping breaks are analyzed by MULTIFLEX computer code, which can provide the load conditions (forcing function which is used as input data for the dynamic system analysis) for components in the primary coolant system, and internals and supports in the RV. The main characteristics of MULTIFLEX are described in Reference 2 below.

Reference 1 - R. Krieg, E.G. Schlechtendahl, K-H. Scholl, "Design of the HDR Experimental Program on Blowdown Loading and Dynamic Response of PWR-Vessel Internals," Nuclear Engineering and Design 43 (1977) 419-435.

Reference 2 - MUAP-09002, Revision 1, "Summary of Seismic and Accident Load Conditions for Primary Components and Piping" (Proprietary Version).

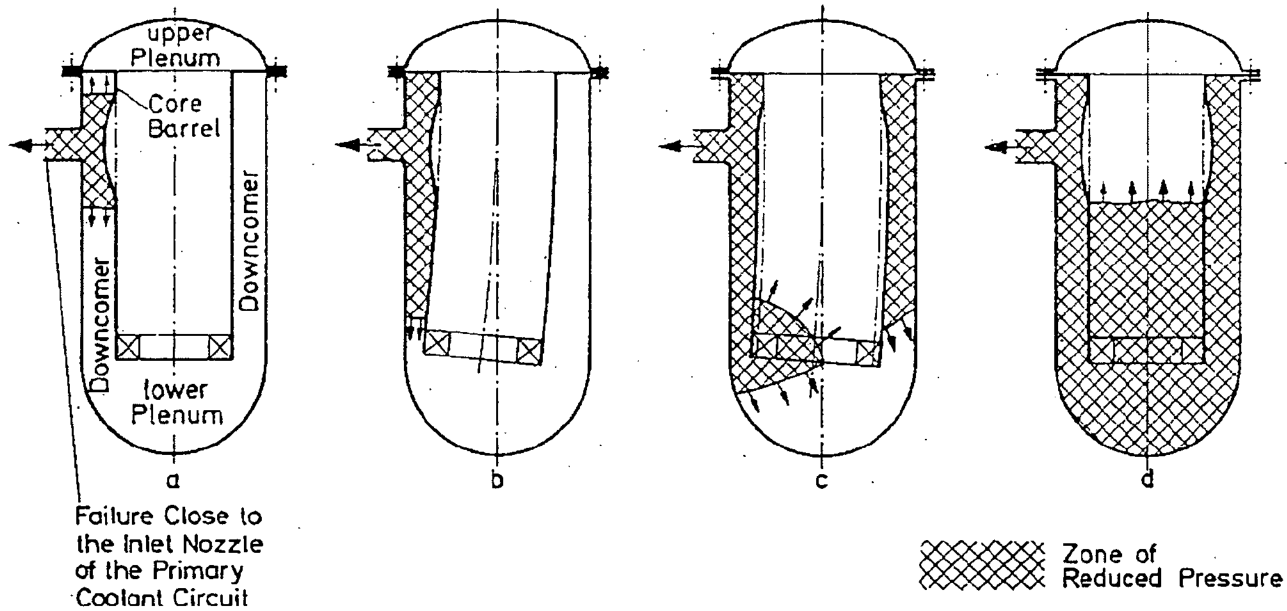

Figure 1 The schematic diagrams of typical phenomenon of the depressurization wave propagation during LOCA (Reference 1)

(b) The LBB criteria discussed in Subsection 3.6.3 has been applied to all of the lines listed in DCD Appendix 3B, Table 3B-2. For consistency with Table 3B-2, the lines described in Subsection 3.9.3.1.2 of the DCD, tenth bullet, will be changed to reference the RCL branch lines rather than the RCS branch lines. Accumulator injection lines are included in RCL branch lines.

(c) US-APWR has applied the LBB criteria to RCS Class 1 piping. As a result of the LBB evaluations, the main reactor coolant piping break and surge line break dynamic evaluations were eliminated. The postulated pipe break events that were evaluated for RCS components and piping is as follows:

- Hot Leg Branch Line Break at the 10 inch Residual Heat Removal / Safety Injection line nozzle
- Cold Leg Branch Line Break at the 14 inch Accumulator line nozzle
- Feedwater Line Break at the Steam Generator Feedwater Nozzle
- Main Steam Line Break at the Steam Generator MS Nozzle

The RCS modeling methodology used is described in Technical Report, MUAP-08005, Revision 0, Section 6.

(d) The pressurizer relief valves are installed on the piping to the pressurizer and are modeled as such in the US-APWR Class 1 piping analysis. The resulting transient load on the pressurizer relief valve is a result of the piping analysis and includes the relief valve opening loads. Therefore, there is no need to apply a dynamic load factor for analyzing the relief valve open system transient as a static load. Reference to subjecting the relief valve open to a dynamic load will be deleted from the DCD as described below.

(e) All four RCS piping loops and associated components of the US-APWR will be affected by a postulated RCP locked rotor event and are analyzed. The RCP locked rotor is postulated to occur in a single loop and therefore, only that loop is evaluated in accordance with Level D design criteria for the accident conditions. The other three non-accident loops are evaluated for integrity using the Level B design criteria which appropriately reflects the loads for the non-accident loops.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2 Section 3.9, Revision 2 changes to be incorporated.

- The first bullet of the sixth paragraph in Subsection 3.9.3.1.2 will be changed to the following:
  - "The RCL, the specific RCL ASME Code, Section III, Class 1 branch lines, and main steam lines listed in Appendix 3B that can be exempted from required pipe rupture considerations by meeting LBB criteria."
- The second bullet of the seventh paragraph in DCD Subsection 3.9.3.1.2 will be changed to the following:
  - "Components and piping are evaluated for the dynamic response to transient loads."

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

4/30/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	NO. 209-1803 REVISION 1
SRP SECTION:	03.09.03 - ASME Code Class 1, 2, and 3 Components
APPLICATION SECTION:	03.09.03
DATE OF RAI ISSUE:	02/25/09

QUESTION NO. RAI 03.09.03-7:

In DCD Tier 2 (Rev. 1) Section 3.9.3.1.3, MHI provides the loading combinations and stress limits criteria for ASME Code, Section III, Class 1 components and supports and Class CS core support structure. DCD Table 3.9-6 summarizes stress criteria per ASME Code Subarticles applicable to these Class 1 and Class CS components and their supports. Address the following:

(a) Explain why vessel design and pump design do not reference ASME Code, Section III, NB-3300 and NB-3400, respectively.

(b) Explain why valve design criteria for the service level D do not reference NB-3527 in its entirety. Clarify whether this criteria applies to all Class 1 valves, active or not.

ANSWER:

(a) Though ASME Code, Section III, NB-3300 and NB-3400 describe the scope of vessel and pump design, both sections refer to ASME Code, Section III, NB-3200 for stress criteria. Since Table 3.9.6 pertains specifically to stress criteria, reference was made to NB-3200 rather than the other subsections.

(b) ASME Code Section III, NB-3527 states that if the design specifications specify any loadings for which level D limits are designated, the guidelines of Appendix F may be used in evaluating those loadings independently of other loadings. Rather than referencing NB-3527 in Table 3.9-6, MHI elected to use the notation afforded by that section to refer to ASME III Appendix F for pressure boundary integrity requirements. As a result, the ASME Code Section III, NB- 3527 is applied to all Class 1 valves, active or not.

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

4/30/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 209-1803 REVISION 1**
SRP SECTION:	**03.09.03 - ASME Code Class 1, 2, and 3 Components**
APPLICATION SECTION:	03.09.03
DATE OF RAI ISSUE:	02/25/09

QUESTION NO. RAI 03.09.03-8:

In DCD Tier 2 (Rev. 1) Section 3.9.3.1.5, MHI provides the loading combinations and stress limits criteria for ASME Code, section III, Class 2 and 3 components and supports. DCD Table 3.9-8 summarizes the stress criteria per ASME Code Subarticles applicable to these Class 2 and 3 components and their supports. Clarify the following:

(a) Article NC-3300 provides criteria for vessel design, while NC-3200 provides an alternative design rules for vessels. DCD Table 3.9-8 for vessels/tanks specifies NC- 3217 for the design and service level A condition. The staff noted that there exists no corresponding NC-3317 similar to NC-3217 on design criteria. Discuss the criteria that are used in the design of the US-APWR vessels in accordance with NC-3217 for service level A condition. Also, explain why these criteria are not applicable to other service level conditions for the vessel design.

(b) MHI states that the environmental impact on fatigue of Class 2 and 3 components will follow guidelines established by the NRC at the time of actual analysis. Explain why this should not be a COL information item.

ANSWER:

(a) Reference to NC-3217 in Table 3.9-8 is not appropriate since that subsection provides design criteria not stress criteria. Table 3.9-8 will be changed in Revision 2 to delete reference to NC-3217 for vessels/tanks for the design and service Level A condition.

(b) MHI will be evaluating the environmental impact on fatigue of Class 2 and 3 components and will be submitting the design report as a DC application document. Therefore, this item should not be considered as a COL item. Appropriate changes to the DCD Subsection 3.9.3.1.5 will be considered upon completion of the evaluation.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2 Section 3.9, Revision 2 changes to be incorporated.

- Change the first row (below titles), second column of Table 3.9-8 to the following: "ASME Code, Section III, NC/ND-3310, 3320"

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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RAI NO.:	**NO. 209-1803 REVISION 1**
SRP SECTION:	**03.09.03 - ASME Code Class 1, 2, and 3 Components**
APPLICATION SECTION:	**03.09.03**
DATE OF RAI ISSUE:	**02/25/09**

QUESTION NO. RAI 03.09.03-9:

MHI states in DCD Tier 2 (Rev. 1) Section 3.9.3.3 that active pumps and valves are required to function under faulted conditions. It further states that DCD Section 3.10 provides the equipment specifications to assess the functional capability of the required components. These criteria and considerations include collapse and deflection limits associated with these components. Discuss (with examples) these criteria associated with the operability assurance of pumps and valves.

