3.4 Human Factors Engineering

3.4.1 Description

The HFE program design process is employed to design the control rooms and the human-system interfaces (HSI) and associated equipment while relating the high-level goal of plant safety into individual, discrete focus areas for the design.

The HFE program enables a design which supports the goal of providing plant operators and technicians safe and efficient access to the required information and controls to monitor and manage the plant processes and equipment. The HFE program also establishes the time and performance criteria for required equipment operations via human reliability analyses (HRA) and recognized guidelines.

The HFE and Control Room Design Team establishes design guidelines, defines program-specific design processes, and verifies that the guidelines and processes are followed. The scope of the HFE program includes the following:

- Location and accessibility requirements for the control rooms and other control stations.
- Layout requirements of the control rooms, including requirements regarding the locations and design of individual displays and panels.
- Basic concepts and detailed design requirements for the information displays, controls, and alarms for HSI control stations.
- Coding and labeling conventions for control room components and plant displays.
- HFE design requirements and guidelines for the screen-based HSI, including the actual screen layout and the standard dialogues for accessing information and controls.
- Requirements for the physical environment of the control rooms (e.g., lighting, acoustics, heating, ventilation and air conditioning (HVAC)).
- HFE requirements and guidelines regarding the layout of operator work stations and work spaces.
- Corporate policies and procedures regarding the verification and validation (V&V) of the design of HSI.

The HFE and Control Room Design Team is also responsible for program concepts for development of operating procedures, staffing requirements, and designer's input to the training program.

The HFE program applies to the design of the main control room (MCR), the Technical Support Center (TSC), the Instrumentation and Control Service Center (I&CSC), the remote shutdown station (RSS), and local control stations (LCS) associated with operation or maintenance. The design of LCS is accomplished concurrent with the applicable system design and follows guidelines established by the HFE and Control

Room Design Team. The HFE and Control Room Design Team also participates in the design of the Emergency Operations Facility (EOF).

The scope of the HFE program includes HSI that are related to plant process monitoring and control, as well as input to procedures and training associated with monitoring and controlling instrumentation and control (I&C) systems. The I&C systems include those required during normal operating modes as well as those required during tests, inspections, surveillances, maintenance, abnormal, emergency, and accident conditions. HSI associated with non-I&C systems (e.g., manual valve operators and other LCS) follow guidelines established by the HFE and Control Room Design Team.

3.4.2 Design Features

1. HFE operating experience review (OER) is performed in accordance with the prescribed process described in the OER Implementation Plan.

2. Functional requirements are performed in accordance with the prescribed process described in the Functional Requirements Analysis (FRA) Implementation Plan.

3. Functional allocation decisions are made based on a set of automation criteria which is defined and validated with the prescribed process described in the FRA Implementation Plan.

4. A task analysis is performed in accordance with the prescribed process described in the Task Analysis (TA) Implementation Plan.

5. The staffing and qualification analysis includes an evaluation of the number and qualifications of personnel needed to operate, maintain, and test the U.S. EPR based on HSI design features.

6. Human reliability analysis evaluates the potential for, and mechanisms of, human errors that may affect plant safety. Integration of human reliability analysis findings with HFE design is performed in accordance with the Human Reliability Analysis (HRA) Implementation Plan.

7. HSI design is performed in accordance with the prescribed process described in the HSI Design Implementation Plan. .

8. The selection of the minimum inventory is performed in accordance with the HSI Design Implementation Plan.

9. Procedures are developed in accordance with the Procedure Implementation Plan which directs the integration of the HFE procedure development. .

10. Training is developed in accordance with the Training Implementation Plan.

11. HFE verification and validation is performed in accordance with the prescribed process described in the Verification and Validation (V&V) Implementation Plan.

12. Design implementation is performed in accordance with the prescribed process described in the Design Implementation Plan.

3.4.3 Inspection, Tests, Analyses and Acceptance Criteria

Table 3.4-1 lists the HFE ITAAC.

Table 3.4-1—Human Factors Engineering ITAAC (5 Sheets)

Commitment Wording		Inspections, Tests, Analyses	Acceptance Criteria
1	HFE operating experience review (OER) is performed in accordance with the prescribed process described in the OER Implementation Plan.	An analysis of the output summary report has been performed.	An output summary report exists and concludes that the lessons learned from the reviewed operating experience have been incorporated into the HSI design.
2	Functional requirements are performed in accordance with the prescribed process described in the Functional Requirements Analysis (FRA) Implementation Plan.	An analysis of the output summary report has been performed.	An output summary report exists and includes: • A list of functions in-scope for meeting plant safety objectives. • Details of the differences between functional requirements for safety functions between predecessor designs and the U.S. EPR. • Technical justification and design basis for each difference between predecessor and U.S. EPR functional requirement.
3	Functional allocation decisions are made based on a set of automation criteria which is defined and validated with the prescribed process described in the FRA Implementation Plan.	An analysis of the output summary report has been performed.	The output summary report exists and includes: • The complete set of automation criteria used including the established control hierarchy between automatic and manual actions. • A list of the functions automated for predecessor EPRs and the differences between the predecessors and the U.S. EPR. • Technical justification for each difference in functional allocation.

