# SAFETY-RELATED VENTILATION DESIGN AUDIT REPORT

NRC Audit Team:

The following U.S. Nuclear Regulatory Commission (NRC) staff members from Office of New Reactors and a supporting contractor from Pacific Northwest Nuclear Laboratory participated in the audit:

- William Ward (Audit Team Leader)
- David Nold (Lead Technical Reviewer)
- Gary Swearingen (Contract Technical Reviewer)

The following key individuals from Mitsubishi Heavy Industries Ltd. (MHI) and Mitsubishi Nuclear Energy Systems (MNES) participated in the audit:

- Ryan Sprengel, MNES (DCD Licensing Engineer)
- Ruriko Takanashi, MNES (Interpreter)
- Yoshihiko Kataoka, MHI (Acting Manager, Plant Layout Engineering Section)
- Junichiro Okuda, MHI (Plant Layout Engineer)

## 1.0 SUMMARY

MHI submitted to the U.S. Nuclear Regulatory Commission (NRC) Design Control Document (DCD) Revision 2 for its United States - Advanced Pressurized Water Reactor application in October 2009. The NRC staff reviewed the information associated with Chapter 9, Section 9.4, "Air Conditioning, Heating, Cooling, and Ventilation Systems," and issued multiple Requests for Additional Information (RAIs). Upon reviewing MHI's responses to the RAIs, the NRC staff concluded that a review of the design details and calculations was needed to make the determination that MHI meets the regulatory requirements for safety-related ventilation.

The audit was conducted at the MNES office in Arlington, Virginia during the week of May 24 - 28, 2010. The NRC staff conducted the audit in accordance with the NRC Office of New Reactors (NRO) Office Instruction NRO-REG-108. The plan for this audit is documented and can be found in the Agencywide Document Access and Management System (ADAMS) under accession number ML101370265, dated May 18, 2010.

The audit review consisted of four parts. Each part related to past RAI question and response exchanges between the NRC staff and MHI, pertaining to the NRC staff's safety evaluation reviews, using Standard Review Plan (SRP) Section 9.4.1 "Main Control Room Heating, Ventilation and Air Conditioning System" (MCRVS) and Section 9.4.5 "Engineered Safety Feature Ventilation System" (ESFVS). The four parts included:

- Review, verify, and identify information and documentation that is related to RAI Number 63-849, Question Number 09.04.01-14 and RAI Number 327-2401, Question Number 09.04.01-5 for SRP 9.4.1. These two RAI questions are related, in that Question Number 09.04.01-5 is a follow-up to Question Number 09.04.01-14.

- Review, verify, and identify information and documentation that is related to RAI Number 64-735, Question Number 09.04.05-1, RAI 9.4.5-4 and its follow-up RAI Number 356-2549, Question Number 09.04.05-4 for SRP 9.4.5.

- Review, verify, and identify information and documentation that is related to RAI Number 64-735, Question Number 09.04.05-1, RAI 9.4.5-3 and its follow-up RAI Number 356-2549, Question Number 09.04.05-3 for SRP 9.4.5.

- Review, verify, and identify information and documentation that is related to RAI Number 64-735, Question Number 09.04.05-01, RAI 9.4.5-22 and its follow-up RAI Number 356-2549, Question Number 09.04.05-9 for SRP 9.4.5.

MHI supplied detailed engineering calculations (documents numbered 15 - 20 in Enclosure 3 of the Audit Report) for six Heating, Ventilation, and Air Conditioning or exhaust systems for the NRC review. MHI also provided a document (document number 9 in Enclosure 3 of the Audit Report) which summarized the planned amended responses to four sets of the RAI responses. This document linked the engineering calculations to the RAI responses for ease of review. The amended RAI responses include planned changes to the DCD. As the audit progressed, MHI provided additional documents (listed in Enclosure 3 of the Audit Report) which were referenced by the calculations initially supplied to the team.

Twice daily during the audit, the NRC team and MHI met to discuss issues identified by the NRC team.

2.0 BASIS

- General Design Criteria (GDC) 19 of Title 10 of the *Code of Federal Regulations*, Part 50, Appendix A, "Control Room," requires that a control room shall be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions, including loss-of-coolant accidents (LOCA). The NRC staff invoked the review requirements of SRP 9.4.1, Section IV.1.C which requires the NRC staff to review calculations in support of its conclusions that the equipment capacities are of adequate design. These requirements form the basis for the questions asked in RAI Number 63-849, Question Number 09.04.01-14 and RAI Number 327-2401, Question Number 09.04.01-5 and the basis for this audit.

- SRP 9.4.5, "Areas of Review," Section I.2. In particular, Section 2, Item D, states that:

  > "Safety-related portions of the ESFVS are also reviewed with respect to the following….The capability of the system to circulate sufficient air to prevent accumulation of flammable or explosive gas or fuel-vapor mixtures from components such as storage batteries and stored fuel."

