

U.S. DEPARTMENT OF ENERGY  
DEPARTMENT-WIDE QUALIFICATION STANDARD

# GENERAL TECHNICAL BASE QUALIFICATION STANDARD

**Defense Nuclear Facilities Technical Personnel**



U.S. Department of Energy  
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## GENERAL TECHNICAL BASE QUALIFICATION STANDARD

### PURPOSE

The General Technical Base Qualification Standard addresses Commitment 4.4.2 in the Department's implementation plan for DNFSB Recommendation 93-3. It is intended to ensure that all technical employees in the Technical Qualification Program have a common level of core technical knowledge. Completion of these requirements also helps to ensure that technical employees have the requisite general knowledge to be sufficiently prepared to meet the next level of technical competency requirements in applicable functional categories.

The General Technical Base Qualification Standard provides the base knowledge of the Technical Personnel Qualification Program. Functional Area Qualification Standards build on this base knowledge to provide greater knowledge and skills for each individual functional area. Facility/Site Specific Qualification Standards then build upon the knowledge and skills of the functional areas and provide the unique knowledge and skills for a functional area at a specific facility or site.

### APPLICABILITY

This qualification standard applies to all Department of Energy technical personnel performing activities related to the management, oversight or operation of defense nuclear facilities. Personnel designated by Heads of Program or Operations offices as participants in the Technical Qualification Program are required to meet the core competencies described in this standard. There are no continuing or retraining requirements associated with the General Technical Base Qualification Standard.

### IMPLEMENTATION REQUIREMENTS

The General Technical Base Qualification Standard addresses eight technical areas. Each of the areas is defined by one or more competency statements indicated by bold print. Each of the competency statements is further explained by a listing of supporting knowledge and/or skills statements. The competency statements define the expected knowledge and/or skills that an individual must possess to meet the intent of the qualification area. The supporting knowledge and/or skills statements further describe the intent of the competency statement. However, each of the supporting knowledge and/or skills statements do not necessarily have to be fulfilled to meet the intent of the competency.

Program and Operations offices shall establish a program and process to ensure that all personnel required to participate in the Technical Qualification Program meet the requirements of this qualification standard. Documentation of completion of the requirements of this qualification standard shall be included in the employee's training and qualification record. Additional information on the technical qualification and documentation process for the Department's technical personnel is provided in the Professional Development of Federal Technical Personnel document (June 1994). This

document is available from the Office of Professional and Technical Training and Development (HR-33).

Equivalencies may be granted for individual areas of the standard based upon an objective evaluation of the employee's prior education, experience and/or training. Documentation of equivalencies should indicate how the competency statements of the subject area(s) have been met. The supporting knowledge and/or skills statements should be considered when evaluating that the competency statements have been met.

Training shall be provided to employees in the Technical Qualification Program who do not meet the intention of the competencies listed in one or more of the sections of the qualification standard. Departmental training will be based upon supporting knowledge and/or skill statements similar to the ones listed for each of the competency areas. Supporting knowledge and/or skill statements shall be used as a basis for evaluating the content of training courses. The method used to evaluate that the employee satisfied the knowledge and/or skill requirements upon the completion of the training shall be documented. The recommended method of evaluation is written examination. When written examinations are used, they should be retained in the employee's training and qualification record.

### **CORE COMPETENCY REQUIREMENTS**

Sections 1 through 8 contain the General Technical Base Qualification Standard competency statements and associated knowledge and/or skill statements.

**Section 1: NUCLEAR FUNDAMENTALS****1.1 Personnel shall demonstrate knowledge of basic atomic structure.**Supporting Knowledge and/or Skills

- a. Identify the basic particles that compose the atom and explain their relationship, associated mass, and charge.
- b. Explain the Bohr Model of the atom.
- c. Explain the following terms:  
         Nuclide          Isotope          Atomic number          Mass number
- d. Referring to the  ${}^A_Z X$  notation for a specific nuclide, determine the number of protons, neutrons, and electrons.