ANSWER:

The stress evaluation applied by ASME Service Level D requirements is intended to assure that the pressure retaining integrity is maintained, but is not intended to assure operability of components. Pump and valve operability is assured by tests and analysis in accordance with SRP 3.10, "Seismic and Dynamic Qualification of Mechanical and Electrical Equipment," Acceptance Criteria II.A. DCD Section 3.10 provides the details for seismic qualification and Section 3.11 describes environmental qualification of active pumps and valves. Subsection 3.9.6 provides details for the Inservice Testing Program to assure pump and valve operability.

Safety-related pump and valve vendors will design against collapse and deflection for faulted conditions. The criteria will be developed on a component specific basis at the time of procurement.

Impact on DCD

There is no impact on the DCD

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

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SRP SECTION:	03.09.03 - ASME Code Class 1, 2, and 3 Components
APPLICATION SECTION:	03.09.03
DATE OF RAI ISSUE:	02/25/09

QUESTION NO. RAI 03.09.03-10:

With regards to pump operability, in DCD Tier 2 (Rev. 1) Section 3.9.3.3.1 MHI provides only definitions of active and inactive pumps. Active pumps are those whose operability is relied upon to perform a safety-related function during transients or events in the respective operating condition categories. The criterion included in this section is the design of these pumps in accordance with ASME Code Section III requirements as outlined in Tables 3.9-6 for Class 1 and 3.9-8 for Class 2/3 pumps.

(a) Since there are Class 1 pumps identified in the DCD Table 3.9-7, clarify why the design criteria for Class 1 pumps are included in DCD Table 3.9-6. (Indicate if these criteria are applied to RCPs or any other Class 1 pumps.)

(b) Discuss how the operability of safety-related pumps is ensured just by satisfying the stress criteria in accordance with ASME Code.

ANSWER:

(a) Table 3.9-7 does not include any Class 1 pumps, only Class 2 and 3 safety related pumps. The design criteria for Class 1 pumps are contained in Table 3.9-6 and are applicable to the RCPs only. Stress analysis to verify structural integrity of the RCPs is performed in accordance with ASME Section III.

(b) The operability of safety-related pumps is assured through various means not only by satisfying the stress criteria in accordance with the ASME Code. Pump operability is initially assured through factory tests conducted before installation. These factory tests include a hydrostatic test for pressure retaining parts, pump seal leakage tests at the hydrostatic test pressure, and pump head versus flow tests. The ability of safety related pumps to operate as a result of adverse seismic and environmental conditions (i.e., equipment qualification), as described in DCD Sections 3.10 and 3.11, is also required to be demonstrated prior to plant operation. Other, post-installation pump testing includes system tests, integrated system tests, cold hydrostatic tests and hot functional tests. Plant operational tests to assure pump operability include the inservice testing (IST) programs as described in Subsection 3.9.6.

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

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Docket No. 52-021

RAI NO.:	NO. 209-1803 REVISION 1
SRP SECTION:	03.09.03 - ASME Code Class 1, 2, and 3 Components
APPLICATION SECTION:	03.09.03
DATE OF RAI ISSUE:	02/25/09

QUESTION NO. RAI 03.09.03-11:

With regards to valve operability, in DCD Tier 2 (Rev. 1) Section 3.9.3.3.2 MHI provides definitions of active and inactive valves. Active valves are those whose operability is relied upon to perform a safety-related function during transients or events in the respective operating condition categories. The criteria described in this section include the design of valves in accordance with ASME Code Section III requirements as outlined in Tables 3.9-6 for Class 1 and 3.9-8 for Class 2/3 valves and a series of tests and inspections prior to service as well as during the plant life. Answer the following:

(a) MHI states that the operability qualification of valve motor operator for the environmental conditions is discussed in DCD Tier 2 (Rev. 1) Section 3.11 which addresses equipment qualification of mechanical and electrical components. Discuss details of this process which ensures the operability of all other type of valve operators, including motor, air, and steam operators.

(b) MHI states that in addition to tests and analyses for valve operability, a representative number of valves of each design type are tested for verification of operability during a simulated Level D service condition (SSE event) by demonstrating operational capabilities within the specified limits. Define the criterion for selecting a representative number of valves (i.e., % of the population and the selection process) and discuss the demonstration of operational capabilities within the specified limits. Also, explain how dynamic loads other than SSE are considered (Note that this also applies to the equivalent static load method for the operability demonstration during a Level D service condition stated in DCD page 3.9-43).

(c) It seems that MHI is referencing IEEE Std 344-2004 for the dynamic qualification of valves, specifically for seismic qualification. The staff has approved the use of 1987 version of this IEEE standard in RG 1.100 and SRP Section 3.10. Discuss with technical justification all provisions that are included in the 2004 edition, but are not addressed in the 1987 version of this standard, and will be used in the dynamic qualification procedures for US-APWR components.

ANSWER:

(a) DCD Table 3D-2 in Appendix 3D contains the list of equipment subjected to environmental qualification and includes various types of valve operators. All valve operators listed will be qualified to the environmental conditions that will be experienced for the particular application as listed in the table. Qualification verification is assured through actuator testing, type-testing, or analysis prior to plant operation. Other vendor tests (such as flow tests, cycle tests, hydrostatic tests) will also be performed if required by the component specifications, which also assure that the actuators are capable of performing their design function. Operability tests in accordance with the IST program are conducted after installation to verify component operability. It should be noted that the US-APWR design does not use steam-operated valves.

(b) The valve manufacturer determines the representative number of valves to verify seismic adequacy based on valve attributes such as size, type, model, flow characteristics, etc. Jet impingement load is considered as dynamic load other than SSE. Verification that the jet impingement load will not adversely affect an intact train is demonstrated through stress analysis or physical separation.

(c) MHI's purpose in referencing IEEE 344-2004 was to adopt only the updated Appendix D which corrected errors in figures contained in IEEE 344-1987. MHI will change DCD Subsection 3.9.3.3.2 to ensure that the reference is only to Appendix D of IEEE 344-2004. The DCD has been reviewed and other DCD subsections which reference IEEE 344-2004 will be changed to reference only Appendix D of IEEE 344-2004 or reference IEEE 344-1987.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2 Section 3.9, Revision 2 changes to be incorporated.

- Change the tenth paragraph of DCD Subsection 3.9.3.3.2 to the following: "The number of preceding earthquakes is calculated based on IEEE Std. 344-2004, Appendix D (Reference 3.9-34) to provide the equivalent fatigue damage of two SSE events."

- Change Reference 3.9-34 of DCD Subsection 3.9.10 to the following:

  3.9-34 <u>IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations</u>, IEEE Std. 344-2004, Appendix D, Institute of Electrical and Electronics Engineers Power Engineering Society, New York, New York, June 2005.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

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APPLICATION SECTION:	03.09.03
DATE OF RAI ISSUE:	02/25/09

QUESTION NO. RAI 03.09.03-12:

DCD Tier 2 (Rev. 1) Section 3.9.3.4 states that the maximum calculated static and dynamic deflections of the component at support locations do not exceed the allowable limits specified in the component design specification. But MHI did not discuss how the maximum static and dynamic deflections are combined from multiple loads for the four service level conditions and how the allowable limits are established for the component in its design specification. Discuss details on calculating the component deflections from different load conditions and how the allowable limits for the component support are determined.

ANSWER:

As established in Technical Report MUAP-09002-P, seismic displacement is calculated by dynamic response analysis using the coupling model of the four loop RCL model and building structure model. The displacement for accident conditions is calculated by dynamic analysis using a four loop RCL model. The maximum displacement of each component is evaluated. Displacement for dead weight, thermal expansion and internal pressure is calculated by static analysis using a four loop RCL model. Component deflections from these load conditions are combined and the allowable limits for the component supports are determined.

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

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RAI NO.:	**NO. 209-1803 REVISION 1**
SRP SECTION:	**03.09.03 - ASME Code Class 1, 2, and 3 Components**
APPLICATION SECTION:	**03.09.03**
DATE OF RAI ISSUE:	**02/25/09**

QUESTION NO. RAI 03.09.03-13:

MHI states in DCD Tier 2 (Rev. 1) Section 3.9.3.4 that in accordance with the ASME Code, Section III, non-mandatory Appendix F, the structural integrity of the seismic Category II pipe supports is ensured so that the SSE would not cause unacceptable structural interaction or failure of seismic Category I SSCs. The support design will follow the intent and general requirement specified in ASME Code, Section III, non-mandatory Appendix F. The staff did not find any details about the design criteria for seismic Category II supports for service level A, B, and C load combinations. Explain why the design of these supports is limited to service level D (faulted) loads only (i.e., ASME Appendix F) and provide details about the overall design criteria for seismic Category II component supports.

ANSWER:

The supports referred to in Subsection 3.9.3.4 do not require seismic evaluation to service level A, B, or C load combinations and are not governed by the ASME Code. It is required, however, that these supports be analyzed and designed such that an SSE event does not cause an unacceptable interaction with the seismic category I piping. The analysis performed confirms that these category II piping supports maintain structural integrity when subjected to the SSE earthquake loading. Therefore, the general requirements specified in ASME Code, Section III, non-mandatory Appendix F are used in the support design and a service level D is appropriate and sufficient.

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

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SRP SECTION:	03.09.03 - ASME Code Class 1, 2, and 3 Components
APPLICATION SECTION:	03.09.03
DATE OF RAI ISSUE:	02/25/09

QUESTION NO. RAI 03.09.03-14:

The staff noted that DCD Tier 2 (Rev. 1) Section 3.9.3.4.2.4 did not provide sufficient information for potential snubber end fitting clearances, mismatch of activation and release rates, and lost motion.

(a) Discuss how the snubber design will account for snubber end fitting clearances, mismatch of activation and release rates, and lost motion.

(b) How each of these elements would affect the calculations of snubber reaction loads and stresses using a linear analysis methodology?

(c) In multiple snubber applications where mismatch of end fitting clearance and lost motion exists, discuss their potential impact on the synchronism of activation level or release rate and, consequently, on the assumption of the load sharing of multiple snubber supports.

