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

November 16, 2009

Mitsubishi Heavy Industries, Ltd.

Contents

1. Background and Objectives

Types of Documents

- **Design Specifications:**
  - ✓ Prepared for Design Certification in accordance with ASME NCA-3250, but not certified by Registered Professional Engineer (RPE)
- **ASME Certified Design Specifications (CDS):**
  - ✓ Prepared for each plant and certified by RPE
- **Stress Reports:**
  - ✓ Prepared for Design Certification in accordance with ASME NCA-3350 and NCA-3550, but not certified by RPE
  - ✓ Including assessment for supports
- **ASME Design Reports:**
  - ✓ Prepared for each plant and certified by RPE
- **Additional Reports:**
  - ✓ Separate from ASME, prepared to address specific DCD requirements, including the following:
    - Environmental Fatigue Analysis
    - Leak Before Break (LBB) Analysis
    - Pipe Break Hazard Analysis

Confirmation of Definition of "Design Report"

- **SRP 14.3.3 Requirement:**
  - ✓ **SRP 14.3.3 discusses an acceptable approach to Tier 1 information for piping design. An example given, reads "For example, the first ITAAC specified in Tier 1 should require that an ASME Code certified stress report exists to ensure …"**

- **MHI's approach is:**
  - **Provide "Stress Reports" during the design phase (and during the procurement phase) to close Design ITAAC**
  - **Provide "ASME Certified Design Reports" during the construction phase by reconciling as-built information to close Construction ITAAC.**

Background (1/2)

- **MHI submitted the Technical Reports which are summaries of "Stress Reports" for Piping Systems and Components (PSCs) in March and May 2009.**
- **MHI discussed these Technical Reports with the NRC at the Public Meeting on May 20th, 2009.**
  The primary schedule and content commitments were as follows:
  - ✓ **"Design Specifications" for all of the PSC will be available for audit at the end of 2009**
  - ✓ **"Stress Reports" related to Technical Reports will be available at the end of 2009**
  - ✓ **"Stress Reports" for the remaining Risk Significant ASME Class 1, 2 and 3 PSC will be available in 2010**
  - ✓ **Environmental Fatigue Analysis for Risk Significant Class 1 PSCs will be available in 2010**
  - ✓ **Pipe Break Hazard Analysis for Risk Significant ASME Class 1 and representative Class 2 and 3 Piping will be available in 2010**

Background (2/2)

- MHI submitted DCD Rev. 2 in Oct. 2009 with the updated building structures.
- In addition, as discussed today, MHI plans to incorporate the NRC's new comments on the seismic evaluation, including a new seismic spectrum.

- The above changes are to be incorporated into the loading conditions to the PSCs.

Note) The schedule presented is based on the assumption that MHI's plan for the seismic evaluation presented in a separate session today is accepted by the NRC. If the MHI proposed plan needs to be changed, the schedule may need adjustment.

Objectives

- To discuss MHI's updated PSC design completion plan based on the DCD Rev. 2.
  1) Overall PSC design and graded approach for the design completion
  2) Proposed ITAAC plan (per the graded approach)
  3) Design completion schedule (taking account of the updated information in DCD Rev. 2)
- To obtain the feedback for MHI's PSC design completion plan from the NRC
- To discuss the audit plan of the PSC stress reports

