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DOE STANDARD

RADIATION PROTECTION 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 Office of Environment, Safety and Health is the Sponsor for the Radiation Protection 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 Radiation Protection 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-1174-2003

U.S. DEPARTMENT OF ENERGY
FUNCTIONAL AREA QUALIFICATION STANDARD

Radiation Protection

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 Radiation Protection 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 Radiation Protection 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 Radiation Protection Functional Area:

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

2. Appraises facilities, procedures, and operations to determine their adequacy to protect the workers and members of the general public from the effects of ionizing radiation.

3. Administers and coordinates radiation protection program(s) for the Department, including independent evaluations and special studies.

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

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

6. Performs technical reviews and provides recommendations on Radiation Protection

Program documents (plans, schedules, etc.).

7. Reviews and comments on a wide variety of operating contractor documents.

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

9. Develops, reviews and implements radiation control policy, requirements, and guidance.

10. Communicates hazards associated with exposure to ionizing radiation.

Position-specific duties and responsibilities for Radiation Protection 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 minimal education and experience for Radiation Protection personnel is:

1. Education:

   Bachelor of Science degree in Health Physics, Radiological Science, or Nuclear Engineering, or a related physical science; or meet the alternative requirements for engineers or scientists specified in the Qualification Standards Handbook.

2. Experience:

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

   In addition to the education and experience stated above, certification by the American Board of Health Physics (ABHP) is highly recommended, and typically may serve as the basis for equivalency for the competencies in the "General Technical" section of this Standard. Successful completion of ABHP certification examination Part I or National Registry of Radiation Protection Technologists (NRRPT) certification may serve as the basis for equivalency for competencies 1-5 in the “General Technical” section 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. Radiation Protection personnel should 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. Radiation protection personnel shall demonstrate a working level knowledge of the various types of radiation and how they interact with matter.

Supporting Knowledge and/or Skills

a. Describe each of the following forms of radiation in terms of structure, mass, origin, and electrostatic charge:

- Alpha
- Beta
- Neutron
- Gamma
- X-ray

b. Describe the interactions of the following with matter:

- Charged particle interactions
  - Alpha particle
  - Beta particle (Positron annihilation and Bremsstrahlung)
- Neutron interaction
  - Elastic scattering
  - Inelastic scattering
  - Fission
  - Capture, absorption, or activation
- Photon interactions
  - Photoelectric effect
  - Compton scattering
  - Pair production

c. Discuss the shielding materials used for each of the above types of radiation and explain which are the best materials based on the interactions of radiation with matter.

d. Define “range” and describe the range energy relations of charged particles including:

- Factors that affect the range of charged particles
- Relative range of alpha and beta in air and tissue

e. Describe the attenuation of gamma and neutron radiation in shielding materials including:

- Exponential attenuation
- Build-up

f. Discuss radiation field characteristics for point, line, plane, and volume distributed sources.

g. Describe the following particle ejection nuclear reactions and provide an example of each:

- Alpha, n
- Gamma, n
- n, Alpha

2. Radiation protection personnel shall demonstrate a working level knowledge of radioactivity and transformation mechanisms.

Supporting Knowledge and/or Skills

a. Define the following terms:

- Activity
- Radioactive decay constant
- Curie/becquerel
- Radioactive half-life
- Radioactive equilibrium
- Decay products
- Parent nuclide
- Activation
- Specific activity
- Naturally Occurring Radioactive Material (NORM)
- Secular equilibrium
- Transient equilibrium
- Four factor formula

b. Describe the following processes including any resulting product of decay:

- Alpha decay
- Beta-minus decay
- Beta-plus decay
- Electron capture
- Isomeric transition
- Internal conversion
- X-ray generation

c. Given the “Chart of the Nuclides,” trace the decay chain for a specified nuclide.

d. Given either the half-life or the radioactive decay constant, solve radioactive decay problems.

e. Using the specific activity or decay constant of an isotope, convert between mass quantities and curies.

f. Convert numerical amounts of radioactivity between curie, becquerel, and dpm.

3. Radiation protection personnel shall demonstrate a working level knowledge of principles and concepts for internal and external dosimetry.

