TESTING METHODS AND IMPLEMENTATION AUDIT REPORT

NRC Audit Team:

- Jeffrey Ciocco, NRC, Lead Project Manager for the US-APWR DC
- Ervin Geiger, NRC, NRR Technical Reviewer for the GSI-191
- Diego Saenz, ECCS SRSB Technical Reviewer for the US-APWR DC
- Christopher VanWert, ECCS SRSB Technical Reviewer for the US-APWR DC

1.0 SUMMARY

Mitsubishi Heavy Industries Ltd. (MHI) submitted to the U.S. Nuclear Regulatory Commission (NRC) a Final Safety Analysis Report for its application of the United States - Advanced Pressurized Water Reactor (US-APWR) on December 31, 2007 (Reference 1). MHI submitted Technical Report MUAP-08013-P, "US-APWR Sump Strainer Downstream Effects" in December 2008 (Reference 2). This technical report analyzes the US-APWR systems and components downstream of the containment sump strainers to ensure that these systems and components will operate as designed under post Loss-Of-Coolant Accident (LOCA) conditions, and supports the US-APWR Design Control Document, Chapter 6, Subsections 6.2 "Containment Systems" and 6.3 "Emergency Core Cooling Systems" (ECCSs). In addition, MHI planned testing of the downstream effects beginning in June 2010.

The NRC staff conducted an audit of MHI's US-APWR downstream effects testing at MHI's facilities in Takasago, Japan during June 28 - 30, 2010. The audit included a presentation of testing methods and observation of the test implementation. As part of the audit, the NRC staff witnessed parts of the debris preparation, sequencing and addition. Discussions were also held regarding quality assurance, scaling, and source term determination.

Included in this audit report is the basis of the audit, observations, results, and the NRC staff's conclusion. No Requests for Additional Information were generated as a result of this audit.

2.0 BASIS

To satisfy the requirements of Generic Design Criteria 38 and Title 10 of the *Code of Federal Regulations,* Part 50.46(b)(5) regarding the long-term spray system and ECCS, the system components downstream of the sump strainer should be designed to allow adequate cooling given the coolant characteristics after passing through the sump strainer. The design of the fuel assembly is a critical element in ensuring long-term recirculation cooling capability. Therefore, adequate testing is needed to verify that long-term coolability is maintained following postulated post LOCA conditions. Regulatory Guide (RG) 1.82, Revision 3 (Reference 3), "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident," as supplemented for pressurized-water reactors (PWRs) by the Nuclear Energy Institute (NEI) Guidance Report (GR) (Reference 4) and the NRC safety evaluation of the NEI GR (Reference 5), provide guidance for PWR debris evaluations.

3.0 OBSERVATIONS AND RESULTS

On June 28, 2010, the NRC staff met with MHI representatives in a pre-test brief and discussed the test procedure for the hot leg test. MHI committed to including this test procedure as part of the test report to be submitted after completion of the Generic Safety Issue 191 (GSI-191), "Assessment of Debris Accumulation on PWR Sump Performance," downstream effects testing. After a presentation of the test procedure, MHI representatives gave the NRC staff a tour of the facility and test apparatus. MHI then proceeded with the hot leg test assuming 100 percent fiber and 100 percent particulate bypass. The NRC staff confirmed that the test was performed in accordance with the test procedure.

After the completion of the test, the NRC staff inspected the test-assembly after it had been removed from the test apparatus. It was noted that while the thickest debris bed was found on the bottom grid, there was a fair amount of debris distribution amongst the spacer grids. The MHI analysis assumptions include an extrapolation of the delta P from the last modeled spacer grid (second intermediate spacer grid) in the test assembly for all of the subsequent spacer grids (numbers 3 through 9) that would be found in a full size US-APWR fuel assembly. The pattern of debris distribution found in the assembly after the test, confirms that this is a conservative assumption.

On June 29, 2010, MHI and theNRC staff discussed the need for a well developed test matrix to ensure that the limiting conditions are caught for the hot and cold leg tests. The NRC staff noted that the plan to perform one hot leg and one cold leg test could not sufficiently ensure that the limiting conditions were modeled. Of particular interest to the NRC staff, was the effect of the particulate to fiber ratio used during testing and the need to ensure the use of limiting conditions.

Discussions were also held regarding the source term used in the tests. It was noted that MHI conservatively assumed a 100 percent bypass of the sump strainer for the particulate and fiber source terms. In previous sump strainer testing, MHI performed a fiber-only test and collected post-strainer samples that could be used to determine the amount of fiber that could pass the sump strainer. The samples had not been tested prior to the downstream effects testing.

On June 30, 2010, MHI presented the preliminary results along with a revised draft test matrix based on discussions from the previous day. The proposed test matrix would provide additional tests designed to capture the limiting test conditions based on possible particulate to fiber ratios given the available source term. After additional clarification, the NRC staff agreed with MHI that its proposed approach would provide the additional justification necessary to ensure that the limiting conditions were tested.

MHI informed the NRC staff, that they plan to submit the final test report by mid-September. The NRC staff will include the final test report as part of its review of MUAP-08013-P, "US-APWR Sump Strainer Downstream Effects."

In addition to the GSI-191 downstream effects related testing and discussions, MHI prepared various tours for the NRC staff while waiting for the test results to be collected. In particular, the NRC staff toured:

1. Corrosion studies test facility
2. Advanced accumulator
3. Non-destructive testing
4. Shake table facility for seismic testing
5. Steam generator tube inspection program
6. Turbine blade manufacturing facility
7. Reactor vessel manufacturing
8. Steam generator manufacturing

4.0 CONCLUSION

The NRC staff began their audit on June 28, 2010, and concluded on June 30, 2010. The testing conducted by MHI consisted of a hot leg test at 100 percent particulate and 100 percent fiber bypass. The NRC staff observed and evaluated the test procedure, test setup, debris introduction, and head loss test data. The NRC staff found no issues with the test preparation or the testing itself. The NRC did have concerns with the original test matrix which was communicated to MHI. MHI developed a draft revised test matrix and informed the NRC staff of their intention to complete testing and submit the test report by mid-September 2010.

REFERENCES:

1. US-APWR DCD Revision 2.

2. Technical Report MUAP-08013-P, Revision 0, “US-APWR Sump Strainer Downstream Effects.”

3. RG 1.82, Revision 3, “Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident.”

4. NEI 04-07, “PWR Sump Performance Evaluation Methodology,” (ADAMS Accession Number ML050550138), dated December 2004.

5. Safety Evaluation for NEI GR 04-07, “PWR Sump Performance Evaluation Methodology,” U.S. Nuclear Regulatory Commission, Washington, DC, December 2004. (ADAMS Accession Number ML050550156).