US-APWR
Human Performance Monitoring Implementation Plan

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Abstract

The US-APWR Human Performance Monitoring Implementation Plan addresses the process of the HFE aspects of a site specific US-APWR human performance. The human performance program proactively looks for human performance degradation in plant operators, and examines plant design changes, HSI design changes, including training changes and procedure changes, for their potential adverse human performance impact on safety significant human actions.

The human performance program also manages corrective actions for the items above, and for any other human performance problems related to safety significant human actions.

Human performance program is executed by the site-specific HFE team, beginning after completion of the Design Implementation Plan, and continuing for the life of the plant.

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List of Acronyms

CBP	computer-based procedure
CFR	Code of Federal Regulations
COL	combined operating license
COLA	combined operating license application
DAS	diverse actuation system
DCD	design certification document
ECCS	emergency core cooling system
EOF	emergency operations facility
EOP	emergency operating procedure
ERG	emergency response guidelines
FA	function allocation
FRA	functional requirements analysis
FSAR	final safety analysis report
HPM	human performance monitoring
GDC	general design criteria
HA	human action
HED	human engineering discrepancy
HFE	human factors engineering
HRA	human reliability analysis
HSI	human-system interface
HSIS	human system interface system
I&C	instrumentation and control
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

RO	reactor operator
SA	staffing and qualifications analysis
SER	significant event report
SOER	significant operating experience report
SRO	senior reactor operator
TA	task analysis
TSC	technical support center
U.S.	United States
US-APWR	United States – Advanced Pressurized Water Reactor
V&V	verification and validation
VDU	visual display unit
WANO	World Association of Nuclear Operators

1.0 PURPOSE

The US-APWR Human Performance Monitoring Implementation Plan addresses the process of the HFE aspects of a site specific US-APWR human performance. Human performance monitoring process applies after the plant is in operation. Human performance monitoring within the scope of this program specifically applies to the following:

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

In addition, the Human Performance Monitoring Plan ensures that no significant safety degradation occurs because of any changes that are made in the plant, including changes to HSI designs, procedures and training, which effect safety significant human actions for the plant personnel defined in other program plans.

The plan requires periodic monitoring and documentation of human performance in actual or simulated plant conditions. Trends are maintained so that degraded performance is identified prior to reaching unacceptable levels. Corrective actions are tracked to resolution.

The US-APWR human performance monitoring program defines the set of activities needed to maintain that the implemented US-APWR HSI (i.e., the “as-built” HSI) meets the HFE requirements defined by the US-APWR HFE program as described in the US−APWR DCD Section 18.12 (Reference 5-1).

2.0 SCOPE

This plan for monitoring design changes covers the HSI in a site specific as-built US-APWR addressed as the following facilities:

- MCR
- Remote shutdown room (RSR)
- Technical support center (TSC)
- Local control stations (LCSs) - consideration of HFE activities for LCSs are limited to those LCSs that support:
  - On-line testing, radiological protection activities, and required chemical monitoring supporting technical specifications
  - Maintenance required by technical specifications
  - Emergency and abnormal conditions response
- Emergency operations facilities (EOFs)

The Human Performance Monitoring program will be applied and continue after the Design Implementation Plan (Reference 5-11) is completed.

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 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
- Staff Requirements Memoranda
- NRC Regulatory Guides
- NRC Branch Technical Positions
- NUREGs
- Other Reference Guidelines

4.0 IMPLEMENTATION PLAN

4.1 Initial Baseline for Human Performance Monitoring

The Part1 of the Technical Report MUAP-09019 “HSI Design” (Reference 5-3) describes the US-APWR Human Factors Engineering (HFE) Overall Implementation Procedure, which is described in Chapter 18 of the US-APWR DCD (Reference 5-1).

Figure 4-1 shows the overall workflow of the human factors engineering process basis of this Implementation Plan.