Supporting Knowledge and/or Skills

a. Define the following terms:

- Dose equivalent
- Shallow dose equivalent
- Deep dose equivalent
- Effective dose equivalent
- Committed dose equivalent
- Committed effective dose equivalent
- Total effective dose equivalent
- Whole body
- Extremity
- Lens of the eye dose equivalent
- Derived air concentrations (DAC)
- Annual limit of intake (ALI)
- Quality factor
- Weighting factor
- Roentgen
- Rad
- Rem
- Sievert
- Gray
- Stochastic effects
- Nonstochastic (deterministic) effects

b. Describe the various types of bioassays, their applications and limitations.

c. Discuss the methods of reducing dose from internally deposited radionuclides.

d. Discuss the process used to evaluate dose based on bioassay results.

e. Describe the principle of operation, proper use, placement, function, and type of radiation detected by the following dose-measuring instruments:

- Thermoluminescent dosimeter, including Albedo dosimeter
- Pocket dosimeter (quartz fiber and electronic)
- Film badge
- Personnel nuclear accident dosimeter

f. Discuss the concepts of International Commission on Radiological Protection (ICRP) Publications 26 and 30 as they relate to internal and external dosimetry.

g. Discuss the newer concepts of ICRP Publications including; 60, 66, 68, 71, and 72 and DOE Radiological Control Technical Positions (RCTP) papers, such as RCTP 2000-01, as they relate to DOE requirements for internal and external dosimetry. The RCTPs are available at: http://www.eh.doe.gov/whs/rhmwp/tpp.html

h. Discuss various methods used to estimate worker exposure in the absence of individual monitoring results.

i. Given airborne radioactivity concentration, DAC value and worker occupancy time, evaluate resulting worker dose.

4. Radiation protection personnel shall demonstrate a working level knowledge of the biological effects of radiation.

Supporting Knowledge and/or Skills

a. Describe the effects of radiation exposure on the cellular level including:

- Direct effects
- Indirect effects

b. Describe the factors affecting radiation sensitivity of cells (i.e., The Law of Bergonie and Tribondeau).

c. Describe the acute effects and corresponding doses associated with the following:

- Blood changes
- Hemopoietic syndrome
- Gastrointestinal syndrome
- Central nervous system syndrome

d. Discuss delayed effects of radiation exposure including:

- Cancer induction
- Genetic effects
- Prenatal developmental effects
- Cataracts

e. Discuss how the Linear Non-threshold Theory is used in developing risk estimates and dose limits associated with exposure to radiation. (The use of International Commission on Radiological Protection (ICRP) Publications 26 and 60 or National Council on Radiation Protection and Measurements (NCRP) Report No. 116 may be helpful).

5. Radiation Protection personnel shall demonstrate a working level knowledge of the principles and use of radiological instrumentation and radiological monitoring/survey practices.

Supporting Knowledge and Skills:

a. Describe the principle of operation of gas-filled detectors.

b. Discuss the following for gas-filled detectors:

- Voltage-response curve (i.e., six region curve)
- The three regions useful for radiation detection and measurement
- The sequence of events that occur following an initial ionizing event in an Ionization Chamber, a Proportional Counter and a Geiger-Mueller Detector

c. Describe the principles of operation of scintillation and solid state detectors.

d. Describe the principle of operation and application of nuclear spectroscopy.

e. Discuss the purpose, principles of detection and operation, and field application of the following:

- Continuous air monitors (CAM)
- Airborne radioactivity samplers

- Area radiation monitors (ARM)
- Criticality detection/alarm systems
- Personnel contamination monitors
- Process radiation monitors

f. Discuss the basic elements and applicable standards of a radiological instrument calibration program, including the following:

- Calibration source selection and traceability
- Source check and calibration frequency
- Instrument energy dependence

g. Discuss the following concepts as they relate to radiological counting measurements:

- Background
- Lower limit of detection
- Minimum detectable activity
- Counting efficiency
- Counting uncertainties

h. Describe various radiological situations and the use of appropriate radiological surveys including: radiation, contamination, and airborne radioactivity surveys.

6. Radiation protection personnel shall demonstrate a working level knowledge of internal and external radiation protection principles and control techniques.

Supporting Knowledge and Skills

a. Discuss the implication of the following on the identification of hazards associated with radiological work activities and how it might affect the controls specified on a Radiation Work Permit (RWP):

- Location of the work (i.e., in a radiation, contaminated, or airborne area)
- System being worked on (i.e., fluid under pressure, hazardous or radioactive)
- Nature of the work activity (inspection, opening system, etc.)

b. Discuss special exposure control, survey and personnel monitoring techniques associated with work in the following areas or situations:

- Non-uniform radiation fields
- High radiation areas
- Contact work with radioactive materials/sources

c. Discuss the hierarchy of controls used to prevent uptakes of radioactive material by personnel, and potential worker hazards associated with implementation of these controls.

d. For a radiological incident (i.e., spill, loss of containment), discuss the potential and magnitude of the following:

- Loose surface contamination levels
- Airborne radioactivity levels

e. Discuss appropriate personal protective equipment (including respiratory

protection) for subsequent entry into and decontamination of the above area.

f. Using reference material and given the activity, calculate radiation levels from a point, line, and plane source.

g. Given buildup factors and half value layers, perform shielding calculations.

h. Using reference material and given a scenario including bioassay results, isotopic and chemical form etc., calculate the internal dose to be assigned to an individual.

