

## MANAGEMENT MEASURES

### 11.6 HUMAN FACTORS ENGINEERING/PERSONNEL ACTIVITIES

#### 11.6.1 PURPOSE OF REVIEW

The purpose of the review is to establish, with reasonable assurance, that the applicant has applied human factors engineering (HFE) to personnel activities identified as items relied on for safety so they will be available and reliable to perform their intended functions when needed. In addition, the review should verify that HFE practices and guidelines are incorporated into human-system interface (HSI) designs and supporting elements to ensure that the HSIs support safe and reliable personnel activities. This provides assurance that the possibility of human error in the facility operations was addressed during the design of the facility by facilitating correct, and inhibiting wrong decisions by operators and by providing means for detecting, correcting, or compensating for error.

#### 11.6.2 RESPONSIBILITY FOR REVIEW

Primary: Human Factors Specialist

Secondary: Lead reviewer of ISA

Supporting: Site Representative or Fuel Cycle Facility Inspector

#### 11.6.3 AREAS OF REVIEW

The review should address personnel activities contained in the ISA for the protection of the workers, the public, and the environment. The application of HFE on the personnel activities should include HSI design and supporting elements such as staffing, training, and procedures.

This HFE/personnel activities review process can be divided into the following areas of review:

1. HSI Design Review Planning,
2. Identification of Personnel Activities,
3. Operating Experience Review,
4. Function and Task Analysis,
5. HSI Design, Inventory and Characterization,
6. Staffing,
7. Procedure Development,
8. Training Program Development, and
9. Human Factors Verification and Validation.

Judgement regarding the areas of review for a given submittal should be based on evaluation of the information provided with respect to (1) provisions made to address personnel activities consistent with the findings of the ISA, (2) the similarity of the associated HFE issues to those for similar type plants, and (3) the determination of whether items of special or unique safety significance are involved.

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### 11.6.4 ACCEPTANCE CRITERIA

#### 11.6.4.1 Regulatory Requirements

The requirement for personnel activities is provided in the following:

Nuclear Regulatory Commission (U.S.), Washington, D.C. "Domestic Licensing of Special Nuclear Material (10 CFR Part 70)." *Federal Register*: Vol. 64, No. 146. pp. 41338–41357. July 30, 1999.

Specific citations are as follows:

1. In § 70.4, "Definitions," the term *items relied on for safety* is defined. Personnel activities are included as an item relied on for safety.
2. In § 70.61(e), the states that each item relied on for safety will be available and reliable to perform its intended function when needed.
3. In § 70.62(c)(vi), items relied on for safety are identified through the performance of an integrated safety analysis as part of the safety program.
4. In § 70.65(b)(6), the application is required to a list of items relied on for safety in sufficient detail to understand their functions in relation to the performance requirements.

#### 11.6.4.2 Regulatory Guidance

There are no regulatory guides that apply to HFE/personnel activities for a new facility licensed under 10 CFR Part 70.

#### 11.6.4.3 Regulatory Acceptance Criteria

The applicant's treatment of personnel activities identified as items relied on for safety should be acceptable if the applicant applied HFE practices and criteria to the personnel activities and supporting HSIs that provide reasonable assurance that the personnel activities will take place and satisfy their safety functions when needed. The specific areas of review should include the following:

1. HSI Design Review Planning - Acceptance should be based on confirmation that the applicant has adequately considered the role of HFE and the means by which it is applied during design, construction and operation of the facility to improve reliability personnel activities identified in the ISA. The applicant should address -- commensurate with the results of the ISA--the following functional areas:
  - a. General HFE Functional Goals and Scope
  - b. HFE Team and Organization/Individual and Responsibilities
  - c. HFE Process and Procedures

