

January 14, 2010

DESIGN CERTIFICATION SECTIONS 6.2 AND 6.3 AUDIT PLAN

January 21, 2010

US-APWR DESIGN CERTIFICATION Mitsubishi Heavy Industries, Ltd Docket No. 52-021

Location Mitsubishi Nuclear Energy Systems, Inc.
1001 19th Street North
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Arlington, VA 22209

Purpose

The purpose is to review, verify and identify information and documentation that is related to net positive suction head (NPSH) calculations for containment spray/residual heat removal (CS/RHR) and safety injection (SI) pumps. The audit will review and evaluate supporting NPSH calculations for the Mitsubishi Heavy Industries (MHI) Design Certification Section 6.2.2, Containment Heat Removal Systems, Table 6.2.2-1 and Section 6.3, Emergency Core Cooling Systems (ECCS), Table 6.3-5, and Figures 6.3-15 and 6.3-16, as well as related Technical Reports MUAP-08001-P, Revision 2, "US-APWR Sump Strainer Performance," and MUAP-08013-P, Revision 0, "US-APWR Sump Strainer Downstream Effects."

Background:

The NRC staff's review of the applicant's information has identified incomplete and inadequate descriptions related to the head losses, assumptions, and design/performance requirements for the NPSH calculations for the ECCS pumps (CS/RHR and SI pumps). Some of the assumptions, such as loss coefficient details, elevations, and pump values are not provided in the design certification document (DCD) to the level of detail and clarity required by the staff to complete its review and make a safety finding. The information associated with NPSH in the United States – Advanced Pressurized Water Reactor (US-APWR) DCD and Technical Report MUAP-08001-P is insufficient for the NRC staff to make the determination that MHI meets the regulatory requirements for NPSH for ECCS pumps.

Additionally, current pressurized water reactors (PWR) have the operating experience of residual heat removal (RHR) pump suction line steam flashing when the RHR system is used as an ECCS after using the RHR system for shutdown cooling. This steam flashing would result in inadequate NPSH for the RHR pump and/or prevent the check valve on the outlet of the refueling water storage tank (RWST) from opening and possibly rendering the RHR system inoperable as an ECCS. Recently, as documented in the Wolf Creek (a Westinghouse 4-loop PWR) licensee event report (LER) 482-2008-008-Rev 2, the licensee conducted a review for potential void formation to address generic letter (GL) 2008-01, Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems.

Wolf Creek determined that the water contained within the length of the RHR pipe (about 140 feet) that lies between the RWST and the minimum-flow line would not be cooled during the RHR cool down period that occurs subsequent to shifting the RHR system to the ECCS mode of operation, after a Mode 4 to Mode 3 transition.

This volume of stagnant water would only be cooled through ambient losses. In a follow-up inspection report (IR) conducted by Region III, IR 05000482/2009006, August 12, 2009 (ML092240087), inspectors identified several findings associated with this event. The NRC staff intends to review the CS/RHR pump NPSH calculations in the context of the operating experience and IR findings.

Regulatory Bases

General Design Criteria (GDC) 38 of Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Appendix A, requires that the containment heat removal system accomplish its safety function to rapidly reduce containment pressure and temperature following a loss-of-coolant accident (LOCA) and to maintain these indicators at acceptably low levels without pump damage caused by cavitation. A supporting analysis should be presented in sufficient detail to permit the NRC staff to determine the adequacy of the analysis. This analysis should also demonstrate that the available NPSH is greater than or equal to the required NPSH. Regulatory Guide (RG) 1.82 Revision 3, describes methods acceptable to the NRC staff for evaluating the NPSH margin.

In accordance with 10 CFR 50.46(b)(5), the NRC staff reviews applications against the requirements for long-term cooling, including adequate NPSH margins in the presence of LOCA generated and latent debris.

To show compliance with GDC 35, the applicant must show that the ECCS pumps will perform their intended functions during postulated accidents. The ECCS should be designed so that sufficient available NPSH is provided to the system pumps assuming the maximum expected temperature of the pumped fluid and no credit for containment pressurization during the accident. Additional guidelines for evaluating the adequacy of pump performance and the availability of the sump for recirculation cooling following a LOCA are presented in RG 1.82 Revision 3, and the Supplemental Response to GL 2004-02, Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors, dated November 2007. Additionally, guidelines for potential void formation in the RHR suction piping are contained in GL 2008-01.

