Luminant MITSUBISHI HEAVY INDUSTRIES, LTD. Dominion US-APWR

US-APWR

Modifications to Standard Plant: Introduction

September 22, 2011

Mitsubishi Heavy Industries, Ltd.

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Purpose of Meeting

- During March 2011, a number of significant changes in seismic analysis were implemented, including changing from a Lumped Mass Stick Model (LMSM) to Finite Element (FE) Model for the R/B Complex SSI Analysis and performing bounding analyses with respect to cracked and uncracked concrete conditions

- During implementation of this new methodology, a number of design challenges arose which have been tracked back to unique details in soil profiles and the original time history input

Purpose of Meeting

- Today we are presenting changes and enhancements to the design inputs to mitigate these design challenges and continue to maintain required safety margins of the US-APWR Standard Plant
- We are also presenting changes to the plant layout to address issues associated with the original 4 inch gap between structures
- Stability analyses are ongoing, but indications are that foundations of Standard Plant structures will require shear keys

Introduction

- On March 31, 2011 the seismic task force held a public meeting with the NRC to identify twelve major topics and an associated path forward for each reflecting the current status
- During June 2011, the first stage of Technical Reports identifying methodology changes was submitted to the staff for review
- On June 15, 2011 and in subsequent conference calls, a path forward for the Containment Internal Structure (CIS) was established

Introduction

- The comprehensive path forward beginning on March 31, 2011 involved employing a conservative methodology with respect to concrete cracking considerations for SSI analyses:
  - ✓ Full stiffness with OBE damping
  - ✓ Reduced stiffness (up to 50% of gross cross section properties considered) with SSE damping
  - ✓ Envelope of responses for the two stiffness cases and for all generic soil profiles used to develop in-structure response spectra (ISRS) results

Issue Statement

- The SSI analyses challenges which occurred as a result of the conservative path forward include:
  - ✓ Unfavorable ISRS results at critical component locations which are pronounced for soil profiles 560-100 and 560-200
  - ✓ Sliding stability challenges for standard plant structures
  - ✓ High bearing pressure demands (low contact ratio due to foundation uplift)
  - ✓ Calculations indicate a required increase in the existing gap between structures

Current Status

- The SSI analyses used in DCD Rev. 3 considered the following inputs:
  - ✓ 8 generic soil profiles (developed using unpublished rock degradation curves)
  - ✓ Acceleration time histories of input design ground motion based on Northridge seismic event
  - ✓ 4 inch gap between all standard plant structures
- Due in part to changes in design basis methodology that were presented in March 2011, certain inputs have been identified which impact the standard design

Resolution Proposal

- The basic SSI analyses inputs used in DCD Rev. 3 shall be modified as follows:
  - ✓ *Modification to generic soil profiles:* a revision to the database of US-APWR standard plant generic profiles will be performed to eliminate excessive peaks in design ISRS and address staff concerns noted in RAI's 821-5984 and 559-5133

Resolution Proposal

- The basic SSI analyses inputs used in DCD Rev. 3 shall be modified as follows (continued):
  - ✓ *Modification to input ground motion acceleration time history:* the current time histories that are based on the Northridge earthquake seed do not provide as good a fit to the CSDRS as the revised acceleration time histories based on Nahanni earthquake seed; changing the input ground motion time histories resolves challenges associated with contact ratio and subsequent bearing pressures

Resolution Proposal

- The basic SSI analyses inputs used in DCD Rev. 3 shall be modified as follows (continued):
  - ✓ *Modification to plant layout:* since the 4” gap is being challenged by recent results of analyses, a larger 16” gap between all standard plant structures and foundations will be established; this change will resolve the negative cumulative effects of gap closure including seismic structural displacement, settlement/tilt, and sliding displacement (shear key engagement)

Resolution Proposal

- The basic SSI analyses inputs used in DCD Rev. 3 shall be modified as follows (continued):
  - ✓ *Modification to foundations:* since sliding stability challenges occur despite the above input modifications, shear keys will be introduced within the standard plant structural stability calculations to ensure a factor of safety against sliding of 1.1; standard plant structures described in the DCD will feature shear keys

Resolution Proposal

Design Challenges	Resolution Proposal: Benefit and Effects of Modifications			
	Modification to Generic Soil Profiles	**Modification to Acceleration Time History**	**Modification to Plant Layout**	**Modification to Foundations - Shear Keys**
Sliding Stability	Minor Benefit	Minor Benefit	N/A	**Major Benefit**
Contact Area / Bearing Pressure	**Major Benefit**	**Major Benefit**	N/A	N/A
Address RAI concerns	**Major Benefit**	N/A	N/A	N/A
Gap Between Structures	N/A	N/A	**Major Benefit**	N/A
ISRS at Critical Locations	**Major Benefit**	Minor Benefit	N/A	N/A

Deliverables

- Relevant deliverables will be identified in each presentation segment with additional detail regarding the design input modifications
  - ✓ *Modification to generic soil profiles*
  - ✓ *Modification to acceleration time history*
  - ✓ *Modification to plant layout*
- The need to perform modifications to foundations including the introduction of shear keys will be assessed for each standard plant structure
- Impacts on existing technical reports, calculation reports available for audit, and DCD chapters will be presented in the afternoon session

Summary

- Results from SSI and stability analyses of standard plant structures have led to modifications to generic soil profiles, input ground motion acceleration time histories, plant layout, and foundations
- Methodology remains unchanged
- Re-performing analyses cases with input changes identified earlier in the presentation
- Results in updates to Technical Reports, Calculation Reports, and the DCD

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Modifications to Standard Plant: Identification of DCD Chapter Impacts

September 22, 2011

Mitsubishi Heavy Industries, Ltd.

