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May 12, 2011

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

Attention: Mr. Jeffrey A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-11135

Subject: Revised Design Completion Plan for US-APWR Piping Systems and Components

References:

(1) Letter (ML102040041) from Y. Ogata (MHI) to U.S. NRC, "Updated Design Completion Plan for US-APWR Piping Systems and Components" dated July 21, 2010
(2) Letter (ML110240150) from D. Matthews (NRC) to Y. Ogata (MHI), "Schedule Change for the United States – Advanced Pressurized Water Reactor Design Certification" dated February 24, 2011
(3) Letter (ML110760142) from Y. Ogata (MHI), K. Yamauchi (MNES), R. Frenzel (Energy Future Holdings), E. Grecheck (Dominion) to U.S. NRC, "Commitments to Improve US-APWR DCD Review Schedule" dated February 18, 2011

In reference (1), Mitsubishi Heavy Industries, Ltd. ("MHI") provided the U.S. Nuclear Regulatory Commission ("NRC") Staff an update to previously submitted information regarding the Design Completion Plan, ITAAC Plan and Proposed Audit Plan for Piping Systems and Components ("PSC"). MHI's design process follows ASME guidance and consists of a Design Specification and Stress Report for associated PSCs. The Design Specification lists the required load conditions and includes seismic loads. The Stress Report provides evaluations of the load conditions, including seismic events.

In reference (2), the NRC raised questions regarding the adequacy of seismic models to reflect the structural response to dynamic loads and the development of floor response spectra and member forces used for the design of structures, systems and components.

As described in reference (3), MHI, with the support of Mitsubishi Nuclear Energy Systems, Inc, Luminant and Dominion, established task teams to address critical issues identified by the NRC. On March 31, 2011, the seismic task team presented the results of an evaluation of previous seismic design activity submitted to the NRC. The seismic task team concluded that the seismic model for evaluating the structural response would be changed from a Lumped Mass Stick Model ("LMSM") to a Finite Element Model ("FEM"). This will serve to resolve the NRC's questions regarding the adequacy of the seismic analysis. The model change may result in different seismic loading inputs for the PSC Stress Reports.

The purpose of this letter is to clarify the impact on the previously provided Design Completion Plan, ITAAC Plan and Proposed Audit Plan for PSCs. An approach is presented, and a conference call or public meeting is requested to get feedback from the NRC staff which may lead to modifying the approach presented. The principles contained in reference

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(1) will not change and MHI will continue to rely on the approach described therein to provide reasonable assurance that safety requirements will be met for a design that is essentially complete prior to the start of plant construction. The major features of the approach include:

- NRC audits of Design Specifications and Stress Reports during the DCD review phase
- Design ITAAC during the procurement phase
- Construction ITAAC for as-built reconciliation

As a result of the change to the FEM, a revised Design Specification will be generated for ASME PSCs. MHI proposes an audit of Stress Reports (LMSM input) and revised Design Specifications (FEM input). The purposes of the audit will be to confirm the methodology utilized to develop Stress Reports and the environmental fatigue evaluation, and also to confirm the adequacy of the new design Specifications.

Although the stress reports available for audit will be based on the LMSM, they will still serve to verify the methodology. Design ITAAC can subsequently be utilized during the procurement phase to confirm the content of the Stress Reports after they have been revised accordingly to incorporate input from the FEM.

It is not expected that the change to the FEM will adversely affect the content of these reports.

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

Sincerely,

Y. Ogata

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

Enclosures:

1. "Revised Design Completion Plan for US-APWR Piping Systems and Components"

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

Contact Information
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Enclosure 1

UAP-HF-11135
Docket No. 52-021

Revised Design Completion Plan for US-APWR Piping Systems and Components

May, 2011

1. INTRODUCTION AND BACKGROUND

Upon the submission of the Application for Design Certification of the US-APWR Standard Plant Design, Attachment 2 ("US-APWR Approach for DAC-ITAAC including Design Completion and Technical Report Submittal Plan") to Enclosure 3 of Mitsubishi Heavy Industries, Ltd ("MHI") Application for Design Certification dated December 31st, 2007 [a] set forth MHI's commitments to the U.S. Nuclear Regulatory Commission ("NRC") for resolving Design Acceptance Criteria for components, piping and fuel assemblies during the design certification review process by additional technical reports and/or NRC audit [1]. The Technical Reports which have been submitted to the NRC contain analyses results and other information to supplement the information already provided in the Design Control Document ("DCD"). In addition, MHI committed to complete and make available for audit the stress analyses and the related design documents for the remaining designated PSC.

