US-APWR

Human Performance Monitoring Implementation Plan

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Revision History

Revision	Date	Page (Section)	Description
0	April 2010	All	Original issued
1	November 2011	General	Revised capitalization of section titles. Revised number of figure.
		p. iv (Abstract)	Revised the first sentence for response to RAI 777 (Question No. 18-127).
		p.1 (Section 1.0)	Revised the first sentence for response to RAI 777 (Question No. 18-127). Added “ensure” to the third paragraph for response to RAI 777 (Question No. 18-128). Added “in a timely manner” to third paragraph for response to RAI 777 (Question No. 18-128).
		p.5 (Section 4.2)	Added description about the goal of human performance monitoring for response to RAI 777 (Question No. 18-125).
		p.6 (Section 4.2.1)	Added the description to the end of the section for response to RAI 777 (Question No. 18-121).
		p.7 (Section 4.2.2)	Revised the last three sentences to “Licensees Corrective Action Programs will determine …” for response to RAI 777 (Question No.18-123).
		p.7 (Section 4.2.4)	Deleted a sentence for response to RAI 777 (Question No.18-124).
		p.9 (Section 4.3)	Added the two sentences to the second paragraph for response to RAI 777 (Question No. 18-122). Revised “followings” to “the following”.

		p.10 (Section 5.0)	Revised description of references.
2	October 2012	All pages	Revised to incorporate comments by the NRC in March 2012 to keep consistency in technical description with DCD Chapter 18, MUAP-09019, MUAP-10008, MUAP-10009, MUAP-10012, MUAP-10013 and MUAP-10014.

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Abstract

The US-APWR Human Performance Monitoring (HPM) Implementation Plan provides an integrated strategy for monitoring human performance, identifying human performance degradation, and prompting related corrective actions. This integrated strategy assures that human performance does not degrade to an unacceptable level over time, including degradation that may occur due to plant design changes. The HPM program proactively looks for human performance degradation of plant operations. This includes human performance degradation for safety significant operator actions that may occur due to plant design changes and human system interface (HSI) design changes, including training changes and procedure changes.

The HPM is a catalyst for corrective actions for the items above, and for any other human performance problems related to safety significant human actions (HAs).

The human performance monitoring program is executed by the licensee after the completion of the Design Implementation program element and prior to fuel load.

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List of Acronyms

CBP	computer-based procedure
CFR	Code of Federal Regulations
DCD	design certification document
HPM	human performance monitoring
HA	human action
HED	human engineering discrepancy
HFE	human factors engineering
HSI	human-system interface
HSIS	human system interface system
INPO	Institute of Nuclear Power Operations
ITAAC	inspection, test, analysis, and acceptance criteria
LCS	local control station
MCR	main control room
MHI	Mitsubishi Heavy Industries, Ltd.
NRC	Nuclear Regulatory Commission, U.S.
OER	operating experience review
PRA	probabilistic risk assessment
QA	quality assurance
RG	Regulatory Guide
RSR	remote shutdown room
TA	task analysis
U.S.	United States
US-APWR	United States – Advanced Pressurized Water Reactor
V&V	verification and validation
WANO	World Association of Nuclear Operators

1.0 PURPOSE

The US-APWR Human Performance Monitoring (HPM) Implementation Plan provides an integrated strategy for monitoring human performance, identifying human performance degradation, and prompting related corrective actions. This integrated strategy assures that human performance does not degrade to an unacceptable level over time, including degradation that may occur due to plant design changes. Human performance monitoring within the scope of this program specifically applies to the following:

- Time critical operator actions
- Correct diagnosis of the cause of abnormal plant events
- Accuracy of procedure execution

In addition, the HPM program is designed to ensure that no significant safety degradation occurs as a result of any changes that are made in the plant, including changes to HSI designs, procedures and training, which affects safety significant operator actions.

The HPM implementation plan requires periodic monitoring and documentation of human performance in actual or simulated plant conditions. Records are maintained so that trends showing degrading performance can be identified prior to performance reaching unacceptable levels. The HPM program interfaces with the plant's corrective actions program to ensure corrective actions are tracked to resolution in a timely manner.

2.0 SCOPE

The HPM Plan is applicable to safety significant operator actions at the following facilities:

- Main control room (MCR)
- Remote shutdown room (RSR)
- Local control stations (LCSs)

The HPM program is applicable after the completion of the Design Implementation Plan is completed and prior to fuel load.

3.0 APPLICABLE CODES, STANDARDS AND REGULATORY GUIDANCE

The compliance to the applicable codes and standards for the US-APWR HSIS design and HFE Process is the same as identified in section 3.0 of the topical report “HSI System Description and HFE Process”, MUAP-07007 (Reference 5-2). The topical report includes following standards and guidelines.

