

**DOE FTCP  
SUPPLEMENTAL COMPETENCIES**

**HUMAN FACTORS ENGINEERING  
FUNCTIONAL AREA QUALIFICATION  
COMPETENCY EXAMPLES**

For

**DOE Defense Nuclear Facilities Technical  
Personnel**

## APPROVAL

The Federal Technical Capability Panel consists of senior U.S. Department of Energy (DOE) managers responsible for overseeing the Federal Technical Capability Program. This Panel is responsible for reviewing and approving qualification standards and competencies for Department-wide application. Approval of this set of competency statements by the Federal Technical Capability Panel is indicated by signature below.



Karen L. Boardman, Chairperson  
Federal Technical Capability Panel

3.19.12

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U.S. DEPARTMENT OF ENERGY  
**COMPETENCIES FOR HUMAN FACTORS ENGINEERING**

**PURPOSE**

The purpose of the following competencies is to establish standardized competency statements related to Human Factors Engineering for use by DOE Technical Qualification Program (TQP) participants who provide technical oversight of contractor activities that could impact safety in nuclear facilities. Satisfactory and documented attainment of the competency requirements demonstrates that TQP participants possess the suggested minimum competence to fulfill their duties and responsibilities in alignment with DOE policies and procedures.

Offices and organizations should assign these competencies as appropriate to supplement the General Technical Base Qualification Standard and the Functional Area Qualification Standards and establish unique competency requirements at the office, site, facility, or position level.

**APPLICABILITY**

These competencies, although optional, should be assigned at the direction of Headquarters or Field Element Managers. They are intended for qualification cards for personnel who provide technical assistance, direction, guidance, oversight, or evaluation of contractor activities impacting the safety of operations of DOE nuclear facilities.

**IMPLEMENTATION**

Each competency statement has supporting knowledge and/or skill statements, that describe the type and depth of knowledge expected. The supporting knowledge and/or skill statements are guidelines, not requirements, and do not necessarily have to be fulfilled in their entirety to meet the intent of the competency.

The competencies suggest a familiarity level or a working level of knowledge; or they require the individual to demonstrate the ability to perform a task or activity. Site management should assign familiarity or working level as is relevant for the participants work responsibilities. The levels are defined as:

**Familiarity level** is defined as basic knowledge of or exposure to the subject or process adequate to discuss the subject or process with individuals of greater knowledge.

**Working level** is defined as the knowledge required to monitor and assess operations/activities, to apply standards of acceptable performance, and to reference appropriate materials and/or expert advice as required to ensure the safety of Departmental activities.

**Expert level** is defined as a comprehensive, intensive knowledge of the subject or possesses sufficient knowledge to provide advice in the absence of procedural guidance. A degree in Human Factors (or a closely related field) from an accredited university is required in order to be considered an expert in Human Factors Engineering. [Included for comparison—no competencies are at expert level].

**Demonstrate the ability** is defined as the actual performance of a task or activity in accordance with policy, procedures, guidelines, and/or accepted industry or Department practices.

## EVALUATION REQUIREMENTS

Evaluation and qualification follow the process described in the organization's TQP Plan. The attainment methods include the following:

- Documented evaluation of equivalencies
- Written examination
- Documented oral evaluation
- Documented observation of performance

## DUTIES AND RESPONSIBILITIES

Human Factors Engineering is part of a nuclear facility's Documented Safety Analysis (DSA) under DOE-STD-3009-94, *Preparation Guide for US Department of Energy Nonreactor Nuclear Facility Documented Safety Analysis*. The Standard, in its discussion of Chapter 13 of a DSA, states that "Human factors engineering ... focuses on designing facilities, systems, equipment, and tools so they are sensitive to the capabilities, limitations, and needs of humans." All technical positions that have a direct role in the safe design and operation of structures, systems, and components should have a working level knowledge of human factors engineering. In addition to Nuclear Safety Specialists (NSS), this is especially important for safety system oversight (SSO) personnel whose job it is to ensure safe design and operation of physical assets. SSO functional areas include Mechanical Systems, Electrical Systems, Civil/Structural, Fire Protection, Instrumentation and Control, and others. Familiarity with Human Factors is highly recommended for anyone with oversight responsibilities for high hazard operations. The following are the typical oversight duties and responsibilities expected of personnel who need increased level of knowledge of Human Factors Engineering (HFE):

- Participate in the oversight of contractor implementation of the Nuclear Safety Management rule (10 CFR 830 Subpart B). Examples include preparation, review and/or recommendation for approval of nuclear basis safety documents: Documented Safety Analyses (DSAs), Technical Safety Requirements (TSRs), Unreviewed Safety Questions (USQ), Safety Evaluation Reports (SERs), etc.

