

AUDIT PLAN FOR US-APWR DESIGN CONTROL DOCUMENT CHAPTER 5.4.7

October 9-10, 2012

US-APWR DESIGN CERTIFICATION

MITSUBISHI HEAVY INDUSTRIES, LTD.

Docket No. 52-021

Location: Mitsubishi Nuclear Energy Systems
1001 19th Street North
7th Floor, Arlington, Virginia

Purpose:

The purpose of this regulatory audit is to review data and/or analyses which could support closure of request for additional information (RAI) 6413, Question 3. Based on review of the response to RAI 6280, Question 3 the staff was unable to make a safety determination regarding the adequacy of the residual heat removal (RHR) system to perform its safety function at mid-loop conditions due to the possibility of vortex formation and subsequent pump air entrainment. As such, follow-on RAI 6413 was written requesting detailed information be provided which supports the applicant's claim that RHR/core spray (CS) pump performance is acceptable at the minimum, mid-loop water level. Closure of RAI 6413 supports completion of the Chapter 5, design control document (DCD) safety evaluation (SE) without open items.

Background:

In RAI 6280, Question 3 the staff asks what tests and/or analyses, at the most limiting RHR flow rate and mid-loop water level, have been performed to ensure that air entrainment and potential vortexing do not challenge the RHR pump safety functions. Question 3 continues by requesting that the applicant described how the tests and/or analyses are applicable to the United States Advanced Pressurized Water Reactor (US-APWR) RHR inlet design. The applicant response to RAI 6280, Question 3, which is documented in UAP-HF-12061, dated March 2012; states that existing Japanese plants operate at similar conditions to the US-APWR with no significant air ingestion. Furthermore, the applicant stated that scale modeling testing for the Japanese APWR confirmed the relationship between RHR pump flow and the mid-loop water level at which air ingestion occurs. No data or analysis was provided supporting these statements. Based on the lack of detail in the applicant's response, the staff was not able to make a safety determination on the RHR/CS pump performance under mid-loop conditions.

Therefore, the staff created follow-on RAI 6413. RAI 6413, Question 3 requests the applicant provide the detailed data which supports that existing Japanese plants with similar RHR flow rates and inlet geometries operate with no significant air ingestion and/or provide scale test data demonstrating the same.

Regulatory Audit Basis:

Review of DCD Chapter 5.4.7 is being conducted in accordance with Section 5.4.7, "Residual Heat Removal System," of NUREG-0800, "Standard Review Plan (SRP) for the Review of Safety Analysis Reports for Nuclear Power Plants." SRP 5.4.7 directs the U.S. Nuclear Regulatory Commission (NRC) staff to review the RHR system during shutdown operations, including reduced inventory and mid-loop operations.

High RHR system availability and reliability during shutdown conditions are important to mitigating risk and maintaining an appropriate level of safety. Specifically, the Technical Rational section of SRP 5.4.7 states,

"GDC 4 requires that SSCs important to safety be designed to accommodate the effects of and be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accident conditions, including such effects as pipe whip and jet impingement. The safety function of the RHR system is to transfer heat from the reactor to the environment during and after plant shutdown. To ensure the availability of the decay heat removal function, the RHR system must be capable of performing heat transfer under the expected operational and postulated accident conditions for the plant. These conditions include consideration of the dynamic effects of flow instabilities and the loadings caused by water hammer events. Compliance with GDC 4 enhances plant safety by providing assurance that the dynamic effects of events such as flow instabilities and water hammer will not affect the capability of the RHR system to remove decay heat."

Vortexing, and the resulting air entrainment, is a dynamic flow instability which could negatively affect the RHR/CS pump from performing its safety function. In addition, air entrained by vortexing could lead to air entrapment in the RHR system leading to a loss of safety function (e.g., water hammer).

Regulatory Audit Scope:

The audit will consist of the following elements:

1. Review of applicant data and/or analyses, including any scaling test reports, which demonstrate that vortexing, and the associated air entrainment, at minimum mid-loop water level does not impact the safety function of the US-APWR RHR system. This includes RHR/CS pump performance and evaluation of possible air entrapment in the system leading to the potential loss of the RHR safety function.

Team Assignments:

Jeffrey Schmidt - Lead Auditor, Office of New Reactors (NRO)
Warren Lyon - Team Member, Office of Nuclear Reactor Regulation
Marie Pohida - Team Member, NRO
Paul Kallan - Project Manager, NRO Logistics:

The audit is scheduled for October 9–10, 2012 at the Mitsubishi Nuclear Energy Systems offices located in Arlington, Virginia.

Special Requests:

The NRC staff requests that Mitsubishi Heavy Industries, Ltd., provide the requested information, workspace for the NRC staff to review the documents, and a telephone for contacting NRC headquarter staff (if necessary) as coordinated through the project manager. The NRC staff shall appropriately handle and protect proprietary information throughout the audit.

Deliverables:

Within 60 days of the closing meeting, the NRC staff will generate an audit summary report. The report will describe the outcome of the audit and summarize any open items resulting from the audit, including potential Requests for Additional Information.

References:

US-APWR DCD, Revision 3

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