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US-APWR Design Certification Simulator Audit Report

1.0 Audit Summary

As part of the review of the US-APWR Design Certification (DC) Application, on July 14 and 15, 2009, members of the Operator Licensing and Human Performance Branch of the Division of Construction Inspection and Operational Programs performed an audit at the Mitsubishi Electric Power Products Inc. (MEPPI) facility in Warrendale, Pennsylvania. The purpose of the audit was to gain a better understanding of the human system interfaces for the United States - Advanced Water Reactor (US-APWR) control room and the human factors engineering (HFE) program that will be used to design them. Another purpose of the audit was to gain a better understanding of the Mitsubishi Heavy Industries (MHI) responses to the U.S. Nuclear Regulatory Commission (NRC) staff's Requests for Additional Information (RAI) with regard to Topical Report MUAP-07007, Revision 2, "HSI System Description and HFE Process," and MUAP-DC018, Revision 1, Chapter 18, "Human Factors Engineering."

The audit bases were:

- Title 10 of the *Code of Federal Regulations* (10 CFR) 50.34, "Contents of Applications; Technical Information"
- NUREG-0800, Chapter 18.0, Revision 2, "Human Factors Engineering"
- NUREG-0711, Revision 2, "Human Factors Engineering"

During this audit, the NRC audit team clarified the topical report scope, and how the topical report basic Human Systems Interface (HSI) system relates to the US-APWR design; the issue of completeness associated with Topical Report MUAP-07007 and the US-APWR Design Certification Document. The NRC staff discussed the need for supplemental information related to the planning and analysis elements detailed in NUREG-0711 for both documents. The NRC staff also discussed the RAIs with MHI to determine if more information was needed in the responses.

The NRC staff communicated that clarification of these issues would aid the NRC staff in completing its safety review and to allow the NRC staff to reach a licensing decision.

2.0 Status of Previous Audits

There were no previous NRC audits dealing with HFE issues in support of the US-APWR DC application.

3.0 Audit Observations and Other Comments

3.1 US-APWR Human System Interfaces

A. Audit Scope

The NRC team observed a MHI demonstration of the basic Human Systems Interface (HSI) as it pertained to the US-APWR control room design. The NRC team also discussed the process that was used to create the human system interfaces for the current simulator and the process that will be used to design subsequent control rooms. The scope of the evaluation included all of the HFE elements within NUREG-0711.

B. Observations

The staff observed a demonstration on the functionality of the US-APWR control room simulator using a steam generator tube rupture event.

Computer-based procedures (CBP) and paper-based procedures were available in the control room simulator. The CBPs have dedicated screens where the operator inputs a check (via touch screen) to note a completed procedure step. The computer procedures do not have any other functionality associated with them, such as operating valves or pumps within the procedures themselves.

During the presentation, the question was asked as to where rules (algorithms) being used for processing information (such as alarm prioritization) were documented. The NRC staff suggested that some of these rules appeared to be sufficiently generic that they should be documented as part of the US-APWR HSI System design.

MHI's simulator at the MEPPI facility reflects the Japanese Ohi Plant control room design. This simulator is being used to verify and validate the basic HSIs of the Japanese design, as they are applied to the US-APWR design, and in modifications to operating Pressurized Water Reactors. After MHI has identified and corrected any human error discrepancies (HED) identified during verification and validation (V&V) testing of the Japanese HSI System, the resulting HSIs will be called the U.S. Basic HSI System.

The V&V process of the Basic HSI System is done in multiple phases; those phases are described as Phase 1A, 1B, 2A, and 2B. Phase 1A converts the Japanese language and measurements into English, and then it validates the English HSI system design and identifies the HEDs. Phase 1B uses the HEDs identified in Phase 1A and incorporates them into the design. It also verifies the anthropomorphic related changes needed to accommodate United States operators, and ensures the

changes have been appropriately implemented. Any changes that are made are then verified and validated again. At the end of Phase 1A and Phase 1B, the U.S. Basic HSI System will be completed. MHI intends to use the HSI system as a starting point for plant control room modifications in current operating plants, and as the base HSI system for the US-APWR control room design.