  Also, pursuant to Regulatory Guide (RG) 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," the DCD needs to contain a design of

sufficient detail so that the NRC staff can perform its own set of confirmatory calculations or review the applicant's calculations to support the writing of the Safety Evaluation Report (SER). These requirements form the basis for the questions asked in RAI Number 64-735, Question Number 09.04.05-1, RAI 9.4.5-4 and its follow-up RAI Number 356-2549, Question Number 09.04.05-4.

- GDC 4, "Environmental and Dynamic Effects Design Bases," with respect to the ESFVS being appropriately protected against dynamic effects and being designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents. The evaluation with respect to GDC 4 also includes evaluation of the adequacy of environmental support provided to structures, systems, and components (SSCs) important to safety located within areas served by the ESFVS. GDC 60, "Control of Releases of Radioactive Materials to the Environment," as related to the systems capability to suitably control release of gaseous radioactive effluents to the environment. These requirements form the basis for the questions asked in RAI Number 64-735, Question Number 09.04.05-1, RAI 9.4.5-3 and its follow-up RAI Number 356-2549, Question Number 09.04.05-3.

- GDC 4 with respect to the ESFVS being appropriately protected against dynamic effects and being designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents. The evaluation with respect to GDC 4 also includes evaluation of the adequacy of environmental support provided to SSCs important to safety located within areas served by the ESFVS. Per the regulatory requirements of RG 1.206, the DCD needs to contain a design of sufficient detail so the NRC staff can perform its own set of confirmatory calculations or review the applicant's calculations to support writing of the SER. These requirements form the bases for the questions asked in RAI Number 64-735, Question Number 09.04.05-01, RAI 9.4.5-22 and its follow-up RAI Number 356-2549, Question Number 09.04.05-9.

## 3.0 OBSERVATIONS AND RESULTS

The NRC staff made the following observations:

Part 1

- The MCRVS Air Handling Unit (AHU) cooling capacity determination needs to be re-calculated to reflect the 1200 cubic feet per minute (CFM) of outside air plus 18kW as a greater heat load than 1800 CFM of outside air. A revision of the DCD Table 9.4.1-1 is needed to reflect this new result. See RAI 642-4770, Question 09.04.01-24.

Part 2

- Table 8.3.2-3 and Figure 8.3.2-1 need to be revised to reflect 120 cells in a battery. See RAI 670-4773, Question 09.04.05-14.

- Inspection, test, analysis, and acceptance criteria for Table 8.3.2 needs to reflect a 1 percent $H_2$ limit. See RAI 670-4773, Question 09.04.05-15.

- A British/European standard is referenced in support of the calculations related to the battery. It is not referenced or justified as an alternative approach in the DCD. MHI needs to document and justify its use. See RAI 670-4773, Question 09.04.05-15.

- Further review will be made regarding the question of the delayed $H_2$ emission when switching from charging to discharging (standard states to allow one hour of continued emission after charging is complete). See RAI 670-4773, Question 09.04.05-18.

Part 3

- MHI uses its operating experience data from Japanese Advanced Pressurized Water Reactors (APWR) (documents numbered 5 - 8 in Enclosure 3 of the Audit Report) as a basis for some parts of the ventilation design. The question is how data from this source is identified and validated as part of the design. The NRC staff will take this back to discuss with its supervision.

Part 4

- Table 9.4.5-1, Sheet 2 of 4, needs revising to reflect the Emergency Feedwater Pump AHU cooling coil capacity of 62,000 btu/hr. See RAI 670-4773, Question 09.04.05-17.

- Chapter 6 needs to identify ESFVS and AEES boundaries by description and figures. See RAI 670-4773, Question 09.04.05-16.

General

- The planned amended RAI responses, with the NRC staff's feedback, needs to be submitted. The amended responses to Section 9.4.1 and Section 9.4.5 RAIs were submitted on July 1, 2010, and can be found in ADAMS under accession number ML101830369.

- The NRC staff is requesting submission of the front matter calculations in the six engineering calculation documents (documents numbered 15 - 20 in Enclosure 3 of the Audit Report) initially provided to the NRC staff is to be provided on the docket. The detailed, room by room calculations do not need to be provided.

- N0-EJ10203 (document number 35 in Enclosure 3 of the Audit Report) has the same values for normal operation, Blackout - Loss of Offsite Power, and LOCA.

## 4.0 CONCLUSION

The four parts identified in the Summary above were reviewed and closed. RAIs were issued to correct new items identified during the audit. MHI's engineering design calculation process is well-organized and follows applicable standards and guidance. All audited calculations had significant background information based on United States references and Japanese APWR plant experience. MHI demonstrated significant depth and breadth of their design process.