7. Radiation protection personnel shall demonstrate a working level knowledge of as-low-as-reasonably-achievable (ALARA) principles, and their application to radiological work activities.

Supporting Knowledge and/or Skills

a. Describe the various components of an effective ALARA program including operations, engineering, and management controls.

b. Describe how optimization techniques, including cost-benefit analysis, are used in the ALARA process.

c. Discuss the essential elements of the job planning process and the post-job ALARA review for work performed in a radiation or radioactive contamination area.

d. Describe the various radiological performance indicators that are applicable to the ALARA process.

e. Calculate person-rem estimates and use the results in ALARA cost-benefit analysis.

f. Discuss methods to minimize Total Effective Dose Equivalent (TEDE) by evaluating the trade-offs in considering the internal and external dose components.

g. Using knowledge of ALARA principles, discuss how to perform an evaluation of a radiation job plan and the associated worker job performance.

8. Radiation protection personnel shall demonstrate a working level knowledge of the application of engineered radiological controls and facility design, including containment/confinement systems.

Supporting Knowledge and/or Skills

a. Discuss the general principles relating to the design and installation of radiation protection containment/confinement systems including the following radiological protection considerations:

- Layout design for nuclear facilities
- Design and selection of components for nuclear facilities
- Selection of materials and the associated surfaces for components used in radiological control areas
- Design, construction, and operation of containment/confinement systems to minimize internal radiation exposure including:

  - Engineered ventilation
  - Engineered containment

- Hot cells
- Radioactive liquid and solid waste processing facilities

- Design, construction, and operation of systems that minimize personnel external radiation exposure including:

  - Shielding
  - Interlock systems

b. Discuss the design and application of temporary engineered radiological controls.

9. Radiation protection personnel shall demonstrate a familiarity level knowledge of the radiological hazards associated with the following and a working level knowledge for site specific radiological hazards:

- **Plutonium operations**
- **Uranium operations**
- **Tritium operations**
- **Nuclear explosive operations**
- **Production/experimental reactors**
- **Accelerator operations**
- **Waste handling/processing operations**
- **Decontamination and decommissioning**
- **Use of radiation generating devices**
- **Environmental restoration activities**

Supporting Knowledge and/or Skills

a. Discuss the basic function and work activities associated with the above list.

b. Discuss fundamental characteristics of the major radiological hazards at the above listed activities. This could include discussion of:

- Mode of decay
- Source
- Energies of major radiations emitted
- Relative principle biological hazard
- Half-life

c. Discuss unique radiological exposure control techniques associated with the above listed activities.

REGULATORY

Note: Many of the documents referenced in this Section can be obtained via the DOE ES&H home page (http://tis.eh.doe.gov/portal/home.htm) or via the Worker Protection Policy and Programs home page (www.eh.doe.gov/whs/rhmwp/).

10. Radiation protection personnel shall demonstrate a expert level knowledge of the Department of Energy (DOE) radiation protection system for occupational workers as set forth in the following policy, requirements and guidance documents:

- **10 CFR 835, Occupational Radiation Protection**
- **Implementation Guidance for use with 10 CFR 835, Occupational Radiation Protection**
- D**OE P 441.1, Department of Energy Radiological Health and Safety Policy**

Supporting Knowledge and/or Skills

a. Discuss the relationship of the above documents in defining the DOE system of radiation protection.

b. Give examples of how DOE P 441.1, Department of Energy Radiological Health and Safety Policy is reflected in requirements and guidance.

c. Explain how the 10 CFR 835 Implementation Guides are used to develop and implement local programs to comply with the radiation protection requirements at the site/facility level.

d. Discuss methods of meeting the key requirements in Subpart A (General Provisions). Include:

- Scope and exclusions
- Definitions
- Radiological units

e. Discuss methods of meeting the key requirements in Subpart B (Management and Administrative Requirements) based upon the guidance in the Radiation Protection Program Implementation Guide and the Occupational ALARA Program Implementation Guide, including:

