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DOE-STD-1180-2004
March 2004

DOE STANDARD

CONSTRUCTION MANAGEMENT FUNCTIONAL AREA QUALIFICATION STANDARD

DOE Defense Nuclear Facilities Technical Personnel

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

AREA TRNG

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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ACKNOWLEDGMENT

The U.S. Department of Energy, Office of River Protection (ORP) is the Sponsor for the Construction Management 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 Construction Management 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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DOE-STD-1180-2004

U.S. DEPARTMENT OF ENERGY
FUNCTIONAL AREA QUALIFICATION STANDARD

Construction Management

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 Construction Management 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 base 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 base 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 Construction Management personnel are included in Appendix A of this document.

DUTIES AND RESPONSIBILITIES

The following are typical duties and responsibilities expected of personnel assigned to the Construction Management functional area:

1. Ensures that construction projects comply with, or are completed in accordance with, DOE Orders, Federal, state, local, and industry standards.

2. Reviews, evaluates, and monitors planning, budgets, costs, and schedules in accordance with authorized baseline and contracts.

3. Manages construction activity in accordance with approved project documents, established engineering practices, and construction industry standards.

4. Provides on-site presence for the evaluation of field construction activities and evaluates contractor performance using surveillance, audits, and inspections.

5. Performs review of design and construction documents to ensure project constructability.

6. Ensures compliance with environmental, safety and health, quality assurance, and Occupational Safety and Health Act requirements.

7. Conducts construction project management briefings and prepares reports to reflect project status, cost and schedule trends, work force adequacy, funding, and project uncertainties.

8. Ensures that accurate and timely project documentation is maintained over the construction project life cycle (configuration management implementation).

9. Participates in the annual budget process for construction projects.

Position-specific duties and responsibilities for Construction Management 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 Construction Management personnel is:

1. Education:

   Baccalaureate degree in engineering or a related discipline; or meet the alternative requirements specified for engineers in the OPM Qualifications Standards Handbook. Baccalaureate degrees in other disciplines may also be appropriate based on the duties to be performed and considering the experience gained in performing related construction management and engineering activities.

2. Experience:

   Industry, military, federal, state, or directly related background that has provided specialized experience in construction management and engineering. Specialized experience may be demonstrated through possession of the competencies in portions of 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 Construction Management 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 but are not requirements.

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. Construction Management personnel shall demonstrate a familiarity, level knowledge of techniques, equipment, and documentation of surveys.

Supporting Knowledge and/or Skills

a. Discuss the mathematical basis for horizontal and vertical control.

b. Discuss the different types of surveying equipment commonly used on a construction project including their applications and limitations.

c. Describe the methods for verifying proper survey equipment calibration.

d. Discuss the care and handling of survey equipment.

e. Describe standard practices for preparing survey field notes.

f. Discuss the appropriate state requirements for preparing survey documentation, drawings, site plans, profiles, and contours.

g. Read and interpret survey field notes.

h. Define and discuss error closure as it applies to surveying.

2. Construction Management personnel shall demonstrate a familiarity level of knowledge for establishing control points.

Supporting Knowledge and/or Skills

a. Select the proper instruments for establishing control points.

b. Discuss the procedure for measuring angles and distances.

c. Determine the proper route using known points.

d. Estimate turning points.

e. Define and discuss the following terms associated with control points:

- Benchmark
- Back-site
- Temporary benchmark
- Turning point
- Latitudes
- Departures
- Instrument height
- Bearings
- Grid coordinates

3. Construction Management personnel shall demonstrate a working level knowledge of the principles and construction methods associated with grading, paving, and drainage for site preparation.

Supporting Knowledge and/or Skills

a. Read and interpret a site plan drawing.

b. Read and interpret a contour map.

c. From a site plan show how quantities of earth required for fill or removal were derived.

d. Discuss field and lab soil compaction methodologies and utilization criteria.

e. Define the following terms as they relate to horizontal curves:

- Point of intersection (PI)
- Point of tangency (PT)
- Point of curvature (PC)

f. Discuss the characteristics of rigid and flexible pavement.

g. Discuss the hydraulics associated with drainage to include:

- Open channel flow
- Flood zone determination

h. Discuss the following elements of hydrostatics related to site preparation:

- Hydrostatic pressure
- Flood routing
- Hydraulic gradient
- Seepage

i. Discuss the construction methods and requirements associated with earth work and trenching. Include the following elements in the discussion:

- Water pollution and soil erosion
- Noise pollution
- Traffic control measures
- Dust control
- Personnel Protection

4. Construction Management personnel shall demonstrate a working level knowledge of techniques for preparing cost estimates.