MHI discussed with the NRC about the seismic calculation methodology and held a public meeting dated March 31, 2011. Based on the public meeting, design inputs to the stress analyses of PSCs may be changed. These changes are to be incorporated into the loading conditions to the PSCs.

This enclosure provides the Updated Design Completion Plan for the US-APWR PSCs with subsequent study results in response to the NRC comments. Details of the seismic calculation method change are documented in another MHI Letter UAP-HF-11134 [b]. MHI believes that this plan will provide adequate stress analysis information for the NRC to conclude that there is reasonable assurance that safety requirements will be met for a design that is essentially complete prior to the start of plant construction.

[a] Letter MHI Ref: UAP-HF-07170 from M. Kaneda (MHI) to U.S. NRC, "Mitsubishi Heavy Industries Ltd. Application for Design Certification of the US-APWR Standard Plant Design" dated December 31st, 2007.

[b] Letter MHI Ref: UAP-HF-11134 from Y.Ogata (MHI) to U.S. NRC, "Revised Completion Plan for US-APWR Seimic and Structural Analyses" dated May 12, 2011.

2. DEFINITIONS

Design Specification:

Design Specifications are prepared for Design Certification (DC) in accordance with ASME NCA-3250, but not certified by a Registered Professional Engineer (RPE).

ASME Certified Design Specification:

ASME Certified Design Specifications are prepared for each plant and certified by a RPE.

Stress Report:

Stress Reports are prepared in accordance with ASME NCA-3250, but not certified by an RPE. Stress Reports consist of modeling, methodology, sizing calculation, analysis and evaluations.

ASME Certified Design Report:

ASME Design Reports are defined by ASME Code (NCA 3551.1 for as-designed and NCA 3554 for the reconciliation). ASME Design Reports are prepared for each plant and certified by a RPE

Additional Reports:

Additional Reports are separate from ASME, and are prepared to address specific DCD requirements, including the following:

- Environmental Fatigue Analysis
- Pipe Break Hazard Analysis

Design ITAAC:

Design ITAAC is PSC analyses and assessments that are not completed in the DC review phase. MHI plans to close Design ITAAC prior to material procurement. These ITAAC will be closed per the closure options defined in NEI 08-01.

Construction ITAAC:

Construction ITAAC is applied to as-built (as-procured) PSCs. These ITAAC will be closed during the construction phase. ITAAC closure is defined in NEI 08-01.

3. DESIGN COMPLETION PLAN

3.1 Design Process for US-APWR PSC

Following ASME guidance, the design process for US-APWR PSC consists of a Design Specification and Stress Report. The Design Specification which identifies sufficient information to define the PSC to be manufactured provides the design input for the Stress Report.

The Design Specification will consist of the following:

- Codes and standards
- Requirements, such as materials, manufacturing, test and examination
- Design input, such as structural requirements and physical characteristics
- Design transients, such as temperature and pressure
- Load conditions, such as seismic load, accident load, thermal load and other mechanical loads
- Other conditions, such as design life

For the stress analysis of the PSCs, it is very important to identify how to define the design input load conditions, and how to define the design transients. Design documents for this information are referred to in the Design Specifications of each component. Design Specifications along with these design documents are the material for the design completion audit.

Based on the above Design Specifications, stress analysis is conducted, and Stress Reports are issued.

The Stress Reports will consist of the following:

- Modeling
- Methodology
- Sizing calculation
- Analysis, such as heat transfer, stress, fatigue
- Evaluations for normal, accident and seismic events, thermal and fatigue and Leak-Before-Break ("LBB") Analysis of piping

In addition to the above stress report, the following evaluations will be conducted (if applicable):

- Environmental Fatigue Analysis
- Pipe Break Hazard Analysis

3.2 Current Status

3.2.1 Current Status of Calculation Code verification and Validation

Calculation Codes used for the stress analysis of MHI manufactured PSCs, environmental fatigue analysis and other calculations including calculations for these input conditions are verified and validated by MHI before the start of the calculation. Computer codes used for these calculations are shown in Table-1 and are available for NRC audit.

