TS

NOT MEASUREMENT SENSITIVE

DOE–STD–1182-2004
March 2004

DOE STANDARD

CIVIL/STRUCTURAL ENGINEERING FUNCTIONAL AREA QUALIFICATION STANDARD

DOE Defense Nuclear Facilities Technical Personnel

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

AREA TRNG

This document has been reproduced directly from the best available copy.

Available to DOE and DOE contractors from ES&H Technical Information Services, U.S. Department of Energy, (800) 473–4375, fax: (301) 903-9823.

Available to the public from the U.S. Department of Commerce, Technology Administration, National Technical Information Service, Springfield, VA 22161; (703) 605–6000.

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

INTENTIONALLY BLANK

TABLE OF CONTENTS

INTENTIONALLY BLANK

ACKNOWLEDGMENT

The Assistant Secretary for Environment, Safety and Health is the Sponsor for the Civil/Structural Engineering 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 Civil/Structural Engineering 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:

Khawaja Akhtar	NNSA Service Center (Team Leader)
Harish Chander	DOE/HQ, EH-53
Subir Sen	DOE/HQ, EH-24
Teh Hsieh	Livermore Site Office
Johnnie Guelker	Pantex Site Office
Brent Gutierrez	Savannah River Site Office
Robert Creed	Idaho Operations Office
Leon Kempner	BPA

INTENTIONALLY BLANK

DOE-STD-1182-2004

U.S. DEPARTMENT OF ENERGY
FUNCTIONAL AREA QUALIFICATION STANDARD

Civil/Structural Engineering

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 Department'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 minimum qualifications standards will be greatly enhanced by 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 Civil/Structural Engineering Functional Area Qualification Standard establishes common functional area competency requirements for Department of Energy 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 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 Functional Area Qualification Standard identifies the minimum technical competency requirements for Department of Energy personnel. Although there are other competency requirements associated with the positions held by DOE 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 DOE 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 and 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, training, certification, or experience. 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 who 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 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 personnel shall participate in continuing education and 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 courses, 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 Civil/Structural Engineering personnel are included in Appendix A of this document.

DUTIES AND RESPONSIBILITIES

The following are the typical duties and responsibilities expected of personnel assigned to the Civil/Structural Engineering Functional Area:

1. Provide oversight and management in the design and construction of facilities to perform the function intended particularly for safety class and safety significant structures, systems, and components.

2. Conduct assessments and evaluations of the integrity of existing facilities to operate safely under required conditions particularly for safety class and safety significant structures, systems, and components.

Position-specific duties and responsibilities for Civil/Structural Engineering 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 background and experience for Civil/Structural Engineering personnel is:

1. Education:

Federal Civil/Structural Engineers are required to meet OPM standards for Occupational Series 810.

2. Experience:

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

3. Professional Registration:

State Professional Registration in either Civil or Structural Engineering, or completion of Professional Registration within four years of accepting Federal employment position covered by 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 Civil/Structural Engineering 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, Department of Energy directives, or other industry standards are referenced in the Qualification Standard, the most recent revision should be used.

GENERAL TECHNICAL

1. Civil/Structural Engineering personnel shall demonstrate an expert level knowledge of the Civil/Structural Engineering related sections and/or requirements of the following DOE Directive and Guides.

- **DOE Order 420.1A, Facility Safety**
- **DOE G 420.1-1, Nonreactor Nuclear Safety Design Criteria and Explosive Safety Criteria Guide for use with DOE O 420.1A, Facility Safety**
- **DOE G 420.1-2, Guide for the Mitigation of Natural Phenomena Hazards for DOE Nuclear Facilities and Non-Nuclear Facilities**

Supporting Knowledge and/or Skills

a. Describe the purpose, scope, and application of requirements detailed in the above Directive and associated Guides.

b. Discuss how hazard and accident analysis are used in design and evaluation of Structures, Systems, and Components (SSCs).

c. Discuss the classification implication of following SSCs:

- Safety class

- Safety significant
- Safety-related

d. Discuss the graded approach methodology that is used by line management to determine an appropriate level of safety provided by Civil/Structural Engineers for SSCs. Include factors that affect the level of safety.

2. Civil/Structural Engineering personnel shall demonstrate an expert level knowledge of the requirements of DOE-STD-1020-2002, Natural Phenomena Hazards Design and Evaluation Criteria for Department Of Energy Facilities.