Supporting Knowledge and/or Skills

a. Discuss how each of the following factors contributes to the development of cost estimates for a construction project:

- Construction plans
- Productivity rates
- Specifications
- Crew composition
- Schedule interpretation and impacts
- General and administrative rates
- Material prices
- Equipment types and rates
- Known labor rates

b. Discuss the impact of job factors on productivity rates.

c. Evaluate time, material, and labor estimates for a construction project.

d. Discuss the effect of escalation and inflation factors on cost estimates.

e. Discuss the purpose of contingency in cost estimating, including an explanation of how it is calculated.

f. Prepare a cost and technical analysis of a contractor's proposal.

g. Discuss funding authorization limits and their impact on the cost estimating process.

h. Develop recommendations for the contracting officer based on cost and technical analysis.

i. Describe the application and use of estimator tools.

5. Construction Management personnel shall demonstrate a working level knowledge of techniques for scheduling construction projects.

Supporting Knowledge and/or Skills

a. Discuss construction project scheduling methods, including an explanation of critical path scheduling.

b. Discuss each of the following elements of construction project scheduling, including the factors of each that could impact the schedule:

- Orderly delivery of equipment and materials in sequence with the installation schedule
- Construction equipment requirements
- Manpower planning and scheduling
- Bidding and award activities

c. Read and interpret the following construction project control aids:

- GANTT Charts (bar chart)
- Site specific electronic scheduling tools
- Networking techniques (critical path method [CPM])
- Percentage completion curve (S curve)
- Labor schedules
- Material schedules
- Equipment schedules
- Finance schedules

d. Describe how the project schedule is used to control cost and schedule as well as tracking it.

e. Evaluate project baseline using resource loaded, time based CPM schedules at a level and frequency that potential problems can be identified and solved before they become real problems.

6. Construction Management personnel shall demonstrate a familiarity level knowledge of contract law applicable to contract specifications and drawings.

Supporting Knowledge and/or Skills

a. Discuss stop-work orders including responsibilities and authorities, and the impact of a stop-work order to project cost and schedule.

b. Describe what constitutes compliance with specifications and drawings.

c. Discuss the process for making changes and modifications to contract specifications or the scope of work.

d. Describe the difference between expressed and implied warranties and how each is addressed in contract specifications.

e. Describe the process for expending funds for a project as it relates to contract law.

f. Describe in general terms the process used to negotiate and establish a construction contract between the Department of Energy and the contractor.

7. Construction Management personnel shall demonstrate the ability to read and interpret engineering piping and instrument drawings (P&ID) at a working level.

Supporting Knowledge and/or Skills

a. Identify the symbols used on engineering piping and instrument drawings for:

- Types of valves
- Types of valve operators
- Basic types of instrumentation
- Types of system components (pumps, etc.)
- Types of lines

b. Identify the symbols used on engineering piping and instrument drawings to denote the location of instruments, indicators, and controllers.

c. Identify how valve conditions are shown on a piping and instrument drawing.

d. Determine the system flow path for a given valve lineup.

8. Construction Management personnel shall demonstrate a working level of knowledge of the application of Federal Acquisition Regulations to a construction project by successful completion of a Contracting Officer Representative course and written examination.

9. Construction Management personnel shall demonstrate the ability to read and interpret electrical diagrams and schematics at a working level.

Supporting Knowledge and/or Skills

a. Identify the symbols used on electrical engineering drawings.

b. Identify the symbols and/or codes used on electrical engineering drawings to show the relationship between components.

c. State the condition in which all electrical devices are shown, unless otherwise noted on the diagram or schematic.

d. Given a simple electrical schematic and initial conditions, identify the power sources and/or loads and their status.

10. Construction Management personnel shall demonstrate the ability to read and interpret electronic block diagrams and logic diagrams at a working level.

Supporting Knowledge and/or Skills

a. Given an electronic block diagram, print, or schematic, identify the symbols that represent the basic components.

b. Identify the symbols on logic diagrams that represent the components.

c. Given a logic diagram and appropriate information, determine the output of each component and the logic circuit.

11. Construction Management personnel shall demonstrate the ability to read and interpret engineering fabrication, construction, and architectural drawings at a working level.

Supporting Knowledge and/or Skills

a. Given the above drawings, read and interpret the following symbology:

- Basic dimensional and tolerance
- Basic fabrication
- Basic construction
- Basic architecture

b. Given a drawing and a completed or partially completed product, compare the product against the specifications on the drawing.

c. Discuss the relationship between specifications and drawings.

d. Describe the process for resolving conflicts between specifications and drawings.

12. Construction Management personnel shall demonstrate a familiarity level knowledge of the principles and concepts of natural phenomena hazards.

