

AMERICAN BOARD OF HEALTH PHYSICS**EXAMINATION PREPARATION GUIDE****SECTION 4****Examination Topics - Role Delineation**

Over a period of about three years in the mid-1980s, the ABHP performed an exhaustive role delineation study of what a typical health physicist does to perform his/her job. This role delineation and the detailed task analyses that followed involved approximately 100 Certified Health Physicists, and was done under the direction of the Professional Examination Service. The goal of this evaluation was to determine what subject areas, skills, and knowledge are required to perform the job of a Health Physicist, the relative importance of each subject area, and the relative seriousness involved with a lack of knowledge in each area. As a result of this study, five main categories (domains) were selected based on subject matter. Each of the five domains was further subdivided into sub-areas to account for the subjects covered in each domain. Based on the ratings done by the large group of Certified Health Physicists, the relative importance of each of the five domains was also determined and a percentage was assigned to each domain.

A survey of health physicists conducted by the ABHP in 1993, reaffirmed the results of the original role delineation study. Based on the results of this survey the relative importance of the domains remained unchanged. The ABHP again performed a survey of Health Physicists in 1999 and made minor changes.

Since the goal of any job-related examination is to test the candidate on the information required to perform their job, the ABHP started (in 1986) to select questions for the Part II examinations so that the subject matter covered by the test questions reasonably approximates the same breakdown as the percentages associated with each of the five domains from the role delineation. Beginning in 1987, questions for Part I were also selected by subject matter to closely represent the five-domain breakdown.

To assist you in understanding the subject matter included in each domain and in each sub-area, a listing of each domain and the sub-areas under each one, along with typical examples of the material covered in each sub-area, are provided. It must be recognized that a given question may be able to be placed into more than one domain and sub-area.

Domains and Sub-Areas**1. Measurements and Instrumentation (25% of total)**

The Measurements and Instrumentation domain covers the selection and use of measuring instruments, the interpretation and reporting of the values obtained from the instruments, data quality objectives and quality control, and the calibration, maintenance and performance testing of instrumentation. Sample collection devices should be included in this domain.

Items to be included in the Measurements and Instrumentation domain:

1.1 Types of Measurements

- Criticality Monitoring and Dosimetry

- Radiation Fields, Ionizing and Non-Ionizing
- External Radiation Dose
- Surface Contamination
- Airborne Radioactivity Levels
- Internal Deposition including bioassay and whole body counting
- Process and Effluent Samples (Liquids, Solids, and Gases)
- Environmental Media
- Specify appropriateness of methods based on radionuclides and general workplace characteristics and operations

1.2 Selection of Instruments

- Response to different types and energies of radiation
- Limitations of instruments
- In-line instruments versus laboratory analyses
- Interpretation of instrument indications

1.3 Analytical Techniques for Sampling

- Application of statistical methods to data analysis
- Measuring removable and fixed contamination
- Frisking and scanning techniques
- Use of air sampling devices
- Testing of exhaust hoods, air flow paths, and exhaust filters
- Use of collection media for tritium, radioiodine, particulates
- Exposure pathways
- Selection of media to be sampled considering radionuclides and processes used
- Representative sampling for process, effluent, and environmental media
- Release of equipment and facilities

1.4 Measurement Methods

- Proper use of instruments to evaluate hazards based on radiation type, source characteristics, required sensitivity, and accuracy and precision
- Analyzing swipe samples
- Dosimetry processing methods
- Proper location of dosimetry
- Uptake and internal dose measurements and calculations
- Analysis of various air samples
- Calculation of DAC-hours
- Calculation of effluent concentrations and resulting dose
- Calculation of environmental media concentrations and resulting dose
- Appropriate inventory of health physics instruments used for radiation monitoring and measuring

1.5 Interpretation and Reporting of Results

- Use of models
- Account for ingrowth of decay products, decay of radionuclides, activation and radioactive decay chains, in all facets of radiation protection
- Application of counting statistics

- Evaluate background counting data to determine proper operation of radiation measurement systems
- Evaluation of radiation fields and stay-times from survey measurements
- Evaluation of whole body and organ dose from dosimetry results
- Evaluation of interferences
- Evaluation of sample results including lower limit of detection, decision level, Type I and Type II measurement errors

1.6 Quality Control and Data Quality Objectives

- Develop control charts for a counting system
- Evaluate adequacy of data management practices
- Identify data quality objectives for license termination/unconditional release survey
- Establish bias and precision performance indices

1.7 Instrument Calibration, Maintenance, and Performance Testing

- Specify appropriate standards for calibration and calibration methods
- Effects of geometry, self absorption, energy and count rate
- Calibration frequency
- Use of standards, blanks and spiked samples in analyses
- Specify performance tests for radiation monitoring and measuring instruments
- Identify improperly operating instruments used for radiation monitoring and measuring

2. Standards and Requirements (20% of total)

The Standards and Requirements domain covers the standards and guidelines of groups such as ICRP, NCRP, ANSI, ASTM, and the requirements of various regulatory agencies such as NRC, DOE, EPA, DOT, OSHA, FEMA, the Postal Service, and state agencies; these regulatory agencies also provide regulatory guidance. Guidance is also provided by industry oversight groups such as ANI and INPO.

