18.12 Human Performance Monitoring

Monitoring human performance is performed throughout the life of the plant so that:

- The results of the integrated system validation are maintained.
- Operator performance does not degrade over time.
- Issues discovered by operating and maintenance personnel are noted, tracked, and corrected before plant safety is compromised.
- Changes made to the design do not result in a degradation of human performance.

The U.S. EPR human performance monitoring (HPM) strategy provides a method to accomplish this goal. A COL applicant that references the U.S. EPR design certification will implement an HPM program similar to that which is described in this section.

18.12.1 Objectives and Scope

The objectives for HPM are:

- To confirm that the design can be effectively used by personnel.
- To confirm that human actions (HA) are accomplished within an acceptable time and meet performance criteria.
- To confirm that design changes do not adversely affect personnel performance.
- To confirm that the acceptable level of performance established during the integrated system validation remains valid.

To verify that the objectives are met, HPM is conducted in areas of the plant requiring HAs, including:

- Main control room (MCR).
- Remote shutdown station (RSS).
- Technical support center (TSC).
- Local control stations (LCS) important to plant safety.

Operation, testing, and maintenance actions during each plant mode are also monitored for human performance.

18.12.2 Methodology

HPM is performed by observing personnel activities (i.e., during training and operation), interviews, self-initiated feedback, and walkthroughs. The use of a corrective action program combined with some means of tracking issues allows design errors, design issues, operator workarounds, operator burdens, or inefficiencies identified to be captured and addressed. Programs such as the design change control process, operator focus index, performance indicators, corrective action program, and maintenance rule are in place to prevent degradation of human performance. The combination of these tools creates a strategy that meets the intent of HPM as described in NUREG-0711 (Reference 1).

18.12.2.1 Corrective Action Program and Issue Tracking

A U.S. EPR operator corrective action program is used so that self-identified and industry performance related issues are documented, reviewed, addressed, and tracked. Addressing these issues prevents the recurrence of degraded performance or failures. Specific issues that should be tracked include:

- HSI design errors.
- HSI design inefficiencies.
- User workarounds.
- Discrepancies between the full-scope simulator and the actual control room.
- Changes to the HSI design that create an adverse affect on other aspects of the design.
- Operating experience reports.

So that issues are captured, plant personnel are encouraged to report errors, deficiencies, workarounds, and design inefficiencies. When an issue is entered into the database, a cognizant engineer performs an analysis to determine safety-significance. Those issues with a high safety-significance are analyzed and corrective actions are promptly generated to lessen the potential for impact to plant safety.

If an adverse trend is noticed, a root cause analysis is performed by a cognizant human factors engineer to determine the extent of cause, extent of condition, and if human performance was a contributor. This analysis generates a thorough understanding of the underlying problem so that appropriate corrective actions can be taken. The results of the root cause analysis are used to categorize the issue and enable trending.

Industry and self-identified operating experience results contribute to enhancing human performance and preventing potential reduction in human performance. The operating experience review program described in Section 18.2 tracks self-identified as

well as industry issues. These issues are screened for human performance issues and analyzed for applicability to the U.S. EPR. Preventive measures are taken for those issues that could potentially adversely impact human performance.

18.12.2.2 Monitoring and Trending

HAs and the level of performance are monitored during simulator-training and during actual plant conditions, when feasible. The data from monitoring is evaluated and the results are entered into the corrective action program for analysis and trending. The results of the trends are used to monitor for any change, positive and negative, in human performance. If the trend shows that performance has degraded, corrective actions are performed.

Risk-significant HAs are monitored more frequently so that degradation of safety-related performance is corrected before the safety of the plant is compromised.

18.12.2.3 Plant Operation

User activities are observed during simulator training and periodically during actual plant operation. The licensed operator training program allows monitoring of human performance and trending. Operator actions during training provide insight to potential operator workarounds, operator errors, and design inefficiencies. HAs are monitored for agreement with established time and performance criteria. These established performance measures are used as the baseline to determine changes in efficiency of user actions or their ability to perform tasks in a timely manner. Changes, along with any discovered design errors and decline in performance, are entered into the corrective action program to be analyzed for possible areas of improvement and used as input into human performance trending.

Other activities, such as communication between the control room and other areas of the plant, are also included in HPM and trending. Any inefficiencies, design errors, or failures noted by personnel are entered into the corrective action program and analyzed for possible areas of improvement and input to human performance trending.

