FINAL SAFETY ANALYSIS REPORT

CHAPTER 18

HUMAN FACTORS ENGINEERING

18.0 HUMAN FACTORS ENGINEERING

This chapter of the U.S. EPR Final Safety Analysis Report (FSAR) is incorporated by reference with supplements as identified in the following sections.

18.1 HUMAN FACTORS ENGINEERING PROGRAM MANAGEMENT

This section of the U.S. EPR FSAR is incorporated by reference with the following supplements.

The U.S. EPR FSAR includes the following COL Item in Section 18.1:

> A COL applicant that references the U.S. EPR design will execute the NRC approved HFE program as described in this section.

This COL Item is addressed as follows:

{UniStar Nuclear Operating Services, LLC} shall execute the NRC approved Human Factors Engineering (HFE) program as described in U.S. EPR FSAR Section 18.1.

18.1.1 Human Factors Engineering Program Goals, Assumptions and Constraints, and Scope

18.1.1.1 Goals

No departures or supplements.

18.1.1.2 Assumptions and Constraints

No departures or supplements.

18.1.1.3 Applicable U.S. EPR Facilities

The U.S. EPR FSAR includes the following COL Item in Section 18.1.1.3:

> A COL applicant that references the U.S. EPR design certification will be responsible for HFE design implementation for a new Emergency Operations Facility (EOF) or changes resulting from the addition of the U.S. EPR to an existing EOF.

This COL Item is addressed as follows:

{The CCNPP site has an existing Emergency Operations Facility (EOF) for CCNPP Units 1 and 2. The existing EOF will be modified to accommodate an interface from CCNPP Unit 3. A description of the EOF is provided in the CCNPP Unit 3 Emergency Plan. The CCNPP Unit 3 Emergency Plan is provided in Part 5 of the COL application. Modifications to the existing EOF will be consistent with the U.S. EPR HFE Program described in U.S. EPR FSAR Chapter 18 and NUREG-0696 (NRC, 1981). These modifications will be evaluated using the U.S. EPR HFE Design Implementation process described in U.S. EPR FSAR Chapter 18. This process will verify the operability of the EOF features for CCNPP Unit 3 and ensure no degradation has occurred to the CCNPP Units 1 and 2 features in the EOF. Specifically, the plan will verify that the design changes to the existing EOF consider the effects on personnel performance and that the changes will provide the necessary support to provide reasonable assurance of effective implementation of the CCNPP Unit 3 Emergency Plan. Also, the modified EOF as-built design will be verified to conform to the verified and validated design that results from the HFE design process. This verification will be addressed through site-specific ITAAC provided in Part 10 of the COL application.}

18.1.1.4 Applicable Human System Interfaces

No departures or supplements.

18.1.1.5 Applicable Plant Personnel

No departures or supplements.

18.1.1.6 Effects of Modifications on Personnel Performance

No departures or supplements.

18.1.2 Human Factors Engineering and Control Room Design Team Organization

No departures or supplements.

18.1.3 Human Factors Engineering Processes and Procedures

No departures or supplements.

18.1.4 Human Factors Engineering Issues Tracking

No departures or supplements.

18.1.5 Technical Program

No departures or supplements.

18.1.6 References

{**NRC, 1981.** Functional Criteria for Emergency Response Facilities, NUREG-0696, U.S. Nuclear Regulatory Commission, February 1981}.

18.2 OPERATING EXPERIENCE REVIEW

This section of the U.S. EPR FSAR is incorporated by reference.

18.3 FUNCTIONAL REQUIREMENTS ANALYSIS AND FUNCTIONAL ALLOCATION

This section of the U.S. EPR FSAR is incorporated by reference.

18.4 TASK ANALYSIS

This section of the U.S. EPR FSAR is incorporated by reference.

18.5 STAFFING AND QUALIFICATIONS

This section of the U.S. EPR FSAR is incorporated by reference with the following supplements.

The U.S. EPR FSAR includes the following COL Item in Section 18.5:

> A COL applicant that references the U.S. EPR design will confirm that actual staffing levels and qualifications of plant personnel specified in Section 13.1 of the COL application remain bounded by regulatory requirements and results of the staffing and qualifications analysis.

This COL Item is addressed as follows:

Confirmation that actual staffing levels and qualifications of plant personnel specified in Section 13.1 remain bounded by regulatory requirements and results of staffing and qualifications analysis shall be verified by the implementation of ITAAC 5 of Tier 1 Table 3.4-1 of the U.S. EPR FSAR. Tier 1 Table 3.4-1 of the U.S. EPR FSAR is incorporated by reference in Part 10 of the COL application.

18.6 HUMAN RELIABILITY ANALYSIS

This section of the U.S. EPR FSAR is incorporated by reference.