**1.2 Personnel shall demonstrate knowledge of basic nuclear theory and principles.**Supporting Knowledge and/or Skills

- a. Explain the three forces that are found within a nucleus.
- b. Explain the terms mass defect and binding energy and their relationship.
- c. Explain the following processes, and trace the decay chain for a specified nuclide on the chart of the nuclides.  
         Alpha decay    Beta-minus decay    Beta-plus decay    Electron capture
- d. Explain the following terms:  
         Radioactivity          Radioactive decay constant          Curie  
         Radioactive half-life          Radioactive equilibrium
- e. Explain the following neutron/nucleus interactions:  
         Elastic scattering          Inelastic scattering
- f. Compare and contrast capture (absorption), fission, and particle ejection nuclear reactions.

**1.3 Personnel shall demonstrate knowledge of the basic fission process and results obtained from fission.**

Supporting Knowledge and/or Skills

- a. Explain the fission process utilizing the liquid drop model.
- b. Compare and contrast the characteristics of fissile material, fissionable material, and fertile material.
- c. Explain the various energy releases that result from the fission process.
- d. Explain the term criticality and how it is detected.
- e. List five factors that affect criticality.
- f. Identify the hazards that result from an unwanted criticality.
- g. Explain the double contingency principle as it relates to criticality control.

**Section 2: RADIOLOGICAL FUNDAMENTALS**

**2.1 Personnel shall demonstrate knowledge of radiological controls, practices, procedures, and theory.**

Supporting Knowledge and/or Skills

- a. Explain the term ionizing radiation.
- b. Explain how nuclear radiation is generated and natural vs. man-made radiation.
- c. Explain each of the following forms of radiation in terms of structure, electrostatic charge, interactions with matter, and penetration potential:  
  
alpha            gamma            beta            neutron (slow and fast)
- d. Explain the types of materials that are best suited for shielding the above radiation types.
- e. Explain the biological effects and the primary hazard(s) of each radiation type.
- f. Explain the term radiation dose and how it is measured including the terms RAD, REM, Roentgen, and international standard units (SI).
- g. Explain the term quality factor and how it is used.
- h. Explain the term ALARA and explain the basic methods for achieving ALARA.

**2.2 Personnel shall demonstrate knowledge of contamination control, practices, procedures, and theory.**

Supporting Knowledge and/or Skills

- a. Explain the term contamination and three types of contamination.
- b. Explain three ways to control contamination.
- c. Explain how contamination is detected.
- d. Explain three ways contamination could enter the body and the methods used to prevent internal contamination.
- e. Explain the methods used for internal dose determination.
- f. Explain the types of personnel protective equipment.

**2.3 Personnel shall demonstrate knowledge of basic radiation detection methods and principles.**

Supporting Knowledge and/or Skills

- a. Explain the type of radiation detected and the method of radiation detection of the following radiation detection instruments;

Gas-filled detector	Proportional Counter	Ionization Chamber
Scintillation Detector	Geiger-Muller Detector	

- b. Explain the proper use, function, and radiation detected by different types of Thermoluminescent Dosimeters and Pocket Ion Chambers.

- c. State the purpose and function of the following radiation monitoring systems:

Criticality	Area	Process	Airborne
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**2.4 Personnel shall demonstrate knowledge of the requirements for radiological control practices, procedures, and limits.**

Supporting Knowledge and/or Skills

- a. Explain the purpose of 10 CFR 835.
- b. Referring to the DOE Radiological Control Manual, explain the following requirements:
- c. Explain level of exposure, how to obtain their personnel records and likely avenues of exposure in the work place.

