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DOE-STD-1173-2003
December 2003

# DOE STANDARD

# CRITICALITY SAFETY FUNCTIONAL AREA QUALIFICATION STANDARD

DOE Defense Nuclear Facilities Technical Personnel

U.S. Department of Energy
**Washington, D.C. 20585**

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# APPROVAL

The Federal Technical Capability Panel consists of senior U.S. Department of Energy managers responsible for overseeing the Federal Technical Capability Program. This Panel is responsible for reviewing and approving the Qualification Standard for Department-wide application. Approval of this Qualification Standard by the Federal Technical Capability Panel is indicated by signature below.

Roy J. Schepens
Chairman
Federal Technical Capability Panel

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# TABLE OF CONTENTS

ACKNOWLEDGEMENT ..... vii
PURPOSE ..... 1
APPLICABILITY ..... 1
IMPLEMENTATION ..... 2
EVALUATION REQUIREMENTS ..... 3
CONTINUING EDUCATION, TRAINING, AND PROFICIENCY ..... 3
DUTIES AND RESPONSIBILITIES ..... 3
BACKGROUND AND EXPERIENCE ..... 4
REQUIRED TECHNICAL COMPETENCIES ..... 5
APPENDIX A, CONTINUING TRAINING, EDUCATION AND PROFICIENCY PROGRAM ..... 24

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ACKNOWLEDGEMENT

The Office of Environment, Safety and Health is the Sponsor for the Criticality Safety Functional Area Qualification Standard. The Sponsor is responsible for coordinating the development and/or review of the Functional Area Qualification Standard by subject matter experts to ensure that the technical content of the standard is accurate and adequate for Department-wide application for those involved in the Nuclear Criticality Safety Program. The Sponsor, in coordination with the Federal Technical Capability Panel, is also responsible for ensuring that the Functional Area Qualification Standard is maintained current.

The following subject matter experts (SMEs) participated in the development and/or review of this qualification standard:

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# U.S. DEPARTMENT OF ENERGY
# FUNCTIONAL AREA QUALIFICATION STANDARD

## Criticality Safety

## PURPOSE

DOE M 426.1-1, Federal Technical Capability Manual, commits the Department to continuously strive for technical excellence. The Technical Qualification Program, along with the supporting Technical Qualification Standards, complements the personnel processes that support the DOE's drive for technical excellence. In support of this goal, the competency requirements defined in the Technical Qualification Standards should be aligned with and integrated into the recruitment and staffing processes for technical positions. The Technical Qualification Standards should form the primary basis for developing vacancy announcements, qualification requirements, crediting plans, interviewing questions, and other criteria associated with the recruitment, selection, and internal placement of technical personnel. Office of Personnel Management (OPM) minimum qualification standards will be greatly enhanced by the application of appropriate materials from the technical Functional Area Qualification Standards.

The Technical Qualification Standards are not intended to replace the OPM Qualifications Standards nor other Departmental personnel standards, rules, plans, or processes. The primary purpose of the Technical Qualification Program is to ensure that employees have the requisite technical competency to support the mission of the Department. The Technical Qualification Program forms the basis for the development and assignment of DOE personnel responsible for ensuring the safe operation of defense nuclear facilities.

## APPLICABILITY

The Criticality Safety Functional Area Qualification Standard establishes common functional area competency requirements for Department of Energy criticality safety personnel who provide assistance, direction, guidance, oversight, or evaluation of contractor technical activities that could impact the safe operation of DOE's defense nuclear facilities. The technical Functional Area Qualification Standard has been developed as a tool to assist DOE Program and Field offices in the development and implementation of the Technical Qualification Program in their organization. For ease of transportability of qualifications between DOE elements, Program and Field offices are expected to use this technical Functional Area Qualification Standard without modification or additions. Needed additional office/site/facility specific technical competencies should be handled separately. Satisfactory and documented attainment of the competency requirements contained in this technical Functional Area Qualification Standard ensures that criticality safety personnel possess the requisite competence to fulfill their functional area duties and responsibilities. Office/Facility-Specific Qualification Standards supplement this technical Functional Area Qualification Standard and establish unique operational competency requirements at the Headquarters or Field element, site, or facility level.

# IMPLEMENTATION

This Technical Qualification Standard identifies the minimum technical competency requirements for DOE criticality safety personnel. Although there are other competency requirements associated with the positions held by DOE criticality safety personnel, this Functional Area Qualification Standard is limited to identifying the specific technical competencies. The competency statements define the expected knowledge and/or skill that an individual must meet. Each of the competency statements is further explained by a listing of supporting knowledge and/or skill statements.

The competencies identify a familiarity level, a working level, or an expert level of knowledge; or they require the individual to demonstrate the ability to perform a task or activity. These levels are defined as follows:

> **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 process sufficient to provide advice in the absence of procedural guidance.
>
> **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.