18.7 HUMAN SYSTEM INTERFACE DESIGN

This section of the U.S. EPR FSAR is incorporated by reference

18.8 PROCEDURE DEVELOPMENT

This section of the U.S. EPR FSAR is incorporated by reference with the following supplement.

The U.S. EPR FSAR includes the following COL Item in Section 18.8:

> A COL applicant that references the U.S. EPR design certification will describe how HFE principles and criteria are incorporated into the development program for site procedures.

This COL Item is addressed as follows:

Plant specific procedures are developed consistent with the guidance of the operational guidelines described in Section 13.5.

18.9 TRAINING PROGRAM DEVELOPMENT

This section of the U.S. EPR FSAR is incorporated by reference with the following supplement.

The U.S. EPR FSAR includes the following COL item in Section 18.9:

> A COL applicant that references the U.S. EPR design certification will describe how HFE principles and criteria are incorporated into the development of training program scope, structure, and methodology.

This COL Item is addressed as follows:

The training program is addressed in Section 13.2.

18.10 VERIFICATION AND VALIDATION

This section of the U.S. EPR FSAR is incorporated by reference.

18.11 DESIGN IMPLEMENTATION

This section of the U.S. EPR FSAR is incorporated by reference.

18.12 HUMAN PERFORMANCE MONITORING

{The following site-specific information represents a Departure to the U.S. EPR conceptual Human Performance Monitoring (HPM) description:

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.

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 (HAs) 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 confirm that the acceptable level of performance established during the integrated system verification is maintained.
- Monitoring is done for HAs commensurate with their safety significance.
- To detect degrading human performance before plant safety is compromised.
- To confirm identified errors in the design are resolved in a timely manner.

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 (LCSs) important to plant safety.

- Emergency Operations Facility (EOF).
- Operational Support Center (OSC).

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

The HPM program establishes the requirements and interfaces for continuous improvement of human performance. The goal of the program is to reduce human errors that lead to plant events by promoting fundamental behaviors that support safe, reliable, and event free operation by:

- Establishing a strategic approach and expectations to improving human performance.
- Establishing processes to maintain and improve human performance.
- Promote behaviors to identify and eliminate error-likely situations.

The program elements include:

- Identification, evaluation, and performance of risk-significant activities using appropriate human performance tools.
- Provision of human performance tools to site personnel and promoting their use through training and procedures.
- Provision of a variety of defense-in-depth measures (such as pre-job briefs, just-in-time training, contingency planning, etc.) to reduce the probability of error and mitigate its effects should an error occur.
- The use of subordinate and peer coaching to reinforce desired behaviors.
- Assessment and trending of human performance through the use of field observations and assessments.
- Provision of feedback on suggestions for improvement.

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 tracking issues allows design errors, design issues, operator workarounds, operator burdens, or inefficiencies to be captured and addressed. Programs such as the design change control process, operator focus index, performance indicators, and corrective action program 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 (NRC, 2004).

18.12.2.1 Corrective Action Program and Issue Tracking

The UniStar Nuclear Quality Assurance Program Description describes the corrective action program used so that issues are documented, reviewed, addressed, tracked, and trended.

Plant personnel are encouraged to report errors, deficiencies, workarounds, and design inefficiencies, to ensure that issues are captured. Personnel performing evaluations of recommended dispositions shall have demonstrated competence in the specific area they are evaluating, have an adequate understanding of the requirements, and have access to pertinent background information.

For significant conditions adverse to quality, the cause of the condition is determined and corrective action taken to preclude recurrence. The identification, cause, and corrective action for significant conditions adverse to quality is documented and reported to appropriate levels of management. Follow-up action is taken to verify implementation of the corrective action.

Trend evaluation is performed in a manner and at a frequency that provides for prompt identification of adverse quality trends. Identified adverse trends are handled in accordance with the corrective action program described in the UniStar Nuclear Quality Assurance Program, and reported to the appropriate level of management.

Industry and self-identified operating experience results contribute to enhancing human performance and preventing potential reduction in human performance. Self-identified human performance operating experience will be documented, reviewed addressed, tracked, and trended through the corrective action program. The industry operating experience issues are screened for human performance and analyzed for applicability to CCNPP Unit 3. 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 Design Change Process

Before a design change that has a significant impact on a Human Interface System (HSI) is implemented in the plant, the change is typically modeled on the 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.

Operational feedback is used to validate that the design is implemented and is operating as expected.

18.12.2.4 Performance Indicators

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.

Adverse trends are entered into the corrective action program. Further analysis may be required to understand the adverse trend and identify effective corrective actions.

18.12.2.5 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. UniStar Nuclear Operating Services maintains the PRA model. After a design change, the PRA model is updated to reflect the new design.

18.12.2.6 Existing Plant Maintenance and Inspection 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.

UniStar Nuclear Operating Services 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

NRC, 2004. NUREG-0711, "Human Factors Engineering Program Review Model," 2004.}