- Evaluate Integrated Safety Management (ISM) related to safety bases: identification, surveillance and maintenance of safety Structures, Systems, and Components (SSCs), safety-related Quality Assurance (QA), selection and implementation of safety-related standards, related nuclear safety management programs, etc.
- Participate in nuclear facility design reviews, safety system status monitoring, etc.
- Evaluate design and analysis uncertainties with the functionalities of systems as described in the DSA.
- Communicate technical safety expectations and issues.

## TECHNICAL COMPETENCIES

Competencies for TQP participants support responsibilities identified in the organization's Functions, Responsibilities, and Authorities Manual (FRAM) and individual position descriptions and assigned areas of responsibility.

Each of the competency statements is a general expectation. Supporting knowledge and/or skills statements further define expectations.

*Note: When regulations or Department of Energy directives are referenced in the Qualification Standard, the most recent revision should be used.*

### Familiarity Level

#### **1. Personnel shall demonstrate a familiarity level of knowledge of Human Factors Engineering (HFE).**

##### Supporting Knowledge and/or Skills

- Define or describe HFE.
- Discuss the history of HFE, and identify some significant accidents where inadequate HFE was a contributing factor.
- Explain how HFE concepts should be integrated in work planning, facility and process design, and oversight activities.
- List the values and potential benefits of HFE.
- Describe where HFE expertise resides today, in DOE and its contractors.
- Describe the applicability of HFE to DOE facilities and operations, including where in the life cycle, as well as the functional areas where it may be used.
- State some of the main orders, standards, and other requirements for HFE.
- Describe the application of HFE within other federal agencies.

#### **2. Personnel shall demonstrate a familiarity level knowledge of Human Factors Engineering (HFE), as articulated in the following DOE orders, guides, standards, and handbooks, as applicable to the person's job responsibilities.**

- DOE O 420.1B *Facility Safety*

- DOE O 422.1 *Conduct of Operations*
- DOE G 420.1-1 *Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria Guide*
- DOE-STD-1186-2004 *Specific Administrative Controls*
- DOE-STD-1189-2008 *Integration of Safety in the Design Process*
- DOE-STD-3009-94 *Preparation Guide for U.S. DOE Nonreactor Nuclear Facility Documented Safety Analyses*
- DOE-STD-3024-98 *Content of System Design Descriptions*, § 3.2.6
- DOE-HDBK-1140-2001 *Human Factors/Ergonomics Handbook for the Design for Ease of Maintenance*

#### Supporting Knowledge and/or Skills

- a. The purpose, scope, applicability, and expectations articulated in the above DOE orders and standards, or related consensus standards, as applicable to the person's job responsibilities.
- b. Identify and discuss the role and use of human factors approaches and methodologies in hazard and accident analysis.
- c. Identify and discuss aspects of person-machine interface that can degrade or enhance the performance of personnel.
- d. Discuss the influence of management and organizational factors on performance.
- e. Understand how human factors can influence the design and resulting effectiveness of human-system interactions.
- f. Identify when a HFE SME involvement/engagement is necessary.

#### Other Existing Competencies

The following is a partial list of existing HFE competencies already included in the cited TQP Functional Area Qualification Standards. Organizations are encouraged to incorporate pertinent statements, as appropriate, within their office and position-specific standards.

#### From the **Chemical Processing FAQS DOE-STD-1176-2010:**

- 21. Chemical processing personnel must demonstrate a familiarity level of knowledge of software quality assurance functional interfaces between safety system software components and the system-level design.**

#### Supporting Knowledge and/or Skills

- a. Identify how system-level requirements are established and then assigned to hardware, software, and human components of a digital instrumentation and control system.

From the Criticality Safety FAQS DOE-STD-1173-2009:

**8. Criticality safety personnel must demonstrate a familiarity level knowledge of the relationship between human factors, human performance, and implementation of criticality safety controls.**

Supporting Knowledge and/or Skills:

- a. Identify and discuss aspects of person-machine interface that can degrade or enhance the safety performance of personnel.
- b. Identify and discuss how written procedures are conducive to reliable or unreliable performance of activities important to safety.
- c. Identify and discuss how personnel training programs can be conducive to safety or prone to error.
- d. Identify and discuss how staffing and qualification of operational personnel are conducive to safe versus unsafe operations.
- e. Identify and discuss the influence of management and organizational factors upon safety of operations.
- f. Identify and discuss the methods used to estimate the probability of significant mistakes made by personnel and the relationship to Probabilistic Risk Assessment (PRA).
- g. Identify and discuss the methods for assessing the reliability of administrative controls in maintaining criticality safety.