Headquarters and Field elements shall establish a program and process to ensure that criticality safety personnel possess the competencies required of their position. That includes the competencies identified in this technical Functional Area Qualification Standard. Documentation of the completion of the requirements of the Standard shall be included in the employee's training and qualification record.

Equivalencies should be used sparingly with the utmost rigor and scrutiny to maintain the spirit and intent of the TQP. Equivalencies may be granted for individual competencies based upon objective evidence of previous education, experience, certification, or training. Objective evidence includes a combination of transcripts, certifications, and, in some cases, a knowledge sampling through a written and/or oral examination. Equivalencies shall be granted in accordance with the Technical Qualification Program Plan of the office qualifying the individual. The supporting knowledge and/or skill statements, while not requirements, should be considered before granting equivalency for a competency.

Training shall be provided to employees in the Technical Qualification Program that do not meet the competencies contained in the technical Functional Area Qualification Standard. Training may include, but is not limited to, formal classroom and computer-based courses, self-study, mentoring, on the job training, and special assignments. Departmental training will be based upon appropriate supporting knowledge and/or skill statements similar to the ones listed for each of the competency statements. Headquarters and Field elements should use the supporting

knowledge and/or skill statements as a basis for evaluating the content of any training used to provide individuals with the requisite knowledge and/or skill required to meet the technical Functional Area Qualification Standard competency statements.

## EVALUATION REQUIREMENTS

Attainment of the individual competencies listed in this technical Functional Area Qualification Standard should be documented by a qualifying official, immediate supervisor, or the team leader of personnel in accordance with the Technical Qualification Program Plan of the office qualifying the individual.

## CONTINUING EDUCATION, TRAINING, AND PROFICIENCY

DOE criticality safety personnel shall participate in continuing training as necessary to improve their performance and proficiency and ensure that they stay up-to-date on changing technology and new requirements. This may include courses and/or training provided by:

- Department of Energy
- Other government agencies
- Outside vendors
- Educational institutions

Beyond formal classroom or computer based course, continuing training may include

- Self Study
- Attendance at symposia, seminars, exhibitions
- Special assignments
- On-the-job experience

A description of suggested learning proficiency activities and the requirements for the continuing education and training program for criticality safety personnel are included in Appendix A of this document.

## DUTIES AND RESPONSIBILITIES

The following are the typical duties and responsibilities expected of defense nuclear facility technical personnel assigned to the Criticality Safety Functional Area:

1. Evaluates criticality safety programs to determine whether the program complies with applicable codes, standards and guides, regulations, Orders and accepted practices.

2. Appraises facilities, procedures, and operations to determine their adequacy to protect the worker and members of the general public from the consequences of a nuclear criticality accident.

3. Administers and coordinates criticality safety programs for the Department, including performing independent evaluations and special studies.

4. Provides technical assistance and advice in the area of criticality safety to other organizations and independent review groups.

5. Reviews Office and/or contractor performance to identify trends indicative of performance or compliance status.

6. Performs technical reviews and provides recommendations on Criticality Safety Program documents (plans, schedules, etc).

7. Reviews and comments on a wide variety of operating contractor documents such as authorization basis documents.

8. Evaluates, oversees, and provides emergency preparedness and emergency response support related to criticality safety incidents in conjunction with contractor, Federal, State and local officials, as required.

9. Develops, reviews and implements criticality safety policy, requirements and guidance.

Position-specific duties and responsibilities for criticality safety personnel are contained in their Office/Facility-Specific Qualification Standard or Position Description.

## BACKGROUND AND EXPERIENCE

The U. S. Office of Personnel Management's Qualification Standards Handbook establishes minimum education, training, experience, or other relevant requirements applicable to a particular occupational series/grade level, as well as alternatives to meeting specified requirements.

The preferred education and experience for criticality safety personnel is:

1. Education:

   Bachelor of Science degree in Nuclear Engineering from an accredited institution or meet the alternative requirements specified in the Qualification Standards Handbook for the GS-0800, Professional Engineering Series

2. Experience:

   Industrial, military, Federal, State, or other directly related background that has provided specialized experience in criticality safety. Specialized experience can be demonstrated through possession of the competencies outlined in this Standard.

# REQUIRED TECHNICAL COMPETENCIES

The competencies contained in this Standard are distinct from those competencies contained in the General Technical Base Qualification Standard. All criticality safety personnel must satisfy the competency requirements of the General Technical Base Qualification Standard prior to or in parallel with the competency requirements contained in this Standard. Each of the competency statements defines the level of expected knowledge and or skill that an individual must posses to meet the intent of this Standard. The supporting knowledge and/or skill statements further describe the intent of the competency statements.