Items to be included in the Standards and Requirements domain:

2.1 Maintenance of Licenses, Permits and Regulations

- Adequacy of information contained in license, permit, application or registration documents
- Evaluate surveys, monitoring, and records necessary to comply with license, permit or registration document requirements
- Determine need for a license

2.2 History and Development

- Evaluate historical records of operation and determine compliance with requirements in effect at that time
- Knowledge of current regulations and standards
 - Measuring external radiation
 - Personnel external exposures
 - Contamination
 - Uptakes and internal doses
 - Air sampling and evaluation of air sample results

- Process and effluent monitoring and analysis of samples
- Environmental monitoring and analysis of samples
- Waste management
- Radioactive shipments, packaging and transportation
- Explain the evolution of radiation protection standards
- Identify the basis of dose level in terms of risk

2.3 Use and Application

- Calculate TEDE from a mixture of internal and external radiation sources
- Assess implementation of regulatory requirements in the field
- Assess compliance status from external dosimetry results, including deep-dose, shallow-dose, and neutron dose
- Design a safety program for
 - EMR, RF, and microwave radiation
 - IR and UV sources
 - Waste minimization and management program
- Determining Compliance by assessing adequacy of radiation control program

2.4 Types of Regulations

- Identify the types of regulations that may apply to a facility process of activity
- Explain the hierarchy of radiation protection recommendations, regulations and standards
- Identify the regulatory agency or agencies having jurisdiction over a facility, process or operation

2.5 Interpretation and Knowledge

- Identify the appropriate regulations and standards for the facility, process, or operation
- Determine compliance with basic regulations and standards by using workplace information and results of survey and monitoring

3. Hazards Analysis and Controls (20% of total)

The Hazards Analysis and Controls domain covers the identification of hazards, the use of engineered controls to eliminate or mitigate the hazard, analysis of potential failures of protective control systems and the radiological consequences of failure, types of controls and assessment of the control effectiveness.

Items to be included in the Hazards Analysis and Controls domain:

3.1 Hazard Identification

- Identify those hazards (such as physical, chemical, criticality) that could result in radiological consequences for a facility, process or operation
- Identify design basis accident for a facility, process, or operation using radioactive material or radiation producing machines
- Analyze controls for unique or first-time operations involving radioactive material or radiation producing machines
- Identify common industrial hygiene or safety problems associate with facilities using radioactive material or radiation producing machines (ozone, e.g.)

3.2 Evaluate and Assess Significance/Consequence

- Evaluate and assess the consequences of a set of hazards identified for a facility using radioactive material or radiation producing machines using fault tree or similar analysis tools
- Analyze potential for failure of protective systems and radiological consequences of failure
- Evaluate facilities, processes or operations to determine challenges to radioactive material control barriers
- Recommend appropriate mechanical protective devices such as shielding, interlocks, ventilation controls, remotely operated equipment, and devices to minimize time of exposure

3.3 Devise and Implement Controls

- Devise technical specifications, operational safety requirements, or limiting conditions for operation in response to hazards identified in an hazards analysis or safety analysis report
- Determine compliance with minimum safety requirements for a set of operational parameters and technical specifications, operational safety requirements, or limiting conditions for operation
- Implement double contingency controls for nuclear criticality safety

3.4 Types of Engineered Controls

- Specify the major components and design of air cleaning systems for particulates, radioiodines, and noble gases
- Recognize routes of exposure to radiation and radioactive material arising from a facility, process or operation
- Specify a program for the shielding requirements for permanent and temporary installation

3.5 Designs and Specifications

- Determine requirements for containment or other contamination protocols within the characteristics of a process or operation
- Evaluate shielding requirements for radiation sources
- Optimize shielding for a facility, process, or operation
- Specify decontamination methods for facilities, materials, and equipment
- Explain the basic methods used to assure nuclear criticality safety and determine compliance with criticality safety specifications
- Explain the double contingency principle as applied to nuclear criticality safety
- Specify a comprehensive inventory control program for radioactive materials
- Design a laser safety program

3.6 Selection and Evaluations

- Specify personal protective equipment and clothing (PPE) program for contamination control including criteria for selection and procedures for donning, doffing, and survey
- Specify personal protective equipment(PPE) program for control of irradiation from external sources, including lead aprons, thyroid collars, leaded gloves, and beta shielding glasses
- Select the appropriate engineered controls for radioactive surface contamination and airborne radioactivity control given the characteristics of a process or operation
- Specify the appropriate air cleaning technology given a description of the process and limitations on effluents to the environment
- Identify limitations in the use of temporary shielding (e.g., excess weight, seismic concerns, etc.)