Terms of Usage

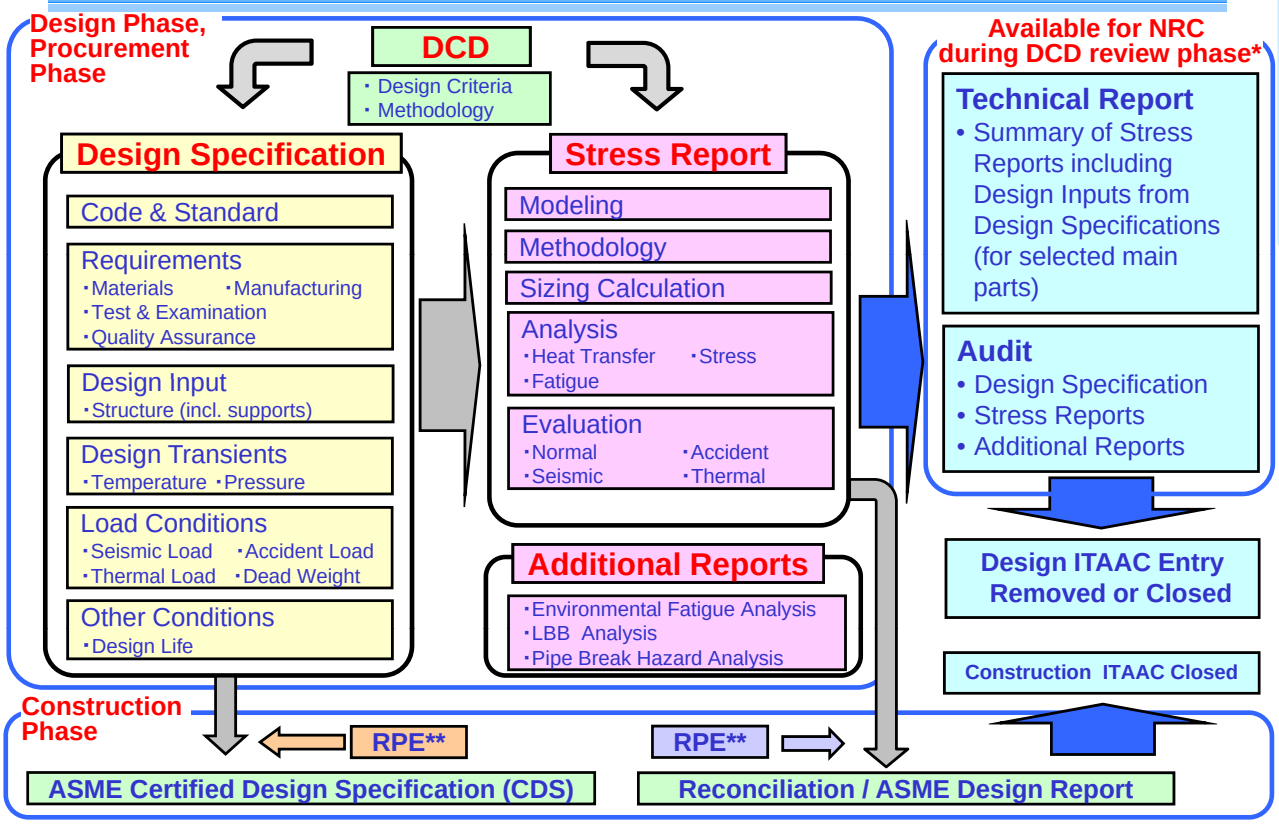
In this presentation the following terms are used:

- **Design ITAAC**
  - ✓ **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 are applied to as-built (as-procured) PSCs.**
  - ✓ **These ITAAC will be closed during the construction phase (i.e. after COL issuance).**
  - ✓ **ITAAC closure is defined in NEI 08-01.**

2. Design Completion Plan

Design Process for PSC (1/2)

(General Process following ASME Guidance)



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* Limited for risk significant PSCs
** Registered Professional Engineer