Supporting Knowledge and/or Skills

a. Describe the purpose, scope, and application of the natural phenomena hazards evaluation and design requirements contained in the above Standard.

b. Discuss the relationship between the hazard exceedence probability, the target performance goal, and the risk reduction ratio. Describe how the risk reduction ratio is achieved.

c. Compare and contrast the procedures for the seismic design and evaluation of Performance Category 1 and 2 structures with the procedures used for Performance Category 3 and 4 structures.

d. Discuss the intent of the deterministic seismic evaluation and acceptance criteria in the above Standard and the alternative evaluation and acceptance criteria.

e. Discuss the evaluation of existing facilities in relation to the design of new facilities for seismic, wind, and flood loads.

f. Provide an overall description of the uniform approach used in the above Standard for the wind load determination for straight, hurricane, and tornado winds.

g. Describe the flood design criteria for Performance Categories 1-4 and the essential items to be included in the design procedure for floods.

h. Describe the essential items that should be included in the design documentation for all natural phenomena hazards considered.

i. Demonstrate the ability to review structural analysis plans and approaches to ensure that methods and models are being properly defined.

j. Conduct a review of design/evaluation analysis and verify that methods used and calculation results are appropriate.

3. Civil/Structural Engineering personnel shall demonstrate a working level knowledge of the Civil/Structural Engineering related sections and/or requirements of the following DOE Standards:

- **DOE-STD-1021-93, Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components**
- **DOE-STD-1022-94, Natural Phenomena Hazards Characterization Criteria**
- **DOE-STD-1023-95, Natural Phenomena Hazards Assessment Criteria**

Supporting Knowledge and/or Skills

a. Describe the purpose, scope, and application of the requirements detailed in the above Standards.

b. Explain the linkage between safety classification of SSCs and assignment of Performance Categories.

c. Discuss system interaction effects and how they influence the assignment of Performance Categories to SSCs.

d. Discuss site characterization requirements for:

- Meteorology
- Hydrology
- Geology and Seismicity
- Geotechnical Studies

e. Describe the development of site-specific seismic hazard curves including the development of a site-specific probabilistic seismic hazard study.

f. Discuss the development of Design Basis Earthquake response spectra.

g. Discuss the criteria for wind hazard assessment.

h. Discuss the criteria for flood hazard assessment.

i. Demonstrate the ability to review site characterization and/or hazard analysis reports to ensure that methods used and calculation results are appropriate.

4. Civil/Structural Engineering personnel shall demonstrate a working level knowledge of the following National Consensus Codes and Standards:

- **ACI 318-02, Building Code Requirements for Structural Concrete and Commentary**
- **ACI 349-01, Nuclear Safety-Related Concrete Structures and Commentary**
- **ACI 530, Building Code Requirements for Masonry Structures, 1999**
- **AISC, Manual of Steel Construction, Load and Resistance Factor Design (LRFD), 1998**
- **AISC, Manual of Steel Construction, Allowable Stress Design (ASD), 1989**
- **ANSI/AISC N690, Specifications for the Design, Fabrication and Erection of Steel Safety-Related Structures for Nuclear Facilities, 1994 and Supplement 1-2002.**
- **ASCE 4-98, Seismic Analysis of Safety-Related Nuclear Structures and Commentary, 1998**
- **ASCE 7-02, Minimum Design Loads for Buildings and Other Structures, 2002**

<u>Supporting Knowledge and/or Skills</u>

a. Discuss the various design loads on structures, and explain how they are combined to achieve performance expectations.

b. Discuss similarities and differences between strength versus allowable design for concrete, steel, and masonry structures.

c. Discuss seismic ductile detailing as required by ACI and AISC.

d. Demonstrate knowledge to review and utilize various industry and proprietary computer

codes.

e. Discuss differences between requirements for nuclear safety-related and nonnuclear structures.

f. Describe minimum documentation requirements to demonstrate compliance with the above consensus codes and standards.

g. Conduct a review of structural analysis to ensure that design loads are properly defined, structural member capacities are adequate, and that all applicable load combinations have been adequately considered.