Audit Scope

The audit scope will include the review of supporting NPSH calculations that amplify on the NPSH input values identified in the DCD Table 5.4.7-2 "Equipment Design Parameters for Containment Spray/Residual Heat Removal Pump," the DCD Table 6.2.2-1 "Input Values Employed in CSS Evaluation Calculations," and the DCD Table 6.3-5 "Safety Injection System Design Parameters," as well as, Figure 6.3-4 "Safety Injection Pump Performance Flow Requirement," Figure 6.3-15, "High Head Safety Injection Flow Characteristic Curve (Minimum Safeguards)," and Figure 6.3-16, "High Head Safety Injection Flow Characteristic Curve

(Maximum Safeguards).” Additionally, the audit will review the Requests for Additional Information (RAI) and responses, if available, and Technical Report MUAP-08001-P sections that are related to the NPSH assumptions and calculations. Responses related to DCD RAI 354-2585 and RAI 354-3715, along with their associated calculations, will be audited. The NRC staff will also review supporting NPSH calculations with current PWR operating experience on steam flashing in the RHR suction piping resulting in inadequate NPSH.

Information and Other Materials On Hand for the Audit

The NRC staff requests for MHI to provide the detailed calculation NPSH files for the SI and CS/RHR pumps. MHI is also requested to have its detailed analysis of conformance with RG 1.82 Revision 3 available (summary is in the DCD). The NRC staff requests that all NPSH calculations and internal documentation listed in the references below, be made available for the audit. In addition, information related to containment sump strainer head loss test plan/protocol, information related to strainer redesign, and MHI’s approach toward using Computational Fluid Dynamics Analysis for strainer qualification will be reviewed.

Audit Team

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No quality assurance (DCIP) support is required for this audit. Any materials deemed to be suitable for submittal or citation will be identified for future quality assurance program audit activities.

Logistics

The audit will be conducted at the location identified above. The audit is scheduled to begin at 9:00 a.m. Participating individuals will meet at the audit location.

Special Requests

Appropriate handling and protection of proprietary information shall be acknowledged and observed throughout the audit.

Deliverables

An audit report will be generated after completion of the audit. The audit outcome will be used to identify information not currently addressed on the docket and for the submittal of additional information for making security findings and regulatory decisions. The audit will assist the NRC staff in the preparation and issuance of further RAIs for the licensing review of the US-APWR Design Certification Application, Section 6.3.

References

1. US-APWR DCD Revision 2
2. Technical Report MUAP-08001-P, Revision 2, US-APWR Sump Strainer Performance
3. Technical Report MUAP-08013-P, Revision 0, US-APWR Sump Strainer Downstream Effects
4. NPSH Calculations for the SI and CS/RHR Pumps
5. MHI documentation demonstrating conformance with RG1.82, Revision 3, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident"
6. LER 482-2008-008-Rev. 2, August 25, 2009 (ML092450426), Wolf Creek Generating Station, Potential for Residual Heat Removal Trains to be Inoperable during Mode Change
7. IR 05000482/2009006, August 12, 2009 (ML092240087), Wolf Creek Generating Station - NRC Focused Baseline Inspection Report
8. GL 2008-01, January 11, 2008 (ML072910759), Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems
9. GL 2004-02, September 13, 2004 (available in the Electronic Reading Room), Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors

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References

1. US-APWR DCD Revision 2
2. Technical Report MUAP-08001-P, Revision 2, US-APWR Sump Strainer Performance
3. Technical Report MUAP-08013-P, Revision 0, US-APWR Sump Strainer Downstream Effects
4. NPSH Calculations for the SI and CS/RHR Pumps
5. MHI documentation demonstrating conformance with RG1.82, Revision 3, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident"
6. LER 482-2008-008-02, August 25, 2009 (ML092450426), Wolf Creek Generating Station, Potential for Residual Heat Removal Trains to be Inoperable during Mode Change
7. IR 05000482/2009006, August 12, 2009 (ML092240087), Wolf Creek Generating Station - NRC Focused Baseline Inspection Report
8. GL 2008-01, January 11, 2008 (ML072910759), Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems
9. GL 2004-02, September 13, 2004 (available in the Electronic Reading Room), Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors

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