Supporting Knowledge and/or Skills

a. Discuss the impact on facilities, and the mitigating factors, associated with the following hazards:

- Flooding
- Wind
- Tornado
- Earthquake and/or other seismic events

b. Describe the safety measures and design features commonly used as safeguards against natural hazards.

c. Discuss design requirements for flooding, wind, tornado, earthquake, and seismic events.

13. Construction Management personnel shall demonstrate a working level knowledge of fire protection requirements for a construction site.

Supporting Knowledge and/or Skills

a. Discuss the fire protection requirements and precautions for material storage on a construction site.

b. Discuss the fire protection safety requirements for egress from areas of a construction site.

c. Discuss the availability and location of fire fighting equipment requirements on a construction site.

d. Discuss the fire protection considerations specific to a construction activity that could affect nuclear safety at a defense nuclear facility.

e. Perform construction site safety inspections of fire protection capabilities and equipment.

14. Construction Management personnel shall demonstrate a working level knowledge of construction methods and accepted construction practices for the following:

- **Structural waterproofing**
- **Architectural finishes**
- **Roofing systems**
- **Mechanical and electrical equipment installation**
- **Material protection and storage**
- **Construction site tools, equipment, and materials**

Supporting Knowledge and/or Skills

a. Discuss the requirements, materials, and methods for waterproofing walls, floors, or other building elements that are subject to hydrostatic pressure, are below the water table, or may be immersed in water.

b. Discuss the construction methods and requirements associated with the following architectural finishes. Include the elements of fire protection, hazardous material contamination, and indoor air quality in the discussion:

- Gypsum board
- Tile
- Acoustical treatment
- Resilient flooring
- Carpet
- Resinous flooring
- Conductive flooring
- Paint
- Wall coverings
- Special coatings

c. Discuss the construction methods and requirements of roofing systems. Include the following elements in the discussion:

- Roofing tiles
- Membrane roofing
- Bituminous roofing
- Sheet metal roofing
- Single ply roofing
- Roof mounted equipment
- Water retention

d. Discuss the construction methods and requirements for installing electrical and mechanical equipment. Include the following elements in the discussion:

- Clearances
- Maintenance access and staging space
- Spill consequences
- Accessibility to cranes and hoists
- Bonding and grounding of equipment

e. Discuss the methods and requirements for material protection and storage on the construction site. Include the following elements in the discussion:

- Theft protection
- Moisture protection
- Temperature protection

f. Describe the use and application of various tools and equipment used on a construction project. Include a discussion of specialty tools used for specific applications.

g. Discuss the characteristics, material strength properties, and service applications for the materials used on a construction project. Include the following elements in the discussion:

- Sand and aggregate
- Construction lumber
- Concrete
- Back-fill material
- Shoring

15. Construction Management personnel shall demonstrate a familiarity level knowledge of the chemical fundamentals of corrosion.

Supporting Knowledge and/or Skills

a. Explain the general corrosion process for iron and steel when exposed to water.

b. Discuss the conditions that can cause galvanic corrosion.

c. Discuss the following types of specialized corrosion:

- Pitting corrosion
- Stress corrosion cracking
- Crevice corrosion

16. Construction Management personnel shall demonstrate a familiarity level knowledge of chemical safety fundamentals.

Supporting Knowledge and/or Skills

a. Discuss the hazards associated with the use of corrosives (acids and alkalies).

b. Describe the general safety precautions to be taken during the handling, storage, and disposal of corrosives.

c. Discuss the general safety precautions to be taken during the use, handling, and storage of compressed gases, specifically including: hydrogen, oxygen, and nitrogen.

d. Discuss the safety precautions for working with cryogenic liquids.

e. Explain the difference between an inflammable material and a combustible material.

f. Describe the general safety precautions to be taken during the use, handling, and storage of inflammable and combustible materials.

g. Describe the information on a material safety data sheet (MSDS) and discuss the uses for material safety data sheets on a construction project.

17. Construction Management personnel shall demonstrate a familiarity level knowledge of the basic principles and concepts of geoscience as applied to soil, erosion, foundations, and earth embankments.

Supporting Knowledge and/or Skills

a. Identify and describe examples of shallow and deep foundations.

b. Discuss the basic elements of embankment design.

c. Define erosion and describe the characteristics and effects of water and wind erosion.

d. Describe the types of tests used to determine the strength and dynamic properties of soils.

e. Describe the unified soil classification system.

f. Discuss the applicability of active, passive, and at-rest pressures to earth retaining structures.

18. Construction Management personnel shall demonstrate a familiarity level knowledge of the basic concepts of hydrology.