**34. Criticality safety personnel must demonstrate a familiarity level knowledge of nuclear accident analysis techniques.**

Supporting Knowledge and/or Skills:

- e. Identify and discuss the role and use of human factors techniques in hazard and accident analysis.

**Project Management.**

Competency in HFE is not required for certification as a Federal Project Director in the Project Management Career Development Program (PMCDP), which is the equivalent of the Project Management FAQS. The Federal Technical Capability Panel recommends that Federal Project Directors be required to demonstrate at least familiarity with HFE. The need for HFE knowledge is reinforced by DOE-STD-1189-2008 *Integration of Safety into the Design Process*, §7.7, Safety Program and Other Important Project Interfaces – Human Factors, which states:

“Human factors for design should be established as a design philosophy early in the conceptual design phase. This philosophy should evolve to consider standard human interface issues. Many codes and standards reflect this approach, and it is inherent in the standards. It is also important

to include operator input and reviews by maintenance and test personnel to ensure access for maintainability and testability.”

From the Instrumentation and Control FAOS DOE-STD-1162-2003:

**15. Instrumentation and control personnel shall demonstrate a working level knowledge of systems integration to achieve performance, effectiveness, and cost objectives.**

Supporting Knowledge and/or Skills

- a. Given a design package for an instrumentation and control system, evaluate its application within an integrated system for the following criteria:
  - Instruments and controls meet the general human factors criteria and considerations for safe and efficient system operation.
  - Instruments and controls perform within the parameters required for safe and efficient system operation.
  - Instrument and control response times are adequate for safe and efficient system operation.
  - Instruments and controls are physically configured for safe and efficient maintenance.
  - Instruments and controls meet the general design criteria for the system in which they are to be used.
- b. Given a proposed application of an instrumentation and control system to an integrated system, evaluate the performance of the integrated system to determine that instrument and control performance requirements will be met.
- g. Discuss the problems presented to instrumentation and control systems under various system applications.

From the Facilities Maintenance Management FAOS DOE-STD-1181-2004:

**3. Facility maintenance management personnel shall demonstrate a working level knowledge of the documentation used for controlling maintenance.**

Supporting Knowledge and/or Skills

- a. Discuss the purpose, use, and content of a work package.
- b. Discuss the purpose, use, and contents of maintenance procedures including the following considerations:
  - Development, including human factor considerations
  - Verification
  - Validation
  - Approval

- Actions taken when procedures cannot be followed as written or when unexpected results occur

**35. Facility maintenance management personnel shall demonstrate a working level knowledge of problem analysis principles and techniques necessary to identify maintenance problems, determine potential causes of problems, and identify corrective action(s).**

Supporting Knowledge and/or Skills

- Discuss the elements of an analysis program.
- Discuss the guidelines for information collecting.
- Discuss event causal factors for human performance problems.
- Discuss event causal factors for equipment performance problems.
- Describe and explain the application of problem analysis techniques including the following:
  - Root cause analysis
  - Causal factor analysis
  - Change analysis
  - Barrier analysis
  - Management Oversight Risk Tree analysis
- Describe and explain the application of the following root cause analysis processes in the performance of occurrence investigations:
  - Events and causal factors charting
  - Root cause coding
  - Recommendation generation
- Compare and contrast immediate, short term, and long term actions taken as the result of a problem identification or an occurrence.
- Describe various data gathering techniques and the use of trending/history when analyzing problems.

**Nuclear Safety Specialist FAQS DOE-STD-1183-2007**

Competency in HFE is not included in qualification as a Nuclear Safety Specialist. However, the Federal Technical Capability Panel recommends that Nuclear Safety Specialists demonstrate working level knowledge of HFE. The need for HFE knowledge is based on the need for Nuclear Safety Specialists to implement DOE-STD-3009-94 *Preparation Guide for U.S. DOE Nonreactor Nuclear Facility Documented Safety Analyses*, including review of Chapter 13 of the DSA, which is specifically about Human Factors. In addition, many of the orders and standards which require knowledge of HFE (listed above) are included in the Nuclear Safety Specialist FAQS.