18.12.2.4 Design Change

Before a design change that has a significant impact on FRA, FA, TA, HSIs, procedures, or training is implemented in the plant, the change is typically modeled on the engineering simulator. Human performance is monitored using applicable scenarios developed during operational condition sampling and used during the integrated system validation (see Section 18.10). These scenarios are limited to only those that use tasks affected by the design change to allow analysis of performance efficiency, degradation, or improvement. During simulation, user actions are observed for their efficiency and ability to perform tasks with the new design. The results are verified

against the existing trend of human performance to determine if the performance was degraded by the design change.

Any degradation in performance resulting from the design change is entered into the corrective action program to be analyzed for possible areas of improvement and used as input to human performance trending. Significant impacts to human performance require that the design change be modified. If no degradation in performance is observed, the design is implemented and results of the HPM are entered into the current trend.

When an approved design change has been implemented into the plant, performance is observed and users are interviewed. Interviews with users are performed to determine any operator workarounds, HSI inefficiencies, or design errors that resulted from the design change. Interview questions are centered on tasks that have been affected by the design change. Particular attention is given to user actions during their initial use of the new design to note any adverse affect on performance, confirm the design change is performing its intended function, and to view any operator workarounds. The significance of the design change impact determines the amount of monitoring effort required.

18.12.2.5 Operational Focus Index

An operational focus index is used to trend performance of operator's day to day activities. Indicators are used to exhibit the level of performance and risk associated with different operational activities. The level of the indicator is based on operator performance for that activity (e.g., Red = Bad, Yellow = Caution, Normal = White, and Green = Good).

Operational activities include:

- Operator workarounds.
- Operator burdens.
- Control room annunciations.
- Worker and maintenance tagouts greater than 90 days.
- Caution tagout greater than 90 days.
- Active fire protection impairment due to problem component.
- Corrective maintenance inventory.
- Plant elective maintenance inventory.
- Temporary modifications.

Indicators are updated periodically with a rolling average used to show trend. Adverse trends are entered into the corrective action program. Further analysis (e.g., root cause or operator interviews) may be required to understand the adverse trend and identify effective corrective actions.

18.12.2.6 Probabilistic Risk Assessment

Probabilistic risk assessment (PRA) models are used when plant or personnel performance can not be simulated, monitored, or measured. Performance data from modeled risk-significant HAs are used to evaluate the risk of the proposed design change on human performance during different operation modes. The U.S. EPR operator maintains the PRA model. After a design change, the PRA model is updated to reflect the new design.

18.12.2.7 Overall Design Control Process

A design control process described in Section 5 of the Human Factors Topical Report (Reference 2) controls the design, design changes, design verification, and analysis activities. A similar process is used by the U.S. EPR operator to control design changes. The process confirms that changes made to the design are adequate and accomplish the goal of the design change. The process also confirms that the design change does not result in adverse effects on personnel performance.

A substantial HSI design change is simulated on the simulator. Evaluation of human performance determines the anticipated impact of the design change, verifies that the performance level has been maintained, and verifies that the design change can be effectively used by personnel. If the design change demonstrates performance enhancements and does not show an adverse impact, it may be implemented into the plant.

18.12.2.8 Existing Plant Programs

Additional plant programs are used to support human performance. Barriers, including the inservice inspection and inservice testing program and the maintenance rule, are used to prevent a negative impact on human performance. To maintain acceptable human performance, structures, systems, and components (SSC) must be maintained in proper working order. Routine testing and inspection of SSC is performed so that deficiencies are corrected before the SSC become ineffective or inoperable.

Operators require proper notification when an SSC is out of commission for maintenance or repair in order to maintain sufficient human performance. Use of an inoperable SSC could potentially be tracked as an error in human performance and indicate a false trend.

18.12.3 Results Summary

HPM is continued throughout the life of the plant. Reports summarizing human performance-related issues, resolution of those issues, implementation status, and operating experience results are maintained for trending purposes. Operating conditions determine the necessary frequency of these summary reports.

A U.S. EPR operator shall maintain an HPM program which meets the intent given in this section. Documentation of HPM summarizes the following:

- Baseline human performance criteria established during V&V.
- HPM implementation strategy.
- Any trends in human performance.
- Operator focus index.
- Human performance-related issues, resolution, implementation status, and operating results.
- Specific human performance issues that can be applied to the standard U.S. EPR plant.

18.12.4 References

1. NUREG-0711, "Human Factors Engineering Program Review Model," U.S. Nuclear Regulatory Commission, 2004.
2. ANP-10279, Revision 0, "U.S. EPR Human Factors Engineering Program," AREVA NP Inc, January 2007.