- Radiation Protection Program
- Internal audits
- Education, Training and Skills
- Written Procedures

f. Discuss methods of meeting the key requirements in 10 CFR 835, Subpart C (Standards for Internal and External Exposure) based upon the guidance in the Internal Dosimetry Program Implementation Guide, the External Dosimetry Program Implementation Guide, the Radiation-Generating Devices Implementation Guide, and the Evaluation and Control of Fetal Exposure Implementation Guide, including:

- Occupational Limits for general employees
- Combining internal and external dose equivalents resulting from DOE activities
- Determination of compliance for non-uniform exposure of the skin
- Limits for the embryo/fetus
- Limits for members of the public and minors entering a controlled area
- Concentrations of radioactive materials in air

g. Discuss methods of meeting the key requirements in 10 CFR 835, Subpart E (Monitoring of Individuals and Areas) based upon guidance in the External Dosimetry Program Implementation Guide, the Internal Dosimetry Program Implementation Guide, the Evaluation and Control of Fetal Exposure Implementation

Guide, the Instrument Calibration for Portable Survey Instruments Implementation Guide and the Workplace Air Monitoring Implementation Guide, including:

- General monitoring requirements
- Individual monitoring
- Area monitoring
- Radioactive contamination control and monitoring
- Receipt of Packages containing radioactive material

h. Discuss methods of meeting the key requirements in 10 CFR 835, Subpart F (Entry Control Program), including:

- Radiological Areas
- Radiation Areas
- High Radiation Areas
- Very High Radiation Areas

i. Discuss methods of meeting the key requirements in 10 CFR 835, Subpart G (Posting and Labeling) based upon the guidance in the Posting and Labeling for Radiological Control Implementation Guide, including:

- General posting and labeling requirements
- Controlled areas
- Radiological areas

j. Discuss methods of meeting the key requirements in 10 CFR 835, Subpart H (Records) based upon the guidance in the Occupational Radiation Protection Record-Keeping and Reporting Implementation Guide, including:

- Individual monitoring records
- Monitoring and workplace records
- Administrative records

k. Discuss methods of meeting the key requirements in 10 CFR 835, Subpart I (Reports to Individuals) based upon the guidance in the Occupational Radiation Protection Record-Keeping and Reporting Implementation Guide, including:

- Annual Dose Report to Monitored Individuals
- Termination Report

l. Discuss methods of meeting the key requirements in 10 CFR 835, Subpart J (Radiation Safety Training) based upon the guidance in the Radiation Safety Training Implementation Guide, including:

- General employee training
- Radiological worker training
- Radiological control technician training
- Use of escorts

m. Discuss methods of meeting the key requirements in 10 CFR 835, Subpart K (Design and Control) based upon the guidance in the Occupational ALARA Program Implementation Guide, including:

- Design features, administrative controls and procedural requirements
- Facility design and modification

- Control features

n. Discuss methods of meeting the key requirements in 10 CFR 835, Subpart L (Radioactive Contamination Control).

o. Discuss methods of meeting the key requirements in 10 CFR 835, Subpart M (Sealed Radioactive Source Control). Use the guidance in the Sealed Radioactive Source Accountability Implementation Guide to support the discussion on sealed source accountability.

p. Discuss methods of meeting the key requirements in 10 CFR 835, Subpart N (Emergency Exposure Situations), including:

- General provisions
- Emergency exposure situations
- Nuclear accident dosimetry

q. Discuss methods of meeting the key requirements on Administrative Control Levels, Work Authorizations, Radiation Safety Training, and Posting.

r. Explain how the Radiation Control Technical Positions, 10 CFR 835 exemption decisions, and official interpretations of 10 CFR 835 are used to adapt the radiation protection requirements to unique conditions at DOE sites and facilities.

11. Radiation protection personnel shall demonstrate a working level knowledge of the following DOE Policy, Order, and Manual Directives, and Technical Standards related to radiation protection:

- **DOE P 450.2A, Identifying, Implementing, and Complying with Environmental, Safety and Health Requirements**
- **DOE Order 5400.5, Ch. 2, Radiation Protection of the Public and the Environment, or when promulgated, 10 CFR 834, Radiation Protection of the Public and the Environment and associated Implementation Guides**
- **DOE Order 5480.4, Ch. 4, Environmental Protection, Safety, and Health Protection Standards**
- **DOE M 231.1-2, Occurrence Reporting and Processing of Operations Information**
- **DOE Order 5480.19, Ch. 2, Conduct of Operations Requirements for DOE Facilities**
- **DOE-STD-1098-99, Department of Energy Standard - Radiological Control**
- **DOE-STD-1121-98, Department of Energy Standard - Internal Dosimetry**