5. Civil/Structural Engineering personnel shall demonstrate a working level knowledge of the Industry and Consensus Codes, Standards, and Provisions related to Civil/Structural analysis and design requirements:

- **IBC 2000, International Building Code**

Supporting Knowledge and/or Skills

a. Discuss analysis/design requirements of building codes and their relationship to DOE Natural Phenomena Hazards standards.

b. Discuss DOE and industry guidance for verifying adequacy of SSCs.

6. Civil/Structural Engineering personnel shall demonstrate a working level knowledge of the seismic principles, seismic analysis, seismic design of new facilities, and seismic evaluation of existing facilities.

- **NEHRP 2000, Recommended Provisions for Seismic Regulations for new Buildings and Other Structures-FEMA 368, 2001**

Supporting Knowledge and/or Skills

a. Discuss how the level of seismicity and site-specific geotechnical conditions influence the seismic design of facilities.

b. Describe importance of structural elements required in the seismic design of new facilities and the methods utilized in seismic strengthening of existing facilities.

c. Discuss methods for determining the magnitude of seismic forces and methods available for performing analysis of engineered structures.

d. Discuss the seismic design of structures, structural elements, load transfer pathways, and material detailing requirements necessary to assure desired seismic performance.

e. Discuss the differences in criteria for design of new facilities and evaluation of existing facilities.

7. Civil/Structural Engineering personnel shall demonstrate a working level knowledge of the Civil/Structural Engineering requirements of the applicable Federal Regulation 10 CFR 830, Nuclear Safety Management, safety-basis documents and processes, and associated Standards and Guides.

- **DOE-STD-1027-92, Hazard Categorization and Accident Analysis Techniques for Compliance With DOE Order 5480.23, Nuclear Safety Analysis Reports**

- **DOE-STD-3009-94, Chg 2, Preparation Guide for U.S. DOE Nonreactor Nuclear Facility Safety Analysis Reports**
- **DOE-STD-1104-96, Review and Approval of Nuclear Facility Safety Basis Documents**
- **DOE G 421.1-2, Implementation Guide for use in Developing Documented Safety Analyses to Meet Subpart B, 10 CFR 830**
- **DOE G 423.1-1, Implementation Guide for use in Developing Technical Safety Requirements**
- **DOE G 424.1-1, Implementation Guide for use in Addressing Unreviewed Safety Question Requirements**

Supporting Knowledge and/or Skills

a. Explain the application of 10 CFR 830 Subpart B, Safety Basis Requirements and the Civil/Structural Engineering personnel's role in the oversight of Safety Authorization Basis.

b. Discuss the contents of the listed Safety Authorization Basis documents/processes and explain their relationship to each other:

- Documented Safety Analysis (DSA)
- Technical Safety Requirements (TSR)
- Unreviewed Safety Question (USQ) process
- Safety Evaluation Report (SER)

c. Discuss the general approval process for the Safety Analysis Report, identifying the specific elements related to the Civil/Structural Engineering review.

d. Discuss the Civil/Structural Engineering related conditions that can lead to determination of an inadequate safety analysis and identify the required actions.

e. Perform a review of Safety Basis documentation to ensure that designated structural safety systems have been properly assessed including a determination that they are performing intended safety functions.

8. Civil/Structural Engineering personnel shall demonstrate a familiarity level knowledge of the relationships between the problems being addressed by safety analysis and building design and computer codes, the design requirements for the codes, and the components of the codes.

Supporting Knowledge and/or Skills

a. Identify how functional requirements and applicability of safety analysis and building design and computer codes are defined, documented, and controlled.

b. Review a development project for safety analysis or design software.

9. Civil/Structural Engineering personnel shall demonstrate the ability to independently conduct peer review of structural analysis and computations and to verify and assess field activities.

Supporting Knowledge and/or Skills

a. Discuss acceptable and unacceptable work performance and the increasing level of rigor required in reviewing Performance Categories 1-4 SSCs.

b. Perform a review of structural analysis for theory and assumptions and verify structural calculations and drawings for numerical accuracy.

c. Conduct a review of testing and inspection reports and periodically observe field compliance with plans and specifications.

d. Lead an assessment of construction and other field activities and develop a report based on findings.

e. Participate in formal meetings to discuss the results of Civil/Structural Engineering Assessments.

10. Civil/Structural Engineering personnel shall demonstrate a working level knowledge of the DOE/facility contract provisions necessary to provide oversight and assessments of a contractor's performance.

