

REQUEST FOR ADDITIONAL INFORMATION 206-1576 REVISION 0

2/25/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 03.09.02 - Dynamic Testing and Analysis of Systems Structures and Components
Application Section: 3.9.2.4

QUESTIONS for Engineering Mechanics Branch 1 (AP1000/EPR Projects) (EMB1)

03.09.02-19

RAI 3.9.2-40

In DCD Tier 2, Subsection 3.9.2.4, the applicant made a commitment to performing preoperational vibration testing and provided details of the sensors to be used.

The staff reviewed Subsection 3.9.2.4 and found that the DCD did not meet some of the expectations recommended in RG 1.20 and SRP 3.9.2. The applicant did not include any information about the pre-operational and startup test program of the steam generator internals. According to SRP 3.9.2 and RG 1.20, the applicant is expected to perform preoperational and initial start-up testing to evaluate potential adverse flow effects for the steam generator internals, including the steam separator. The applicant is therefore requested to provide the following:

If the steam generators for the MHI US APWR are classified as prototypes, describe the pre-operational and startup test program to demonstrate that adverse flow effects will not cause unanticipated excessive flow-induced vibrations or structural damage. The test program description should include a list of test flow modes, a list of sensor types and locations, a description of test procedures and methods to be used to process and interpret the measured data, including bias errors and uncertainties, a description of the visual inspections to be made, a comparison of test results with the analytical predictions, and the acceptance criteria for stress levels and for comparison with the analysis results. If the steam generators are classified as non-prototypes, provide the requested information for the components with deviations from the prototype design or operating conditions. If the steam generator internal structures are a non-prototype design, provide reference to the tests of the prototype steam generator and give a brief summary of the results.

The staff needs this information to assure conformance with GDC-1 and 4. Revise Subsection 3.9.2.4 of the DCD to include a detailed description of the pre-operational and startup test program of the steam generator internals.

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03.09.02-20

RAI 3.9.2-41

According to Section 3.9.2 of the SRP, a preoperational test program for the steam delivery system should be described in Subsection 3.9.2.4 of the DCD.

In DCD Tier 2, Subsection 3.9.2.4, the applicant did not describe the preoperational and start-up vibration test program for the steam delivery systems. The staff needs this information to confirm that appropriate vibration test program is planned to ensure that adverse flow effects will neither cause unanticipated flow-induced vibrations of significant magnitude nor structural damage of the steam delivery systems. The applicant is requested to provide additional details about the flow-induced vibration measuring and monitoring program for the preoperational and start-up tests of the steam delivery system, including the steam separator, the safety relief valves and the steam lines. The requested additional information should address the measurement locations with diagrams, test conditions, hold points to allow data acquisition and analysis, and inspection and monitoring program. This is necessary to assure conformance with GDC-1 and 4. Revise subsection 3.9.2.4 of the DCD to include additional details about the preoperational and start-up vibration test program of the steam delivery systems.

03.09.02-21

RAI 3.9.2-42

The vibration assessment report MUAP-07027-P provides details about the types and locations of the transducers that will be used in the preoperational vibration test program, the test conditions, and inspection program.

The staff reviewed the technical report MUAP-07027-P and found that although the overall concept of this test program seems reasonable, it is not clear what provisions are made to ensure that adequate data will be obtained even if several sensors fail during the preoperational test. Subsection 3.9.2.4 of the DCD document does not address the issue of instrumentation redundancy. The applicant is requested to discuss the provisions made in the vibration test program to ensure sufficient redundancy in the instrumentation such that adequate information is obtained from the preoperational and start-up vibration test program. It is essential that sufficient information is obtained from the vibration tests to be able to assess the margin of safety of the critical components of the reactor internals and the steam delivery system. This is necessary to assure conformance with GDC-1 and 4. Revise subsection 3.9.2.4 of the DCD to include additional details about provisions made to ensure sufficient redundancy in the instrumentation.

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03.09.02-22

RAI 3.9.2-43

A major conclusion, based on the results of the vibration assessment program described in technical report MUAP-07027-P, is that the vibration responses of the reactor internals without the core are the same or slightly larger than those with the core. Therefore, the applicant proposes to conduct the preoperational and start-up vibration testing (cold hydraulic test and hot functional test) only before loading the core. It is argued that the vibration levels after loading the core will be bounded by those measured without the core.

The staff has reviewed the technical report MUAP-07027-P and is concerned about the validity of this conclusion, and also about other undesirable/safety consequences that may arise if the preoperational tests are performed without the core. The applicant is requested to substantiate the validity of the argument that the dynamic response of the reactor internals under normal and operational flow transient conditions with fuel assemblies in the core is the same or slightly smaller than that under hot functional test conditions without the core. Verification of this argument is needed to assess the proposal made by the applicant to confine data acquisition during the initial start-up tests to the hot functional tests before core loading. In responding to this RAI, the applicant is requested to address the following issues and their influence on the effect of core loading on the dynamic response of the reactor internals:

- (a) The scale model tests were performed on a J APWR, which has a shorter core than that of the US APWR. In addition, the geometry of the scale model seems to represent the 4-loop reactor rather than the US APWR.
- (b) Dynamic similarity of the scale model tests and the reactor prototype.
- (c) Effect of fuel assembly on flow distribution and pattern within the reactor, including the cross-flow velocity in the upper and lower plenums of the reactor vessel.
- (d) Since the pressure drop will be lower without the core, the bypass/leakage flow will be smaller than with the core. This may affect leakage flow-induced vibration, especially at the exit nozzles of the core barrel.
- (e) The operating point on the Q-H characteristic curve of the RCP will be different from that with the core.
- (f) Vibration tests of the fuel assemblies can not be performed unless the core is present in the reactor.

The DCD and the vibration assessment report do not discuss the effect of the above mentioned issues. The applicant is requested to adequately address these issues so that the staff can assess conformance with GDC-1 and 4. Revise the vibration assessment report to address the staff concerns and refer to these additions in Subsection 3.9.2.4 of the DCD.