Supporting Knowledge and/or Skills

a. Define hydrology as it applies to construction management and engineering.

b. Describe the flow of subsurface groundwater.

19. Construction Management personnel shall demonstrate a familiarity level knowledge of the Department of Energy's design and construction processes.

Supporting Knowledge and/or Skills

a. Discuss the following elements of the Department design process:

- Congressional project approval process
- Actual preparation of a conceptual design report
- Architect/engineer selection process
- Design approval process

b. Discuss the Department's construction process following a project's certification for construction. Include in the discussion the difference between direct hire and indirect hire construction contracts, and the role of Department construction management and engineering personnel in the construction process.

20. Construction Management personnel shall demonstrate a familiarity level knowledge of basic electrical equipment.

Supporting Knowledge and/or Skills

a. Discuss the basic purpose of a transformer.

b. Discuss the applications of alternating current (AC) and direct current (DC) generators and motors on a construction project.

c. Discuss application of the following as backup power supplies:

- UPS inverters
- Diesel generators
- Motor generators
- Auto transfer switches

d. Discuss the types and function of electrical switchgear used on a construction project.

e. Identify and discuss the application of the different types of circuit breakers.

21. Construction Management personnel shall demonstrate a familiarity level knowledge of basic electrical equipment operation.

Supporting Knowledge and/or Skills

a. Discuss the various types of batteries used in electrical systems. Include the following elements of battery operation in the discussion:

- Capacity
- Voltage applications
- Battery life expectancy
- Environmental requirements for safe battery operation

b. Discuss the basic operation of alternating current (AC) and direct current (DC) generators.

c. Discuss the basic operation of the various types of alternating current (AC) and direct current (DC) motors. Include in the discussion the following elements of motor operation as applicable to alternating current (AC) or direct current (DC) motors:

- Starting current vs. running current
- Current vs. load characteristics
- Applications for different types of motors

d. Discuss the basic operation of the various types of transformers. Include in the discussion the following elements of transformer operation and design:

- Theory of operation
- Purpose of the transformer
- Transformer ratings
- Transformer cooling requirements

e. Identify and discuss the operation of the different types of electrical switchgear.

22. Construction Management personnel shall demonstrate a familiarity level knowledge of instrumentation and control systems.

Supporting Knowledge and/or Skills

a. Describe the functions that temperature, pressure, level, flow, position, and radiation detectors provide.

b. Describe the basic operation of process control systems used in the following applications:

- Temperature measurement
- Flow measurement
- Pressure measurement
- Level measurement
- Position measurement

c. Discuss the requirements specific to instrumentation and control system components that are important to safety.

d. Describe the operation of the following types of actuators used in process control systems:

- Pneumatic
- Hydraulic
- Solenoid
- Electric motor

23. Construction Management personnel shall demonstrate a familiarity level knowledge of the construction and operation of basic mechanical components.

Supporting Knowledge and/or Skills

a. Describe the function, construction, and operation of the following types of pumps:

- Centrifugal pump
- Positive displacement pump
- Single stage and multiple stage pumps
- Submersible pumps

b. Describe the basic construction and operation of the following types of valves:

- Gate valve
- Globe valve
- Butterfly valve
- Check valve
- Relief and safety valves

c. Discuss the function and application of the following types of filters/strainers used in mechanical fluid flow systems and ventilation systems:

- Cartridge filters
- Pre-coated filters
- Bucket strainers
- Deep-bed filters
- HEPA filters
- Particulate filters
- Duplex strainers

d. Discuss the causes of water hammer and pressure spiking.

e. Describe the operation of a compressed air system, including a discussion of the basic function of each of the following components:

- Compressor
- Moisture separator
- Intercooler
- After cooler
- Receiver
- Air dryer

f. Describe the basic operation of pressure regulating, temperature control, and flow control valves in a process system.

g. Describe the basic operation of a heat exchanger used in a process system.

h. Describe the basic design and operation of a typical heating, ventilation, and air conditioning (HVAC) system.

24. Construction Management personnel shall demonstrate a familiarity level knowledge of mechanical system/component installation.

Supporting Knowledge and/or Skills

a. Discuss the following elements and components of mechanical system piping design. Include a discussion of construction methods used in the installation of each component:

- Pipe hangers
- Piping supports
- Snubbers
- Piping insulation and vapor barriers
- Piping installation
- Piping anchors
- Piping material
- Field routing of piping
- Expansion joints

b. Discuss the following types of piping connections and their application to different piping sizes and uses:

- Threaded connections
- Flanged connections
- Socket welded connections
- Butt welded connections
- Re-weldable joints
- Bayonet joints
- Compression joints

c. Describe the basic construction methods and precautions associated with the installation of the following types of mechanical components:

- Large pumps
- Heat exchangers
- Air conditioning units
- Compressors
- Tanks and pressure vessels

25. Construction Management personnel shall demonstrate a familiarity level knowledge of the systems for industrial waste treatment, storm drains, and sanitary waste treatment.