Access training	Dose limits	Posting types and use
Access Requirements		

**2.5 Using references, personnel shall demonstrate knowledge of the purpose of the following DOE Orders:**

1540.3A	Base Technology for Radioactive Material Transportation Packaging Systems
5400.5	Radiation Protection of the Public and the Environment
N5480.6	Radiological Control Manual
5480.11	Radiation Protection for Occupational Workers
5480.15	Department of Energy Laboratory Accreditation Program for Personnel Dosimetry



**Section 3: ENVIRONMENTAL MANAGEMENT**

- 3.1 Personnel shall demonstrate knowledge of DOE/Federal orders, standards, and regulations related to environmental protection, restoration, and waste management issues.**

Supporting Knowledge and/or Skills

- a. Explain the purpose of the following environmental regulations as they apply to the Department and M&O contractors.

National Environmental Policy Act (NEPA)  
 National Pollution Discharge Elimination System (NPDES)  
 Occupational Safety and Health Act (OSHA)  
 Resource Conservation and Recovery Act (RCRA)  
 Comprehensive Environmental Response, Compensation, and Liability Act-  
 Superfund Act (CERCLA)

- b. Using references, explain the purpose of the following environmental regulations as they apply to the Department and contractors:

Asbestos Hazard Emergency Response Act (AHERA)  
 Atomic Energy Act  
 Clean Water Act (CWA)  
 Clean Air Act (CAA)  
 Emergency Planning and Community Right-To-Know Act  
 Federal Facilities Compliance Act (FFCA)  
 Federal Insecticide, Fungicide, and Rodenticide Act of 1988 (FIFRA)  
 Fish and Wildlife Coordination Act (FWCA)  
 Hazardous Materials Transportation Act (HMTA)  
 Pollution Prevention Act of 1990 (PPA)  
 Safe Drinking Water Act (SDWA)  
 Superfund Amendment Reauthorization Act (SARA)  
 Toxic Substance Control Act (TSCA)

- c. Using references, explain the purpose of the following DOE Orders as they apply to the Department and contractors:

5400.1 General Environmental Protection Program  
 5400.2A Environmental Compliance Issue Coordination  
 5400.3 Hazardous and Radioactive Mixed Waste Program  
 5400.4 Comprehensive Environmental Response, Compensation, and  
 Liability Act Requirements  
 5400.5 Radiation Protection of the Public and the Environment  
 5440.1E National Environmental Policy Act

5480.1B	Environment, Safety, and Health Program for Department of Energy Operations
5480.4	Environmental Protection, Safety, and Health Protection Standards
5482.1B	Environment, Safety, and Health Appraisal Program
5484.1	Environmental Protection, Safety, and Health Protection Information Reporting Requirements
5820.2A	Radioactive Waste Management

- d. Compare and contrast the associated material classification criteria for the following:

Low Level Radioactive Waste	Hazardous Waste
High Level Radioactive Waste	Mixed Hazardous Waste

- 3.2 Personnel shall demonstrate knowledge of the purpose and general content of the sections of a typical Environmental Impact Statement (EIS).**

Supporting Knowledge and/or Skills

- a. Using a typical Environmental Impact Statement as a reference, explain the purpose of the sections as they apply to the Department and its contractors.
- b. Using a typical Environmental Impact Statement as a reference, explain the role of the Department in the generation, review, and approval process associated with an Environmental Impact Statement.
- 3.3 Personnel shall demonstrate knowledge of the purpose and content of 29CFR1910.120 Hazardous Waste Operations and Emergency Response.**

Supporting Knowledge and/or Skills

- a. Using 29CFR1910.120 as a reference, explain its purpose as it applies to the Department and contractors with respect to:
- Cleanup Operations
  - Corrective Actions
  - Voluntary Clean-up Operations
  - Operations Involving Hazardous Wastes
  - Emergency Response Operations
- b. Using 29CFR1910.120 as a reference, explain the role of the Department in the identification, assessment, and reaction to potential risks posed by hazardous wastes that exist at Department sites.