Supporting Knowledge and/or Skills

a. Describe the relevant requirements, interrelationships and importance of the listed Orders, notices, codes, and regulations, guides, technical manual(s).

b. Discuss the role of radiation protection personnel with respect to these Orders and regulations.

c. Discuss how Conduct of Operations is applied to radiation protection activities.

d. Discuss how the standard, Radiological Control, is now applied (i.e., as a requirement or as a technical standard) in your Program, or at the site(s) or facility(s) for which you have responsibility.

e. Discuss the following as they relate to occurrence reporting:

- How soon after an event or condition is identified must it be characterized
- Who must be notified at the facility where it occurred
- The two broad groups or conditions in which a health physicist would likely be involved in identifying the reportable event

12. Radiation protection personnel shall demonstrate a familiarity level knowledge of the identification, reporting, investigation, and enforcement related to potential noncompliance with nuclear safety requirements:

Supporting Knowledge and/or Skills

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

b. Discuss the Price-Anderson Amendment Act's applicability to the Department's nuclear safety activities.

c. Discuss the purpose and scope of the current nuclear safety rules including:

- 10 CFR 708, DOE Contractor Employee Protection Program
- 10 CFR 820, Procedural Rules for DOE Nuclear Activities
- 10 CFR 830, Nuclear Safety Management

d. Discuss the Department’s Enforcement Program including:

- Identification and reporting of potential noncompliance with nuclear safety requirements
- Roles and responsibilities of Department of Energy employees

13. Radiation protection personnel shall demonstrate a familiarity level knowledge of radioactive waste management:

Supporting Knowledge and/or Skills

a. Discuss the Department’s policy regarding the handling and management of waste as described in DOE Order 435.1, Ch. 1, Radioactive Waste Management.

b. Define the following terms:

- Low level waste
- High level waste
- Transuranic waste
- Mixed waste

c. Discuss the Department’s policies on waste management including:

- Generation reduction
- Segregation
- Minimization
- Pollution prevention
- Disposal

d. Discuss the process for determining whether or not waste is classified as mixed

waste.

14. Radiation protection personnel shall demonstrate a working level knowledge of Department of Energy (DOE) requirements and guidance related to safety management.

Supporting Knowledge and/or Skills

a. Describe the relevant requirements, purpose, interrelationships and importance of the following requirements and guides to radiation protection activities:

- 10 CFR 830, Nuclear Safety Management
- DOE Manual 411.1-1B, Safety Management Functions, Responsibilities, and Authorities
- DOE Order 414.1-1A, Ch. 1, Quality Assurance
- DOE Guide 414.1-2, Quality Assurance Management System Guide for use with 10 CFR 830.120 and DOE O 414.1-1A
- DOE Order 420.1A, Facility Safety
- DOE Guide 421.1-1, DOE Good Practices Guide Criticality Safety Good Practices Program Guide for DOE Nonreactor Nuclear Facilities
- DOE Guide 421.1-2, Implementation Guide For Use in Developing Documented Safety Analyses To Meet Subpart B Of 10 CFR 830
- DOE Guide 423.1-1, Implementation Guide For Use In Developing Technical Safety Requirements
- DOE Guide 424.1-1, Implementation Guide For Use In Addressing Unreviewed Safety Question Requirements
- DOE Order 430.1B, Real Property Asset Management
- DOE-STD-1073-93, Guide for Operational Configuration Management Program
- DOE-STD-3009-94, Ch. 2, Preparation Guide for U.S. DOE Nonreactor Nuclear Facility Safety Analysis Reports
- DOE-HDBK-3010-94, Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities,
- DOE-STD-3011-2002, Guidance for Preparation of Basis for Interim Operation (BIO) Documents,
- DOE-STD-1027-92, Ch. 1, Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports

b. Discuss the role of radiation protection personnel with respect to the above listed requirements and guidance.

c. Define the following safety management terms:

- Authorization basis
- Design basis
- Safety limit
- Administrative controls

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

- Criticality incident
- Double contingency principle
- Geometry control
- Nuclear criticality safety
- Significant quantity of fissionable material

e. Describe the responsibilities of Operating and Management (O&M) and Management and Integration (M&I) contractors for the development and maintenance of a Documented Safety Analysis (DSA).

f. Discuss the development and maintenance of site/facility safety management documents and procedures for modifications.