The second phase of the MHI HFE implementation process (Phase 2) is also divided into two parts. Phase 2 uses the NUREG-0711 HFE process to develop the US-APWR control room design. In Phase 2A, the planning and analysis elements of NUREG-0711 (task analysis, functional requirements analysis and function allocation, human reliability analysis, operating experience review, staffing and qualifications and HFE program management) will be conducted to identify additional HFE design requirements that need to be added to the U.S. Basic HSI System. Phase 2B will verify and validate the products of this process. The resulting HSIs will be called the US-APWR HSI System.

Information on the HFE process elements (Task Analysis, Functional Requirements Analysis and Function Allocation, Staffing and Qualifications, Human Reliability Analysis, Operating Experience Review, and HFE Program Management) used to initially develop the Japanese HSI system is not available. Based on information reviewed during the audit, the NRC staff believes this basis information will not be required for two reasons. First, the Japanese Basic HSI System is being used as a starting point; it contains only generic HSI descriptions that Operating Experience has demonstrated to be effective elements of a control room design. Second, this basic design is being adjusted by applying the NUREG-0711 planning and analysis elements listed above. This will ensure a complete US-APWR HSI system design basis.

C. Conclusion

The NRC team gained an understanding of the HFE process being used by MHI to develop the US-APWR control room. This understanding will allow the NRC staff to issue clear RAIs where the NRC staff has identified potential concerns. The NRC staff also gained a better understanding of the basis for the submittal of Topical Report MUAP-07007 and US-APWR Design Control Document (DCD). However, the NRC team communicated to MHI that the information submitted for design certification approval that would satisfy NUREG-0711 criterion was either still not sufficient, or not available, and that this information should be provided. MHI agreed to provide a map that would clarify where the relevant documentation to address each criterion could be found.
The mapping to NUREG-0711 criterion that will be provided, in addition to, the information provided by MHI in their presentation will assist the NRC staff in the review of Topical Report MUAP-07007 and the US-APWR DCD.

3.2 MUAP-07007, Revision 2 and US-APWR DCD, Revision 1, RAI Responses

A. Audit Scope

The NRC staff observed a MHI presentation of responses to NRC staff RAIs. The NRC staff goal was to ensure that the responses to RAIs, on both the topical report and DCD, were sufficient for the NRC staff to complete their review. The scope included the elements of NUREG-0711.

B. Observations

MHI's presentation responded to the NRC staff's RAIs and supplemental RAIs to date, giving a summary of what was included in their responses. RAI responses were discussed for each section of NUREG-0711. The RAI responses are supplemented by Technical Report MUAP-09019, "US-APWR HSI Design", submitted on June 30, 2009. This technical report details the implementation of the HFE program for the US-APWR.

C. Conclusion

The applicant has responded to all of the RAIs, issued as of the date of this report, in the NRC staff's reviews of the US-APWR HFE design and of Topical Report MUAP-07007 concerning the basic HSI design. MHI has committed to provide a mapping of the NUREG-0711 criteria to Topical Report MUAP-07007, which will highlight gaps and provide assistance to the NRC staff in their review. The NRC staff will review each MHI response to the RAIs on the US-APWR HFE design and the basic HSI design and will conduct further meetings or issue subsequent clarifying RAIs as needed.

4.0 Entrance and Exit Meetings

In the entrance meeting on July 14, 2009, the NRC audit team met the MHI staff and management who were involved in the US-APWR DC application and the U.S. Basic HFE System. The NRC staff discussed the scope of the audit and outlined the areas to be reviewed. In the exit meeting on July 15, 2009, the NRC audit team discussed the audit activities and deliverables for MHI and the NRC staff.

APPENDIX A: LIST OF ACRONYMS

CBP	Computer-Based Procedures
DC	Design Certification
DCD	Design Control Document
HED	Human Error Discrepancies
HFE	Human Factors Engineering
HSI	Human Systems Interface
MEPPI	Mitsubishi Electric Power Products Incorporated
MHI	Mitsubishi Heavy Industries, Ltd.
NRC	Nuclear Regulatory Commission
RAI	Requests for Additional Information
US-APWR	United States – Advanced Pressurized Water Reactor
V&V	Verification and Validation