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April 17, 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-09172

Subject: MHI's Response to US-APWR DCD RAI No. 259-2117

References: 1) "Request for Additional Information No. 259-2117 Revision 1, SRP Section: 03.12 – ASME Code Class 1, 2, and 3 Piping Systems and Piping Components and Their Associated Supports; Application Section: 3.12" dated 3/4/2009.

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. 259-2117 Revision 1."

Enclosed are the responses to the four questions contained within 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. 259-2117, Revision 1

CC: J. A. Ciocco
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NRO

Contact Information

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Enclosure 1

UAP-HF-09172
Docket No. 52-021

Response to Request for Additional Information No. 259-2117, Revision 1

April, 2009

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

4/17/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 259-2117 REVISION 1**
SRP SECTION:	**03.12 - ASME Code Class 1, 2, and 3 Piping Systems and Piping Components and Their Associated Supports**
APPLICATION SECTION:	**03.12**
DATE OF RAI ISSUE:	**03/04/09**

QUESTION NO. RAI 03.12-1:

Describe how the mass point spacing based on the formula in DCD 3.12.4.2 is able to capture the vibration mode associated with the cut-off frequency mode.

ANSWER:

The formula in DCD 3.12.4.2 calculates the required length of a pipe segment, between two mass points, based on a simply supported beam that would produce a natural frequency equal to the term F_R. PIPESTRESS program input data has a specific field to enter the value of F_R, which is used to enter a pre-selected cut-off-frequency.

DCD Subsection 3.12.4.2 will be revised to clarify.

Impact on DCD

See Attachment 1 for the mark-up of DCD Tier 2, Section 3.12, Revision 2, changes to be incorporated.

- Add the following text to the end of the first sentence of the fifth paragraph of Subsection 3.12.4.2: "and is based on a simply supported beam that would produce a natural frequency equal to a preselected cut-off-frequency."

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:	**03/04/09**

QUESTION NO. RAI 03.12-2:

In DCD Section 3.12.5.10, the applicant states that the surge line is to monitor for the effect of thermal stratification during hot functional testing. The applicant is requested to clarify how the surge line monitoring activity during hot functional test (HFT) is able to represent heatup/cooldown operation. The applicant is also requested to demonstrate that HFT has the same heatup/cooldown rate and operation to represent RCS conditions during normal operation. In addition, the applicant is requested to describe how to track surge line monitoring activity since this activity is not listed as a COL information in DCD 3.12.7.

ANSWER:

The pressurizer surge line temperature is monitored during RCS Hot Functional Testing (HFT) heatup and cooldown as described in DCD Chapter 14.2. The heatup and cooldown operating procedures used during HFT are the same as that of normal operation. That is, during heatup, RCS temperature is raised by reactor coolant pump operation to reach no-load temperature; RCS pressure is maintained at low pressure by low pressure letdown subsystem, and after the pressurizer steam bubble is generated, pressure is increased gradually by the pressurizer heaters. During cooldown, the RCS is first cooled down by using turbine bypass valves, pressure is decreased gradually by using pressurizer spray, and at the initiation of RHR operation and termination of pressurizer steam bubble, RCS pressure is maintained at low pressure by the low pressure letdown subsystem. Both heatup and cooldown operations employ water solid operation of the pressurizer when the RCS is at low pressure. Equipment used during these operations are the same as those used during normal plant heatup and cooldown.

In summary, HFT has the same heatup (maximum 50°F/hr. for the RCS and 100°F/hr. for the pressurizer) and cooldown (maximum 100°F/hr. for the RCS and 200°F/hr. for the pressurizer) rates and RCS conditions as during normal operation.

Since this surge line monitoring activity is performed only for the first US-APWR plant during HFT as described in DCD 3.12.5.10, it is not necessary to include this activity in COL information.

MHI will clarify in the DCD that surge line temperature will be monitored during HFT heatup and cooldown to determine the extent of thermal stratification.

Impact on DCD

See Attachment 1 for the mark-up of DCD Tier 2, Section 3.12, Revision 2, changes to be incorporated.

- Change Item 3 of Subsection 3.12.5.10 to: "The temperature of the surge line is to be monitored for the effects of thermal stratification at heatup and cooldown during hot functional testing."

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:	**03.12**
DATE OF RAI ISSUE:	**03/04/09**

QUESTION NO. RAI 03.12-3:

In DCD 3.12.6.11, the applicant states that all rigid supports have a cold condition gap of 1/16 inch all around the pipe surface in the restrained direction. The applicant is requested to explain how the pipe can be supported vertically during cold condition with a 1/16 inch all around gap between pipe surface and the support.

ANSWER:

The first paragraph of 3.12.6.11 will be revised to clarify that in the case of vertical restraints a gap of 1/8" will be maintained above the pipe surface in the vertical upward directions, as the pipe surface will rest on the support in the cold installed condition.