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

**1. Criticality safety personnel shall demonstrate a working level knowledge of the fission process.**

Supporting Knowledge and/or Skills

a. Define the following terms:

- Excitation energy
- Cross Section
- Fissile material
- Fissionable material
- Fertile material

b. Sketch the fission cross section for both U-235 and Pu-239 as a function of neutron energy. Label each significant energy region and explain the implications of the shape of the curves for criticality safety.

c. Explain why only the heaviest nuclei are easily fissioned.

d. Explain why uranium-235 fissions with thermal neutrons and uranium-238 fissions only with fast neutrons.

e. Characterize the fission products in terms of mass groupings and radioactivity.

f. Define sub-critical, critical, super-critical, reproduction factor, prompt neutron fraction, and delayed neutron fraction.

g. Discuss isotopes other than U-235 and Pu-239 that are fissionable.

**2. Criticality safety personnel shall demonstrate a working level knowledge of the various types of radiation interaction with matter.**

Supporting Knowledge and/or Skills

a. Describe the interactions of the following with matter:

- Alpha particle
- Beta particle
- Positron
- Neutron

b. Describe the following ways that gamma radiation interacts with matter:

- Compton scattering
- Photoelectric effect
- Pair production

**3. Criticality safety personnel shall demonstrate a working level knowledge of criticality control and safety parameters.**

Supporting Knowledge and/or Skills

a. Discuss the effects and applications of the following factors relevant to criticality safety of operations:

- Mass
- Interaction
- Geometry
- Moderation
- Reflection
- Concentration
- Volume
- Neutron absorbers
- Enrichment

b. Discuss the influence of the presence of non-fissionable materials mixed with, or in contact with, fissionable material on nuclear criticality safety.

c. Discuss the concept of contingencies for checking the validity of criticality safety limits.

**4. Criticality safety personnel shall demonstrate a working level knowledge of alarm systems for criticality accidents.**

Supporting Knowledge and/or Skills

a. Define the following terms:

- Criticality accident
- Minimum accident of concern
- Process area

b. Discuss the general principles associated with the use of criticality alarm systems including the following:

- Installation
- Coverage
- Detection
- Alarms
- Dependability

c. Discuss the requirements for testing the criticality alarm system.

**5. Criticality safety personnel shall demonstrate a working level knowledge of neutron absorbers.**

Supporting Knowledge and/or Skills

a. Describe the use of neutron poisons.

b. Explain the absorption characteristics of the following elements in terms of their cross-sections.

- cadmium
- boron
- chlorine
- hydrogen

c. Explain the purpose and use of Raschig Rings as a neutron poison.

**6. Criticality safety personnel shall demonstrate a familiarity level of knowledge of terminology used in nuclear safety analysis.**

Supporting Knowledge and/or Skills

a. Define the following accident related terms:

- Accident
- Authorization basis
- Beyond design basis accident
- Design basis
- Design basis accidents
- Evaluation guidelines

b. Define the following hazard related terms:

- Hazard
- Hazard Classification
- Hazard Category 1
- Hazard Category 2
- Hazard Category 3
- Hazardous Material

c. Define the following safety limit related terms:

- Limiting conditions for operations
- Limiting control settings
- Risk
- Safety analysis
- Safety basis
- Safety limits
- Criticality safety limits

d. Differentiate between the following categories of individuals who may be affected by an accident at a Department nuclear facility:

- Off-site individual
- On-site individual
- Public
- Worker, including collocated worker

e. Differentiate between the function of structures, systems, and components in the following classifications:

- Safety-class structures, systems, and components
- Safety-significant structures, systems and components

f. Differentiate between the function and contents of the following documents:

- Safety Analysis Report (SAR)
- Technical Safety Requirements (TSR)
- Documented Safety Analysis (DSA)
- Unreviewed Safety Question Determination (USQD)

g. Differentiate between the plant/facility features which have the following designations:

- Mitigating features
- Preventive features

h. Differentiate between the following types of facilities:

- Nuclear facility
- Non-reactor nuclear facility

**7. Criticality safety personnel shall demonstrate a familiarity level knowledge of nuclear accident analysis techniques.**

Supporting Knowledge and/or Skills

a. Identify and discuss essential elements of deterministic and probabilistic risk assessment techniques.

b. Identify and discuss the methods used to determine and analyze failure modes.

c. Discuss the methods used in the calculation of criticality safety, source term, environmental transport, and dose assessment activities including commonly used computer models.

d. Discuss the methods used to identify and categorize the hazards associated with Department nuclear systems.

**8. Criticality safety personnel shall demonstrate a familiarity level knowledge of terminology associated with probabilistic risk assessment (PRA) techniques.**

Supporting Knowledge and/or Skills

a. Define the following terms with respect to probabilistic risk assessments:

- Probability
- Reliability
- Availability
- Unavailability
- Risk
- Safety
- Accident sequence
- Dominant contributors
- Minimal cut set

b. Define the following terms and differentiate between the associated processes:

- Event tree
- Fault tree

**9. Criticality safety personnel shall demonstrate a working level knowledge of calculational methods used in criticality safety evaluations.**

Supporting Knowledge and/or Skills

a. Identify and discuss the application of several common hand calculation methods (i.e., buckling method, solid angle method, surface density and density analog).

b. Prepare an example using each one of the hand calculational methods listed above.