Supporting Knowledge and/or Skills

a. Describe the basic design for a sanitary waste treatment system.

b. Discuss the following methods of waste water treatment:

- Primary
- Secondary
- Tertiary

c. Discuss the functions of the following components:

- Clarifier
- Trickling filters
- Pumping station
- Wet well

d. Discuss the methods and requirements for solid waste disposal associated with sanitary waste treatment systems.

e. Discuss the construction and installation requirements for sewers and force mains.

f. Discuss the installation and construction requirements for storm drain and sewer main piping that pass under a security barrier.

g. Discuss the hydraulics associated with the following:

- Runoff into storm sewers
- Open channels
- Street drainage

REGULATORY

26. Construction Management personnel shall demonstrate a familiarity level knowledge of the following laws and Department of Energy Order related to environmental protection, safety and health: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); Resource Conservation and Recovery Act (RCRA); National Environmental Policy Act (NEPA); Clean Water Act (CWA); Clean Air Act (CAA); Toxic Substances Control Act (TSCA); DOE Order 5480.4, Environmental Protection, Safety, and Health Protection Standards.

Supporting Knowledge and/or Skills

a. Discuss the purpose, scope, and application of the listed Acts and DOE Order. Include in this discussion the key terms, essential elements, and personnel responsibilities and authorities.

b. Discuss the contractor's responsibilities for environmental safety and health protection, as stated in the above documents.

c. Determine the potential implications resulting from violations and describe the procedure for communicating the results to the contractor and to Department management.

d. Discuss the application of the listed environmental protection Acts to a construction project during the conceptual, execution, acceptance, and close-out phases of the project.

27. Construction Management personnel shall demonstrate a working level knowledge of the quality assurance processes and procedures applicable to construction management in 10 CFR 830.120, Quality Assurance Requirements.

Supporting Knowledge and/or Skills

a. Discuss the purpose, scope, and application of 10 CFR 830.120. Include in this discussion key terms, essential elements, and personnel responsibilities and authorities.

b. Discuss the quality assurance measures required for each of the following elements of a project:

- Design configuration control
- Procurement control
- Instructions, procedures, and drawings
- Document control
- Identification, control, and traceability of materials, parts, and components
- Control of special processes
- Inspection
- Test control
- Calibration and control of test and measurement equipment
- Handling, storage, shipping, and preservation of material, parts, or components
- Nonconformity of material, parts, or components
- Corrective action
- Quality assurance records
- Audits

c. Describe the screening process for the identification and inspection of suspect or counterfeit material items.

d. Describe the roles and responsibilities of Department of Energy quality assurance personnel and construction personnel for quality control during construction activities.

28. Construction Management personnel shall demonstrate a working level knowledge of the unreviewed safety question process of 10 CFR 830.

Supporting Knowledge and/or Skills

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

b. Describe the situations that require implementation of the USQ process.

c. Define the situations that represent an Unreviewed Safety Question.

d. Describe your contractors USQ process.

29. Construction Management personnel shall demonstrate a working level knowledge of the Documented Safety Analysis (DSA) and the Technical Safety Requirements (TSR) as described in 10 CFR 830, and safety implementation in accordance with DOE Order 420.1A, Facility Safety.

Supporting Knowledge and/or Skills

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

b. Discuss the purpose of the DSA and TSRs.

c. Describe the responsibilities of contractors authorized to operate defense nuclear facilities regarding the DSA and TSRs.

d. Discuss how hazard and accident analysis are used in design and evaluation of Structures, Systems, and Components.

e. Describe how safety structures, systems, and components are addressed in the DSA and discuss the implications of the following classifications:

- Safety Class
- Safety Significant
- Defense In Depth

f. Discuss the relationship between the construction schedule and the development or modification of the facility DSA.

30. Construction Management personnel shall demonstrate a working level knowledge of the Occupational Safety and Health Act (OSHA) requirements in the following chapters of the Code of Federal Regulations:

- **29 CFR 1910, Occupational Safety and Health Standards**
- **29 CFR 1926, Safety and Health Regulations for Construction**

Supporting Knowledge and/or Skills

a. Discuss how the Occupational Safety and Health Act applies to and impacts Department construction projects.

b. Identify the requirements in the Occupational Safety and Health Act that form the basis of authority for construction management personnel in the oversight and management of construction projects.

c. Discuss the basic requirements in the listed documents for each of the following areas associated with construction projects:

- Personnel protective equipment (PPE)
- Electrical safety
- Safety hazards associated with welding
- Safety hazards associated with materials handling and storage
- Safety hazards associated with machinery
- Safety hazards associated with portable and hand tools
- Safety hazards associated with concrete and masonry
- Safety hazards associated with scaffolding

d. Discuss the responsibilities of the construction manager in ensuring compliance with Occupational Safety and Health Act requirements.

e. Describe the actions to be taken to correct a deficiency with the requirements of the listed documents.

f. Develop an assessment plan for inspection of construction activities and the construction site for compliance with Occupational Safety and Health Act requirements.