- 3.4 Personnel shall demonstrate knowledge of potential personal and organizational liability associated with the Federal environmental regulations with applicability to Department facility operations.**

Supporting Knowledge and/or Skills

- a. Using references, explain the liabilities associated with the following environmental regulations as they apply to the Department and contractors:

Asbestos Hazard Emergency Response Act (AHERA)  
Clean Water Act (CWA)  
Clean Air Act (CAA)  
Comprehensive Environmental Response, Compensation, and Liability Act -  
Superfund Act (CERCLA)  
Emergency Planning and Community Right-To-Know Act  
Hazardous Materials Transportation Act (HMTA)  
National Environmental Policy Act (NEPA)  
National Pollution Discharge Elimination System (NPDES)  
Occupational Safety and Health Act (OSHA)  
Pollution Prevention Act of 1990 (PPA)  
Resource Conservation and Recovery Act (RCRA)  
Safe Drinking Water Act (SDWA)  
Superfund Amendment Reauthorization Act (SARA)  
Toxic Substance Control Act (TSCA)

- 3.5 Personnel shall demonstrate knowledge of potential personal and organizational liability associated with the Federal Facilities Compliance Act (FFCA)**

Supporting Knowledge and/or Skills

- a. Using the Federal Facilities Compliance Act as a reference, explain the liabilities associated with the Federal Facilities Compliance Act including the following:

Federal Agency Liability  
Federal Employee Liability  
Civil Penalties  
Criminal Penalties  
Resource Conservation and Recovery Act (RCRA)

**Section 4: QUALITY ASSURANCE**

- 4.1 Personnel shall demonstrate the knowledge of quality assurance principles necessary to assure safe, effective and efficient operation of DOE sites and associated facilities.**

**Supporting Knowledge and/or Skills**

- a. Referring to DOE Order 5700.6C, Quality Assurance, explain the purpose and key features of the ten (10) criteria to be used in developing quality assurance Programs.
- b. Referring to NQA-1, Nuclear Quality Assurance, explain the purpose of the eighteen (18) basic quality assurance requirements.
- c. Explain the essential elements of a quality assurance plan.
- d. Explain the Department's responsibilities for the implementation, assessment, and improvement of quality assurance programs
- e. Explain the purpose, origination process, review process, and approval process for quality assurance procedures.
- f. Explain the purpose, the implementation process, and the reporting process associated with quality assurance audits.
- g. Explain the relationship between quality assurance and quality control.
- h. Referring to DOE Order 5480.26, Trending and Analysis of Operations Information Using Performance Indicators, explain the purpose as it relates to quality assurance issues.
- i. Explain the purpose and requirements of 10CFR830.120

**Section 5: INDUSTRIAL SAFETY**

- 5.1 Personnel shall demonstrate knowledge of the Occupational Safety and Health Act (OSHA) necessary to identify safe/unsafe work practices.**

**Supporting Knowledge and/or Skills**

- a. Explain DOE's responsibilities with respect to OSHA including the following:

Hazard recognition and evaluation	Accident investigation
Hazard reduction/elimination	Job safety analysis
Accident/injury/illness prevention	Blood-Borne Pathogens

- b. Using references, explain the purpose of 29 CFR 1910, Occupational Safety and Health Standards.
- c. Using references, explain the purpose of 29 CFR 1960, Basic Program Elements for Federal Employee Occupational Safety and Health and Related Matters.
- d. Explain the regulatory interfaces between OSHA and other regulatory agencies.
- e. Explain workplace inspection techniques.
- f. Explain the major components of the OSHA Hazard Communication Protocol.
- g. Using references, explain the purpose of the following DOE Orders:
- 3790.1B Federal Employee Occupational Safety and Health Program  
 5480.1B Environmental, Safety, and Health Programs for DOE Operations  
 5483.1A Occupational Safety and Health Program for DOE Contractor Employees at Government-Owned-Contractor-Operated (GOCO) Facilities

- 5.2 Personnel shall demonstrate knowledge of Fire Safety for Department facilities necessary to identify safe/unsafe work practices.**

**Supporting Knowledge and/or Skills**

- a. Explain the critical aspects of fire prevention, emergency planning and control of fires.
- b. Explain fire hazards that could affect the safety of facility personnel.
- c. Explain the key elements of the National Fire Protection Association Life Safety Code.
- d. Explain the purpose of Fire Hazard Analysis.

d. Explain the term critical lifts.