ANSWER:

(a) The end clearances are minimal. The project procurement specifications will require snubber vendors/manufacturers to provide tight fitting pins and spherical bearings that allow for off axis movement while minimizing lost motion at both ends of the connection (i.e., the pipe clamp and the end structural attachment). Any end fitting clearances, as well as release rates and lost motion, will be accounted for in the average dynamic spring rate provided to the designer by the manufacturer.

(b) These elements are accounted for in the spring rate of the snubber. The magnitude of the reaction of the snubber is affected by the spring rate used. Since these elements are accounted in the spring rate, these elements will also effect snubber load resulting from the piping stress analysis.

(c) There are two types of multiple snubber application: in parallel and in series.

1. For parallel applications, like a trapeze type arrangement on a riser, each snubber has independent motion. Therefore, small differences in the synchronism of the two snubbers will not result in any substantial load differential between the two snubbers. For example, when the snubber on the one end of the riser clamp locks, the other end of the riser will start rotating about the pin of the first snubber. This will cause the second snubber to lock almost immediately and take its share of the load. However, as long as the manufacturer supplies the entire assembly (i.e., the same wall brackets, snubbers, and pipe attachments at both ends), the lost motion will be almost identical, as the manufacturing tolerances are very tight at the connection points. Additionally, hydraulic snubbers by their nature will load share more effectively, as they have no internal "dead band", and begin to respond immediately.

2. For snubbers in series (e.g., multiple axial snubbers on the same run of pipe), the issue of non-synchronized locking of the snubbers is possible. The first snubber that locks has the potential to pickup the entire axial load of the pipe without the other snubbers necessarily locking at the same instant since the axial motion of the pipe will be entirely stopped by the first snubber that locks and no motion is left for the pipe to activate the other snubbers. Therefore, multiple snubbers in series in one direction will not be used in the piping design.

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

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APPLICATION SECTION:	03.09.03
DATE OF RAI ISSUE:	02/25/09

QUESTION NO. RAI 03.09.03-15:

MHI states, in DCD Tier 2 (Rev. 1) Section 3.9.3.4.2.7, that the support design specification requires snubbers to be designed in accordance with ASME Code, Section III, Subsection NF. The design requirement includes analysis for normal, upset, emergency, and faulted loads. MHI also states that these calculated loads are then compared against the manufacturer's design and/or test capacities to ensure that the stresses are below the ASME Code's allowable limits. The staff, however, found no specific design requirements provided for snubbers.

(a) Provide a detailed discussion on the specific design rules of Subsection NF that applies to snubbers.

(b) Provide a detailed discussion on how the load capacity for design, normal, upset, emergency, and faulted conditions is derived and compared against the vendor's allowables, for both mechanical and hydraulic snubbers. Note that in DCD Section 3.9.3.4.2.2 it is stated that the snubber loading demand calculated for piping must meet the design load capacity. Confirm if this is also applicable to component supports.

ANSWER:

(a) Subsection NF of the Code imposes many rules for the design of snubbers that pertain primarily to the snubber vendor, who must incorporate all of the Code parameters into the equipment design. For example, the parameters stated in the Code, Subsection NF-3412.4, such as design loadings, required force, time and displacement relationship, capability to operate in environmental conditions, and material characteristics, are all relevant to the manufacturer of the snubber. The attributes required for the piping design will be included in the snubber procurement specifications. The selected vendor will incorporate the stated provisions into the snubber design for compliance to the requirements of the ASME Code, Subsection NF and the DCD. Once these requirements have been incorporated into the design, the pipe support designer will select a snubber that is appropriate for the snubber design conditions.

(b) The pipe support vendor issues a Certified Design Report Summary (CDRS) or a Load Capacity Data (LCD) sheet which lists the allowable loads for each size and for each loading condition [i.e., design, normal (level A), upset (level B), emergency (level C) and faulted (level D)]. Also included is the "stroke" of each size snubber (i.e., the difference between the fully retracted and fully extended position of the piston). The loads on the snubber are taken from the piping stress analysis based on the location within the piping and are combined to determine the loads for levels A, B, C, and D in accordance with the requirements specified in DCD Table 3.12-4. These loads are then compared with the corresponding allowable loads published by the pipe support vendor in the CDRS or LCD sheet to assure that loading levels are within the allowable loads. In addition, the pipe support designer specifies the setting of the piston in the cold position so that the snubber can move freely for all operating thermal conditions, within the specified travel range (stroke) specified by the vendor.

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

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APPLICATION SECTION:	03.09.03
DATE OF RAI ISSUE:	02/25/09

QUESTION NO. RAI 03.09.03-16:

In DCD Tier 2 (Rev. 1) Section 3.9.3.4.2.7, item 6 states that specific environmental design conditions and snubber functionality is assured under harsh service condition. Also, under snubber test program MHI states that based on initial in-situ snubber dynamic lock-up testing and thermal motion testing, a comparison of test data with analytical data (force and/or displacement time histories due to earthquakes and/or dynamic transients) assures that the piping or component stress analysis model and as-built snubber configuration performs within the analytical boundaries. However, MHI did not provide a detailed, delineated description of snubber manufacturing, qualification, and installation tests.

(a) Item 6 references to subsection 3.9.3.4.2.5 which addresses design specifications. Explain how this subsection addresses snubber qualification under harsh environment.

(b) Based on initial in-situ snubber dynamic lock-up testing and thermal motion testing, a comparison of test data with analytical data (force and/or displacement time histories due to earthquakes and/or dynamic transients) assures that the piping or component stress analysis model and as-built snubber configuration performs within the analytical boundaries. Clarify how this comparison between the test and analytical data is performed to ensure snubber performance within the analytical boundaries.

(c) Discuss the procedure and scope of manufacturing, qualification and installation test programs, separately, for both the mechanical and hydraulic snubbers of different sizes and manufacturers,

(d) Discuss how the criteria for each pertinent snubber functional parameter are met in the testing,

(e) Provide the codes and standards used for the test programs, and

(f) The reference to ASME Section XI (Reference 3.9-43) indicates no edition/addenda. Provide the ASME Code edition and addenda for Section XI that will be used for the USAPWR design.

ANSWER:

(a) The snubber vendor/manufacturer manufactures the snubber to comply with Subsection NF-3412.4, which specifies that the snubber must be capable of operating in the environmental conditions to which it will be exposed; namely, temperature, irradiation, corrosive atmosphere, moisture and airborne particles. The manufacturer specifies in the CDRS (or LCD) the maximum temperature that the snubber can be exposed. The manufacturer will only use materials, fluids, lubricants, seals, etc., that are radiation resistant. The manufacturer will use materials that are corrosion resistant. The manufacturer will use material and assembly methods that can support operation in a humid environment. The snubber will be designed so that it can perform its function unimpeded if airborne particles accumulate on any exposed surface of the snubber.

(b) To determine the allowable loads for loading levels A, B, C and D, the manufacturer performs testing that simulate the actual conditions to which the snubber will be subjected. The pipe support designer assures that the snubber will perform the intended function during a dynamic event by confirming that the pipe stress analysis loads for each loading level do not exceed the corresponding allowable loads.

(c) The following information provides an overview of the procedure and scope of manufacturing, qualification and installation test programs for both mechanical and hydraulic snubbers. This information is considered typical for the snubber types listed; however, specific requirements will be detailed in the procurement specification.

Qualification testing of hydraulic snubbers normally consists of dynamic load tests, environmental tests (humidity, fungus, salt fog, and sand and dust), and vibration tests. Between each qualification test, an acceptance test would be performed consisting of a drag and velocity test.

Production and in-service testing for hydraulic snubbers normally consists of a drag test and a velocity test. Additional snubber tests include thermal aging tests and dynamic tests to determine average spring rates.

Qualification testing for mechanical snubbers normally consists of dynamic load tests, temperature tests, environmental tests (humidity, salt spray, and sand and dust), life (i.e, cycle) tests, and faulted load test. Between each qualification test, an acceptance test would be performed consisting of an acceleration test, lost motion test, and a drag test.

Manufactures will also perform functional testing of mechanical snubbers prior to shipment consisting of lost motion, acceleration (activation), and final drag testing. Functional testing for in-service conditions can consist of drag tests and acceleration tests.

(d) The following information provides an overview of how the criteria for each pertinent snubber functional parameter are met in the testing. This information is considered typical for the snubber types listed; however, specific criteria will be detailed in the procurement specification and specific methods established by the selected manufacturers.

For drag testing a hydraulic snubber, a test machine extends and retracts the snubber at a slow speed simulating movement due to thermal expansion. The measured resistance, or drag force is recorded and the maximum or peak value is derived. Maximum drag should not exceed approximately 2% of rated load for production testing and typically 2% for in-service testing.

For velocity testing a hydraulic snubber, a test machine applies a load to the unit the velocity versus load data is obtained. The test load applied to the unit is usually 50% and 100% of rated load. Acceptance criteria for velocity testing will depend upon the type of hydraulic snubber; bleed only or lockup and bleed.

Lost motion testing of mechanical snubbers ensures that the maximum axial displacement to activate the restraint function is minimal. The unit is fixed in one position (i.e., the inertia mass is held rigid) and the test machine applies a load in both tension and compression. A trace of the load versus displacement is recorded and compared against the established acceptance criteria.

Drag testing of a mechanical snubber is similar to that of a hydraulic snubber though the acceptance criteria is normally approximately 1% of rated load for production testing.

Acceleration testing of mechanical snubbers is performed to determine the operability of the snubber; that is, whether the snubber will limit the acceleration of the piping or equipment to a threshold value. The test machine applies a preset load, typically 10% to 100% of rated load, in extension and in retraction. The change in velocity of the machine with respect to the change in time determines the acceleration of the snubber. Accelerations greater than the acceptance criteria in either direction would result in a rejection.

(e) The following information provides an overview of the codes and standards used for the test programs. This information is considered typical for the snubber types listed; however, specific criteria will be detailed in the procurement specifications.