31. Construction Management personnel shall demonstrate a working level knowledge of National Fire Protection Association (NFPA) industry standards for construction management and engineering.

Supporting Knowledge and/or Skills

a. Discuss the purpose, scope, and application of the National Fire Protection Association industry standards. Include in this discussion key terms, essential elements, and personnel responsibilities and authorities.

b. Identify the National Fire Protection Association industry standards necessary to evaluate the appropriate elements of a project.

c. Determine contractor compliance with the requirements of the National Fire Protection Association industry standards as they apply to contract design requirements and construction activities during a walkthrough at a defense nuclear facility.

32. Construction Management personnel shall demonstrate a working level knowledge of the Uniform Building Code (UBC) industry standards for construction management and engineering.

Supporting Knowledge and/or Skills

a. Discuss the purpose, scope, and application of the Uniform Building Code industry standards. Include in this discussion key terms, essential elements, and personnel responsibilities and authorities.

b. Identify the Uniform Building Code industry standards necessary to evaluate the appropriate elements of a project.

c. Determine contractor compliance with the requirements of the Uniform Building Code industry standards as they apply to contract design requirements and construction activities during a walkthrough at a defense nuclear facility.

33. Construction Management personnel shall demonstrate a working level knowledge of the Pre-stressed Concrete Institute (PCI) industry standards for construction management and engineering.

Supporting Knowledge and/or Skills

a. Discuss the purpose, scope, and application of the Pre-stressed Concrete Institute industry standards. Include in this discussion key terms, essential elements, and personnel responsibilities and authorities.

b. Identify the Pre-stressed Concrete Institute industry standards necessary to evaluate the appropriate elements of a project.

c. Discuss application of PCI industry standards to construction activities and inspection during a walkthrough of a concrete structure.

34. Construction Management personnel shall demonstrate a working level knowledge of construction methods and accepted construction practices associated with reinforced concrete design as described in the following American Concrete Institute (ACI) documents:

- **ACI-301, Specifications for Structural Concrete for Buildings**
- **ACI-315, Detailing of Concrete Reinforcement**
- **ACI-318, Building Code Requirements for Structural Concrete and Commentary**
- **ACI-349, Code Requirements for Nuclear Safety Related Concrete Structures and Commentary**
- **ACI-311.4R, Guide for Concrete Inspection**
- **ACI-311.5R, Guide for Concrete Plant Inspection and Testing of Ready-Mixed Concrete**
- **ACI-305R, Hot Weather Concreting**
- **ACI-306R, Cold Weather Concreting**

Supporting Knowledge and/or Skills

a. Discuss the standard construction methods for plain, reinforced, or pre-stressed concrete structures. Include a discussion of the concrete materials, design, and construction of the following:

- Sanitary engineering structures
- Concrete forms
- Concrete reinforcement
- Cast-in-place concrete
- Pre-cast concrete
- Cementitious decks for buildings
- Mass concrete
- Post tension concrete
- Tilt-up concrete

b. Discuss the construction climatic considerations for hot and cold weather concreting including the code requirements in ACI-305R and ACI-306R.

c. Identify and discuss the minimum building code requirements for reinforced concrete in ACI-318.

d. Identify and discuss the requirements for concrete construction in ACI-349.

e. Discuss the longitudinal and shear reinforcement requirements for beam design.

f. Describe the inspection methods used for concrete during a walkthrough of a concrete structure. Relate these inspection methods to the structure and its construction.

35. Construction Management personnel shall demonstrate a working level knowledge of welding, weld testing and inspection, and the criteria in the following American Welding Society (AWS) codes:

- **AWS D1.1, Structural Welding Code – Steel**
- **AWS D1.2, Structural Welding Code – Aluminum**
- **AWS D1.3, Structural Welding Code - Sheet Steel**
- **AWS D5.2, Standard for Welded Steel, Elevated Tanks, Standpipes, and Reservoirs for Water Storage**

Supporting Knowledge and/or Skills

a. Describe the welding techniques, materials, and equipment used for different metals and applications.

b. Describe the welding techniques, materials, and equipment used for nonmetals.

c. Discuss the requirements for welder qualification and the methods for ensuring that qualifications are current.

d. Describe the techniques and requirements for destructive testing of welds.

e. Discuss the following methods of weld inspection:

- Visual
- Radiographing
- Dye penetrant
- Ultrasonic

f. During a facility or construction site walkthrough evaluate accessible weld joints. Describe welding methods and inspection techniques that apply to each weld.