**Section 6: CONDUCT OF OPERATIONS****6.1 Personnel shall demonstrate knowledge of the principles of Conduct of Operations and relate these principles to an operational environment.****Supporting Knowledge and/or Skills**

- a. Referring to a copy of DOE Order 5480.19, Conduct of Operations Requirements for DOE Facilities,(including Attachment 1) locate applicable guidelines and requirements for specific activities.
- b. Explain how each eighteen chapters in Attachment 1 of the DOE Order 5480.19, contributes to an effective and safe operational environment.
- c. Identify the key elements of assessments, surveillances, and audits, and their application.
- d. Explain the self-assessment process.
- e. Referring to actual copies of facility Occurrence Reports, explain how a lack of proper conduct of operations at DOE facilities has led to improper operational results.
- f. Referring to a copy of each: DOE Order 4330.4B, Maintenance Management Program; 5000.3B, Occurrence Reporting; and 5700.6C, Quality Assurance; Explain how the orders contribute to a proper environment for conduct of operations.
- g. Explain the purpose of Safeguards and Security, and the role that it plays with regards to conduct of operations.
- h. Explain what proper critique principles and processes are, including key elements.
- i. Explain root cause and its importance to operational safety.
- j. Explain what Lessons Learned are and their importance to operational safety.
- k. Explain Stop Work Authority and your role in its application.
- l. Explain the Cost Plus Award Fee process and its role in the management of Department facilities.
- m. State the purpose of the Occurrence Reporting system and process.
- n. Explain the key elements that determine the safety significance of a condition.
- o. Explain the key elements of a Lockout and Tagout system.

**Section 7: NUCLEAR SAFETY DOCUMENTS AND EVALUATION**

- 7.1 Personnel shall demonstrate knowledge of basic nuclear safety documents and nuclear safety evaluation principles, methods and tools.**

**Supporting Knowledge and/or Skills**

- a. Identify and explain the types of Hazard Classifications and how they are established/determined.
- b. Explain the purpose and main topics covered by each of the following safety-related documents:

Design Basis Reports

Hazard Categorization and Accident Analysis (DOE-STD-1027)

Safety Analysis Report (DOE Order 5480.23)

Technical Safety Requirements (DOE Order 5480.22)

Unreviewed Safety Questions (DOE Order 5480.21)

- c. Identify the situations that constitute an Unreviewed Safety Question.
- d. Explain the terms hazard and risk.
- e. Identify who is responsible for safety at the Department's facilities.

- 7.2 Personnel shall demonstrate knowledge of the Department of Energy Directive System.**

**Supporting Knowledge and Skills**

- a. Explain the following terms:

Policy Statement

Regulation

Order

Notice

Safety/Implementation Guide

Technical Standards

Adopted Standards

DOE Standards

DOE Specifications

DOE Handbooks

- b. Explain the hierarchical system of documents used by the Department to establish its nuclear safety policy and the objectives, requirements, and guidance for implementation of that policy.



**Section 8: TECHNICAL COMMUNICATIONS****8.1 Personnel shall demonstrate proficiency in technical communications .****Supporting Knowledge and/or Skills**

- a. Demonstrate proficiency in written communication including business and technical writing.
- b. Explain the format requirements for business and technical writing.
- c. Demonstrate a working knowledge in the principles and process of editing written documents.
- d. Demonstrate proficiency in oral communications including briefings, one-on-one presentations, and formal presentations.
- e. Demonstrate a working knowledge in the types, uses, and applications of electronic communications such as computer systems use and local area networks.
- f. Demonstrate knowledge of interpersonal communications necessary to effectively communicate, verbally and nonverbally, with DOE management, DOE technical personnel, and all levels of contractor personnel.