- Evaluate the effectiveness of different decontamination methods

3.7 Use and Operations

- Determine if engineered controls are adequately implemented considering a description or diagram of a process or work location
- Assess the effectiveness of engineered controls using the results of workplace surveys and monitoring
- Identify safety requirements for the use of engineered controls (e.g., radiation monitoring of filters, traps, allowable differential pressure, drainage, etc.)
- Specify methods of source reduction (e.g., decontamination, material substitution) to minimize dose

3.8 Document and Communicate

- Prepare a hazards analysis report
- Explain the conclusions of a hazards analysis report to a non-technical audience

4. Operations and Procedures (20% of total)

The Operations and Procedures domain covers the application or incorporation of radiation protection considerations into an operating program.

Items to be included in the Operations and Procedures domain:

4.1 Standard Operating Practices and Procedures

- Specify the minimum set of health physics procedures for a given facility, process, or operation
- Specify appropriate radiological cautions into operating procedures for a facility, process or operation involving radioactive material or radiation-producing machines
- Specify radiation protection practices in the aftermath of a terrorist attack using a nuclear weapon or radioactive contamination using an improvised device
- Specify contamination control practices for a particular process or operation
- Work with other disciplines to develop appropriate processes and procedures
- Conduct periodic (announced and unannounced) audits or personnel implementing procedures to determine compliance
- Prepare an emergency response exercise scenario package for a nuclear facility or transportation scenario

4.2 Emergency Response

- Develop an emergency response plan for a facility, process or operation involving the use of involving radioactive material or radiation-producing machines
- Develop methods and procedures for recovery of lost radioactive sources
- Perform rapid assessment of potential off-site doses from an accident at a nuclear facility
- Develop appropriate protective action recommendations to off-site authorities
- Establish dose controls for emergency workers
- Specify procedures for handling of radioactively contaminated persons, including decontamination and decorporation
- Define graded responses for each type of emergency category

- Evaluate the conduct of emergency response drills and exercises
- Perform a "quick sort" procedure to evaluate personnel doses in a nuclear criticality accident

4.3 Basis for Operations and Program

- Explain the basis for radiation protection program requirements considering the characteristics of the facility, operation, or process
- Provide a technical justification for the frequency of surveys, monitoring, and personnel monitoring for a specified facility, operation, or process

4.4 Program Types

- Propose administrative practices to maintain personnel exposures as low as reasonably achievable using the characteristics of a facility, process, or operation
- Specify a respiratory protection program that encompasses respirator or other respiratory protective device (fresh-air hood, bubble suit, etc.) selection, fit testing, and maintenance record keeping
- Specify an access control program for a facility using radioactive material or radiation-producing machines
- Specify a radiological environmental monitoring program for a nuclear facility
- Specify a program for control of sealed radioactive sources
- Specify a radiation safety program for industrial radiography operations using sealed radioactive sources

4.5 Records

- Specify the radiation protection records required for a facility, process or operation, to demonstrate compliance with license, permit or registration requirements
- Specify the minimum content of the following types of health physics records:
 - Instrument calibration
 - Radiation/contamination survey
 - Air sample analysis
 - Process or effluent sample results
 - Reconstruct estimates of releases using historical records of processes, effluents, and meteorological data
- Communication - Explain the risks and significance of radiation exposure

5. Fundamentals and Education (15% of total)

The fundamentals and education domain covers the content of training the health physicist receives and the training the health physicist prepares, reviews, and presents

5.1 Skills of the Trade - explain

- Linear no-threshold model and its application to radiation protection
- Basis for current radiation protection standards
- Effects of chronic and acute exposure to ionizing radiation
- Risk of radiation exposure to embryo/fetus
- Difference between high and low level radioactive waste and the types of controls necessary for the safe disposal of each

- Dose-response model for deterministic radiation health effects
- Health effects of exposure to lasers, UV radiation, and RF radiation
- Heritable ill-health, teratogenesis, and carcinogenesis in the context of radiation exposure
- Principles of radiation protection for practices and interventions
- Dependence of biological effects on radiation "quality," LET, lineal energy, and microdosimetry
- How neutrons interact with tissue (e.g., thermal, fast)
- Why alpha particles differ in their effects (per unit energy deposited) from beta, gamma, and x-rays
- What is known about the natural radiation environment as a function of geography and altitude, solar cycle, and solar flares
- Technogenic additions to the radiation environment (e.g., fallout, nuclear accidents, releases from routine operations, technological enhancement, and deliberate production of radiation)
- Known effects of major radiological incidents and accidents (e.g., criticality accidents, Three Mile Island, Chernobyl)

5.2 Types

- Determine the minimum training and education requirements for radiological workers
- Determine qualification criteria for radiological control/health physics/radiation protection technicians
- Develop a radiation training program for general employees, industrial radiography operation using sealed radioactive sources, emergency response personnel
- Perform a job-task analysis to determine job-specific training requirements

FUNDAMENTAL CHARACTERISTICS OF COMMONLY ENCOUNTERED RADIONUCLIDES

The candidate should be familiar with fundamental characteristics of those radionuclides commonly encountered in the radiation protection field including:

H-3	Sr-90
C-14	Tc-99m
P-32	(I-125, I-129, & I-131)
S-35	
Co-60	Cs-137
	Ra-226

Fundamental characteristics include basics such as the mode of decay, principal type(s) of radiation emitted, energies of radiation emitted, and half-life.



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