36. Construction Management personnel shall demonstrate a working level knowledge of construction methods and accepted construction practices associated with structural steel as described in the following documents:

- **American Institute of Steel Construction AISC-M021 , Manual of Steel Construction**
- **American Institute of Steel Construction AISC-N690-94, Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities. American Institute of Steel Construction AISC-S326, Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings Uniform Building Code (UBC)**

Supporting Knowledge and/or Skills

a. Discuss the structural design requirements and standard construction methods associated with the following:

- Light gauge steel
- Pre-engineered metal buildings
- Steel water tanks
- Transmission towers
- Steel joists
- Steel decks
- Structural steel connections and fastening

b. Define the following:

- Minimum edge distance
- Unbraced length
- Beam bearing plate
- Web crippling

c. Given data and the appropriate equations, calculate the following for a steel member:

- Average shear stress
- Parabolic shear stress
- Bending stress
- Axial stress
- Torsional shear stress

d. List the causes of buckling of load bearing columns and beams.

e. Describe the following types of connections:

- Friction
- Bearing
- Tension
- Rigid
- Non-rigid
- Semi-rigid

f. Evaluate scaffolding and temporary work platform arrangements for structural integrity and stability.

g. Walkthrough a structure with exposed structural steel and discuss the applicable construction methods and practices associated with the structural steel.

37. Construction Management personnel shall demonstrate a working level knowledge of electrical equipment installation methods and National Electrical Code (NEC) requirements.

Supporting Knowledge and/or Skills

a. Discuss the classification of electric cable.

b. Determine the requirements in the National Electrical Code (NEC) for the installation of electrical equipment under a given set of conditions.

c. Describe the construction methods, equipment, and components used to install electrical distribution systems.

d. During a facility walkthrough describe the NEC requirements for the facility and construction activities to install the electrical equipment.

MANAGEMENT, ASSESSMENT, AND OVERSIGHT

38. Construction Management personnel shall demonstrate a working level knowledge of project management principles and the methods used to ensure that contractor resources are applied to meet quality, safety, technical, cost, and schedule commitments.

Supporting Knowledge and/or Skills

a. Explain the purpose of project management, and describe the life cycle of a typical project.

b. Describe the primary roles and responsibilities of construction management and engineering personnel.

c. Describe typical documents and data sources used in Project Management.

d. Identify, explain, and discuss the relationship of the major elements of a project.

e. Explain the purpose and use of a Project Execution Plan.

f. Discuss the five elements of the Department of Energy program for operational configuration management as described in DOE-STD-1073-2003, Configuration Management:

- Design requirements
- Document control
- Program management
- Change control
- Assessments

g. Explain the use of safety plans in the management of projects.

h. Discuss the relationship between work breakdown structure (WBS) and cost and schedule.

i. Describe the purpose and use of work packages and/or planning packages.

j. Describe the purpose of schedules, and discuss the use of milestones and activities.

k. Describe the critical path method of scheduling.

l. Explain the concept of a project management baseline and describe the baseline used in project management.

m. Discuss the following elements of construction project contract labor:

- Availability of labor skills
- Interaction of labor crafts
- Standby requirements and their impact on the schedule
- Craft jurisdiction
- Union vs. non-union
- Skills and labor rates

n. Describe how performance and productivity rates are established.

o. Discuss the use of a resource loaded, time based, CPM schedule for the day-to-day control of a project and its importance in meeting cost and schedule baseline.

39. Construction Management personnel shall demonstrate the ability to apply construction management principles in the execution of construction methods, constructability reviews, planning, and performance measurement for a construction project at a working level.

Supporting Knowledge and/or Skills

a. Determine whether a construction project execution plan can be implemented safely and cost-effectively and still meet the project specifications.

b. Determine the availability of the resources, equipment, and qualified subcontractors necessary to implement a construction project execution plan.

c. Evaluate a contractor decision to make or buy.

d. Evaluate construction project execution plans and schedules for feasibility.

e. Manage contingency funding.

f. Prepare a Project Status Report and determine deviations from the estimates.

40. Construction Management personnel shall demonstrate the ability to apply principles of risk management in preparing a risk assessment for a construction project at a familiarity level.