The applicable codes for qualification testing of hydraulic and mechanical snubbers are ASME Section III, NF-3400 and ASME QME-1 Subsection QDR. Subsection NF-3412.4, *Snubbers,* references ASME QME-1 Subsection QDR for qualification testing and OM Code for in-service testing. Subsection QDR-6000 provides the basic methods for qualification of snubbers, and more specifically QDR-6223.1 contains the functional parameter for hydraulic snubbers and QDR-6223.2 contains the functional parameter for mechanical snubbers.

The applicable codes for in-service testing of hydraulic and mechanical snubbers include ASME Section XI Subsection IWF-1220 (Ref. 3.9-43) and OM Code Subsection ISTD-5000 (Ref. 3.9-44). ASME Section XI Subsection, IWF-1220, *Snubber Inspection Requirements,* states that the in-service inspection requirements for snubbers are outside the scope of that Division, and subsequently references ASME OM code for the examination and test requirements for snubbers.

(f) DCD Reference 3.9-43 will be changed to note, ASME Code, Section XI, 1995 Edition through the 2003 Addenda, as indicated in Subsection 3.9.6.4.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2 Section 3.9, Revision 2 changes to be incorporated.

- Change Reference 3.9-43 of DCD Subsection 3.9.10 to the following:

  3.9-43 Rules for Inservice Inspection of Nuclear Power Plant Components, ASME Boiler and Pressure Vessel Code. ASME Section XI, 1995 Edition through the 2003 Addenda, American Society of Mechanical Engineers.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

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Docket No. 52-021

RAI NO.:	NO. 209-1803 REVISION 1
SRP SECTION:	03.09.03 - ASME Code Class 1, 2, and 3 Components
APPLICATION SECTION:	03.09.03
DATE OF RAI ISSUE:	02/25/09

QUESTION NO. RAI 03.09.03-17:

In DCD Tier 2 (Rev. 1) Section 3.9.3.4.2.6, MHI discusses instruction manual containing complete guidance for testing, maintenance, and repair of snubbers. This manual specifies the required inspection locations and the periods of inspection. Hydraulic snubbers for piping require that a fluid level indicator is equipped to ascertain the level of fluid in the snubber. Snubber thermal movement, clearance, and gaps are periodically verified, including motion measurements, and acceptance criteria assure compliance with ASME Code, Section III, Subsection NF. Clarify why the hydraulic snubbers for piping are equipped with level indicators, but not those used for component supports. Also, clarify if similar instruction manual is developed for mechanical snubbers and discuss its contents.

ANSWER:

The hydraulic snubbers are equipped with fluid level indicator, whether they are used for pipe supports or for equipment supports. The DCD will be revised to remove reference only to pipe supports as described below.

The requirement of an installation instruction manual applies to both hydraulic and mechanical snubbers. The content of the instruction manual for mechanical snubbers will contain information such as the mechanical shock arrestor service life extension program and address maintenance items such as snubber re-grease and repair.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2, Section 3.9, Revision 2 changes to be incorporated.

- Change the last sentence of the first paragraph in Subsection 3.9.3.4.2.6 to the following: "The applicable design specification requires that hydraulic snubbers be equipped with a fluid level indicator so that the level of fluid in the snubber can be ascertained."

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

4/30/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

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APPLICATION SECTION:	03.09.03
DATE OF RAI ISSUE:	02/25/09

QUESTION NO. RAI 03.09.03-18:

In DCD Tier 2 (Rev. 1) Section 3.9.3.4.5, MHI states that special engineered pipe supports, designed without the use of manufactured standard supports or supplementary steel supports, are used for the US-APWR piping design. They utilize non-standard specialized components and can have both mechanical and structural characteristics. These support types are used generally on systems that have high thermal expansion and require seismic or vibration support to minimize the use of snubbers. The staff noted that MHI did not provide sufficient details regarding the design criteria and dynamic testing of these supports. Answer the following:

(a) Discuss examples of special engineered pipe supports that will be used in the piping design, which will allow high thermal expansion and require seismic or dynamic restraint. Include their mechanical and structural characteristics.

(b) MHI states that the supports for ASME Code, Section III, Class 1, 2, and 3 components including pipe supports satisfy the requirements of the ASME Code, Section III, Subsection NF. Identify and discuss what Subsection NF criteria are applicable to this support class. Provide loads and load combinations specifically applicable to this design.

(c) MHI states that the criteria for Appendix F in ASME Code, Section III, are used for the evaluation of Level D service conditions. When supports for components not built to ASME Code, Section III, criteria are evaluated for the effect of Level D service conditions, the allowable stress levels are based on tests or accepted industry standards comparable to those in Appendix F of ASME Code, Section III. Explain, with examples, what tests or accepted standards will be used that are comparable to Appendix F limits.

(d) It is stated in the DCD that to ensure operability of active equipment, including valves, ASME Code, Section III limits for Level C service loadings are met for the supports of these items. Provide the technical basis for this operability assurance, specifically when seismic loads are included for Level D service loadings.

(e) MHI states that the use of baseplates with concrete expansion anchors is minimized in the US-APWR. Concrete expansion anchors may be used for pipe supports. For these pipe support baseplate designs, the baseplate flexibility requirements of IE Bulletin 79-02, Revision 2, are met by accounting for the baseplate flexibility in the calculation of anchor bolt loads.

(i) Clarify if the design and installation of all anchor bolts will follow ACI 349-2001 subject to conditions and limitations specified in RG 1.199 and IE Bulletin 79-02, Rev. 2. (ii) Discuss design criteria when expansion and undercut anchor bolts will be used for safety-related system components. (iii) Explain why this baseplate design is unique to special engineered pipe supports? Confirm if the baseplate design is also applicable to other ASME Code Class 1, 2, and 3 component supports.

ANSWER:

(a)-(d) MHI has determined that special engineered pipe supports will not be used in the US-APWR design and will replace the discussion with the text for Subsection 3.9.3.4.5 during Revision 2 of the DCD.

(e) Design of components anchorage to concrete follows the requirements of ACI-349 Appendix B considering the limitations of RG 1.199. All aspects of anchor bolt design, baseplate flexibility and factors of safety are utilized as identified in IE Bulletin 79-02, Rev.2.

DCD Subsection 3.9.3.4.5, which discusses component anchorage, will be revised as discussed in the response to (a) through (e) above.

See the responses to RAI 205-1584 Question 3.9.2-10 and RAI 214-1920 Question 3.9.2-34 for related discussion.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2 Section 3.9, Revision 2 changes to be incorporated.

- Change Subsection 3.9.3.4.5 to the following:

  "**3.9.3.4.5 Component Support Baseplate and Anchor Bolt**

  The use of baseplates with concrete expansion anchors is minimized in the US APWR. Concrete expansion anchors may be used for component supports. Design of component anchorage to concrete follows the requirements of ACI-349 Appendix B (Reference 3.9-50) considering the limitations of RG 1.199 (Reference 3.9-51). All aspects of the anchor bolt design, baseplate flexibility and factors of safety are utilized as identified in IE Bulletin 79-02, Revision 2 (Reference 3.12-24)."

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

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QUESTION NO. RAI 03.09.03-19:

MHI also states in DCD Tier 2 (Rev. 1) Section 3.9.3.4.6 that where the design and service stress limits specified in the code do not necessarily provide direction for the proper consideration of operability requirements for conditions which warrant consideration, Section II.3 and Appendix A of SRP 3.9.3, RG 1.124 and RG 1.130 are used for guidance. Where these stress limits apply, the treatment of functional capability, including collapse, deformation and deflection limits are evaluated and appropriate information is developed for inclusion into the design specification. Explain what consideration of operability requirements of component supports is addressed. Also, discuss how the functional capability, including collapse, deformation and deflection limits, is evaluated.

ANSWER:

Operability requirements of component supports will be provided in detail in the design specifications.

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

4/30/2009

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DATE OF RAI ISSUE:	**02/25/09**

QUESTION NO. RAI 03.09.03-20:

MHI states in DCD Tier 2 (Rev. 1) Section 3.9.3.4.6 that ASME Code, Section III component supports are designed, manufactured, installed, and tested in accordance with all applicable codes and standards. Supports include hangers, snubbers, struts, spring hangers, frames, energy absorbers, and limit stops.

(a) Identify codes and standards that are applicable for the design, manufacturing, installation and testing of each type of component supports.

(b) Provide design criteria for energy absorbers and limit stops that will be used for component supports. (Note that DCD Tier 2 (Rev. 1) Section 3.12.6.5 indicates these support types are not used for piping design.)

ANSWER:

(a) Applicable codes and standards for component support design, manufacturing, installation and testing will be provided in design specifications in detail.

(b) Energy absorbers and limit stops are not used for in the US-APWR design. The DCD will be changed as shown below

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2 Section 3.9, Revision 2 changes to be incorporated.

- Insert the following new Subsection 3.9.3.4.7 after existing Subsection 3.9.3.4.6:

3.9.3.4.7 Use of Energy Absorber and Limit Stops

Energy absorbers and limit stops are not used as ASME Code, Section III, Class 1, 2 and 3 component supports in the US-APWR design.

3.9.3.4.8 Snubbers Used as Component Supports

- Change [DCD Revision 0] Subsection 3.9.3.4.7 to Subsection 3.9.3.4.8.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

4/30/2009

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QUESTION NO. RAI 03.09.03-21:

In DCD Tier 2 (Rev. 1) Section 3.9.3.4.6.1, MHI discusses the design methods for Class 1 component supports and includes supports for reactor vessel, steam generators, reactor coolant pumps, and the pressurizer. The structural analysis of these ASME Code, Section III, Class 1 component supports includes the loads, load combinations, and stress allowable limits in accordance with the ASME Code, Section III, Subsection NF and Appendix F. Externally applied loads for each system operating, system transient, and accident condition that are generated from the RCL piping analysis are applied and are appropriately combined with component generated support loads. The combination of loadings considered for each component support uses the criteria in Appendix A, RG 1.124, and RG 1.130. Computerized finite element analysis programs are used to determine the support stresses and reaction loads. Address the following:

(a) Discuss the modeling and analysis methods of supports used for major components (RV, SG, RCP and Pressurizer). Include how the effect of hydrodynamic loads and building settlement loads associated with these components is considered in the design of these supports.