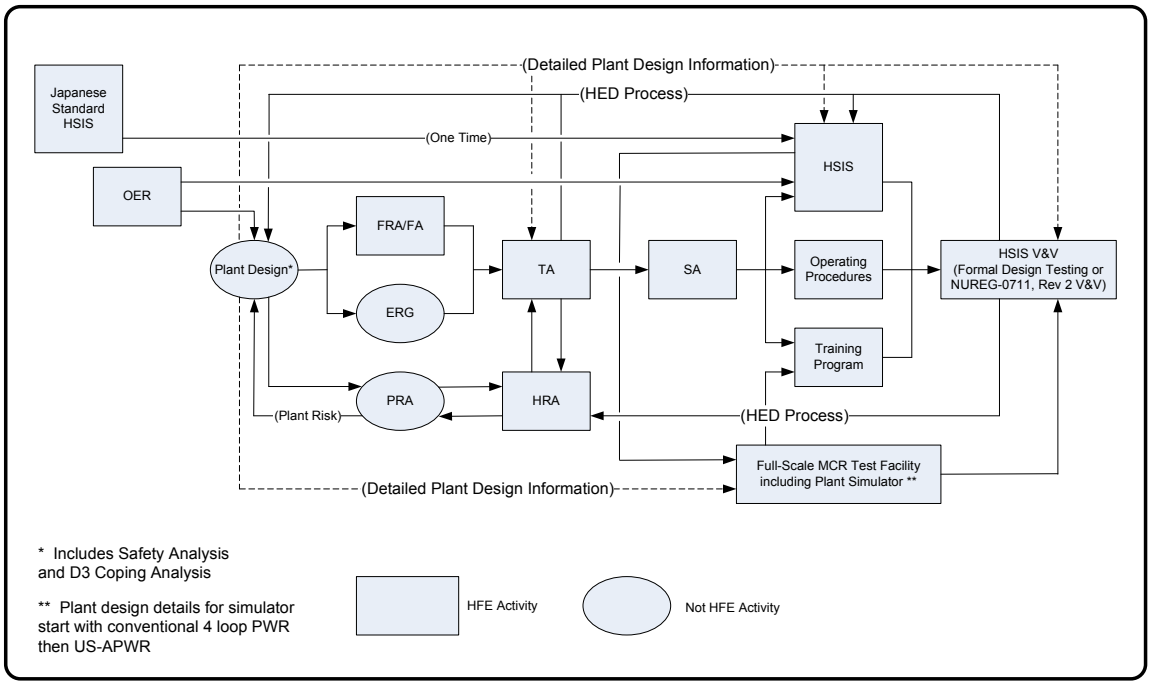

Figure 4-1 HFE Overall Work Flow

The Human Engineering Discrepancies (HEDs) are extracted, evaluated, resolved (if possible) and recorded at each elements of the human factors engineering process.

HEDs are the means or mechanism by which potential deficiencies in the HSIS are identified and tracked. Through each HFE element of Figure 4-1 activities HEDs will be generated to be evaluated and when the evaluation indicates, resolved. The issues tracking system is used in the US-APWR HFE program.

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

The Human Performance Monitoring program will be applied after the Design Implementation Plan is completed.

- 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 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 procedure development is conducted in accordance with an implementation procedure that reflects the requirements of the Procedure Development Implementation Plan (Reference 5-8).

- 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 is acceptable to maintain plant safety and respond to abnormal plant conditions. The training program has been development in accordance with an implementation procedure that reflects the requirements of the Training Program Development Implementation Plan (Reference 5-9).

4.2 Implementation Procedure

4.2.1 Identifying Human Performance Problems and Causes

Reliable human performance is a requirement for safe operations in many settings, including operations of commercial nuclear power and nuclear materials. In order to identify and resolve human performance problems, a systematic method is to be used which consists of following process:

- Identification and characterization of human performance problems
- Methods and information used to proactively investigate human performance
- The analyses used to determine the causes of the human performance problems
- The likely effectiveness of corrective action plans

The documentation may focus on system or equipment performance without discussion of the human actions and decisions that contributed to the event or condition.

For some problems that the licensee may identify, human actions 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 the 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.

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 INPO (see Reference 5-16, 17 and 18) 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 adverse human performance trend presents. In addition, the role of the human action in an event sequence will also influence the extent to which an error is investigated. For example, an error that was the root cause of an event will likely receive more attention than an error that only contributed to the event.

The investigation should be systematic to overcome the many challenges to investigating human performance. A systematic investigation process assures that the evidence gathered is complete, valid and reliable. Evidence validity refers to the accuracy of the information.

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. In this section, methods for systematically investigating human performance problems are presented.

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

Criteria are applied to determine when an investigation should be terminated. These could include, for example, a pre-set deadline for completing the investigation, reaching a dead-end due to the unavailability of further evidence, or a decision that the problem under investigation is minor and does not warrant the expenditure of further resources. For events that the licensee has classified as significant, the investigation is typically not terminated until the investigator and licensee management concur that sufficient evidence has been gathered to support the determination of the causes of the human performance problem and to develop specific and effective corrective actions.