Contents

- Cause of impacts to each DCD chapter (layout or seismic input)
- Identification of detailed impacts on each DCD chapter to indicate magnitude of impacts

-Tier 1	-Ch. 8
-Ch. 1	-Ch. 9
-Ch. 2	-Ch. 11
-Ch. 3	-Ch. 12
-Ch. 6	-Ch. 15

Overview

- Seismic inputs and site layout are changing, however no impact is anticipated to existing DCD methodologies including those presented on March 31, 2011
- Impacts to piping systems described in the DCD driven by the site layout changes are considered insignificant
- DCD impacts are limited to simple text and layout updates

DCD Impacts

Cause of Impact: Layout Change

(1) Plot plan, layout drawing, and description changes due to gap increase to 16”

- ✓ **Tier 1** – Section 2.2, Building configuration, Building architectural layout
- ✓ **Chapter 1** – Section 1.2, Power Block, Building Layout
- ✓ **Chapter 3** –
  - Section 3.7.2.4, Separated from category II structures by gaps of at least four inches
  - Section 3.7.2.8.2, Turbine building clearance to adjacent structures is four inches
  - Section 3.8.4.1, 3.8.5.1, Separated by gap of four inches
  - Section 3.8, Figures and layout drawings
  - Appendix 3J, Structural drawings
  - Appendix 3K, Layout drawings of waterproof doors

DCD Impacts

(1) Plot plan, layout drawing, and description changes due to gap increase to 16” (Continued)

- ✓ **Chapter 8** – Section 8.3, Class 1E electrical equipment layout
- ✓ **Chapter 9** – Section 9.5 and Appendix 9A, Fire area drawings, fire hazard analysis summary, fire zone / fire area interface (2)
- ✓ **Chapter 11** – Section 11.5, Drawing for the location of radiation monitors (Note: no impact on the locations of radiation monitor in the each building)
- ✓ **Chapter 12** – Section 12.3, Radiation zones for Normal Operation/Shutdown, General Plant Arrangement with Post Accident Vital Areas, Post Accident Radiation Zone Map

Chapter 12 Note: These figures are prepared by using plot plans and general arrangements. Plot plan and layout drawing changes are simple for Chapter 12, and there is no impact on any evaluation including the assignment of radiation zones.

DCD Impacts

(2) Atmospheric Dispersion Factor (χ/Qs) Evaluation

- ✓ **Chapter 2** –
  - Section 2.3.4
  - Table 2.3.4-7, Horizontal distance source to receptor, straight distance and direction receptor to source
- ✓ **Chapter 15**

- ✓ Atmospheric dispersion factors (χ/Qs) relate to distance between point of release of radioactivity and receptor
- ✓ Increased gap between structures increases receptor distance between adjacent structures
- ✓ Current atmospheric dispersion factor (χ/Qs) evaluation is conservative (with increased distance) and will not be changed since the current evaluation remains bounding
- ✓ No impact on Short-Term Atmospheric Dispersion Estimates for Accident Releases

DCD Impacts

(3) Length of Piping Change

- ✓ **Chapter 3** –
  - Negligible change of temperature and pressure inside steam/feedwater piping area as a result of Mass and Energy Release analysis of Main Feedwater Line Break
  - Insignificant increase in pipe length results in less than a 0.1% increase in the volume bounded by calculation margin
- ✓ **Chapter 6** –
  - Main steam line volume change due to gap increase to 16”
  - Insignificant increase in pipe length results in less than a 0.3% increase in the volume bounded by calculation margin

DCD Impacts

Cause of Impact: Seismic Input Change

(1) Text Description and Figure Updates

- ✓ **Chapter 2** – Table 2.0-1, Revision to soil profiles description and data, bearing capacity demands, allowable settlements
- ✓ **Chapter 3** – Section 3.7, 3.8, Appendix 3H, Appendix 3I, Numerous updates are identified in the draft MHI letter

Summary

- Detailed impact assessment will be provided in an MHI letter
- No impact is anticipated to existing DCD methodologies
- Magnitude of impacts to the DCD driven by the site layout changes and seismic input changes is minor

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Modifications to Standard Plant: Identification of Technical Report Impacts

September 22, 2011

Mitsubishi Heavy Industries, Ltd.