The DCD will be updated to add these computer codes.

3.2.2 Current Status of PSC Design

Design Specifications for PSCs were completed in March 2009 as stated in Table 2 of Reference (1). However, these Design Specifications will be revised to incorporate the revised load conditions as shown in Section 3.3 and 3.4 of this document.

Stress Analysis Summary Reports have been submitted to the NRC as technical reports based on the current load conditions as shown in Table-2 of this document. Technical Reports on Environmental Fatigue evaluation based on the current load conditions for each Class 1 PSC and Pipe Break Hazard methodology reports have also been submitted as shown in Table-2.

Detail reports based on the former design input conditions are being prepared as stated in Table 2 of Reference (1).

3.3 Effects of Seismic Calculation Method Change

The seismic analysis methodology, which is one of the design inputs to stress analyses of PSCs, will be revised based on the change of calculation model from Lumped Mass Stick Model (LMSM) to Finite Element Model (FEM) for the Reactor Building Complex. This will require a revision to the Design Specifications and Stress Reports before design completion.

The stress analysis methodology for PSCs is independent of seismic design inputs obtained from LMSM or FEM. The methodology of stress analysis before and after the revised documents is the same as shown in Figure-1 below. Stress Reports based on the LMSM can be used to confirm the methodology utilized.

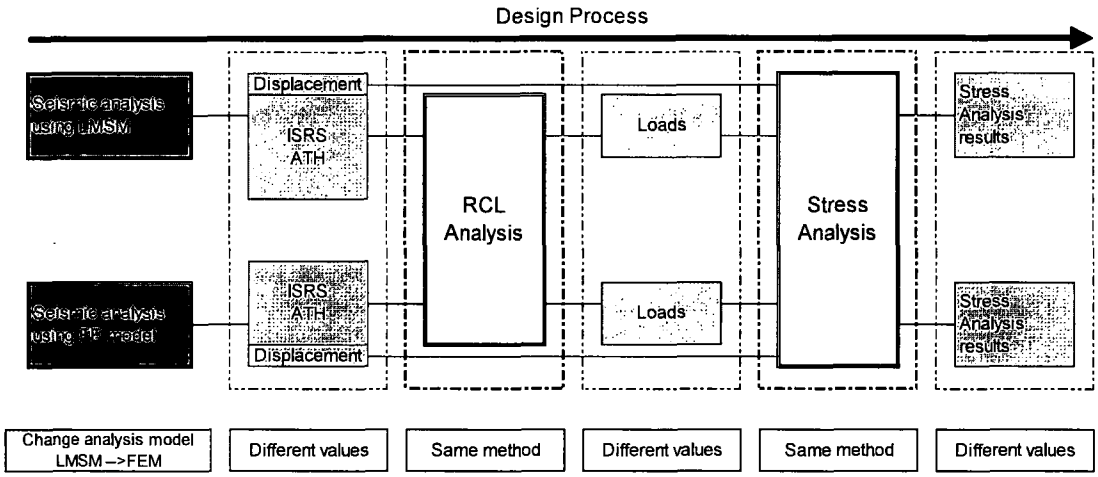

Figure-1: Design Process of PSCs

3.4 Design Completion Plan

1) Design during DCD Review Phase

Based on the change of seismic calculation method for structures, design specifications, stress reports, and the environmental fatigue evaluation reports will be changed accordingly. However, the audit of Stress Reports including the environmental fatigue evaluation can proceed because the purpose of the audit will be to confirm the methodology utilized to develop the Stress Report. The audit can adequately evaluate the methodology because it is independent of the actual load inputs. The audit can also confirm the adequacy of the new Design Specification. MHI believes that the Pipe Break Hazard methodology is discussed separately using technical reports MUAP-10017 (Rev.1) and MUAP-10022 (Rev.0), and the adequacy will be discussed separately from the proposed audit.

The audit availability is divided into two phases, August 2011 and March 2012. Detailed audit materials and timing are discussed in Section 4 of this document.

The MHI Design Completion Plan for US-APWR PSCs is summarized in Table-3. In this table, the schedule of the available information (e.g. Design Specifications, Stress Report and Environmental Fatigue Analysis) is presented. This information will be available for audit along with Computer Program verification and validation results.