- Code of Federal Regulations (CFR)
- Staff Requirements Memoranda
- NRC Regulatory Guides (RG)
- NRC Branch Technical Positions
- NUREGs
- IEEE Standards
- Other Industry Standards

4.0 IMPLEMENTATION PLAN

4.1 Initial Baseline for HPM

The Part1 of the Technical Report MUAP-09019 “HSI Design” (Reference 5-3) describes the US-APWR Human Factors Engineering (HFE) Overall Implementation Procedure.

Figure 4.1-1 shows the overall workflow of the HFE process and is the basis of this Implementation Plan.

HEDs are the means or mechanism by which potential deficiencies in the HSIS are identified and tracked. Through each HFE element activity of Figure 4.1-1, HEDs will be generated, evaluated, and tracked to resolution in the issue tracking system used in the US-APWR HFE program.

The management procedure of the HEDs is described in Part 1, Section 6 of MUAP−09019.

The HPM procedure is applicable after the completion of the Design Implementation Plan is completed and prior to fuel load.

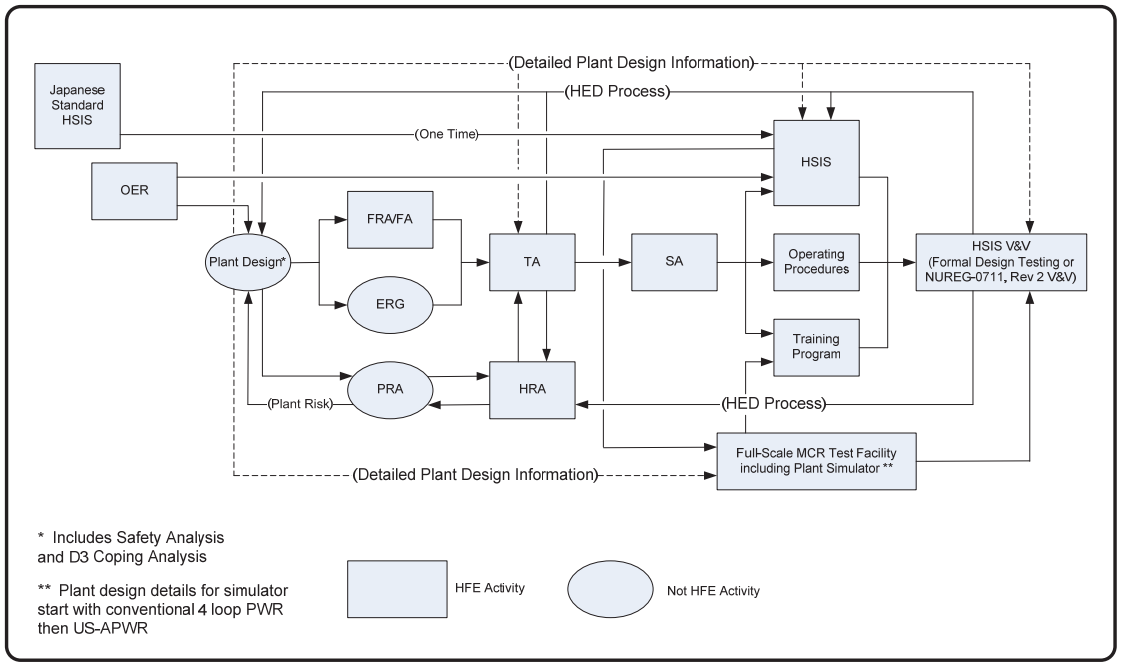

Figure 4.1-1 HFE Overall Work Flow

- The scope of HSI design, which is developed and/or evaluated by the HFE program, includes operations, accident management, maintenance, tests, inspections and surveillances that are important to safety. The HSI design process is conducted in accordance with an implementation procedure that reflects the requirements of the US-APWR HSI Design Implementation Plan (Reference 5-7).
- The scope of procedures, which is developed and/or evaluated by the HFE program, includes operations, accident management, maintenance, tests, inspections and

surveillances that are important to safety. The procedures guide and support human interactions with plant systems and control plant-related events and activities.

- The scope of training, which is developed and/or evaluated by the HFE program, includes operations, accident management, maintenance, tests, inspections and surveillances that are important to safety. The training provided to operations and maintenance personnel supports maintaining plant safety and response to abnormal plant conditions.