Supporting Knowledge and/or Skills

a. Assess construction project risks that identify critical systems, subsystems, and other factors that require focused work and resolution.

b. Evaluate the assessed level of risk for a construction project.

c. Describe the basis for a risk assessment.

d. Identify the critical construction project elements that contribute to the risk.

e. Identify the consequences of the risk.

f. Identify the stage of the construction project in which the risk exists.

41. Construction Management personnel shall demonstrate the ability to perform project management duties in providing construction management and engineering support to a project at a working level.

Supporting Knowledge and/or Skills

a. Ensure that cost, schedule, and scope requirements are met.

b. Act as principal contact and liaison for the exchange of information between the contractor and the Department.

c. Ensure that instructions to the contractor are within the terms of the contract.

d. Ensure compliance by the contractor with the technical, safety, and administrative requirements of the contract.

e. Participate in the formulation and approval of plans and schedules.

f. Arrange for contacts between the construction contractor, other participants, and appropriate staff as required.

42. Construction Management personnel shall demonstrate a working level knowledge of assessment techniques, reporting, and follow-up actions used to evaluate contractor performance.

Supporting Knowledge and/or Skills

a. Describe the role of Construction Management personnel in overseeing Government-Owned Contractor-Operated (GOCO) facilities.

b. Describe the assessment requirements and limitations of construction management and engineering personnel in interfacing with contractor employees.

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

d. Explain the essential elements of a performance-based assessment including the areas of investigation, fact-finding, and reporting. Include a discussion of the essential elements and processes associated with the following assessment activities:

- Exit interviews
- Closure process
- Tracking to closure
- Follow-up
- Contractor corrective action implementation

e. Describe the actions to be taken if the contractor challenges the assessment findings. Explain how such challenges can be avoided.

43. Construction Management personnel shall demonstrate the ability to assess contractor and/or Federal construction management and engineering activities and make all necessary reports at a working level.

Supporting Knowledge and/or Skills

a. Given different sets of performance data, compare and contrast the data to highlight acceptable and unacceptable work performance.

b. Describe the methods by which noncompliance is determined and communicated to contractor and Department of Energy management.

c. Conduct an assessment of a contractor's construction management and engineering activities and develop and submit the resulting assessment report.

d. Perform an independent assessment of contractor operations.

e. Conduct an interview representative of one that would be conducted during an occurrence investigation.

f. Develop an assessment report using the findings from an assessment.

g. Discuss the results of Construction Management assessments in a formal meeting between Department of Energy management and senior contractor management.

44. Construction Management personnel shall demonstrate a working level knowledge of problem analysis principles and the techniques necessary to identify problems, determine potential causes of problems, and identify corrective action(s).

Supporting Knowledge and/or Skills

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

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

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

d. Interpret a fault tree analysis.

e. Participate in a contractor or Department of Energy problem analysis and critique the results.

45. Construction Management personnel shall demonstrate the ability to interact with Federal, state, local, and public stakeholder representatives at a working level.

Supporting Knowledge and/or Skills

a. Discuss the roles and responsibilities of site and/or community advisory boards on Construction Management issues.

b. Discuss the Department of Energy's position on construction management and engineering issues that impact Federal, state, local, and public stakeholder segments.

c. Discuss the Freedom of Information Act and its impact on Department of Energy Construction Management programs. Discuss security precautions to be taken in relevant programs in terms of the Freedom of Information Act.

d. Communicate effectively with the public and other stakeholders.

e. Given Construction Management related program data, identify those portions of the data required to be communicated to organizations external to the Department of Energy Construction Management personnel. Discuss any potential impacts on Department of Energy programs.

f. Communicate with Headquarters Program Office representatives, Department of Energy Legal representatives, contractors, state, and local officials.

46. Construction Management personnel shall demonstrate the ability to define and ensure effective implementation of required quality assurance activities for a construction project at a working level.

Supporting Knowledge and/or Skills

a. Describe the quality assurance program for a construction project.

b. Participate in material and test evaluations to validate that material specification requirements have been met.

c. Participate in source supply certification of mills, quarries, labs, batch plants, and weld shops.

d. Gather trending data and trace actions to correct recurring deficiency problems.

e. Evaluate the contractor's quality assurance plan.

f. Monitor quality assurance activities in the field and measure them against the quality assurance plan.

g. Participate in quality assurance plan surveillance.

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

Construction Management 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 Construction Management area as determined appropriate by management. This may include courses/training provided by Department of Energy, 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 Construction Manager at a Department of Energy facility.

3. Attend seminars, symposia, or technical meetings related to Construction Management.

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

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:
EM
NNSA
EH
NE
SC

Preparing Activity:
DOE-ORP (EH-22)

Project Number:
TRNG-0043

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