15. Radiation protection personnel shall demonstrate a familiarity level knowledge of Federal regulations and Department of Energy (DOE) Orders related to emergency planning and preparedness as they pertain to radiological incidents.

Supporting Knowledge and/or Skills

a. Describe the relevant requirements, purpose, interrelationships and importance of the following Orders and regulation:

- 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response
- DOE Order 151.1A, Comprehensive Emergency Management and series of Guides (G 151.1-1)
- DOE Order 5530.3, Ch. 1, Radiological Assistance Program
- DOE Order 5530.5, Ch. 1, Federal Radiological Monitoring and Assessment Center

b. Describe what is meant by an Operational Emergency.

c. Describe how the following guides are used:

- Protective Action Guide
- Emergency Response Planning Guide

d. Discuss the conditions that would require an operational emergency to be classified as an:

- Alert
- Site Area Emergency
- General Emergency

e. Discuss the role of radiation protection personnel with respect to the Orders and regulations in supporting knowledge and/or skill a.

f. Discuss the emergency response assistance that is available from the following:

- Nuclear Emergency Response Team
- Accident Response Group
- Aerial Measuring System
- Atmospheric Release Advisory Capability
- Federal Radiological Monitoring and Assessment Center
- Radiation Emergency Assistance Center/Training Site
- Radiological Assistance Program

16. Radiation protection personnel shall demonstrate a familiarity level knowledge of Department of Energy (DOE) Orders related to Federal and contractor personnel training and qualification.

Supporting Knowledge and/or Skills

a. Describe in general the training and qualification requirements for contractors specified in DOE Order 5480.20A, Ch. 1, Personnel Selection, Qualification and Training Requirements for DOE Nuclear Facilities.

b. Describe the Technical Qualification Program for Federal employees delineated in DOE Order 360.1B, Training.

c. Discuss the purpose, scope, and application of DOE-STD-1107-97, Knowledge, Skills and Abilities for Key Radiation Protection Positions at DOE Facilities.

17. Radiation protection personnel shall demonstrate a working level knowledge of national and international radiation protection standards and recommendations.

Supporting Knowledge and/or Skills

a. Discuss the content and application of the following national and international documents on radiation protection:

- Radiation Protection Guidance to the Federal Agencies for Occupational Exposure (52 FR 2822)
- Recommendations of the International Commission on Radiological Protection (ICRP), Publication 26
- Recommendations of the ICRP, Publication 30
- Recommendations of the ICRP, Publication 60
- Recommendations of the ICRP, Publication 66
- Recommendations of the ICRP, Publication 68
- Recommendations of the ICRP, Publication 71
- Recommendations of the ICRP, Publication 72
- BEIR V Executive Summary
- Recommendations on Limits for Exposure to Ionizing Radiation, National Council on Radiological Protection, Report No. 91
- Limitation of Exposure to Ionizing Radiation, National Council on Radiation Protection, Report No. 116
- Practices for Respiratory Protection, American National Standards Institute (ANSI Z88.2-1992)

b. Discuss how the previously referenced documents relate to Department of Energy (DOE) radiation protection requirements.

18. Radiation protection personnel shall demonstrate a familiarity level knowledge of the Federal regulations, guidelines, and Department of Energy (DOE) Orders pertaining to the decontamination and decommissioning of nuclear facilities.

Supporting Knowledge and/or Skills

a. Familiarity with the DOE policy and requirements regarding the management, control, and release of property containing residual radioactivity, as contained in:

- DOE/EH-413-0002, Facility Disposition: Principles for Accelerated Project Management
- DOE Order 5400.5, Ch. 2, Radiation Protection of the Public and the Environment
- DOE-STD-1120-98, Integration of Environment, Safety and Health into Facility Disposition Activities

b. General familiarity with requirements and guidance from other Federal agencies, or from DOE in collaboration with other Federal agencies (e.g., Nuclear Regulatory Commission, NRC; Environmental Protection Agency, EPA) regarding the decontamination, decommissioning, and release of property that may be applicable to the disposition of DOE sites and facilities.

c. Familiarity with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM; NUREG-1575; EPA 402-R-97-016) for planning, conducting, evaluating, and documenting building surface and surface soil final status radiological surveys for demonstrating compliance with dose or risk-based regulations or standards.

d. Knowledge of guidance regarding the development and analysis of property release options, and determination of authorized limits for property and material to be managed or released from DOE, as contained in DOE Implementation Guide G-441.1, Control and Release of Property with Residual Radioactive Material.