**10. Criticality safety personnel shall demonstrate a working level knowledge of critical and subcritical experiments.**

Supporting Knowledge and/or Skills

a. Describe the types of data derived from critical experiments and its use in criticality safety.

b. Discuss the physics of critical experiments including fundamental concepts associated with critical experiments (e.g. six factor formula, approach to critical, reactivity insertion, multiplication, reactor kinetics, reactivity changes, etc.).

c. Participate in a criticality experiment demonstration.

**11. Criticality safety personnel shall demonstrate a working level knowledge of computer codes used in criticality safety evaluations.**

Supporting Knowledge and/or Skills

a. Develop input model for one monte carlo and one deterministic code (i.e., MONK, VIM, SCALE, MCNP, DANTSYS, ANISN, COG).

b. Describe how cross section data impact Monte Carlo and deterministic codes.

c. Describe the importance of validation of computer codes and how accomplished.

d. Describe the methodology supporting Monte Carlo codes and deterministic codes.

e. Describe advantages and pitfalls of Monte Carlo calculations and deterministic codes.

f. The diffusion theory model is not strictly valid for treating fissile systems in which neutron absorption, voids, and/or material boundaries are present. In the context of these limitations, identify a fissile system for which a diffusion theory solution would be adequate.

g. Discuss the International Handbook of Evaluated Criticality Safety Benchmark Experiments Handbook, including its purpose, accessibility, and application to computer code validation.

**12. Criticality safety personnel shall demonstrate a working level knowledge of development of criticality safety evaluations.**

Supporting Knowledge and/or Skills

a. Prepare two criticality safety evaluations for two different applications selected from those listed in f., g. and i. below.

b. Describe development of contingency analysis and controls.

c. Describe key personnel in preparation of criticality safety evaluations and determination of process upsets.

d. Describe how subcritical margins and limits are determined.

e. Describe when validation and bias estimates must be considered.

f. Describe considerations when evaluating various fissile processes, including common process upsets:

- Aqueous
- Metal
- Recovery
- Fabrication/Foundry
- Mixed Waste

g. Describe considerations for evaluating material storage:

- Pits
- Waste
- Fuel elements
- Solutions
- Metal parts

h. Discuss elements of industry reference material:

- LA-10860-MS, Critical Dimensions of Systems Containing U235, Pu239, and U233, 1986
- LA-12808, Nuclear Criticality Safety Guide, 1996
- BNWL-SA-4868, Anomalies of Criticality
- LA-11627-MS, Glossary of Nuclear Criticality Terms

i. Describe elements to consider when preparing a Safety Analysis Report for Packaging (SARP).

**13. Criticality safety personnel shall demonstrate a working level knowledge of previous criticality accidents and their causal factors.**

Supporting Knowledge and/or Skills

a. Discuss common precursors to criticality accidents.

b. LA-13638, A Review of Criticality Accidents, 2000 Revision, 2000.

**14. Criticality safety personnel shall demonstrate a working level knowledge of Department of Energy (DOE) Order 231.1A Environment, Safety and Health Reporting and DOE M 231.1-2, Occurrence Reporting and Processing of Operations Information with respect to its impact on Department nuclear safety.**

Supporting Knowledge and/or Skills

a. State the purpose of DOE Order 231.1A, Environment, Safety and Health Reporting and DOE Manual 231.1-2, Occurrence Reporting and Processing of Operations Information.

a. Define the following terms:

- Event
- Condition
- Facility
- Notification Report
- Occurrence Report
- Reportable Occurrence

c. Discuss the Department's policy regarding the reporting of occurrences as outlined in DOE Order 231.1A, Environment, Safety and Health Reporting.

d. State the different categories of reportable occurrences and discuss each.

e. Discuss the categorization, notification, and timeliness requirements associated with the following:

- Notification Report
- Final Report
- Closing out and verifying Occurrence Reports
- Contractor Occurrence Reporting Procedures

f. Discuss the general process for preparing and submitting occurrence reports and their follow-up.

g. Using DOE O 231.1A, Environment, Safety and Health Reporting, discuss the role of criticality safety personnel in nuclear safety-related reportable occurrences.

h. Given an occurrence report, determine the following:

- The adequacy of the review process used
- That causes were appropriately defined
- That corrective actions addressed causes
- That the lessons learned were appropriate
- That corrective actions have been completed

i. Using an occurrence report involving criticality safety activities, identify and discuss the factors contributing to the occurrence.