Impact on DCD

See Attachment 1 for the mark-up of DCD Tier 2, Section 3.12, Revision 2, changes to be incorporated.

- Add the following sentence to end of the first paragraph of Subsection 3.12.6.11: "However, in the case of vertical restraints during the cold condition the pipe surface will be in contact with the support in the direction of gravity, 1/8" gap will be maintained above the pipe surface in the vertical upward direction."

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:	**03/04/09**

QUESTION NO. RAI 03.12-4:

In DCD 3.12.5.11, the applicant described the USAPWR safety relief valve design. SRP subsection 3.9.3.II provides the guidance on acceptance criteria for the safety relief valve design, states that the SAR should also include a description of the calculation procedure, computer programs, and other methods to be used in the analysis. The applicant is requested to provide a description of the calculation procedure, and computer programs used for designing the USAPWR safety relief valve.

ANSWER:

The calculation procedure for the design and installation of safety relief valves is in accordance with ASME Code, Appendix O. The computer programs used for designing the US APWR safety relief valves are listed in Subsection 3.12.4.1.1.

DCD Tier 2 Subsections 3.12.4.1.1 and 3.12.5.11 will be revised to clarify the above.

Impact on DCD

See Attachment 1 for the mark-up of DCD Tier 2, Section 3.12, Revision 2, changes to be incorporated.

- Change the first paragraph, forth bullet, second paragraph in Subsection 3.12.4.1.1 to:

  "This program is used for the analysis of a behavior, such as water hammer, safety/relief valve discharge etc., by modeling flow volume and flow path."

- Add the following sentence at the end of the third paragraph of Subsection 3.12.5.11. "See Subsection 3.12.4.1.1 for the computer program used in the analysis (Reference 3.12.21)."

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

This completes MHI's responses to the NRC's questions.

- Abaqus

  Abaqus (Reference 3.12-19) is a general-purpose computer program for structural analysis.

  This program is used for temperature distribution analysis and thermal stress analysis according to piping geometries and design transients such as fluid temperature, coefficient of heat transfer, and flow rate.

- ANSYS

  ANSYS (Reference 3.12-20) is a general purpose finite element structural analysis computer program.

- RELAP-5

  RELAP-5 (Reference 3.12-21) is a computer program for the fluid transient analysis.

  This program is used for the analysis of a behavior, such as water hammer, safety/relief valve discharge etc., by modeling flow volume and flow path.

  The pressure and flow rate time-history can be obtained.

- E/PD STRUDL

  E/PD STRUDL (Reference 3.12-22) is a computer program that has the capability to perform the structural analysis of pipe supports in compliance with ASME Code, Section III, Section NF (Reference 3.12-2), and AISC Codes (Reference 3.12-23).

  This computer program is designed to perform analysis of the pipe support structure, including the base plate flexibility per NRC IE Bulletin 79-02 (Reference 3.12-24) as applicable and perform a code stress check of the various components of the support assembly (e.g., structural stock items, welds, anchor bolts, and support vendor components based on data used from vendor's catalog values per vendor's certified design reports).

3.12.4.1.2 Program Validations

Verification tests are to demonstrate the capability of the computer program to produce valid results for test problems encompassing the range of permitted usage defined by the program documentation. Subsection 3.9.1.2 describes the various methods used for computer program validations.

3.12.4.2 Dynamic Piping Model

For dynamic analysis, the piping system is idealized as a three dimensional space frame. The analysis model consists of a sequence of nodes connected by straight pipe elements and curved pipe elements with stiffness properties representing the piping, and other in-line components.

Piping restraints and supports are idealized as zero length springs with appropriate stiffness values for the restrained degrees of freedom.

In the dynamic mathematical model, the distributed mass of the system, including pipe, contents, and insulation weight, is represented as lumped masses located at each node, which is designated as a mass point.

The minimum number of degrees of freedom in the model is to be equal to twice the number of modes with frequencies below a pre-selected cut-off-frequency.

The following formula is used to determine the spacing between two successive mass points and is based on a simply supported beam that would produce a natural frequency equal to a preselected cut-off-frequency. The PIPESTRESS program uses this formula for mass point spacing.

$$L = \sqrt{\left[\frac{K}{F_R}\right]\sqrt{\frac{EI}{W}}}$$

where

K = 0.743

L = Mass point spacing (ft)

F_R = Cut-off frequency (Hz)

E = Modulus of elasticity of pipe material (psi)

I = Moment of inertia of pipe cross-section (in^4)

W = Mass per unit length of piping + insulation + contents (lbm/ft)

Concentrated weights of in-line components, such as valves, flanges, and instrumentation, are also modeled as lumped masses.

Torsional effects of eccentric masses are included in the analysis.

The mass contributed by the support is included in the analysis when it is greater than 10% of the total mass of the adjacent pipe span (including pipe, contents, insulation, and concentrated masses).