e. Familiarity with DOE dose and risk modeling tools applicable to the decontamination and decommissioning of sites and facilities, such as: (1) the RESRAD (RESidual RADioactivity) code (User's Manual for RESRAD Version 6, Argonne National Laboratory, ANL/EAD-4, 2001); and (2) the RESRAD-BUILD code (A Computer Model for Analyzing the Radiological Doses Resulting from the Remediation and Occupancy of Buildings Contaminated with Radioactive Material, ANL/EAD-LD-3, 1994).

f. Cursory knowledge of currently available technologies, and innovative technologies as available, that are applicable to the cleanup, decontamination, and decommissioning of DOE facilities.

g. Knowledge, as appropriate to decontamination and decommissioning activities, regarding radiological control practices to minimize occupational exposures to ionizing radiation, as contained in the DOE Standard, Radiological Control (DOE-STD-1098-99).

19. Radiation protection personnel shall demonstrate a familiarity level knowledge of the standards and Department of Energy (DOE) Orders pertaining to the packaging and transportation of radioactive materials.

Supporting Knowledge and/or Skills

a. Discuss the purpose and scope of the DOE Order 460.1B, Packaging and Transportation Safety.

b. Describe the authorities and responsibilities of radiation protection personnel with respect to DOE Order 460.1B, Packaging and Transportation Safety.

20. Radiation protection personnel shall demonstrate a familiarity level knowledge of the Department's philosophy and approach to implementing Integrated Safety Management.

Supporting Knowledge and/or Skills

a. Explain the objective of Integrated Safety Management.

b. Discuss the following existing Department programs and initiatives that lead to successful implementation of Integrated Safety Management:

- Standards/Requirements Identification Documents (S/RIDs) and Work Smart Standards
- Contract reform and performance-based contracting
- Activities at Research and Development Laboratory related to safety management (i.e., pilot oversight program for line ES&H management.)
- Operational Readiness Reviews (ORR)

c. Discuss the purpose, content, and application of DOE Policy 450.4, Safety Management System Policy and DOE G 450.4-1B, Integrated Safety Management System Guide.

21. Radiation protection personnel shall demonstrate a familiarity level knowledge of the Department's guidance for the structure, function, and operation of a radiation generating device (RGD) control program as discussed in Implementation Guide G 441.1-5, Radiation Generating Devices.

Supporting Knowledge and/or Skills

a. Describe the different types of radiation-generating devices that may be used at Department of Energy (DOE) facilities including:

- X-ray machines
- Accelerators
- Irradiators
- Radiography sources

b. Using Implementation Guide G 441.1-5, Radiation Generating Devices, discuss the difference between an open beam and cabinet X-ray system and the different types of controls (design, equipment, and administrative) that can be used to prevent radiation exposure above DOE limits.

c. Discuss possible exposure incidents (or ones that have actually happened in medicine, private industry, or at DOE facilities) as a result of improper practices with accelerators, irradiators, and radiography sources, or loss of control of sources.

d. Discuss possible actions to control sources at DOE facilities, especially radiography sources brought on DOE sites by subcontractors who may be unaware

of the site Radiation Protection Program (RPP) and 10 CFR 835, Occupational Radiation Protection, requirements.

ADMINISTRATIVE

22. Radiation protection personnel shall demonstrate a familiarity level knowledge of contract management and administration of contractor organizations participating in the radiological protection programs.

Supporting Knowledge and/or Skills

a. Discuss the key elements of typical contractual relationships between the Department of Energy and its contractors.

b. Discuss the roles and responsibilities of radiation protection personnel with respect to the contract management and administration process.

23. Radiation protection personnel shall demonstrate a familiarity level knowledge of the general principles associated with project management.

Supporting Knowledge and/or Skills

a. Discuss the purpose and requirements of the following DOE Orders related to project/property management:

- 430.1B, Real Property Asset Management
- 413.1A, Management Control Program

b. Discuss the radiation protection personnel responsibilities related to project management, administration, and coordination of the radiation protection programs.

MANAGEMENT, ASSESSMENT, AND OVERSIGHT

24. Radiation protection personnel shall demonstrate a working level knowledge of assessment (compliance and performance) principles and techniques necessary to identify facility and program deficiencies, event precursors, potential systemic causes, corrective actions, and best practices.