- d. HFE Issues Tracking
  - e. HFE Functional Description
2. Identification of Personnel Activities - Acceptance should be based on the ability of the applicant to identify the personnel activities as items relied on for safety from the ISA summary. The activities should be described to the extent that the reviewer can understand what the human is to do, which HSIs are involved, and the importance of the action. The personnel activities should include:
    - a. Accident sequences in which human errors are causes.
    - b. Operator actions that are credited as safeguards.
    - c. HSIs intended to support those personnel activities required to prevent, detect, and correct conditions that could be root-causes or contributing factors to accidents.
    - d. HSIs intended to support those personnel activities required to mitigate the consequences of accidents.
  3. Operating Experience Review (OER) - Acceptance should be based on the verification that the applicant has identified and analyzed for relevance HFE-related problems and issues encountered in previous designs that are similar to the proposed design under review.
  4. Functional Allocation Analysis and Task Analysis - Acceptance should be based on verification that (1) the allocation of functions between personnel and plant system elements takes advantage of human strengths and avoids demands that are not compatible with human capabilities, and (2) the task requirements on plant personnel have reasonable performance demands for accomplishing the allocated functions.
  5. HSI Design - The HSI design process and the detailed HSI design that is a product of that process should be acceptable by verification that the applicant has appropriately translated function and task requirements to the detailed designs of HSI components (such as alarms, displays, controls, and operator aids) through the systematic application of HFE principles and criteria. In addition, the applicant has appropriately considered environmental conditions that could have an effect on personnel involved in the activity and factored those considerations into the HSI design.
  6. Staffing - Staffing should be acceptable if the applicant has reviewed the requirements for the number and qualifications of personnel in a systematic manner that includes a thorough understanding of task requirements and applicable regulatory requirements for the range of applicable plant conditions and personnel activities.
  7. Procedure Development - The description of procedure development for personnel activities identified as relied on for safety should satisfy the acceptance criteria in SRP Section 11.5. The procedures should be based on the task analyses and should integrate the personnel activities and the associated HSIs needed to accomplish those activities.

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8. Training Program Development - The description of the process for the development of personnel training should satisfy the acceptance criteria in SRP Section 11.4. Training requirements should be based on the task analyses and should focus on the relationship between the personnel activities and the associated HSIs needed to accomplish those activities.
9. Verification and Validation - A description of the verification and validation (V&V) process should be acceptable if confirms that the design conforms to HFE design principles that enables plant personnel to successfully perform personnel activities to achieve plant safety. The scope of V&V should address those personnel activities discussed in item 2 above and HSI design requirements listed in item 5 above. An acceptable V&V process should consist of a combination of the five activities listed below:
  - a. HSI task support verification - an evaluation to ensure that HSI components are provided to address personnel activities identified in the ISA. The HSI task support verification should be acceptable by verification that the aspects of the HSI (e.g., alarms, controls, displays, procedures, and data processing) that are required to accomplish personnel activities are available through the HSI. It should also be verified that the HSI minimizes the inclusion of information, displays, controls, and decorative features that inhibit personnel activities.
  - b. HFE design verification - an evaluation to determine whether the design of each HSI component reflects HFE principles, standards, and guidelines. The method and the results of the HFE design verification should be acceptable if the HSI has been designed to be appropriate for personnel activities and operational considerations as defined by the HSI design process consistent with accepted HFE guidelines, standards, and principles. Mockup(s), model(s), or other tools can be used by the applicant to perform the HFE design verification.
  - c. Integrated system validation - a performance-based evaluation of the integrated design to ensure that the HFE/HSI supports safe operation of the plant. Integrated system validation should be performed after HFE problems identified in earlier review activities have been resolved or corrected because these may negatively affect performance and, therefore, validation results. All critical or risk-significant personnel activities as defined in the task analysis and the ISA should be tested and found to be adequately supported in the design, including the performance of such actions outside the control room.
  - d. Human factors issue resolution verification - an evaluation to ensure that the HFE issues identified during the design process have been acceptably addressed and resolved. Issue resolution verification should be acceptable if all issues documented in the HFE issue tracking system are satisfactorily addressed. Issues that cannot be resolved until the HSI design is constructed, installed, and tested should be specifically identified and incorporated into the final plant HFE/HSI design verification.
  - e. Final plant HFE/HSI design verification - assurance that the implementation of the final design of the HSI and supporting systems (for example, procedures and training

programs) conform to the V&Ved design that resulted from the HFE design process. Final plant HFE/HSI design verification should be performed if the V&V activities, described above, did not fully evaluate the actual installation of the final HSI design in the plant. Final verification should be acceptable if in-plant implementation of the HFE design conforms to the design description that resulted from the HFE design process and V&V activities.

V&V activities should be performed in the order listed above, as necessary. However, iteration of some steps may be necessary to address design corrections and modifications that occur during V&V.

## **11.6.5 REVIEW PROCEDURES**

### **11.6.5.1 Acceptance Review**

The primary reviewer should evaluate the application to determine whether it addresses the “Areas of Review” discussed in Section 11.6.3, above. If significant deficiencies are identified, the applicant should be requested to submit additional material before the start of the safety evaluation.