All of the HFE program elements above culminate in integrated system validation, where human performance for safety significant operator actions is measured to confirm the adequacy of the US-APWR HSI. The safety significant operator actions and the expectations for human performance for those actions establish the ISV Acceptance Criteria for the HSIS. These actions and the measurements for those actions also establish the baseline for the HPM program that continues for the life of the plant. The HPM program ensures that human performance is maintained at a level consistent with that observed and measured during ISV.

4.2 Implementation Procedure

The goal of the HPM program is to ensure that no significant safety degradation occurs as a result of changes in human performance, including any changes that may be due to design changes made in the plant. Human performance problems are identified through HFE evaluation of data collected from actual plant events, and periodic simulated training activities specifically designed to monitor human performance for degradation in key areas. Human performance deficiencies are analyzed to determine their cause. Practical experience has shown that different methods to monitor human performance may result in different conclusions. Therefore, in order to assure robust results that do not overlook important conclusions, the US-APWR strategy is to apply a combination of tools as described in NUREG/CR 6751. After determining the cause(s) of problems, corrective action plans are developed and implemented to preclude recurrence of the human performance deficiency. The following sections describe the integrated HPM implementation strategy.

4.2.1 Identifying Human Performance Problems and Causes

Reliable human performance is a requirement for safe operations in many settings, including commercial nuclear power. A systematic method has been developed to be used to identify and resolve human performance problems. This method consists of:

- Identification and characterization of human performance problems
- Techniques and information used to proactively investigate human performance
- The analyses used to determine the causes of the human performance problems
- A means to measure the effectiveness of corrective action plans

For some problems that the licensee may identify, HAs and decisions may not be important contributors to the problem. In others, human behavior may be central to creating the problem, and an understanding of the nature and causes of that behavior is necessary to develop

effective corrective actions. In the latter case, it is important that the human performance problem be characterized in sufficient detail to support problem resolution.

The US-APWR design includes computer based recording systems to collect and store plant data that may help to understand trends, , sequence of events, and conditions leading up to a problem such that the role the human played in problem initiation, progression, consequence, and recovery can be determined. This plant data will be used to directly support the plant corrective action system. Human performance will be monitored and documented based on actual plant conditions during plant startup and operation. This will be accomplished through review of computer event logs, which include process parameter and component status history, computer based procedure (CBP) execution history, and post event personnel debriefings. Evaluation techniques are used (see References 5-14, 15 and 16) to gather and evaluate the required information from these data systems to trend and determine problem causes and develop appropriate corrective actions.

In cases when human performance under actual plant conditions cannot be monitored, measured or simulated, such as operations at local control stations (LCSs) or manual actions outside of the MCR, available information that is determined by engineering judgment to most closely approximate performance data under actual conditions will be used. In these cases, a hierarchical and systematic logic will be applied to the selection, evaluation, and documentation of the appropriate surrogate data. Using the review criteria found in Reference 5-16 as guidance, the following sources of information will be used to prioritize plant and human performance data to best approximate performance in actual conditions:

i. Actual plant data of the event from plants records and testamentary evidence.

ii. Plant historical baseline and operating records of similar or related events.

iii. Desktop evaluations and analysis including applications of the plant task analysis (TA), probabilistic risk assessment (PRA) and safety analysis.

iv. Structured and specific dynamic training simulator exercises.

v. Past or ongoing training program records from the training simulator.

vi. Predecessor plant data.

vii. Industry Operating Experience Review (OER).

viii. Structured expert opinion.

In most cases when performance under actual conditions cannot be monitored, measured or simulated it is expected that a combination of sources of information will be applied to predict performance trends, evaluate events and determine corrective action.

4.2.2 Investigation Methods for Human Performance

The purpose of investigating human performance problems is to gather the information necessary to identify their causes and develop effective corrective actions.

The tools developed by Institute of Nuclear Power Operations (INPO) (see Reference 5-14, 15 and 16) for predecessor power plants, or similar methods modified for the US−APWR, will be used.

In general, the thoroughness with which an error or a human performance problem will be investigated and analyzed depends upon the assessed significance (e.g., safety, potential

economic impact) of the event sequence in which the error occurred or the potential for harm that an adverse human performance trend presents. In addition, the role of HA in an event sequence will also influence the extent to which an error is investigated. For example, a human error that is determined to be the root cause of an event will likely receive more attention than a human error that is determined to only contribute to the event.

The investigation should be systematic to help overcome the challenges inherent to investigating human performance. A systematic investigation process helps assures that the evidence gathered is complete, valid and reliable.

Evidence reliability refers to whether or not different investigators would find the same information and reach the same conclusions from it. A complete investigation identifies the direct, contributing and root causes of the human performance problem so that corrective actions can be developed to minimize recurrence of the same and similar problems.