Table 3.4-1—Human Factors Engineering ITAAC (5 Sheets)

Commitment Wording		Inspections, Tests, Analyses	Acceptance Criteria
4	A task analysis is performed in accordance with the prescribed process described in the Task Analysis (TA) Implementation Plan.	An analysis of the output summary report has been performed.	a. The output summary report exists and includes a description of how iterations of TA for procedure development, the procedures themselves, and training programs result in an HSI design that supports in-scope control, information, and support requirements.
			b. The draft operating procedure guidelines identify functions needed to complete the given series of tasks.
5	The staffing and qualification analysis includes an evaluation of the number and qualifications of personnel needed to operate, maintain, and test the U.S. EPR based on HSI design features.	An analysis of the V&V activities driven by the initial staffing assumptions for the U.S. EPR document has been performed.	The output summary report of the U.S. EPR staffing and qualifications analyses demonstrates that the HSI design supports the number, roles, and responsibilities of the plant operating staff to adequately meet the demands of the processes of the plant.
6	Human reliability analysis evaluates the potential for, and mechanisms of, human errors that may affect plant safety. Integration of human reliability analysis findings with HFE design is performed in accordance with the Human Reliability Analysis (HRA) Implementation Plan.	An analysis of the output summary report has been performed.	The output summary report exists and documents the list of risk-important human actions (HA) and summarizes how those HA and the associated tasks and scenarios were addressed during the various parts of the HFE design process including validation of HRA assumptions.

Table 3.4-1—Human Factors Engineering ITAAC (5 Sheets)

Commitment Wording		Inspections, Tests, Analyses	Acceptance Criteria
7	HSI design is performed in accordance with the prescribed process described in the HSI Design Implementation Plan.	An analysis of the output summary report has been performed.	The output summary report exists which: • Demonstrates that the HSI design was performed in accordance with the prescribed process. • Documents the HSI descriptions including how the design requirements and design characteristics were met. • Documents the outcome of tests and evaluations performed in support of V&V of HSI design.
8	The selection of the minimum inventory is performed in accordance with the HSI Design Implementation Plan.	An analysis is performed on the final HSI design results documents.	A final results summary document exists that concludes that the HSI design process for the minimum inventory was conducted in accordance with the implementation plan and contains: • The detailed HSI description including its form, function and performance requirements and characteristics. • The basis for the HSI requirements and design characteristics. • The records of the basis of the design changes. • The outcomes of tests and evaluations.

Table 3.4-1—Human Factors Engineering ITAAC (5 Sheets)

Commitment Wording		Inspections, Tests, Analyses	Acceptance Criteria
9	Procedures are developed in accordance with the Procedure Implementation Plan which directs the integration of the HFE procedure development.	An analysis of the output summary report has been performed.	An output summary report exists which: • Addresses the final set of procedures and support equipment developed using the established methodology. • Includes the results of verification and validation activities as they relate to procedure development. • Describes how procedures will be maintained and updates controlled. • Gives a description of how operators access and use procedures, especially during operational events including: • Storage of procedures. • Ease of operator access to the correct procedures.
10	Training is developed in accordance with the Training Implementation Plan.	An analysis of the output summary report has been performed.	An output summary report exists and includes: • The roles of organizations that contributed to the training program. • How learning objectives were developed and translated into the use of associated knowledge, skills, and attributes. • The use of resources (e.g., lectures, simulators, computer-based training, schedule) for training. • Methods used to evaluate effectiveness of the program.

Table 3.4-1—Human Factors Engineering ITAAC (5 Sheets)

Commitment Wording		Inspections, Tests, Analyses	Acceptance Criteria
11	HFE verification and validation is performed in accordance with the prescribed process described in the Verification and Validation (V&V) Implementation Plan.	An analysis of the output summary report has been performed.	The output summary report exists which: • Demonstrates that the V&V was performed in accordance with the prescribed process. • Demonstrates that the design conforms to HFE design principles. • Demonstrates that the design enables plant personnel to successfully perform their tasks to achieve plant safety and other operation goals. • Provides results of V&V activities and conclusions from these activities.
12	Design implementation is performed in accordance with the prescribed process described in the Design Implementation Plan.	An analysis of the output summary has been performed.	The output summary report exists that demonstrates: • The design implementation was performed in accordance with the prescribed process for validation that the as-built design conforms to the standard design resulting from the HFE V&V process. • Appropriate issues identified in the HFE issues tracking database have been adequately addressed.

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