4.2.3 Root Cause Analysis

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, but yield reliable and useful results when performed properly. Use of these standard techniques may not always be warranted, the licensees apply these techniques only to the more significant problems. When standard root cause analysis techniques are used, more than one cause is typically identified for a human performance problem which leads to the need for a corrective action plan

4.2.4 Corrective Action Plans

Developing effective corrective actions typically requires a thorough root cause analysis and an understanding of available methods for enhancing human performance. Depending upon the significance and scope of the cause(s) 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. As a minimum, corrective actions must address each of the causal factors identified from the investigation. The corrective actions are planned to following elements:

- Training program upgade
- 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 assigns responsibility to specific individuals for accomplishing the actions. The measures for determining the success of the corrective actions is also defined or used to refine the plan when necessary. Other management initiatives and events may arise that take precedence over implementing the corrective actions. The method for monitoring the on-going effectiveness of the corrective action plan and human performance problems is to be documented.

4.2.5 Continuous Human Performance Improvement Process

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

Strategic perspective actions will be continued for following;

- **Operating experience review** 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 be make effective use of the operating experience information (for example, Nuclear Network, the INPO and MHI's experience in Japan) and have a systematic way of providing "just-in-time," relevant, operating experience information. The right information on events should be useful to the user as he or she prepares to perform the 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**. Training programs ensure people are qualified to perform their jobs. The knowledge, skills, and attitudes acquired in the formal training program must match closely with the requirements of the job. These are accomplished using a systematic approach to training, which addresses individual and organizational needs, as well as performance discrepancies. A thorough understanding of the knowledge and skills associated with a particular job is one of the most important factors for 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.

- **Change management** is a process that reduces the potential of error, when making changes. Changes and initiatives need to be implemented with careful preparation and 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 are high. Use of plant simulator before the change is one of the most useful way to identify problems before.

- I**ndependent Reviews** of station activities by outside organizations or agencies provides an opportunity to reveal "blind spots" to station management and plant personnel that otherwise would have remained hidden, or "latent." Quality assurance departments, corporate oversight groups, consultants, NRC residents, peer review by WANO and INPO evaluations and assistance provide opportunities to identify latent conditions.

4.3 Results

A human performance monitoring strategy is developed and documented as the US-APWR Human Performance Monitoring Program. The US-APWR HPM program guides the human performance monitoring for the life of the plant and the process to identify and disposition human performance issues. This human performance monitoring procedure is applicable after the completion of the Design Implementation Plan is completed. It is verified during the DCD Tier 1 ITAAC phase as Table 2.9-1 item 6.

In addition, periodic status reports will be documented, and human performance issues are identified as HEDs and are tracked and dispositioned in accordance with the site specific QA program. The periodic status report will describe followings:

- 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

5-1 Design Control Document for the US-APWR, Chapter 18, Human Factors Engineering, MUAP-DC018 , Revision 2, October 2009

5-2 MUAP-07007, “HSI System Description and HFE Process,” Revision 3, October 2009

5-3 MUAP-08014, “Human System Interface Verification and Validation (Phase1a),” Revision 0, December 2008

5-4 MUAP-09019, “HSI Design,” Revision 0, June 2009

5-5 NUREG/CR-6751, “The Human Performance Evaluation Process: A Resource for Reviewing the Identification and Resolution of Human Performance Problems.,” June 2009

5-6 MUAP-10008, ”Staffing and Qualifications Implementation Plan,” April 2010

5-7 MUAP-10009, ”HSI Design Implementation Plan,” April 2010

5-8 MUAP-10010, ”Procedure Development Implementation Plan,” April 2010

5-9 MUAP-10011, ”Training Program Development Implementation Plan,” April 2010

5-10 MUAP-10012, ”Verification and Validation Implementation Plan,” April 2010

5-11 MUAP-10013, ”Design Implementation Plan,” April 2010

5-12 CN Number 05-030, NRC Inspection Manual: Chapter 0609, “Significance Determination Process,” 2001.

5-13 CN Number 05-031, NRC Inspection Manual: Chapter 2515, “Light-Water Reactor Inspection Program - Operations Phase,” 2002.

5-14 IP-71152, “Sustained Control Room and Plant Observation,” U.S. NRC Inspection Procedure

5-15 IP-71841, “Human Performance,” U.S. NRC Inspection Procedure

5-16 NUREG/CR-6751, “The Human Performance Evaluation Process: A Resource for Reviewing the Identification and Resolution of Human Performance Problems,” September 2001

5-17 INPO 05-002, “Human Performance Tools for Engineers and Other Knowledge Workers”

5-18 INPO 06-002, “Human Performance Tools for Workers”

5-19 INPO 06-003, “Human Performance Reference Manual”