(b) For each component support (RV, SG, RCP and Pressurizer), provide (or refer to appropriate DCD Sections) sketches of its support design, loads and load combinations, applicable stress limit criteria, and codes and regulatory guidance. Include the fatigue evaluation criteria.

(c) Provide design criteria for the Class 1 piping supports, specifically for the RCL.

ANSWER:

(a) The methodology of modeling of component supports is described in Technical Report, MUAP-08005 Revision 0, Section 6.

(b) Outline sketches of component supports are provided in US-APWR DCD, Figure 3.8.3-1 for RV support, Figure 3.8.3-2 for SG, Figure 3.8.3-3 for RCP and Figure 3.8.3-4 for the Pressurizer. Loads, load combination and stress criteria of component supports are provided in US-APWR DCD, Table 3.9-4, 3.9-6, and 3.9-8. The fatigue evaluation will be performed in accordance with ASME Code, Section III, Subarticle NF.

(c) The design criteria for Class 1 piping supports are provided in Section 3.12. Reactor Coolant piping is modeled by combining the models used for the RV, SG and RCPs. This coupled RCL model includes the component supports attached to the RV, SG and RCP. There are no supports attached to RCL piping. Therefore, there are no design criteria for RCL piping support in US-APWR DCD.

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

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DATE OF RAI ISSUE:	02/25/09

QUESTION NO. RAI 03.09.03-22:

In DCD Tier 2 (Rev. 1) Section 3.9.3.4.6.2, MHI discusses the design criteria (models and methods) for ASME Code Class 2 and 3 component supports. These component supports are generally of linear or plate and shell type; however, standard component supports may be used. Address the following:

(a) It is stated that the analyses or test methods and associated stress or load allowable limits that are used in the evaluation of linear supports for Level D service conditions are those defined in Appendix F of the ASME Code, Section III. Discuss and identify analysis and test methods of Appendix F used for both linear type and plates and shell type component supports.

(b) MHI states that the combination of loadings considered for each component support within a system, including the designation of the appropriate service stress for each loading combination are consistent with the criteria in Appendix A (of SRP Section 3.9.3), RG 1.124 and RG 1.130. Identify any differences between the load combination criteria presented in the DCD and the RGs for the linear type and plates and shell type component supports.

(c) Note that all references to Subsection NF-3320 for load combinations stated in the DCD are related to Class 1 component supports where the DCD Tier 2 (Rev. 1) Section addresses Class 2 and 3 component supports. Also, the reference to NF-3231 does not exist in the Code. Clarify these discrepancies.

(d) MHI states that for active ASME Code, Section III, Class 2 or 3 pumps, support adequacy is proven by satisfying the criteria in DCD Tables 3.9-4 and 3.9-8. In addition to these requirements for meeting stress limits, an evaluation of pump/motor support misalignment is required. Explain what is meant by support misalignment and discuss the evaluation process.

(e) MHI states that active valves are, in general, supported only by the pipe attached to the valve. Exterior supports on the valve are generally not used. Discuss the design criteria for valves where external supports are used.

ANSWER:

(a) MHI does not use the allowable stress limits and the evaluation of linear supports for service level D conditions. The signature test methods are defined in ASME Code, Section III, Appendix F for Class 2 and 3 component supports.

(b) The load combination for the component supports is determined in accordance with SRP 3.9.3 Appendix A, and provided in DCD Table 3.9-4. The design criteria conform to the requirements of Section C of RG1.124 and Section C of RG1.130. For linear type and plates and shell type component supports, there is no difference between the load combination criteria presented in the DCD and that presented in the RGs.

(c) Third bullet of paragraph five of DCD Subsection 3.9.3.4.6.2, the applied requirement is stated as NF-3231 which is not appropriate and will be deleted as shown below.

(d) ASME Code, Section III, article NF-3000 stress limits do not require the evaluation of the support misalignment for Class 2 and 3 pumps/motors. The paragraph contained in DCD Subsection 3.9.3.4.6.2 will be deleted as shown below.

(e) Class 2 and 3 valve and piping supports are designed in accordance with the design criteria of ASME Code, Section III, article NF-3000 and applicable criteria. In the cases where there are no valve external supports, the loads applied by the valves on the piping are part of the design criteria for the piping supports. The statement contained in DCD Subsection 3.9.3.4.6.2 will be deleted during Revision 2.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2 Section 3.9, Revision 2 changes to be incorporated.

- Change the third bullet of the fifth paragraph in Subsection 3.9.3.4.6.2 to the following: "Emergency – For emergency conditions, the allowable stresses or load ratings are 33% higher than those specified for normal conditions. This is consistent with Subsection NF of ASME Code, Section III (Reference 3.9-1) in which (see NF-3250 and NF-3260), limits for emergency conditions are 33% greater than the normal condition limits."
- Delete the sixth paragraph in Subsection 3.9.3.4.6.2 in its entirety.
- Delete the seventh paragraph in Subsection 3.9.3.4.6.2 in its entirety.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

4/30/2009

US-APWR Design Certification

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QUESTION NO. RAI 03.09.03-23:

In DCD Tier 2 (Rev. 1) Section 3.9.3.4.7, MHI discusses snubbers used as component supports. Snubbers are generally hydraulic; however, there are mechanical snubbers available that lock-up at equivalent hydraulic velocities. Details of snubber design, testing, operation, maintenance, inspection, and other functional characteristics are presented in DCD Tier 2 (Rev. 1) Section 3.9.3.4.2.

(a) It is stated that there are mechanical snubbers available that lock-up at equivalent hydraulic velocities. Clarify what does this mean. Provide criteria or individual cases when mechanical or hydraulic snubbers are used in the component support design.

(b) MHI also states that with the implementation of LBB criteria and the elimination of the analysis of dynamic effects of pipe breaks detailed in Subsection 3.6.3, the use of snubbers is minimized in these LBB qualified piping systems. Discuss how snubbers are minimized based on the satisfaction of the LBB criteria for a piping system.

ANSWER:

(a) For hydraulic and mechanical snubbers, the movement is not equivalent so that the lock-up system is different for arresting a movement. MHI will change Subsection 3.9.3.4.7 as shown below.

(b) Snubbers are used at the SG intermediate shell support and upper shell support in the RCL. The support design is performed using the necessary and sufficient number of snubbers to satisfy the SG seismic design. The results generated by using the calculated MCP piping load to meet the LBB criteria minimize the use of snubbers.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2 Section 3.9, Revision 2 changes to be incorporated.

- Change the first paragraph in Subsection 3.9.3.4.7 to the following: "Snubbers are considered manufactured standard support components. Snubber manufacturers provide various sizes of snubbers and rated loading consistent with ASME Level A, B, C, and D service conditions. Snubbers are generally hydraulic; however, there are mechanical snubbers which have adequate functionality that is resistance to drift velocity change. Details of snubber design, testing, operation, maintenance, inspection, and other functional characteristics are presented in this subsection."

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

3.9.3.1 Loading Combinations, System Operating Transients, and Stress Limits

This subsection establishes the criteria for the selection and definition of design limits and loading combinations associated with normal operation, postulated accidents, and specified seismic and other transient events for the design of ~~other~~ safety-related ASME Code, Section III (Reference 3.9-1) components. These load combinations may include the effects of dead load, internal and external pressure, component and insulation weights, and fluid effects due to various system operational characteristics including testing, predicted thermal expansion, seismic induced dynamic loads and displacements, support reaction loads, and other loads as specified by the requirements of the ASME Code, Section III (Reference 3.9-1), Subsection NB, NC, ND, NF or NG Code depending upon component and Service Level classification.

The basis of the ASME component design acceptance for applicable loading combinations involves comparison of calculated stress and fatigue demand levels to acceptable stress and fatigue capacity allowables specified by ASME Code, Section III (Reference 3.9-1). The ASME Code acceptance standards differ depending on whether a component is classified as ASME Code, Section III, Class 1, 2, or 3. In addition to the ASME classification, plant operational modes and frequency of system operating and/or transient events are used to define which ASME service limit (Level A [Normal], Level B [Upset], Level C [Emergency], Level D [Faulted], and Test) applies. These service limits are defined in Subsection 3.9.1. The system operating and/or transient events are developed from guidance provided in ANS N51.1-1983 (Reference. 3.9-2). The design transients for the US-APWR Class 1 RCS are defined in Subsection 3.9.1. These transients are determined based on a 60-year plant operational life and are classified into the ASME Level A, Level B, Level C, and Level D service limits, and test conditions, depending on the expected frequency of occurrence and severity of the event. The design transients for ASME Level A and B service conditions are required by the ASME Code, Section III, Subsection NB-3200 (Reference 3.9-1), in the evaluation of cyclic fatigue for the Class 1 components and piping. The effects of seismic events are also included in the evaluation of cyclic fatigue by defining a 1/3 SSE seismic event as Level B service condition which will require fatigue evaluation of both thermal and seismic effects. The number of cycles considered are based on equivalent of usage factor where 300 cycles at 1/3 SSE stress range equals the same usage factor as 20 cycles a SSE stress range (see Reference 3.9-~~33~~34).

3.9.3.1.1 Seismic Load Combinations

As indicated in Subsection 3.9.1, mechanical components, classifications are in accordance with ASME Code, Section III, Subsection NCA-2000 (Reference 3.9-1) for Division 1 systems, components, and supports. The required load combinations including seismic events for ASME Code, Section III (Reference 3.9-1), Classes 1, 2, and 3 components and structures is presented in Tables 3.9-3 and 3.9-4, and for piping and pipe supports, in tables within Section 3.12. Table 3.9-5 provides the definition of terms associated with Tables 3.9-3 and 3.9-4.