### **11.6.5.2 Safety Evaluation**

After determining that the application is acceptable for review in accordance with Section 11.6.5.1, above, the primary reviewer should perform a safety evaluation against the acceptance criteria described in Section 11.6.4. If during the course of the safety evaluation, the primary reviewer determines the need for additional information, the primary reviewer should coordinate a request for additional information with the licensing project manager. The staff should use a tiered approach for evaluating the HFE design. The upper tier is at the program description level, with high-level plant mission goals that are divided into the functions necessary to achieve the mission goals. The middle tier encompasses functions that are allocated to human and system resources and that are divided into tasks (personnel activities) for the purposes of specifying the alarms, information, and controls that are designed to accomplish function assignments. The tasks should be arranged into meaningful jobs and the HSI should be designed to best support job task performance. The lower tier is the detailed design (of the HSI, procedures, and training) and how they are incorporated into the facility design. Evaluation of the HFE design should be broad-based and include aspects of normal and emergency operations, testing, maintenance, etc., consistent with findings in the ISA.

The submittal should be reviewed at multiple tiers to ensure personnel activities identified into the ISA are translated into the facility design.

The primary review staff should review the ISA summary to ensure personnel activities have been suitably characterized as part of items relied on for safety that are needed to prevent or mitigate consequences of concern. Information from analyses conducted to address the criteria of SRP Chapter 3 should be incorporated as an input to the HFE design process, including the development of HSI design and test requirements. This input is articulated in acceptance

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criterion two. The extent HFE elements are applied should be based on the number, type, and complexity of the personnel activities.

The secondary reviewer should ensure that the types of personnel activities relied on for safety are appropriate. Furthermore, the secondary reviewer should ensure there is coordination between HFE and the ISA, and that lessons learned are incorporated into the ISA.

The supporting reviewers should assist in the tiered approach of the review in that they may look at specific examples of human factors engineering in an existing facility.

### **11.6.6 EVALUATION FINDINGS**

The primary reviewer should write an SER section that addresses each topic reviewed under this SRP Section and explains why the NRC staff has reasonable assurance that the personnel activities described in the application are acceptable. License conditions may be proposed to impose requirements where the application is deficient. The SER should include a summary statement of what was evaluated and the basis for the reviewers' conclusions.

The staff can document the evaluation as follows:

*The staff has reviewed the human factors activities for the TWRS facility according to Standard Review Plan Section 11.6. [Insert a summary statement of what was evaluated and why the reviewer finds the submittal acceptable.]*

*The applicant has identified the personnel activities identified in the ISA and demonstrated how human factors engineering (HFE) principles, including function and task analysis, were incorporated into those human-safety interface (HSI) designs to ensure reliability of the activities. The applicant has conducted an operating experience review of applicable facilities and incorporated lessons learned into the design process. In addition, the applicant has verified the adequacy of the HFE principles and HSI through use of validation and verification and has incorporated these principles into identified support functions of training, procedures, and staffing.*

*Meeting the above requirements provides an acceptable basis for finding that there is reasonable assurance that personnel activities in the context of items relied on for safety will be available and reliable to perform their intended functions when needed.*

### **11.6.7 REFERENCES**

1. Nuclear Regulatory Commission (U.S.), Washington, D.C. "Domestic Licensing of Special Nuclear Material (10 CFR Part 70)." *Federal Register*: Vol. 64, No. 146. pp. 41338–41357. July 30, 1999.
2. Nuclear Regulatory Commission (U.S.) (NRC). NUREG-0700, Rev.1, Vol.1, "Human-System Interface Design Review Guideline." NRC: Washington, D.C. June 1996.

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3. Nuclear Regulatory Commission (U.S.) (NRC). NUREG-0711, "Human Factors Engineering Program Review Model." NRC: Washington, D.C. July 1994.
4. Department of Defense (DOD). MIL-STD-1472D, "Human Engineering Design Criteria for Military Systems, Equipment and Facilities." DOD: Washington, D.C. March 1989.
5. The Institute of Electrical and Electronics Engineers (IEEE). IEEE Std 1023-1988, "IEEE Guide for the Application of Human Factors Engineering to Systems, Equipment, and Facilities of Nuclear Power Generating Stations." IEEE: New York, NY. May 1989.