**15. Criticality safety personnel shall demonstrate a working level knowledge of the Nuclear Safety Management Rule, 10CFR830, requirements related to Unreviewed Safety Questions and the associated DOE Guide 424.1-1, Implementation Guide for Use in Addressing Unreviewed Safety Question Requirements.**

Supporting Knowledge and/or Skills

a. Discuss the reasons for performing an Unreviewed Safety Question determination.

b. Define the following terms:

- Accident analyses
- Safety analysis
- Technical Safety Requirements

c. Describe the situations for which a criticality safety evaluation is required to be performed.

d. Define the conditions for an Unreviewed Safety Question.

e. Describe the responsibilities of contractors authorized to operate defense nuclear facilities for the performance of safety evaluations.

f. Describe the actions to be taken by a contractor upon identifying information that indicates a potential inadequacy of previous safety analyses or, a possible reduction in the margin of safety as defined in the Technical Safety Requirements.

g. Discuss the actions to be taken if it is determined that an Unreviewed Safety Question is involved.

h. Discuss the following terms as they apply to Unreviewed Safety Questions:

- Margin of Safety
- Important to Safety
- Safety Basis

**16. Criticality safety personnel shall demonstrate a working level knowledge of the Nuclear Safety Management Rule, 10CFR830, requirements related to Technical Safety Requirements and the associated DOE Guide 423.1-1, Implementation Guide For Use In Developing Technical Safety Requirements.**

Supporting Knowledge and/or Skills

a. Discuss the purpose of Technical Safety Requirements.

b. Describe the responsibilities of contractors authorized to operate defense nuclear facilities for Technical Safety Requirements.

c. Define the following terms and discuss the purpose of each:

- Safety Limit
- Limiting Control Settings
- Limiting Conditions for Operation
- Surveillance Requirements

d. Describe the general content of each of the following sections of the Technical Safety Requirements:

- Use and Application
- Safety Limits
- Operating Limits
- Surveillance Requirements
- Administrative Controls
- Basis
- Design Features

e Discuss the conditions that constitute a violation of the Technical Safety Requirements and state the reporting requirements should a violation occur.

f. Discuss the requirements for administrative control of the Technical Safety Requirements.

g. Discuss the possible source documents that may be used in developing Technical Safety Requirements.

h. Discuss the requirements for emergency actions that depart from the approved Technical Safety Requirements.

**17. Criticality safety personnel shall demonstrate a working level knowledge of the Nuclear Safety Management Rule, 10CFR830, requirements related to Documented Safety Analyses and the associated DOE Guide 421.1-2, Implementation Guide In Developing Documented Safety Analysis to Meet Subpart B of 10 CFR 830**.

Supporting Knowledge and/or Skills

a. Discuss the four basic purposes and objectives of Documented Safety Analysis.

b. Describe the responsibilities of contractors authorized to operate defense nuclear facilities for the development and maintenance of a Documented Safety Analysis.

c. Define the following terms and discuss the purpose of each:

- Design Basis
- Engineered Safety Features
- Safety Analysis

d. Describe the requirements for the scope and content of a Documented Safety Analysis and discuss the general content of each of the required sections of the Report.

e. Discuss the approval requirements for the Documented Safety Analysis for new facilities and subsequent changes.

f. Define who approves facility operations prior to achieving Documented Safety Analysis upgrade approval.

g. Discuss the requirements for the contractor to maintain the Documented Safety Analysis current.

**18. Criticality safety personnel shall demonstrate a working level knowledge of Department of Energy (DOE) Order 420.1A, Facility Safety, with respect to its impact on Department criticality safety**.

Supporting Knowledge and/or Skills

a. Discuss the purpose and policy associated with DOE Order 420.1A, Facility Safety.

b. Define the following terms associated with nuclear criticality safety:

- Criticality incident
- Double contingency principle
- Geometry control
- Nuclear criticality safety
- Significant quantity of fissionable material
- Temporary exemption
- Requirements for CAAS

c. Discuss the Management and Operating (M&O) Contractor responsibilities for to the following in relation to criticality safety activities:

- Criticality safety evaluations
- Monitoring
- Surveillance
- Transportation
- Storage

d. Discuss the role of Department criticality safety personnel with respect to the implementation of the requirements of DOE Order 420.1A.

**19. Criticality safety personnel shall demonstrate a familiarity knowledge of the criticality safety-related requirements contained in Department of Energy (DOE) Order 6430.1A, General Design Criteria. If DOE Order 420.1A, Facility Safety, has superceded 6430.1A in the facility contract, replace information as applicable.**

Supporting Knowledge and/or Skills

a. Discuss the purpose, scope, and applicability of DOE Order 6430.1A, General Design Criteria.

b. Discuss the Department policy and objectives with respect to safety-class criteria.

c. Discuss the Responsibilities and Authorities section of DOE Order 6430.1A, General Design Criteria, with respect to implementation.

d. Discuss the content of the General Requirements section of Division 13 - Special Facilities of DOE Order 6430.1A, General Design Criteria.