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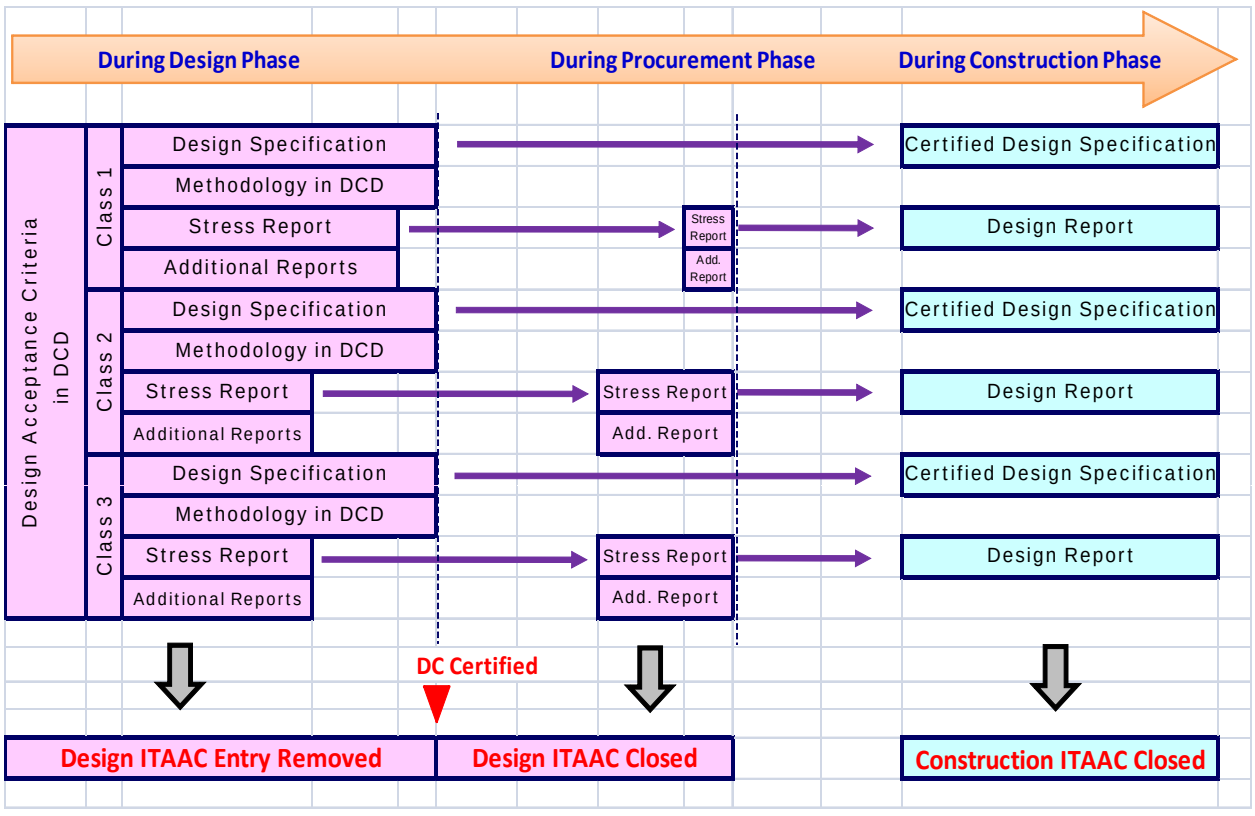
Design Process for PSC (2/2)

(Design Process General Timeline)



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Design Completion during DCD Review Phase
(Design ITAAC entry removal)

The following will be available for the NRC audit during the DCD review phase. MHI believes these will be sufficient for the NRC's SER:

1. **"Design Specifications" for all of the PSCs include design input for the "Stress Report"**
2. **"Stress Reports" for all of the risk-significant PSCs: The methodology is consistent with ASME as described in the DCD. Technical Reports already submitted are the summaries of "Stress Reports"**
3. **"Environment Fatigue Analyses" for all of the risk-significant Class 1 PSCs**
4. **"LBB Analyses" for all of the risk-significant piping**
5. **Detailed methodology of "Pipe Break Hazard Analysis" for a representative risk-significant Class 1 piping**

Design Completion after DC Issuance
(Design ITAAC closure)

The following will be available for the NRC during the first part of procurement phase (prior to material procurement) to close "Design ITAAC":

1. **"Stress Reports" for the remaining low risk PSCs**
2. **"Environment Fatigue Analyses" for the remaining low risk Class 1 PSCs**
3. **"Pipe Break Hazard Analyses" for the remaining piping**

Design Reconciliation during Construction
(Construction ITAAC closure)

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

1. **ASME Certified Design Specification (CDS)**
2. **ASME Certified Design Report**
3. **LBB Evaluation Report**
4. **Pipe Break Hazard Analysis Report**

Available Documents for PSC Design

Phase				Design Phase (During DCD Review)				
Piping Systems and Components				Design Specifications	Stress Report	Environmental Fatigue Analysis	LBB Analysis	Pipe Break Hazard Analysis
ASME Class CS & 1	Components			X	X	X	NA	NA
	Valves	Risk significant		X	X	X	NA	NA
		Low risk		X	X*	X*	NA	NA
	Piping	Risk significant		X	X	X	X	X
		Low risk		X	X*	X*	NA	X*
ASME Class 2 & 3	Components	Risk significant	Representative Item (CS/RHR Heat Exchanger, ESWP Outlet Strainer)	X	X	NA	NA	NA
			Others	X	X	NA	NA	NA
		Low risk	Representative Item (Accumulator)	X	X	NA	NA	NA
			Others	X	X*	NA	NA	NA
	Valves	Risk significant		X	X	NA	NA	NA
		Low risk		X	X*	NA	NA	NA
	Piping	Risk significant	Representative Item (MS piping)	X	X	NA	X	X*
			Others	X	X	NA	NA	X*
		Low risk		X	X*	NA	NA	X*