Two occurrences of an SSE are assumed in the qualification of seismic category I systems and components, including core support structures, using the Level D service condition for pressure boundary integrity. Additionally, fatigue sensitive components are qualified for cyclic motion due to earthquakes smaller than the SSE. Included in the analyses, are the seismic effects of seismic events with amplitude not less than 1/3 SSE amplitude[3]. The number of earthquake motion cycles used is based on IEEE Std 344-2004, Appendix D (Reference 3.9-34) guidance. This guidance requires the equivalent fatigue damage of two full SSE events with 10 high-stress cycles per event, therefore, 20 high-stress cycles. One SSE cycle is equivalent to 15 cycles at 1/3 SSE amplitude in accordance with Reference 3.9-34; therefore, 20 full SSE cycles are equivalent to 300 cycles at 1/3 SSE amplitude.

Tables 3.9-3 and 3.9-4 provide required loads and load combinations associated with ASME Code, Section III (Reference 3.9-1), Class 1, 2, 3 and Class CS systems, components and supports.

~~Due to the low probability of occurrence of a SSE during operational modes occurring less than 10% of the plant's operation time, the SSE is analyzed in combination only with those operating modes that occur greater than 10 percent of the time.~~

The SSE is~~, therefore,~~ considered combined under the following PCs:

- Normal plant full (100%) power conditions and normal plant operating temperatures are considered for material properties and are used in combination with SSE.
- It is assumed that a simultaneous Loss of Offsite Power and a single failure within ~~of~~ a safety-related system occur as a result of an SSE event. In addition, it is assumed that non safety-related systems are unavailable.
- For concurrent events, the timing sequence and initiating conditions that occur between the SSE and occasional transients such as valve discharge are considered combined when the SSE is the initiator of the transient condition. The SSE duration is considered as 22 seconds. Non-seismic structures and components are assumed to be functionally and structurally unavailable at the beginning of the SSE. A single failure assumption is considered for a single active component.
- An evaluation of non safety-related systems is performed to assure that their failure in an earthquake does not impact or jeopardize plant safe shutdown or required post accident monitoring.
- The fire protection lines that could affect safe-shutdown equipment or required post accident equipment through rupture and/or flooding during or following a seismic event are required to be seismically qualified.

[3] OBE as used in Table 1 of SRP 3.9.3, Appendix A and in ASME Code, Section III for stress evaluation subject to fatigue is 1/3 SSE with SSE damping. The earthquake inertial and anchor movement loads used in the Level B stress intensity range and alternating stress calculation is taken as 1/3 of the peak SSE inertial and anchor movement loads. In this case, the number of cycles to be ~~(continued on next page) (continued from previous page)~~ considered for earthquake loading is 300 as derived in accordance with Appendix D of IEEE Standard 344-2004 (Reference 3.9-34). In certain cases for non-standard SSCs, the 1/3 SSE may be adjusted higher for site-specific design since the site-specific value of OBE is determined by the COL Applicant as discussed in "OBE" of DCD Subsection 3.7.1.1 ~~as permitted by SECY 93-087 (Reference 3.9-17)~~. If used, the COL Applicant is to demonstrate that applicable stress, strain, and deformation limits are satisfied based on the site-specific OBE selected.

the response, and the seismic anchor motion loads represent the static secondary portion.

- Subsection 3.7.3 and Section 3.12 provide the seismic analysis methods used in qualification of piping systems.

Transient loading resulting from a postulated pipe break is analyzed.

- Dynamic flow and pressure loads are analyzed.
- Postulated pipe breaks and the interaction effects on safety-related components and structures are considered based on the requirements of GDC 4 and NUREG-0800, SRP 3.6.1 (Reference 3.9-35) and SRP 3.6.2 (Reference 3.9-36). The pipe rupture event considered for loading is the largest pipe that does not satisfy LBB criteria.
- Asymmetric blowdown load is discussed in Section 3.9.2.5.
- DCD Subsections 3.6.1 and 3.6.2 define postulated pipe break locations and requirements for the evaluation of postulated pipe breaks.

LBB criteria described in Subsection 3.6.3 are used in accordance with GDC 4 and NUREG 1061, Volume 3 (Reference 3.9-37), to determine the following:

- The RCL, the specific ~~RCS~~ RCL ASME Code, Section III, Class 1 branch lines and main steam lines listed in Appendix 3B that can be exempted from required pipe rupture considerations by meeting LBB criteria.
- Piping in these systems that do not meet LBB screening criteria and; therefore, require pipe rupture analysis.

Additional transient loadings are considered as follows:

- Sudden opening and closing of active valves, relief valves and safety valves.
- Components and piping evaluated for the dynamic response to transient loads. ~~The relief valve open system (sustained) is evaluated as a static load subject to a dynamic load factor (DLF).~~

Additional loading events and the effects on safety-related equipment are examined. The loads are evaluated for local and global stress effects on a case-by-case basis and are not combined with any other Level C or D service condition. These additional loads include the following conditions:

- A RCP locked rotor event in the RCL is evaluated for pressure effects and dynamic fluid transient effects on the RCP, SG channel head, and reactor coolant piping. During this event, the RCP is assumed to come to a rapid (but not instantaneous) stop and to transfer the angular momentum through the motor enclosure and pump casing to the SG nozzle and reactor coolant piping. The stresses calculated for this event are evaluated using Level D service limits for the immediately affected components and supports in the affected RCL and using Level B service limits for components in the other RCL. The Level B service stress limits for components outside the affected loop are used for both

Prior to installation, the following tests, as appropriate to the function and mission of the valve, are performed: shell hydrostatic test, backseat and main seat leakage tests, disc hydrostatic tests, and operational tests to verify that the valve opens and closes.

Cold hydro tests, hot functional tests, periodic inservice inspections, and periodic inservice operations are performed in situ to verify the functional capability of the valve.

Section 3.11 describes the operability qualification of motor operators for the environmental conditions.

For active valves with extended structures, an analysis of the extended structure is performed for equivalent static SSE loads applied at the center of gravity of the extended structure.

In addition to these tests and analyses, a representative number of valves of each design type are tested for verification of operability during a simulated Level D service condition SSE condition event by demonstrating operational capabilities within the specified limits.

Valve sizes that cover the range of sizes in service are tested.

When seismic qualification is based on dynamic or equivalent static load testing for structures, systems or subsystems that contain mechanisms that must change position in order to function, operability testing is performed for the SSE preceded by one or more earthquakes. The number of preceding earthquakes is calculated based on IEEE Std 344-2004, Appendix D (Reference 3.9-34) to provide the equivalent fatigue damage of two SSE events.

The seismic qualification testing procedures for valve operability testing are as follows:

The valve is mounted in a manner that will conservatively represent typical valve installations. The valve includes the operator, accessory solenoid valves, and position sensors when attached to the valve in service.

The operability of the valve during a Level D service condition is demonstrated by satisfying the following criteria:

A static load or loads equivalent to those resulting from the accelerations due to Level D service conditions is applied to the extended structure center of gravity so that the resulting deflection is in the nearest direction of the extended structure. The design pressure of the valve is applied to the valve during the static deflection tests.

The valve is cycled while in the deflected position. The valve must function within the specified operating time limits while subject to design pressure.

Electrical motor operators, position sensors, and pilot solenoid valves necessary for operation are qualified in accordance with IEEE seismic qualification standards (Reference 3.9-15). Section 3.10 describes the methods and criteria used to qualify electrical equipment.

ATTACHMENT 1
to RAI 209-1803

3.9.3.4.2.5 Design Specifications

The design specification contains the following and includes the performance, structural, and mechanical properties of the snubbers as provided in the above subsections:

1. General functional requirement
2. Operating environment
3. Applicable codes and standards
4. Materials of construction and standards for hydraulic fluids and lubricants
5. Environmental, structural, and performance design verification tests
6. Production unit functional verification tests and certification
7. Packaging, shipping, handling, and storage requirements
8. Description of provisions for attachments and installation
9. Quality assurance and assembly quality control procedures for review
10. Acceptance by the purchaser

The COL Applicant is to assure snubber functionality in harsh service conditions, including snubber materials (e.g., lubricants, hydraulic fluids, seals).

3.9.3.4.2.6 Considerations for Inspection, Testing, Repair, and/or Replacement of Snubbers

An installation instruction manual contains complete instructions for the testing, maintenance, and repair of the snubber. It contains the required inspection locations and the periods of inspection. The program for inservice examination and testing of snubbers in the completed US-APWR construction is prepared in accordance with the requirements of ASME Code, Section XI (Reference 3.9-43) and ASME OM Code (Reference 3.9-13). Applicable industry and regulatory guidance is used including RG 1.192 (Reference 3.9-44). The intervals for visual examination are the subject of Code Case OMN-13 (Reference 3.9-45), which is accepted under the RG 1.192 (Reference 3.9-44). The examination and test procedures for the snubber is included in the IST program plan, developed per the implementation schedule as described in Chapter 13, Section 13.4. The ~~pipe support~~ applicable design specification requires that hydraulic snubbers be equipped with a fluid level indicator so that the level of fluid in the snubber can be ascertained.

Snubber thermal movement is reviewed, adequate clearance and gaps are verified, including motion measurements, and acceptance criteria assure compliance with ASME Code, Section III (Reference 3.9-1), Subsection NF.

3.9.3.4.2.7 Snubber Design and Testing

Snubbers are designed to meet operational requirements for withstanding sudden dynamic motion due to earthquakes or sudden transient events. Snubbers must be capable of moving freely during thermal cycling under various modes of plant operation. In addition, snubbers are designed to structural capacity limits that are designated by the manufacturer. Design specifications require specific lock-up rates under dynamic inertia loads as well as static seismic loads are considered in the design of frame supports per ASME Code, Section III (Reference 3.9-1), Subsection NF.

For insulated pipes, special pipe guides such as pipe saddles with one or two way restraint may be used in order to minimize the heat loss of piping systems.

Frame type supports have a limited total gap of 1/8th inch to avoid thermal binding due to radial thermal expansion of the pipe. For large pipes with higher temperatures, this gap is evaluated to assure that no thermal bending occurs. The minimum total gap is specified to assure that it is adequate for the thermal radial expansion of the pipe to avoid any thermal binding.