**20. Criticality safety personnel shall demonstrate a familiarity level knowledge of Department of Energy (DOE) Order 425.1C, Start-up and Restart of Nuclear Facilities, with respect to nuclear safety issues.**

Supporting Knowledge and/or Skills

a. Discuss the purpose, scope, and applicability sections of the DOE Order.

b. Discuss the content of the requirements section of the DOE Order.

c. Discuss the Responsibilities and Authorities section of the DOE Order, with respect to implementation.

d. Define the following terms as they relate to DOE Order 425.1C, Start-up and Restart of Nuclear Facilities, and nuclear safety:

- Facility shutdown
- Operational readiness review
- Operational readiness review implementation plan
- Operational readiness review scope
- Plan-of-action
- Prestart finding
- Readiness assessment
- Unplanned shutdown

e. Discuss Management and Operating Contractor responsibilities for implementing DOE Order 425.1C, Start-up and Restart of Nuclear Facilities.

f. Discuss the role of Department criticality safety personnel in implementing the requirements of DOE Order 425.1C.

**21. Criticality safety personnel shall demonstrate a working level knowledge of the following criticality safety-related American National Standards Institute/American Nuclear Society (ANSI/ANS) standards:**

- **ANSI/ANS-8.1, Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors.**
- **ANSI/ANS-8.3, (ANSI N-16.2), Criticality Accident Alarm System**
- **ANSI/ANS-8.5, (ANSI N-16.4), Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material**
- **ANSI/ANS-8.7, Guide for Nuclear Criticality Safety in the Storage of Fissile Materials.**
- **ANSI/ANS-8.15, Nuclear Criticality Control of Special Actinide Elements**
- **ANSI/ANS-8.19, Administrative Practices for Nuclear Criticality Safety**
- **ANSI/ANS-8.20, Nuclear Criticality Safety Training**
- **ANSI/ANS-8.21, Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors**
- **ANSI/ANS-8.22, Nuclear Criticality Safety Based on Limiting and Controlling Moderators**
- **ANSI/ANS-8.23, Nuclear Criticality Accident Emergency Planning and Response**
- **ANSI/ANS-13.3, Dosimetry for Criticality Accidents**

Supporting Knowledge and/or Skills

a. Describe the contents, requirements, and relationship among the above American National Standards Institute/American Nuclear Society Standards.

b. Discuss the applicability of the above American National Standards Institute/American Nuclear Society Standards to the Department facilities and processes.

c. Discuss the role of the Department criticality safety personnel in implementing the requirements of these Standards.

**22. Criticality safety personnel shall demonstrate a familiarity level knowledge of the following Department of Energy (DOE) Orders, Technical Standards, and Notice:**

- **DOE Order 2300.1B, Audit Resolution and Follow-up**
- **DOE Order 224.2, Auditing of Programs and Operations**
- **DOE Order 5400.5 (Chg 2), Radiation Protection of the Public and Environment**
- **DOE Order 5660.1B, Management of Nuclear Materials**
- **DOE Order 474.1A, Control and Accountability of Nuclear Materials**
- **DOE Policy 450.4, Safety Management System Policy**

- **DOE Guide 450.4, Integrated Safety Management System Guide**
- **DOE Policy 450.5, Line Environment, Safety and Health Oversight**
- **DOE-STD-3006-93, Planning and Conduct of Operational Readiness Reviews**
- **DOE-STD-1027-92, Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports**
- **DOE-STD-3011-2002, Guidance for Preparation of Basis for Interim Operation (BIO) Documents**
- **Secretary of Energy Notice (SEN) SEN-35-91, Nuclear Safety Policy**
- **DOE-STD-3009-94, Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports.**
- **DOE-HDBK-3010-94, Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities**
- **Regulatory Guide 3.71, Nuclear Criticality Safety Standards for Fuels and Material Facilities**

Supporting Knowledge and/or Skills

a. Describe the contents, requirements, and relationship between the above Orders, Technical Standards, and Secretary of Energy Notice.

b. Describe the role of criticality safety personnel with respect to the requirements in these Orders, Standards, and Secretary of Energy Notice.

**23. Criticality safety personnel shall demonstrate a familiarity level knowledge of the Price-Anderson Amendment Act of 1988 and its impact on Department of Energy criticality safety activities.**

Supporting Knowledge and/or Skills

a. Describe the purpose and scope of the Price-Anderson Amendment Act.

b. Discuss the Act's applicability to the Department criticality safety activities.

c. Discuss the civil and criminal penalties imposed on the Department, Management and Operating Contractors, and Subcontractors as the result of a violation of applicable rules and regulations related to criticality safety.

d. Discuss the requirements associated with the topics below, as they are affected by Rule-making aspect of the Price-Anderson Amendment Act:

- Safety Analysis Reports
- Unreviewed Safety Questions
- Quality Assurance Requirements
- Defect Identification and Reporting
- Conduct of Operations at DOE Nuclear Facilities
- Technical Safety Requirements
- Training and Certification
- Maintenance Management