** Prior to material procurement*

3. ITAAC Plan

3.1 ITAAC Plan for Stress Report/Design Report

ITAAC Closure Plan (1/3)
(Proposed Design ITAAC for Stress Report of Class 1 PSC)

Proposed Revision of DCD Rev. 2 Tier 1 Table 2.3-2
(All proposed changes are in Blue.)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1.a The ASME Code Section III, Class 1 piping systems and components (PSC) are designed to retain their pressure integrity and functional capability under internal design and operating pressures and design basis loads.	1.a.i An inspection of the stress report for the risk-significant ASME Code, Section III, Class 1 PSC will be performed.	1.a.i The stress report(s) exist and conclude that the design of the risk-significant ASME Code Section III Class 1 PSC comply with the requirements of the ASME Code Section III.
	1.a.ii An inspection of the stress report for low risk ASME Code Section III, Class 1 PSC will be performed.	1.a.ii The stress report(s) exist and conclude that the design of low risk ASME Code Section III Class 1 PSC comply with the requirements of ASME Code Section III.

- ***The ITAAC entry 1.a.i is expected to be removed after the NRC's audit in 2010 once satisfied.***
- ***The ITAAC entry 1.a.ii will be closed during the procurement phase.***

ITAAC Closure Plan (2/3)
(Design ITAAC for Stress Report of Class 2&3 PSC)

DCD Rev. 2 Tier 1 Table 2.3-2

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
3. The ASME Code Section III, Class 2 and 3 piping systems and components (PSC) are designed to retain their pressure integrity and functional capability under internal design and operating pressures and design basis loads.	3.i An inspection of the stress report for the risk-significant ASME Code, Section III, Class 2 and 3 PSC will be performed.	3.i The stress report(s) exist and conclude that the design of the risk-significant ASME Code Section III Class 2 and 3 PSC comply with the requirements of ASME Code Section III.
	3.ii An inspection of the stress report for low risk ASME Code Section III, Class 2 and 3 PSC will be performed.	3.ii The stress report(s) exist and conclude that the design of low risk ASME Code Section III Class 2 and 3 PSC comply with the requirements of ASME Code Section III.

- ***The ITAAC entry 3.i is expected to be removed after the NRC's audit in 2010 once satisfied.***
- ***The ITAAC entry 3.ii will be closed during the procurement phase.***

ITAAC Closure Plan (3/3)
(Example of Construction ITAAC for Design Report)

DCD Rev. 2 Tier 1 Table 2.4.4-5

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
2.a.ii The ASME Code Section III components of the ECCS identified in Table 2.4.4-2 are reconciled with the design requirements.	2.a.ii A reconciliation analysis of the components using as-designed and as-built information and ASME Code Section III design report(s) (NCA-3550) will be performed.	2.a.ii The ASME Code Section III design report(s) (certified, when required by ASME Code) exist and conclude that the as-built ASME Code Section III components of the ECCS identified in Table 2.4.4-2 are reconciled with the design requirements. The report documents the results of the reconciliation analysis.
2.b.ii The ASME Code Section III piping of the ECCS, including supports, identified in Table 2.4.4-3 are reconciled with the design requirements.	2.b.ii A reconciliation analysis of the piping of the ECCS, including supports, using as-designed and as-built information and ASME Code Section III design report(s) (NCA-3550) will be performed.	2.b.ii The ASME Code Section III design report(s) (certified, when required by ASME Code) exist and conclude that the as-built ASME Code Section III piping of the ECCS, including supports, identified in Table 2.4.4-3 is reconciled with the design requirements. The report documents the results of the reconciliation analysis.

Such ITAAC will be closed during the construction phase.