Supporting Knowledge and/or Skills

a. Describe the role of Civil/Structural Engineering personnel in contractor oversight.

b. Describe the assessment requirements and limitations of Civil/Structural Engineering personnel interfacing with contractor employees.

c. Describe how planning, observing, interviewing, and document research are used during an assessment.

d. Explain the essential elements of an assessment including the areas of investigation, fact-finding, and reporting.

e. Discuss the system engineering concept as it applies to oversight of safety systems, using the guidance in DOE-STD-1073-93, Configuration Management.

11. Civil/Structural Engineering personnel shall demonstrate the ability to represent DOE as subject matter experts for Civil/Structural Engineering activities during the oversight and management of engineering programs.

Supporting Knowledge and/or Skills

a. Prepare program or technical data for communicating to external organizations and discuss any potential impacts on DOE programs.

b. Demonstrate skill in dealing with public and other stakeholders.

c. State security precautions to be taken when dealing with the public and other stakeholders.

d. Discuss the applicability of reports/recommendations from external entities such as the Defense Nuclear Facilities Safety Board (DNFSB) or the Government Accounting Office (GAO) and any resulting implementation plans that affect the Civil/Structural Engineering programs.

APPENDIX A
CONTINUING EDUCATION, TRAINING AND PROFICIENCY PROGRAM

The following list represents suggested continuing education, training and other opportunities that 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

Civil/Structural Engineering personnel shall participate in an Office/Facility-specific continuing training and qualification program.

1. It is recommended that 24 or more proficiency points be earned in any three-year period after certification of satisfactory completion of the prerequisite and competency requirements for a Federal Civil/Structural Engineer. Personnel unable to meet proficiency requirements may be granted an extension of up to 2 years based upon submitting a schedule approved by the qualifying official.

   Active participation in Civil/Structural Engineering duties

   - 1 point per year for each 500 work hours performing Civil/Structural Engineering duties
   - Not to exceed 12 points in 3 years

   Participation in Civil/Structural Engineering assessments/evaluations

   - 1 point for each assessment of 2 weeks duration on-site
   - Assessments lasting less than 2 weeks may be rolled-up into 2 week totals
   - Not to exceed 6 points in 3 years

   Maintenance of PE Registration in Civil/Structural Engineering

   - 1 point per year

   Pass EIT Exam or PE exam in Civil/Structural Engineering

   - 4 points per exam
   - One time only

   Membership in Civil/Structural Engineering organizations

   - 1 point per year per organization
   - Not to exceed 6 points in 3 years

   Active member in technical committee in field of Civil/Structural Engineering

   - 1 point per year per committee
   - Not to exceed 6 points in 3 years

Chair technical committee in field of Civil/Structural Engineering

- 1 point per year
- Not to exceed 3 points in 3 years

Professional publication on Civil/Structural Engineering topics

- 1 point per publication
- Not to exceed 3 points in 3 years

Successfully complete undergraduate and graduate-level Civil/Structural Engineering courses

- 1 point per credit hour in year earned
- Not to exceed 12 points in 3 years

Successfully complete in-house or other professional level Civil/Structural Engineering courses/seminars

- 1 points per training or 1 point per CEU
- Not to exceed 6 points in 3 years

Attend professional Civil/ Structural Engineering conferences, workshops and meetings

- 1 point per participation
- Not to exceed 6 points in 3 years

Presentations at Civil/Structural Engineering conferences, meetings, seminars, and courses

- 1 point per presentation
- Not to exceed 6 points in 3 years

2. Other activities that do not earn proficiency points may also be performed as part of the qualification program:

   Engage in self-study of new regulations, requirements, or advances related to Civil/Structural Engineering

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

INTENTIONALLY BLANK

CONCLUDING MATERIAL

Review Activity:
EM
NNSA
EH
NE
SC

Field and Operations Offices
CBFO
CH
ID
OH
OR
ORP
RFFO
RL
SR

Area and Site Offices
Argonne Area Office
Brookhaven Area Office
Fermi Area Office
Kansas City Site Office
Livermore Site Office
Los Alamos Site Office
Nevada Site Office
Pantex Site Office
Princeton Area Office
Savannah River Site Office
Sandia Site Office
Y-12 Site Office

Preparing Activity:
DOE-EH-22

Project Number:
TRNG-0045