For the piping design, complete design methodology including computer code and environmental fatigue evaluation methodology are available for audit. For component design, complete design specifications for all risk significant ASME Class 1, 2, 3 components, except valves and orifice, and design methodology of Class 1 components including computer code and environmental fatigue evaluation methodology will be available for audit.

2) During Procurement after Design Certification

During the procurement phase, after Design Certification, the following will be available to close Design ITAAC:

- Stress Reports of all the ASME Code Section III PSCs using seismic loads based on the FEM

3) Design Reconciliation during Construction

During the construction phase, as-built PSCs will be reconciled with the following information to close Construction ITAAC:

- ASME Certified Design Specifications
- ASME Certified Design Reports including LBB evaluation results
- Pipe Break Hazard Analysis Reports

MHI believes that this design information is sufficient prior to the start of plant construction, and commits to the NRC the schedule for its availability for NRC audit.

4. AUDIT AVAILABILITY

4.1 Audit August 2011

The following will be available for audit in August 2011:

- Verification and Validation Reports on calculation codes
- Stress Reports using seismic responses resulting from the LMSM, for representative PSCs
- Environmental Fatigue Evaluation using seismic responses resulting from the LMSM, for representative PSCs

1) Verification and Validation of Calculation Codes

The computer programs listed on Table-1 are used for static, dynamic, and hydraulic transient analysis of the APWR design. Verification and validation reports of these programs will be available in August 2011, except for the following:

- Computer Codes already submitted and discussed by topical reports
- Computer Codes used for Class 2&3 piping stress analysis (calculated before material procurement)

2) Methodology of Stress Analysis

Stress Reports for PSCs, which are using seismic responses resulting from the LMSM, will be available in August 2011 as shown in Table-3.

3) Methodology of Environmental Fatigue Evaluation

Environmental fatigue evaluation reports for Class 1 PSCs, which use seismic responses resulting from the LMSM, will be available in August 2011 as shown in Table-3.
MHI requests that the NRC assess the adequacy of MHI's methodology for environmental fatigue evaluation.

4.2 Audit March 2012

Design Specifications for all risk significant ASME Class 1, 2, 3 Components

Design specifications for all PSCs were already prepared as shown in Section 3.2.2 above, however these specifications should be revised based on the seismic input change. Design specifications of all risk significant ASME Class 1, 2, and 3 components, except valves and orifice, will be modified to incorporate the seismic responses resulting from the FEM, will be available in March 2012 as shown in Table-3.
Background information documents related to the bases of design transients and details of load conditions referred to each design specification will also be available.

5. SUMMARY

- Seismic loads for PSCs may be changed since the seismic analysis model of the R/B Complex will be changed from LMSM to FEM.
- Design process and design methodology for stress analysis are the same for the analysis results by LMSM and FEM.
- Adequacy of design specifications, the design process and design methodology for representative PSCs will be available in August 2011. MHI proposes two audits: one for verification and validation of calculation codes and stress analysis methodology along with environmental fatigue evaluation methodology, the other for design specifications along with background information documents of specifications in March 2012.
- Comparison of ISRS obtained from LMSM and FEM will be addressed in a Technical Report.
- Design ITAAC will be closed during the procurement phase.

Table-1(1/2): Computer Programs used for the analyses (Commercial Codes)

Computer Code	Contents for the Analysis	Related DCD Sections	Note
ABAQUS	Stress Analysis Heat Transfer Analysis	3.9.1 3.9.3 (Technical Report)	
ANSYS	Structure Analysis	3.9.1 (Technical Report)	
RELAP 5	Thermal Flow Analysis	3.9.1, 3.12.4 15.0.2	Not for Audit. MUAP-07013 submitted
GOTHIC	Thermal Flow Analysis	3.6.2, 3.9.1 (Technical Report)	
MULTI FLEX	Thermal Flow Analysis	3.9.1	
NASTRAN	Structure Analysis	3.9.1	
PIPESTRESS	Stress Analysis for Piping	3.12 (Technical Report)	
E/PD STRUDLE	Stress Analysis for Class 2 and 3 Piping	3.12 (Technical Report)	Not for Audit. Stress analyses of Class 2 and 3 piping is for Design ITAAC.
PICEP	LBB Evaluation	Appendix 3B (Technical Report)	
STAAD.Pro	Stress Analysis of Piping Supports	3.12	