3.2 ITAAC Plan for Additional Reports

- Environmental Fatigue Analysis
- LBB Analysis
- Pipe Break Hazard Analysis

ITAAC Closure Plan (1/5)
(Proposed Design ITAAC for Environmental Fatigue Analysis)

Proposed Revision of DCD Rev. 2 Tier 1 Table 2.3-2
(All proposed changes are in Blue.)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1.b The usage factors for ASME Code Section III Class 1 PSC are evaluated for both air and reactor coolant environments.	1.b.i An analysis of the risk-significant ASME Code, Section III, Class 1 PSC will be performed.	1.b.i Report(s) exist and conclude that the usage factors for risk-significant ASME Code Section III Class 1 PSC are evaluated for air and reactor coolant environments.
	1.b.ii An analysis of the low risk ASME Code, Section III, Class 1 PSC will be performed.	1.b.ii Report(s) exist and conclude that the usage factors for low risk ASME Code Section III Class 1 PSC are evaluated for air and reactor coolant environments.

- ***The ITAAC entry 1.b.i is expected to be removed after the NRC's audit in 2010 once satisfied.***
- ***The ITAAC entry 1.b.ii will be closed during the procurement phase.***

ITAAC Closure Plan (2/5)
(Design ITAAC for LBB Analysis)

DCD Rev. 2 Tier 1 Table 2.3-2

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
2. RCPB and MSS piping systems are designed in accordance with the LBB method.	2. A LBB analysis using the LBB method will be performed for each RCPB and MSS piping system.	2. The results of the LBB analysis conclude that the stress values conform to the LBB acceptance criteria using the LBB assumptions.

The ITAAC entry is expected to be removed after the NRC's audit in 2010 once satisfied.

ITAAC Closure Plan (3/5)
(Example of Construction ITAAC for LBB Analysis)

DCD Rev. 2 Tier 1 Table 2.4.4-5

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
13. Each of the as-built piping identified in Table 2.4.4-3 as designed for LBB meets the LBB criteria, or an evaluation is performed of the protection from the dynamic effects of a rupture of the line.	13. Inspections of the as-built piping will be performed based on the evaluation report for LBB or the protection from dynamic effects of a pipe break, as specified in Section 2.3.	13. The LBB acceptance criteria are met by the as-built piping and pipe materials, or the protection is provided for the dynamic effects of the piping break.

Such ITAAC will be closed during the construction phase.

ITAAC Closure Plan (4/5)
(Proposed Design ITAAC for Pipe Break Hazard Analysis)

Proposed Revision of DCD Rev. 2 Tier 1 Table 2.3-2
(All proposed changes are in Blue.)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
4. Safety-related SSCs are protected against or qualified to withstand the dynamic and environmental effects associated with analyses of postulated failures in high-energy piping and moderate piping systems.	4.i Dynamic effect analysis will be performed for the high-energy piping system. The analysis includes the evaluation of pipe whip and jet impingement.	4.i Report(s) exist and conclude that for each postulated piping failure, the reactor can be shut down safely and maintained in a safe, cold shutdown condition without offsite power. The report confirms whether (A) piping stresses in the containment penetration area are within allowable stress limits, (B) pipe whip restraints and jet shield designs can mitigate pipe break loads, (C) loads on safety-related SSCs are within design load limits.
	4.ii Environmental effect analysis will be performed for the high-energy piping and moderate-energy piping systems. The analysis includes the evaluation for spray wetting, flooding, environmental conditions, as appropriate.	4.ii Report(s) exist and conclude that for each postulated piping failure, the reactor can be shut down safely and maintained in a safe, cold shutdown condition without offsite power. The report confirms whether SSCs are protected or qualified to withstand the environmental effects of postulated failures.

This ITAAC will be closed during the procurement phase.

ITAAC Closure Plan (5/5)
(Proposed Construction ITAAC for Pipe Break Hazard Analysis)

Proposed Revision of DCD Rev. 2 Tier 1 Table 2.3-2
(All proposed changes are in Blue.)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
5. Safety-related SSCs are reconciled with the as-designed high-energy pipe break mitigation features.	5. A reconciliation analysis of the as-built high energy line using as-designed pipe break hazard analysis report and as-built information will be performed.	5. Report(s) exist and conclude that the high-energy pipe break mitigation features are installed in the as-built plant as described in the design and reconciliation analysis.

This ITAAC will be closed during the construction phase.