Supporting Knowledge and/or Skills

a. Describe the relevant aspects and process of compliance-based assessments versus performance-based assessments.

b. Describe the elements of an inspection/assessment plan (investigation, fact-finding, validation, and reporting).

c. Explain what is meant by an event precursor.

d. Describe methods used to identify, develop, and group systemic deficiencies identified at the radiation protection program level and facility-specific level.

e. Explain documentation requirements used for the assessment processes.

f. Describe several performance indicators that would indicate the need to conduct a radiation protection audit.

g. Describe the key elements of an assessment appraisal report.

h. Explain methods used to select interview candidates and conduct interviews for the assessment process.

i. Describe how corrective actions/recommendations are developed and communicated to line management.

j. Describe administrative methods used to track and provide closure of identified deficiencies.

25. Radiation protection personnel shall demonstrate the ability to evaluate the adequacy of radiation protection programs against the requirements of regulations, Department of Energy (DOE) Orders and rules pertaining to radiation protection.

Supporting Knowledge and/or Skills

a. Describe the scope, contents, development, review and approval process for a site's documented Radiation Protection Program as required by 10 CFR 835.101(a).

b. Using the documents listed below, prepare an action plan which adequately outlines interviews and observations to be conducted, and details documents to review during an evaluation of contractor compliance with radiation protection requirements:

- 10 CFR 835, Occupational Radiation Protection
- Implementation Guidance for use with 10 CFR 835, Occupational Radiation Protection
- DOE Order 5400.5, Ch. 2, Radiation Protection of the Public and the Environment or 10 CFR 834, Radiation Protection of the Public and the Environment, when promulgated
- DOE Order 5480.19, Ch. 2, Conduct of Operations Requirements for DOE Facilities
- DOE-STD-1098-99, Department of Energy Standard - Radiological Control
- DOE Order 5480.4, Ch. 4, Environmental Protection, Safety, and Health Protection Standards
- DOE Order 460.1B, Packaging and Transportation Safety

c. Using an appropriate level of coverage, conduct an evaluation of contractor compliance with radiation protection requirements. During this evaluation, demonstrate the ability to properly conduct interviews, observations, and document reviews.

d. Given data from an evaluation, analyze the results of the evaluation to determine contractor compliance or noncompliance with the requirements.

e. Given the results from an analysis of contractor compliance or noncompliance, document the results and communicate the results to contractor and Department line management.

26. Radiation protection personnel shall demonstrate the ability to trend radiation protection-related information/data.

Supporting Knowledge and/or Skills

a. Trend and analyze operations information and discuss its relationship to radiation protection activities.

b. Given a list of performance indicators, determine what type of assessment should be performed and in what areas.

c. Given DOE Order 231.1, Ch. 2, Environment, Safety, and Health Reporting, discuss the key elements of the Order and provide examples of its application.

d. Discuss the analysis and trending of radiological data available in the DOE Occupational Radiation Exposure Report or the Radiation Exposure Monitoring System (REMS) for the Department and contractor Employees (see Web site http://rems.eh.doe.gov/ for this information).

27. Radiation protection personnel shall demonstrate the ability to effectively communicate the hazards associated with exposure to ionizing radiation.

Supporting Knowledge and/or Skills

a. Discuss the essential elements of effective hazard communication.

b. Explain the health physicist's mission of protecting workers, the public, and the environment from unnecessary exposure to ionizing radiation.

c. Describe how an explanation of the following can be used to effectively communicate hazard:

- Comparing occupational dose limits to natural background radiation
- Develop comparisons to commonly accepted hazards that puts radiation exposure at a site in perspective

d. Explain how excessive hazard avoidance can be dangerous, costly, and wasteful.

e. Discuss other job related mortality statistics and how they compare with the risk of mortality from jobs which have occupational exposure to radiation.

f. Explain how to use the following techniques in the context of radiation hazard communication:

- Listening skills
- Tone of voice
- Body language, eye contact
- Analogies, illustrations, demonstrations
- Real-life experiences

g. Participate in hazard communication activities with peers, Department management, or contractor personnel.

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

Radiation Protection 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 Radiation Protection 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. Attend seminars, symposia, or technical meetings related to Radiation Protection.

3. Engage in self-study of new regulations, requirements, or advances related to Radiation Protection.

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

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

6. Association or interaction with professional health physics organizations such as the Health Physics Society, American Board of Health Physics, and the National Registry of Radiation Protection Technologists is encouraged.

CONCLUDING MATERIAL

Review Activity:
EM
NNSA
EH
NE
SC

Preparing Activity:
DOE-EH-52

Project Number:
TRNG-0041

Field and Operations Offices
CBFO
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Area and Site Offices
Argonne Area Office
Brookhaven Area Office
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Kansas City Site Office
Livermore Site Office
Los Alamos Site Office
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Princeton Area Office
Savannah River Site Office
Sandia Site Office
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