Contents

- Overview
- Identification of Impacted Technical Reports and Changes
- Summary

Overview

- Seismic inputs and site layout are changing, however there is no impact to existing Calculation or Technical Report methodologies
- DCD Section 3.7 and 3.8 Technical Reports will be revised and submitted by the end of October 2011
- DCD mark-ups and update to previous RAI responses will follow in November 2011 after a proposed NRC meeting is held to discuss contents of the Technical Report updates

Technical Report Impacts

- Impacts of TRs associated with DCD Sections 3.7 and 3.8:

MUAP-10001 Rev. 4: Seismic Design Bases of the US-APWR Standard Plant, October 2011

- ✓ Update development of soil profiles and strain compatible properties
- ✓ Update time history from Northridge to Nahanni
- ✓ Update description of structures and layout

MUAP-10006 Rev. 2: Soil-Structure Interaction Analyses and results for the US-APWR Standard Plant, October 2011

- ✓ Results of SSI Analysis for R/B (updated to FE model) and PS/B (updated design and stiffness) based on the updated MUAP-10001
- ✓ Update to reflect gap assessment
- ✓ Update discussion on gaps between buildings

Technical Report Impacts

MUAP-11001 Rev. 2: A/B Model Properties, SSI Analyses, and Structural Integrity Evaluation, October 2011

- ✓ Revise due to updated time history and soil profile inputs
- ✓ Results of SSI for A/B relative displacement (change for reduced stiffness)
- ✓ Results of Stability of A/B (previously excluded)
- ✓ Update to reflect gap assessment
- ✓ Re-evaluate/reconcile structural evaluation for new basemat ISRS

Technical Report Impacts

MUAP-11002 Rev. 1: T/B Model Properties, SSI Analyses, and Structural Integrity Evaluation, October 2011

- ✓ Update the methodology for T/B to be compatible with the methodology used in A/B
- ✓ Results of SSI for T/B to be consistent with DCD Rev. 3 and based on the updated MUAP-10001
- ✓ Update to reflect gap assessment

MUAP-11007 Rev. 1: Results of Evaluation using LMSM for R/B Complex, October 2011

- ✓ Revise due to updated time history and soil profile inputs
- ✓ Results of Sliding Stability (FE model)
- ✓ Results of Sensitivity Study on Water Table Effect (FE Model)
- ✓ Results on Sensitivity Study on Embedment Effect (LMSM)

Technical Report Impacts

MUAP-11011 Rev. 1: Effects of Structure-Soil-Structure Interaction (SSSI) on Standard Seismic Design of US-APWR Plant, October 2011

- ✓ Results of SSSI Analysis based on the updated MUAP-10001

Technical Report Impacts

- Impacts of TRs associated with other DCD sections:

MUAP-08012 Rev. 2: Sump Strainer Stress Report, March 2012

  - ✓ Stress Results based on SSI Analysis for R/B (FEM)

MUAP-07033 Rev. 2: Mechanical Analysis for US-APWR New and Spent Fuel Racks, March 2012

  - ✓ Stress Results based on SSI Analysis for R/B (FEM)

MUAP-08007 Rev. 3: Evaluation Results of US-APWR Fuel System Structural Response to Seismic and LOCA Loads, April 2012

  - ✓ Stress Results based on SSI Analysis for R/B (FEM)

Technical Report Impacts

MUAP-10023 Rev. 4: Initial Type Test Result of Class 1E Gas Turbine Generator System, April 2012

- ✓ Re-evaluation of the test results based on SSI Analysis for PS/B
- ✓ Stress Results of the other components (e.g., the Generator and Air Receiver Assembly) based on SSI Analysis for PS/B

UAP-SGI-08001 Rev. 4: Design Certification Physical Security Element Review, December 2011

- ✓ Revision/reconciliation based on the adjusted layout

UAP-SGI-08002 Rev. 3: High Assurance Evaluation Assessment, December 2011

- ✓ Revision/reconciliation based on the adjusted layout

Summary

- Detailed impact assessment of Technical Reports for submittal and Calculations available for audit will be provided in an MHI letter
- No impact to existing Calculation or Technical Report methodologies

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Modifications to Standard Plant: Conclusion

September 22, 2011

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Conclusion

- Results from SSI and stability analyses of standard plant structures have led to modifications to generic soil profiles, input ground motion acceleration time histories, plant layout, and foundations
- Methodology remains unchanged
- Re-performing analyses cases with input changes identified above
- Results in updates to Technical Reports, Calculation Reports, and the DCD

Conclusion

- DCD Section 3.7 and 3.8 **Technical Reports** will be revised and submitted by the end of **October 2011**
- **DCD mark-ups** and update to previous **RAI responses** will follow in **November 2011** after a proposed NRC meeting is held to discuss contents of the Technical Report updates

Conclusion

- **NRC meeting proposed for Early November** to review contents of Technical Reports and discuss status of DCD mark-ups and updated previous RAI responses
- Review draft MHI letter
- Closing remarks and questions