- Categorization, Notification, Reporting, and Processing of Operational Occurrences at DOE Nuclear Facilities

e. Discuss the role of Department Criticality safety personnel with respect to implementing the requirements of the Price-Anderson Amendment Act in accordance with the following:

- 10 CFR 820, Procedural Rules for DOE Nuclear Activities
- 10 CFR 830, Nuclear Safety Management
- 10 CFR 835, Occupational Radiation Protection
- DOE STD-1083, Requesting and Granting Exemptions to Nuclear Safety Rules
- Office of Enforcement and Investigation procedure "Enforcement of DOE Nuclear Safety Requirements under Price-Anderson Amendments Act of 1988"
- Office of Enforcement and Investigation procedure "Identifying, Reporting, and Tracking Nuclear Safety Noncompliance under Price-Anderson Amendments Act of 1988"

**24. Criticality safety personnel shall demonstrate a working level knowledge of the requirements in Department of Energy (DOE) Technical Standard DOE-STD-3007-93, Guidelines for Preparing Criticality Safety Evaluations at DOE Non-Reactor Nuclear Facilities.**

Supporting Knowledge and/or Skills

a. Describe the documentation requirements for a criticality safety evaluation conforming to this standard.

b. Discuss the role of this standard in establishing appropriate analytical techniques for criticality safety evaluations.

c. Discuss the relationship between DOE-STD-3007-93, Guidelines for Preparing Criticality Safety Evaluations at DOE Non-Reactor Nuclear Facilities, and DOE Order 420.1A, Facility Safety.

**25. Criticality safety personnel shall demonstrate a familiarity level knowledge of the following criticality safety-related American National Standards Institute/American Nuclear Society (ANSI/ANS) standards:**

- **ANSI/ANS-8.6, Safety in Conducting Subcritical Neutron-Multiplication Measurements In Situ**
- **ANSI/ANS-8.9, Nuclear Criticality Safety Criteria for Steel-Pipe Intersections Containing Aqueous Solutions of Fissile Materials**
- **ANSI/ANS-8.10, Criteria for Nuclear Criticality Safety Controls in Operations With Shielding and Confinement**
- **ANSI/ANS-8.12, Nuclear Criticality Control and Safety of Plutonium-Uranium Fuel Mixtures Outside Reactors**

- **ANSI/ANS-8.17, Criticality Safety Criteria for the Handling, Storage and Transportation of LWR Fuel Outside Reactors**

**26. Criticality safety system personnel shall demonstrate a familiarity level knowledge of communications (both oral and written) when working or interacting with the contractor, stakeholders, and other internal and external organizations.**

Supporting Knowledge and/or Skills

a. Identify the various internal and external groups with whom criticality safety personnel must interface in the performance of their duties.

b. Describe the media that may be utilized to communicate with these groups.

**27. Criticality safety personnel shall demonstrate a familiarity level knowledge of nuclear safety-related data and information management requirements in accordance with the requirements of the following Department of Energy (DOE) Orders:**

- **DOE Order 200.1, Information Management Program**
- **DOE Order 414.1A, Quality Assurance**
- **DOE Order 241.1A, Scientific and Technical Information Management**

Supporting Knowledge and/or Skills

a. Describe the Authorized Disposition Requirements for criticality safety-related records in DOE Order 200.1, Information Management Program.

b. Describe the requirements for documents and records in DOE Order 414.1A, Quality Assurance.

c. Describe the purpose, scope, contents, and requirements in these Orders.

d. Discuss the applicability of the above Orders to the Department criticality safety activities and processes.

e. Discuss the role of the Department criticality safety personnel in implementing the requirements of these Orders.

**28. Criticality safety personnel shall demonstrate a familiarity level knowledge of the following Department of Energy (DOE) safeguards, security, and nuclear material accountability Orders for nuclear safety-related issues:**

- **DOE Order 5610.13, Joint Department of Energy/Department of Defense Nuclear Weapons System Safety, Security, and Control Activities**
- **DOE Order 470.1, Safeguards and Security Program**
- **DOE Order 473.1, Physical Protection Program**
- **DOE Order 474.1A, Control and Accountability of Nuclear Materials**

- **DOE Order 471.1A, Identification and Protection of Unclassified Controlled Nuclear Information**
- **DOE Order 5660.1B, Management of Nuclear Materials**

Supporting Knowledge and/or Skills

a. Describe the purpose, scope, contents, and requirements of these Orders.

b. Discuss the applicability of the above Orders to the Department criticality safety activities and processes.

c. Discuss the role of the Department criticality safety personnel in implementing the requirements of these Orders.

**29. Criticality safety personnel shall demonstrate a working level knowledge of assessment techniques (such as the planning and use of observations, interviews, and document reviews) to assess facility performance, report results of assessments, and follow up on actions taken as the result of assessments**.

