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TOKYO, JAPAN

March 27, 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-09118

Subject: MHI's Response to US-APWR DCD RAI No. 208-1574

Reference: 1) "Request for Additional Information No. 208-1574 Revision 0, SRP Section: 03.09.02 – Dynamic Testing and Analysis of Systems Structures and Components, Application Section: 3.9.2.6, 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. 208-1574, Revision 0."

Enclosed are the responses to the RAI 3.9.2-70 is contained within 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.

Enclosure:

1. Response to Request for Additional Information No. 208-1574, Revision 0

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

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NRO

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Docket No. 52-021
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Enclosure 1

UAP-HF-09118
Docket No. 52-021

Response to Request for Additional Information No. 208-1574,
Revision 0

March, 2009

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

3/27/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: NO. 3.9.2-70 REVISION 0

SRP SECTION: 3.9.2 – DYNAMIC TESTING AND ANALYSIS OF SYSTEMS STRUCTURES AND COMPONENTS

APPLICATION SECTION: 3.9.2.6

DATE OF RAI ISSUE: 2/25/2009

QUESTION NO.: 3.9.2-70

In compliance with the recommendations of RG 1.20, the applicant is clearly committed to performing correlations between the vibration tests and the analytical results and also to resolving any discrepancies that may arise.
The staff reviewed DCD Tier 2, Subsection 3.9.2.6, and found that the applicant did not provide information about the acceptance criteria for comparing the analytical and the measured results. The applicant is requested to discuss the acceptance criteria that will be used when comparing the results of the vibration tests with the analytical results.
These may include acceptance criteria for load definitions (e.g. pressure measurement results), dynamic characteristics of the system (e.g. resonance frequencies and mode shapes, vibration response), stress analysis calculations (e.g. strain gages results), and acoustic response of the reactor and the steam generator environment. The staff needs this information to confirm that appropriate acceptance criteria are devised for the correlations of the vibration tests with the analytical results, and thereby assures conformance with GDC-1 and 4. Revise subsection 3.9.2.6 of the DCD to include additional details about the acceptance criteria which will be used when comparing the results of the vibration tests with the analytical results. If this information is given elsewhere in the DCD, refer to it in Subsection 3.9.2.6.

ANSWER:

Following Regulatory Guide 1.20 and SRP 3.9.2, the data from the pre-operational vibration test described in Subsection 3.9.2.4, including accelerations, amplitudes, strains and component modal frequencies, will be compared with the corresponding predicted and allowable values. The following lists the specific items to be evaluated together with their acceptance criteria. In general, Category 1 criteria are related to the integrity of the components while Category 2 criteria are related to the adequacy of the analysis technique. Contingency plans in case these criteria are not met are given.

A. Modal Frequencies

Category 2 Criterion: The measured frequencies for the fundamental beam mode and the lowest shell modes must not differ from the predicted values by more than 10%.

B. Damping Ratios

Category 2 Criterion: The measured damping ratios, as determined from the half-power point method, must be within a factor of 2.0 of what are used in the prediction analysis.

C. Forcing Function due to Flow Turbulence

Category 2 Criterion: The rms amplitude of measured broad –band random turbulence pressure fluctuation in the downcomer must be within a factor of 2.0 of the corresponding predicted values in the analysis.

D. Forcing Function due to RCP Pulsation

Category 2 Criterion: The measured 0-p amplitude of the RCP induced acoustic loads in the down -comer and the upper plenum must be within + 0 or - 50% of the corresponding predicted values in the analysis.

E. Stress due to FIV and RCP Loads

Category 1 Criterion: For deterministic stresses (such as those induced by RCP loads), the stress levels as deduced from the measured strains (using strain gages) must not incur any fatigue usages on the components. For random stresses (such as those induced by flow turbulence), the stress levels as deduced from 4.5 times the measured rms strains must not incur any fatigue usages on the components. The combined stresses of the above two, as determined by the absolute sum, must not incur any fatigue usages on the components.

Category 2 Criterion: For deterministic stresses, the stress levels as deduced from the measured strains must be within + or – 50% of the corresponding computed values in the prediction analysis. For random stresses, the rms stresses as deduced from the measured rms strains must be within a factor of 3.0 of the corresponding computed values, with the correction of damping ratios between measured and analysis condition.

F. Similarity of the Dynamic System Model between FIV and Seismic/LOCA

Category 2 Criterion: The dynamic models in the FIV and in the seismic/LOCA analyses are generally similar except in the assumed boundary conditions. Because of the much larger displacements experienced in seismic and LOCA events compared with those experienced in flow-induced vibrations, the assumed boundary conditions in the former type of analysis may be different from those in FIV analyses in order to better simulate the larger displacements anticipated.

G. Adverse Flow Effects

Category 1 Criterion: No fluid-elastic instability or lock-in vortex-induced vibration is experienced in the pre-operational test.

Contingency Plans in Case the Acceptance Criteria are not met

Category 1 Criteria

In case any category 1 criterion is not met, the overall impact on the design of the reactor internals will be evaluated. The reactor will not put into operation until it is sure that the design can accommodate the larger than expected vibration responses.

Category 2 Criteria

In case any category 2 criterion is not met, the difference will be resolved by the post-preoperational test analysis.

Impact on DCD

The above information will be included in the revised version of MUAP-070027, Chapter 3.5 Test Acceptance Criteria.

Subsection 3.9.2 of the DCD will be revised to incorporate the comments in QUESTION NO.3.9.2-70; as follows after MUAP-07027 is revised;

3.9.2.6 Correlations of Reactor Internals Vibration Tests with Analytical Results

To confirm the computational methodology for flow-Induced vibration response, including structure modeling and forcing function assessment, a simulation analysis of the APWR 1/5th scale model flow test was conducted. The vibration responses of the core barrel, computed with the best estimate damping ratio, is compared with the measured results.

In the prediction analysis of the US-APWR reactor internals vibration responses, a damping ratio smaller than the best estimate value is used to assure conservative results.

The measured data from the reactor internals pre-operational vibration test described in Subsection 3.9.2.4 will be compared with the predicted and allowable responses in accordance with the acceptance criteria. These will include accelerations, strains and natural frequencies. Detailed information about the acceptance criteria is described in Chapter 3.5 of Ref. 3.9-22. In accordance with Regulatory Guide 1.20 (Reference 3.9-21), any discrepancies between the predicted and measured values will be accounted for and fully explained. If necessary, the input parameters, such as the turbulent forcing function and the damping ratio in the vibration analysis will be adjusted in accordance with the measured data and the analysis repeated to resolve the differences between the analytical and measured results.

Ref. 3.9-22: MUAP-070027 R1 "The comprehensive vibration assessment program for the US-APWR Reactor Internals.

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.