3.12.4.3 Piping Benchmark Program

Piping benchmark problems included in NUREG/CR-1677, Vol. 1 and 2 (Reference 3.12-17) are used to validate the PIPESTRESS computer code used in piping stress analysis. In addition, three piping benchmark problems from NUREG/CR-6414 (Reference 3.12-25) are also used to validate the PIPESTRESS computer code.

3.12.4.4 Decoupling Criteria

Branch lines and instrument connections may be decoupled from the analysis model of a larger run of piping provided that either the ratio of the branch pipe mean diameter to the pipe run mean diameter (D_b/D_r) is less than or equal to 1/3, or the ratio of the moments of inertia of the two lines (I_b/I_r) is less than or equal to 1/25.

Structural integrity of the pressurizer surge line of the US-APWR plant is to be assured by performing the following activities for the first US-APWR plant.

1. Fatigue evaluation is to be performed by considering the repeated event of thermal stratification occurring in the pressurizer surge line. It will be confirmed by analysis and hot functional test that thermal deflections of piping do not result in adverse consequences.

   If the fatigue evaluation results yield noncompliance with the Code, items 2 thru 4 below, are to be performed.

2. Operational alternatives such as plant start-up and cooldown, which are the most severe conditions for thermal stratifications of the pressurizer surge line due developing the largest difference of temperature between hot leg and pressurizer, are to be considered for mitigation of thermal stratification in the US-APWR.

3. The temperature of the surge line is to be monitoreding for the effects of thermal stratification at heatup and cooldown during hot functional testing.

4. Monitoring results are to be included in stress and fatigue analysis to ensure Code compliance.

3.12.5.11 Safety Relief Valve Design, Installation, and Testing

The requirements of "Rules for the Design of Safety Valve Installations", ASME Code, Appendix O (Reference 3.12-30) are followed in the design and installation of safety valves and relief valves for overpressure protection.

Discharge forces of safety or relief valves using open vent stacks to discharge directly to the atmosphere are normally calculated using static methods and a conservative dynamic load factor. While performing stress analysis, these discharge forces are applied to evaluate stresses and restraint/support design loads using static equivalent force analysis methods.

Discharge forces of safety or relief valves using piped discharges to vessels or headers are not considered as steady state forces, but are analyzed as forces acting at changes in directions (elbows and branch connections) during the initial discharge phase. A static equivalent force analysis or a time-history dynamic force analysis are performed on the piping system to evaluate resulting stresses and support/restraint design loads. See Subsection 3.12.4.1.1 for the computer program used in the analysis (Reference 3.12.21).

If several relief or safety valves are placed on a common header, the most adverse sequence of valve discharges are used to calculate piping stresses and support/restraint design loads.

The friction force *F* cannot be greater than the product of the pipe movement and the stiffness of the pipe support in the direction of movement.

3.12.6.11 Pipe Support Gaps and Clearances

All rigid supports have a cold condition gap of 1/16th inch all around the pipe surface in the restrained direction. These small gaps allow the rotation of the pipe and also allow for radial thermal expansion of the pipe. However, in the case of vertical restraints during the cold condition the pipe surface will be in contact with the support in the direction of gravity, 1/8" gap will be maintained above the pipe surface in the vertical upward direction.

In the unrestrained direction, the gaps are greater than the expected maximum movement of the pipe.

Stiff pipe clamps, which are preloaded to prevent themselves from lifting off the piping under dynamic loading conditions, are not used for ASME Code, Section III, Class 1 (Reference 3.12-2) piping.

3.12.6.12 Instrumentation Line Support Criteria

The acceptance criteria for instrumentation line supports are from ASME Code, Section III, Subsection NF for seismic category I (Reference 3.12-32) and seismic category II instrumentation lines. Non-seismic instrumentation lines are designed per the rules of "Manual of Steel Construction, 9th Edition", AISC (Reference 3.12-23).

The applicable loading combinations for these supports are those used for normal and faulted conditions in Table 3.12-4.

3.12.6.13 Pipe Deflection Limit

Manufacturer's recommendations for the limitations in its hardware are followed for those piping supports that utilize standard manufactured components. Such limitations include travel limits for variable and constant support spring hangers, swing angles for rod hangers, struts, and snubbers. The variability check of variable support spring hangers is performed per applicable Codes.

3.12.7 Combined License Information

COL 3.12(1) *Deleted*

COL 3.12(2) *If any piping is laid out in the yard, the COL Applicant is to generate site-specific seismic response spectra, which may be used for the design of these piping systems or portions of piping system.*

COL 3.12(3) *If the COL Applicant finds it necessary to lay ASME Code, Section III (Reference 3.12-2), Class 2 or 3 piping exposed to wind or tornado loads, then such piping must be designed to the plant design basis loads.*