3.9.3.4.5 ~~Special Engineered Pipe Supports~~ Component Support Baseplate and Anchor Bolt

~~Special engineered pipe supports are engineered pipe supports other than manufactured standard supports or supplementary steel supports. Special engineered supports are supports that use non-standard specialized components and can have both mechanical and structural characteristics. These support types are used generally on systems that have high thermal expansion and require seismic or vibration support.~~

~~The design criteria and dynamic testing requirements for the ASME Code, Section III (Reference 3.9-1) piping supports are as follows:~~

~~The supports for ASME Code, Section III (Reference 3.9-1), Class 1, 2, and 3 components including pipe supports satisfy the requirements of the ASME Code, Section III (Reference 3.9-1), Subsection NF. The welded connections of tube steel members satisfy the requirements of the Structural Welding Code, ANSI/AWS D1.1 (Reference 3.9-47), Section 10. The boundary between the supports and the building structure is based on the rules found in the ASME Code, Section III, (Reference 3.9-1), Subsection NF. Table 3.9-1 presents the loading conditions. Table 3.9-4 summarizes the load combinations. The stress limits are presented in Tables 3.9-6 and 3.9-8 for the various service levels.~~

~~The criteria for Appendix F in ASME Code, Section III (Reference 3.9-1), is used for the evaluation of Level D service conditions. When supports for components not built to ASME Code, Section III (Reference 3.9-1) criteria are evaluated for the effect of Level D service conditions, the allowable stress levels are based on tests or accepted industry standards comparable to those in Appendix F of ASME Code, Section III (Reference 3.9-1).~~

~~In order to provide for operability of active equipment, including valves, ASME Code, Section III limits for Level C service loadings are met for the supports of these items.~~

~~Dynamic loads for components loaded in the elastic range are calculated using DLFs, time-history analysis, or any other method that accounts for elastic behavior of the component. A component is assumed to be in the elastic range if yielding across a section does not occur. Local yielding due to stress concentration is assumed not to affect the validity of the assumptions of elastic behavior. The stress allowables of Appendix F for elastically analyzed components are used for Code components. Inelastic stress analysis is not used.~~

~~The use of baseplates with concrete expansion anchors is minimized in the US-APWR. Concrete expansion anchors may be used for pipe supports. For these pipe support baseplate designs, the baseplate flexibility requirements of IE Bulletin 79-02, Revision 2 (Reference 3.9-48), are met by accounting for the baseplate flexibility in the calculation of anchor bolt loads.~~

The use of baseplates with concrete expansion anchors is minimized in the US APWR. Concrete expansion anchors may be used for component supports. Design of component anchorage to concrete follows the requirements of ACI-349 Appendix B (Reference 3.9-50) considering the limitations of RG 1.199 (Reference 3.9-51). All aspects of the anchor bolt design, baseplate flexibility and factors of safety are utilized as identified in IE Bulletin 79-02, Revision 2 (Reference 3.12-24).

3.9.3.4.6 ASME Code, Section III, Class 1, 2, and 3 Component Supports

The establishment of the design/service loadings and limits are in accordance with the ASME Code, Section III (Reference 3.9-1), Division 1, Article NCA-2000 and Subsection NF. These loadings and stress limits apply to the structural integrity of components and supports when subjected to combinations of loadings derived from plant and system operating conditions and postulated plant events. The combination of loadings and stress limits are included in the design specification of each component and support. Where the design and service stress limits specified in the code do not necessarily provide direction for the proper consideration of operability requirements for conditions which warrant consideration, Section II.3 and Appendix A of SRP 3.9.3 (Reference 3.9-27), RG 1.124 (Reference 3.9-41) and RG 1.130 (Reference 3.9-42) are used for guidance. Where these stress limits apply, the treatment of functional capability, including collapse, deformation and deflection limits are evaluated and appropriate information is developed for inclusion into the design specification.

ASME Code, Section III (Reference 3.9-1) component supports are designed, manufactured, installed, and tested in accordance with all applicable codes and standards. Supports include hangers, snubbers, struts, spring hangers, frames, energy absorbers, and limit stops. Pipe whip restraints are not considered as pipe supports.

Section 3.13 provides the requirements for the design of bolts for component supports. Review of programs for ensuring bolting and threaded fastener adequacy and integrity is performed under NUREG-0800, SRP 3.13 (Reference 3.9-49).

The design and installation of all anchor bolts are performed in accordance with Appendix B to "Anchoring to Concrete", American Concrete Institute (ACI) 349 (Reference 3.9-50) subject to the conditions and limitations specified in RG 1.199 (Reference 3.9-51).

It is preferable to attach pipe supports to embedded plates; however, surface-mounted baseplates with undercut anchor bolts can be used in the design and installation of supports for safety-related components.

The load combinations and allowable stresses for ASME Code, Section III (Reference 3.9-1), Class 1 component supports are given in Tables 3.9-4 and 3.9-6.

- Emergency – For emergency conditions, the allowable stresses or load ratings are 33% higher than those specified for normal conditions. This is consistent with subsection NF of ASME Code, Section III (Reference 3.9-1) in which (see NF-3250 and NF-3260 ~~3231~~) limits for emergency conditions are 33% greater than the normal condition limits.
- Faulted – Stress limits are specified in Appendix F which assure that no large plastic deformations will occur (Stress less than 1.2 S_y). If any inelastic behavior is considered in the design, detailed justification is provided for this limit. Otherwise, the supports for active components are designed so that stresses are less than or equal to S_y. Thus, the operability of active components is not endangered by the supports during faulted conditions.

2. Plates and shells supports are designed to the following service level and stress limits:

- Normal – Normal condition limits are those specified in Subsection NF-3320 of ASME Code, Section III (Reference 3.9-1).
- Upset – Limits for upset conditions equal normal condition limits and are consistent with Subsection NF-3320 of ASME Code, Section III (Reference 3.9-1).
- Emergency – For emergency conditions, the allowable stresses or load ratings are 20% higher than those specified for normal conditions.
- Faulted – Same as faulted limits for linear supports.

~~For active ASME Code, Section III, Class 2 or 3 pumps, support adequacy is proven by satisfying the criteria in Tables 3.9-4 and 3.9-8. In addition to these requirements for meeting stress limits, an evaluation of pump/motor support misalignment is required.~~

~~Active valves are, in general, supported only by the pipe attached to the valve. Exterior supports on valves are generally not used.~~

3.9.3.4.7 Use of Energy Absorber and Limit Stops

Energy absorbers and limit stops are not used as ASME Code, Section III, Class 1, 2 and 3 component supports in the US-APWR design.

3.9.3.4.8~~7~~ Snubbers Used as Component Supports

Snubbers are considered manufactured standard support components. Snubber manufacturers provide various sizes of snubbers and rated loading consistent with ASME Level A, B, C, and D service conditions. Snubbers are generally hydraulic; however, there are mechanical snubbers ~~available that lock-up at equivalent hydraulic velocities~~ which have adequate functionality that is resistance ~~toward~~ to drift velocity change. Details of snubber design, testing, operation, maintenance, inspection, and other functional characteristics are presented in this subsection.

Snubber manufacturers are required to construct safety-related snubbers to ASME Code, Section III (Reference 3.9-1), Subsection NF standards. The US-APWR layout

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Power Plants. NUREG-0800, SRP 3.9.2, Rev.3, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

3.9-26 Design Response Spectra for Seismic Design of Nuclear Power Plants. Regulatory Guide 1.60, Rev.1, U.S. Nuclear Regulatory Commission, Washington, DC, December 1973.

3.9-27 Stress Limits for ASME Class 1, 2, and 3 Components and Component Supports, and Core Support Structures Under Specified Service Loading Combinations. Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800 SRP Section 3.9.3 and Appendix A to SRP 3.9.3, Rev.2, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

3.9-28 General Design Criteria for Nuclear Power Plants, Domestic Licensing of Production and Utilization Facilities, Energy. Title 10, Code of Federal Regulations, Part 50, Appendix A, U.S. Nuclear Regulatory Commission, Washington, DC.

3.9-29 Codes and Standards, Domestic Licensing of Production and Utilization Facilities, Energy. Title 10, Code of Federal Regulations, Part 50.55a, U.S. Nuclear Regulatory Commission, Washington, DC.

3.9-30 Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants, Energy. Title 10, Code of Federal Regulations, Part 52, U.S. Nuclear Regulatory Commission, Washington, DC.

3.9-31 Contents of Applications, Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants, Energy. Title 10, Code of Federal Regulations, Part 52.47(b)(1), U.S. Nuclear Regulatory Commission, Washington, DC.

3.9-32 Issuance of Combined Licenses, Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants, Energy. Title 10, Code of Federal Regulations, Part 52.80(a), U.S. Nuclear Regulatory Commission, Washington, DC.

3.9-33 Earthquake Engineering Criteria for Nuclear Power Plants, Domestic Licensing of Production and Utilization Facilities, Energy. Title 10, Code of Federal Regulations, Part 50, Appendix S, U.S. Nuclear Regulatory Commission, Washington, DC.

3.9-34 IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations, IEEE Std. 344-2004, Appendix D, Institute of Electrical and Electronics Engineers Power Engineering Society, New York, New York, June 2005. ~~IEEE Std 344-2004.~~

3.9-35 Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside Containment, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800, SRP 3.6.1, Rev. 3, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

3.9-36 Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800, SRP 3.6.2, Rev.2, US Nuclear Regulatory Commission, Washington, DC, March 2007.

3.9-37 Evaluation of Potential Pipe Breaks, NUREG-1061, Vol. 3, U.S. Nuclear Regulatory Commission Piping Review Committee, November 1984.

3.9-38 Guidelines for Evaluating Fatigue Analyses incorporating the Life Reduction of Metal Components Due to the Effects of the Light Water Reactor Environment for New Reactors. Regulatory Guide 1.207, Rev.1, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

3.9-39 Nuclear Facilities-Steel Safety-Related Structures for Design, Fabrication and Erection. (1994 edition), ANSI/AISC N690, American National Standards Institute/American Nuclear Society.

3.9-40 Manual of Steel Construction. American Institute of Steel Construction, 9th Edition, 1989.

3.9-41 Service Limits and Loading Combinations for Class 1 Linear-Type Component Supports. Regulatory Guide 1.124, Rev.2, US Nuclear Regulatory Commission, Washington, DC, February 2007.