4. Schedule

Updated Status of Schedule

- **Technical Reports based on DCD Rev. 1 were submitted in March and May 2009.**
- **"Design Specifications" and "Stress Reports" for the representative PSCs based on DCD Rev. 1 will be available for the NRC audit in January 2010.**
- **It is noted that there is no change in the design criteria and methodology between DCD Rev. 1 and Rev. 2.**
- **"Stress Reports" for Risk Significant ASME Class 1, 2 and 3 PSCs based on DCD Rev. 2 will be available for the NRC audit by the end of 2010.**

Note) The schedule presented is based on the assumption that MHI's plan for the seismic evaluation presented in a separate session today is accepted by the NRC. If the MHI proposed plan needs to be changed, the schedule may need adjustment.

Schedule for Documents for PSC Design

Phase				Design Phase (During DCD Review)				
Piping Systems and Components				Design Specifications	Stress Report	Environmental Fatigue Analysis	LBB Analysis	Pipe Break Hazard Analysis
ASME Class CS & 1	Components			3/2009	12/2009 (1) 12/2010 (2)	12/2009 (1) 12/2010 (2)	NA	NA
	Valves	Risk significant		12/2009	12/2010 (2)	12/2010 (2)	NA	NA
		Low risk		12/2009	(3)	(3)	NA	NA
	Piping	Risk significant		3/2009	12/2009 (1) 12/2010 (2)	12/2009 (1) 12/2010 (2)	12/2009 (1) 12/2010 (2)	12/2009 (4) 12/2010 (2)
		Low risk		12/2009	(3)	(3)	NA	(3)
ASME Class 2 & 3	Components	Risk significant	Representative Item (CS/RHR Heat Exchanger, ESWP Outlet Strainer)	12/2009	12/2010 (2)	NA	NA	NA
			Others	12/2009	12/2010 (2)	NA	NA	NA
		Low risk	Representative Item (Accumulator)	3/2009	12/2009 (1) 12/2010 (2)	NA	NA	NA
			Others	12/2009	(3)	NA	NA	NA
	Valves	Risk significant		12/2009	12/2010 (2)	NA	NA	NA
		Low risk		12/2009	(3)	NA	NA	NA
	Piping	Risk significant	Representative Item (MS piping)	3/2009	12/2009 (1) 12/2010 (2)	NA	12/2009 (1) 12/2010 (2)	(3)
			Others	12/2009	12/2010 (2)	NA	NA	(3)
		Low risk		12/2009	(3)	NA	NA	(3)

(1) Prepared for DCD Rev. 1 (Stress Reports in accordance with Technical Reports submitted in March or May 2009)
(2) Prepared for DCD Rev. 2 (Stress Reports including supports)
(3) Prior to material procurement
(4) Methodology is presented

Proposed Audit Plan for PSC Design

- **Because of no change in the design criteria and methodology between DCD Rev. 1 and Rev. 2, MHI proposes an NRC audit as early as January 2010 for the representative PSCs (i.e. PSCs provided in the submitted Technical Reports in March and May 2009).**
  MHI wants NRC feedback so it can be incorporated into the DCD.
  MHI believes such an approach will facilitate the NRC's review and maintain the current review schedule.
- **Following documents will be available for January 2010 audit:**
  - ✓ **Design Specifications**
  - ✓ **Stress Reports (based on DCD Revision 1 inputs)**
  - ✓ **Additional Reports (based on DCD Revision 1 inputs)**
    - ✓ **Environmental Fatigue Analysis for all of the risk-significant Class 1 PSCs**
    - ✓ **LBB Analysis for all of the risk-significant piping**
    - ✓ **Pipe Break Hazard Analysis (Detailed methodology of "Pipe Break Hazard Analysis" for a representative risk-significant Class 1 piping)**
  - ✓ **Verification results for Computer Codes used for the analyses**
- **DCD revision 2 reports will be available by the end of 2010.**

Conclusions

- **MHI's updated PSC design completion plan following the DCD Rev. 2 is presented using a graded approach.**
- **Design ITAAC will remain for certain low risk PSC. However, most of the Design ITAAC entries for risk-significant PSCs are expected to be removed during the DCD review phase.**
- **MHI proposes an audit of the design criteria and methodology of the PSC stress reports beginning in January 2010 for representative PSCs.**
- **Additional design information using DCD Rev. 2 will be available for audit at the end of 2010.**
- **MHI believes such an approach will facilitate the NRC's review and maintain the current review schedule.**