Supporting Knowledge and/or Skills

a. Describe the role of criticality safety systems personnel in the assessment of Government Owned Contractor Operated (GOCO) facilities.

b. DOE-STD-1158-2002, Self-Assessment Standard for DOE Contractor Criticality Safety Programs, 2002.

c. Describe the assessment requirements and limitations associated with the interface with contractor employees.

d. Discuss the essential elements of a performance-based assessment including:

- Investigation
- Fact finding
- Exit interview
- Reporting
- Follow-up
- Closure

e. Describe the following assessment methods and the advantages or limitations of each method:

- Document review
- Observation
- Interview

f. Describe the action to be taken if the contractor challenges the assessment findings and explain how such challenges can be avoided.

**30. Criticality safety personnel shall demonstrate a working level knowledge of the Department of Energy (DOE)/facility contract provisions necessary to provide oversight of a contractor's operations.**

Supporting Knowledge and/or Skills

a. Describe the role of criticality safety personnel in contractor oversight.

b. Compare and contrast the following:

- Department of Energy's expectations of a Management and Operating (M&O) contractor
- A Management and Operating contractor's expectations of the Department of Energy

c. Identify the key elements and features of an effective Department of Energy and Management and Operating contractor relationship.

d. Describe the responsibility criticality safety personnel have associated with contractor compliance under the Price-Anderson Amendments Act.

e. Describe the role of criticality safety personnel in the performance measure process.

f. Explain the responsibilities of criticality safety personnel for DOE Order 442.1A, Department of Energy Employee Concerns Program, and the identification, reporting, reviewing, and documentation of employee concerns.

**31. Criticality safety personnel shall demonstrate a familiarity level knowledge of problem analysis principles and the techniques necessary to identify Department problems, potential causes, and corrective action(s) associated with criticality safety issues.**

Supporting Knowledge and/or Skills

a. 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

b. Describe the following types of investigations and discuss an example of the application of each:

- Type A
- Type B

- Type C

c. Compare and contrast immediate, short term, and long term actions taken as the result of a problem identification or an occurrence.

d. Given event and/or occurrence data, apply problem analysis techniques and identify the problems and how they might have been avoided.

e. Describe various data gathering techniques and the use of trending/history when analyzing problems

**32. Personnel shall demonstrate a working level knowledge of the 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.

b. Identify the typical requirements that define functional interfaces between safety system software components and the system-level design, as described in standards such as ANSI/IEEE 830, IEEE Guide to Software Requirements Specifications and IEEE 7-4.3.2, Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations.

c. Identify the specific records that must be maintained and the requirements for maintaining these records to document the development of safety system software.

d. Review a development project for safety system software. Explain how the functional interfaces between components and the system level design were established and controlled.

**33. Criticality safety personnel shall demonstrate a working level knowledge of the guidance provided in DOE Technical Standard DOE-STD-1134-99, Review Guide For Criticality Safety Evaluations.**

Supporting Knowledge and/or Skills

a. Describe the purpose and general structure of the guide.

b. Using the guide as a reference, discuss the guidelines provided for use by DOE criticality safety personnel when reviewing criticality safety evaluations produced by a Contractor.

# APPENDIX A
# CONTINUING TRAINING, EDUCATION AND PROFICIENCY PROGRAM

The following list represents suggested continuing education, training and other opportunities are available for DOE personnel after completion of the competency requirements in this technical Functional Area Qualification Standard. It is extremely important that personnel involved with this program maintain their proficiency through continuing education, training, reading, or other activities such as workshops, seminars, and conferences. The list of suggested activities was developed by the Subject Matter Experts involved in the development of the Functional Area Qualification Standard and is not all-inclusive.

## LIST OF CONTINUING EDUCATION, TRAINING AND OTHER ACTIVITIES

Criticality safety personnel shall participate in an Office/Facility-specific continuing training and qualification program that includes the following elements:

1. Continuing technical education and/or training covering topics directly related to the criticality safety area as determined appropriate by management. This may include courses/training provided by the Department of Energy, the Los Alamos Criticality Experimental Facility (LACEF) 3-day and/or 5-day criticality training courses, other government agencies, outside vendors, or local educational institutions. Continuing training topics should also address identified weaknesses in the knowledge or skills of the individual personnel.

2. Actively perform the duties of a criticality safety engineer at a Department of Energy facility a minimum of 24 hours per year.

3. Attend seminars, symposia, or technical meetings related to criticality safety.

4. Engage in self-study of new regulations, requirements, or advances related to criticality safety.

5. Participation in practical exercises such as emergency or operational drills, simulations, or laboratory-type exercises.

6. Specific continuing training requirements shall be documented in Individual Development Plans.

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## CONCLUDING MATERIAL

**Review Activity:**

| **DOE** | **Field and Operations Offices** |
|---|---|
| NNSA-DP | Idaho |
| | Los Alamos |
| EH | Oak Ridge |
| EM | Pantex |
| | Richland |
| NE | Sandia |
| SC | Savannah River |
| RW | |

**Preparing Activity:**
DOE EH-24

**Project Number:**
TRNG-0035