3.9-42 Service Limits and Loading Combinations for Class 1 Plate-and-Shell-Type Component Supports. Regulatory Guide 1.130, Rev.2, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

3.9-43 Rules for Inservice Inspection of Nuclear Power Plant Components, ASME Boiler and Pressure Vessel Code. ASME Section XI, 1995 Edition through the 2003 Addenda, American Society of Mechanical Engineers.

3.9-44 Operation and Maintenance Code Case Acceptability, ASME OM Code, Regulatory Guide 1.192, US Nuclear Regulatory Commission, Washington, DC, June 2003.

3.9-45 Requirements for Extending Snubber Inservice Visual Examination Interval at LWR Power Plants, American Society of Mechanical Engineers (ASME) Code Case OMN-13, Rev.0, 2000.

3.9-46 Technical Evaluation of Generic Issue 113: Dynamic Qualification and Testing of Large Bore Hydraulic Snubbers, NUREG/CR-5416, Nitzel, M.E.; Ware, A.G. EG&G Idaho Inc.; Page J.D. NRC; September 1992 (EGG-2571).

3.9-47 Structural Welding Code – Steel. ANSI/AWS D1.1, American National Standards Institute/American Welding Society.

3.9-48 Pipe Support Base Plate Designs using Concrete Expansion Anchor Bolts. IE Bulletin 79-02, Rev.2, U.S. Nuclear Regulatory Commission, Washington, DC, November 1979.

3.9-49 Threaded Fasteners – ASME Code Class 1, 2, and 3, Design of Structures, Components, Equipment, and Systems, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800, SRP 3.13, Rev.0, U.S. Nuclear Regulatory Commission, Washington, DC, June 1996.

3.9-50 Anchoring to Concrete. ACI 349, American Concrete Institute.

3.9-51 Anchoring Components and Structural Supports in Concrete. Regulatory Guide 1.199, Rev.0, U.S. Nuclear Regulatory Commission, Washington, DC, November 2003.

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Table 3.9-3 Minimum Design Loading Combinations for ASME Code, Section III, Class 1, 2, 3 and CS Systems and Components

ASME Service Level	Design Loading Combinations[3][6]~~[12]~~
Design	$P + DL + L_{DM} + L_{EM}$
Level A	$P_M^{(1)} + DL + L_{EM}$
	$P_M^{(1)} + DL + L_{DFN}^{(7)} + L_{EM}^{(7)} + TH_{TRN} + TH_{MTL}$
Level B	$P_M^{(1)} + DL + L_{EM}^{(7)} + TH_{TRN} + TH_{MTL} + SRSS^{(2)} ((SSEI + SSEA)^{(11)} + L_{DFU}^{(7)})$
Level C	$P_M^{(1)} + DL + L_{DFE}$~~(5)~~$^{(7)} + L_{EM}^{(7)}$
	$P_M^{(1)} + DL + L_{DF} + L_{EM}^{(8)}$
Level D	$P_M^{(1)} + DL + L_{DFF}^{(7)} + L_{EM}^{(7)}$
	$P_M^{(1)} + DL + SRSS^{(2)} ((SSEI + SSEA) + DBPB) + L_{EM}^{(4)}$
	$P_M^{(1)} + DL + RV_{OS} + SRSS^{(2)} (SSEI + SSEA) + L_{EM}^{(9)}$
	$P_M^{(1)} + DL + L_{DFS} + SRSS^{(2)} ((SSEI + SSEA) + DBPB + L_{DF}) + L_{EM}^{(8)}$
Hydrostatic Test	$H_{DL}^{(10)}$

Notes:

1. P_M is the maximum operational pressure for various ASME service levels of operation and dependent on the type of transient that occurs at a particular service level. During an earthquake P_M is considered normal operational pressure at 100% power levels.
2. SRSS sums the squares of each load and determines the resultant square root.
3. Loadings generated by static displacement of the concrete containment vessel and building settlement are added to the loading combinations for ASME Code, Section III, Class 2 and 3 systems.
4. When determining appropriate load combinations involving L_{EM}, a determination of the timing sequence and initiating conditions that occur between P_M and L_{EM} are considered.
5. Deleted. ~~Pressurizer safety valve discharge and associated load is classified under an emergency service condition.~~
6. Table 3.9-5 provides a description of loads listed in this table.
7. In determining service level A, B, C, and D load combinations, the timing sequence and initiating conditions that occur between P_M, L_{DFN}, L_{DFU}, L_{DFE}, L_{DFF}, and L_{EM}, are considered respectively.
8. In determining appropriate service level load combination, the timing sequence and initiating conditions that occur between P_M, L_{DF}, and L_{EM}, are considered.
9. In determining appropriate service level load combination, the timing sequence and initiating conditions that occur between P_M, RV_{OS}, and L_{EM}, are considered.
10. If, during operation, the system normally carries a medium other than water (air, gas, steam), sustained loads should be checked for weight loads during hydrostatic testing as well as normal operation weight loads.
11. The earthquake inertial and anchor movement loads used in the Level B Stress Intensity Range and Alternating Stress calculations are taken as 1/3 of the peak SSE inertial and anchor movement loads or as the peak SSE inertial and anchor movement loads. If the earthquake loads are taken as 1/3 of the peak SSE loads then the number of cycles to be considered for earthquake loading are 300 as derived in accordance with Appendix D of Institute of Electrical and Electronic Engineers Standard 344-1987 (Reference. 3.9-15). If the earthquake loads are taken as the peak SSE loads then 20 cycles of earthquake loading are considered.
12. ~~If a loading is considered negligible or is non-existent, it is ignored in the service level combinations.~~

Table 3.9-4 Minimum Design Loading Combinations for Supports for ASME Code, Section III, Class 1, 2, and 3 Piping and Components(2)

Condition	Design Loading Combinations(3)(10)
Design	$DL + L_{DM}$
Level A Service	$DL + TH_i + L_{EM} + L_{DFN}$(4) + F
Level B Service	$DL + TH_i + L_{EM} + L_{DFU}$(4))
Level C Service	$DL + TH_i + L_{EM} + L_{DFE}$(5)(4)
	~~$DL + TH_i + L_{EM} + L_{DF}$~~
Level D Service	$DL + TH_i + L_{EM} + RV_{OS}$ + SSEI + SSEA + SE(6)(8)
	$DL + TH_i + L_{EM} + L_{DFF}$(4)
	$DL + TH_i + L_{EM}$ + SRSS (DBPB + (SSEI + SSEA + SE))(6)
	$DL + TH_i + L_{EM}$(7) + L_{DFS} + SRSS (DBPB + (SSEI + SSEA + SE))(6) + L_{DFF})(7)
Hydrostatic Test	H_{DL}(9)

Notes:

1. SRSS sums the squares of each load and determines the resultant square root.
2. Loadings generated by static displacement of the concrete containment vessel and building settlement are added to the loading combinations for ASME Code, Section III, Class 2 and 3 systems.
3. Table 3.9-5 provides a description of loads listed in this table.
4. In determining service level A, B, C, and D load combinations, the timing sequence and initiating conditions that occur between TH_i, L_{DFN}, L_{DFU}, L_{DFE}, L_{DFF}, and L_{EM}, are considered respectively.
5. Deleted. ~~Pressurizer safety valve discharge and associated load is classified under an emergency service condition.~~
6. SE is support self weight excitation of the support, caused by seismic building inertial loads. SSEI, SSEA, and SE are combined using absolute summation.
7. In determining appropriate service level load combination, the timing sequence and initiating conditions that occur among TH_i and L_{DFE} are considered.
8. In determining appropriate service level load combination, the timing sequence and initiating conditions that occur between TH_i and RV_{OS} are considered.
9. If, during operation, the system normally carries a medium other than water (air, gas, steam), sustained loads should be checked for weight loads during hydrostatic testing as well as normal operation weight loads.
10. ~~If a loading is considered negligible or is non-existent, it is ignored in the service level combinations.~~

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Table 3.9-8 Stress Criteria for ASME Code, Section III Class 2 and 3 Components and Supports

Design/ Service Level	Vessels/Tanks	Piping (6)	Pumps	Valves, Disks, Seats	Component Supports (1)(2)
Design and Service Level A	ASME Code, Section III, ~~NC-3217~~ NC/ND-3310, 3320	See Section 3.12	ASME Code, Section III, NC/ND-3400	ASME Code, Section III, NC/ND-3510	ASME Code, Section III, (3)
Service Level B (Upset)	ASME Code, Section III, NC/ND-3310, 3320	See Section 3.12	ASME Code, Section III, NC/ND-3400	ASME Code, Section III, NC/ND-3520	ASME Code, Section III, (3)
Service Level C (Emergency)	ASME Code, Section III, NC/ND-3310, 3320	See Section 3.12	ASME Code, Section III, NC/ND-3400	ASME Code, Section III, NC/ND-3520	ASME Code, Section III, (3)
Service Level D (Faulted)	ASME Code, Section III, NC/ND-3310, 3320	See Section 3.12	ASME Code, Section III, NC/ND-3400	ASME Code, Section III, NC/ND-3520 (5)	ASME Code, Section III, (3)(4)

Notes:

1. Component supports include equipment and piping supports. For pipe support criteria explanation refer to Section 3.12 of the DCD. For component supports refer to Section 3.9.3 of the DCD.
2. RG 1.124, Rev. 1 provides additional methods that can be used for evaluating component supports in addition to ASME Code, Section III, Subsection NF requirements.
3. ASME Code, Section III, Subsection NF, Table 3131(a)-1 provides reference paragraphs for Subsection NF procedural sections used for design of component supports, piping supports, and standard supports.
4. Subsection 3.9.3.4 provides criteria for component supports used for active equipment, valves, and piping with active valves.
5. Active valve operability is demonstrated by testing or analysis. Pressure integrity verification of active valves is based on using the ASME Code allowables one level less than the service loading condition. Subsection 3.9.3.2 provides additional information on test requirements.
6. Table 3.12-3 provides additional stress limit information for piping.