Table-1 (2/2): Computer Programs used for the analyses (MHI Manufactured House Codes)

Computer Code	Contents for the Analysis	Related DCD Sections	Note
P4TEDIA	Post Treatment of ABAQUS	3.12 (Technical Report)	
P2DLOP	Post Treatment	3.12 (Technical Report)	
CEFF – N	Environmental Fatigue Evaluation of Piping	3.12 (Technical Report)	
CLASSB2	Post Treatment of Stress Analyses and Environmental Fatigue Evaluation of Components	3.9.3 (Technical Reports)	
CLASS2D			
CLASS3D			
CLASS3DX			
EDITSTRS			
EVALPRI			
EVALSEFAV			
RATCHET			
ASMETEMP			
EVALIRAMJ			
EB3500			
RIGHT			
SABRINA			
MCPFEM			
MCPEVALPRI			
MCPEVALSI			

Table-2: Stress Report Summary Transmittal to NRC

(Including Environmental Fatigue evaluation Reports and Pipe Break Hazard Methodology Reports)

Document Number	Revision	Document Title	Transmitted Date
MUAP-09001	0	Summary of Design Transients	1/30/2009
MUAP-09002	2	Summary of Seismic and Accident Load conditions for Primary Components and Piping	12/28/2010
MUAP-09004	1	Summary of Stress analysis Results for CSS	1/31/2011
MUAP-09005	2	Summary of Stress analysis Results for RV	3/04/2011
MUAP-09006	1	Summary of Stress analysis Results for SG	3/15/2011
MUAP-09007	2	Summary of Stress analysis Results for PZR	3/07/2011
MUAP-09008	2	Summary of Stress analysis Results for RCP	3/31/2011
MUAP-09009	1	Summary of Stress Analysis Results for the US-APWR Control Rod Drive Mechanism	2/28/2011
MUAP-09010	3	Summary of Stress analysis Results for RCL Piping	3/15/2011
MUAP-09012	1	Summary of Stress analysis Results for ACC	1/07/2011
MUAP-09013	2	Summary of Stress Analysis Results for the US-APWR Main Steam Piping inside Containment Vessel	3/18/2011
MUAP-11003	1	Summary of Stress analysis Results for Surge Line	3/18/2011
MUAP-10015	1	Summary of Environmental Fatigue Analysis Results for Class 1 Components	9/30/2011
MUAP-10016	0	Summary of Environmental Fatigue Analysis Results for Class 1 Piping	7/14/2010
MUAP-11004	0	Summary of Environmental Fatigue Analysis Results for Surge Line Piping	9/30/2011
MUAP-10017	1	Methodology of Pipe break Hazard Analysis	12/28/2010
MUAP-10022	0	Evaluation of Jet Impingement Issues Associated with Postulated Pipe Rupture	2/9/2011

Table-3: Design Completion Plan for PSCs in the US-APWR DCD

PSCs		Design Specifications (Revision)	Stress Report	Environmental Fatigue Analysis	LBB Analysis	Pipe Break Hazard Analysis
Piping	Reactor Coolant Loop Piping	3/2012	8/2011 (1)	8/2011 (1)	8/2011 (1)	2/2011 (2)
	Pressurizer Surge Line Piping	3/2012	8/2011 (1)	8/2011 (1)	8/2011 (1)	2/2011 (2)
	MSS Piping (inside Containment Vessel)	3/2012	8/2011 (1)	NA	8/2011 (1)	2/2011 (2)
	Others	(3)	(3)	NA	NA	2/2011 (2)
Components	Class CS	3/2012	8/2011 (1)	N/A	N/A	N/A
	Class 1 (Risk Significant (4))	3/2012	8/2011 (1)	8/2011 (1)	N/A	N/A
	Class 2 & 3 (Risk Significant (4))	3/2012	(3)	NA	N/A	N/A
	Others	(3)	(3)	NA	N/A	N/A

(1) Analysis reports using LMSM seismic condition are available by August 2011 for audit.
(2) Pipe break hazard analysis methodology is discussed separately by Technical Reports submittal.
(3) Prior to procurement
(4) Except valves and orifice