The basis for completing the investigation of a human performance problem will be documented.

Licensees investigation in the Corrective Action Programs will determine the level of significance of the event, assign the appropriate level of investigation, and drive all investigations to logical conclusions.

4.2.3 Root Cause Analysis

Because standard root cause analysis techniques, such as events and causal factors charting and analysis, change analysis and barrier analysis, are resource-intensive and time-consuming to apply, their use may not always warranted. However, to yield reliable and useful results, the licensees should apply these techniques to the more significant problems. When standard root cause analysis techniques are used, it is not unusual for more than one cause to be identified for a human performance problem.

4.2.4 Corrective Action Plans

Developing effective corrective actions to significant problems requires a thorough analysis and an understanding of available methods for enhancing human performance. Depending upon the significance and scope of the cause(s) which are identified, corrective action plans may vary in scope from correcting a single cause, such as a missing tag on a valve, to a general organizational improvement plan. At a minimum, corrective actions must address each of the causal factors identified from the investigation. The corrective actions consist of:

- Training program upgrade
- Modification of Procedures
- Changes to HSI software
- HSI hardware upgrades

Corrective action plans define the steps for achieving the plan’s objectives in detail and assign responsibility to specific individuals for implementing each step. The measures for determining the success of corrective actions are also defined and may be used to refine the plan when

necessary. The method for monitoring the on-going effectiveness of the corrective action plan is to be documented.

4.2.5 Continuous Human Performance Improvement Process

To improve human performance and plant performance, efforts should be made to minimize the occurrence of errors at all levels of the organization, especially at the job site, and to validate the integrity of defenses, barriers, controls, or safeguards, especially for risk-significant systems.

Strategic consideration includes the following;

- **OER** is most effective when the right information is communicated to the right people in time to make a difference. The OER process used for development of basic design of the US-APWR is described in Part 1 of Reference 5-2. The station should make effective use of the operating experience information (for example, Nuclear Network, INPO event reports and MHI's experience in Japan) and have a systematic way of providing relevant "just-in-time" operating experience information. The right information on events should be useful to the user as he or she prepares to perform a similar assigned task. Operating experience that is properly reflected in procedures should lessen the severity and number of recurring problems. Operating experience information may also be incorporated into other documents such as standing orders, lesson plans, and the work planning process.

- **Training and Qualification**. A thorough understanding of the knowledge and skills associated with a particular job is one of the most important factors in error prevention. The ability to maintain situation awareness and to practice a questioning attitude is strengthened when plant personnel know their equipment and how it is supposed to operate. Training programs ensure people are qualified to perform their jobs. The knowledge, skills, and attitudes acquired in the formal training program are used to fulfill the requirements of the job. Effective training is accomplished using a systematic approach which addresses individual and organizational needs, as well as performance discrepancies.

- **Change management** is a process that is designed to reduce the potential for error caused by making changes. Changes and initiatives need to be implemented with careful preparation and with consideration of the various dynamics that come to bear within an organization or work group. Without a structured approach to planning and implementing change, the error potential (by managers and staff) and failure rates increase.

- **Use of the plant simulator** to validate a change before it is implemented is one of the most effective means to identify and correct problems they occur.

- **Independent Reviews** of station activities by outside organizations or agencies provide an opportunity to reveal "blind spots" to station management and plant personnel that otherwise could have remained hidden." Quality assurance (QA), corporate oversight group audits, outside consultants, NRC residents, peer reviews by World Association of Nuclear Operations (WANO) and INPO evaluations and assistance provide opportunities to identify hidden conditions.

4.3 Results

A HPM process is developed and documented within implementing procedures for the plant specific HPM Program, in accordance with this US-APWR HPM Implementation Plan. The site specific HPM program guides HPM, which includes the process to identify, track and disposition human performance issues for the life of the plant. The site specific HPM implementation procedures are applicable after the completion of the Design Implementation Plan is completed and prior to fuel load. The implementation procedures are inspected to confirm compliance with this US-APWR HPM Implementation Plan for closure of the design control document DCD Tier 1 ITAAC.

In addition, periodic status reports will be issued to document dispositions of human performance issues. The site specific HPM program establishes the requirements for identification, tracking and disposition of human performance issues. The HPM program addresses the same issues defined by Part 1, Section 6 of MUAP-09019 (Reference 5-4), but identifies site specific processes. The periodic status report will describe the following:

- Changes made to the HSIs, procedures, and training do not have adverse effects on personnel performance (e.g., changes do not interfere with previously trained skills).
- The acceptable level of performance is maintained.

5.0 REFERENCES

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5-17 Human Performance Reference Manual, INPO 06-003