
CONTENT SPECIFICATIONS FOR THE EXAMINATION IN NUCLEAR MEDICINE TECHNOLOGY



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The purpose of the ARRT Examination in Nuclear Medicine Technology is to assess the knowledge and cognitive skills underlying the intelligent performance of the tasks typically required of the staff technologist at entry into the profession. To identify the knowledge and skills covered by the examination, the ARRT periodically conducts practice analysis studies involving a nationwide sample of staff technologists¹. The results of the most recent practice analysis are reflected in this document. The complete task inventory, which serves as the basis for these content specifications, is available from our website www.arrt.org.

The table below presents the five major content categories, along with the number and percentage of test questions appearing in each category. The remaining pages provide a detailed listing of topics addressed within each major content category.

This document is not intended to serve as a curriculum guide. Although certification programs and educational programs may have related purposes, their functions are clearly different. Educational programs are generally broader in scope and address subject matter not included in these content specifications.

CONTENT CATEGORY	PERCENT OF TEST	NUMBER OF QUESTIONS ²
A. Radiation Protection	10%	20
B. Radionuclides and Radiopharmaceuticals	12%	24
C. Instrumentation and Quality Control	18%	36
D. Diagnostic and Therapeutic Procedures	50%	100
E. Patient Care and Education	<u>10%</u>	<u>20</u>
	100%	200

1. A special debt of gratitude is due to the hundreds of professionals participating in this project as committee members, survey respondents, and reviewers.
2. Each exam includes an additional 20 unscored (pilot) questions. On the pages that follow, the approximate number of test questions allocated to each content category appears in parentheses.

A. RADIATION PROTECTION (20)

I. Patient and Personnel Protection (10)

- A. Biological Effects of Radiation
 - 1. cellular biology
 - 2. effects of radiation on cells
 - a. direct and indirect action
 - b. radiolysis of water
 - c. LET and RBE
 - 3. stochastic and deterministic effects
 - 4. acute effects of total body radiation
 - a. radiation sickness
 - b. hemopoietic syndrome
 - c. gastrointestinal syndrome
 - d. central nervous system syndrome
 - 5. long term effects of radiation
 - a. somatic
 - b. genetic
 - 6. relative tissue and organ sensitivity (e.g., law of Bergonié and Tribondeau)
 - 7. effects of radiation on embryo/fetus
- B. Basic Concepts of Radiation Protection
 - 1. units of radiation exposure
 - 2. principles of time, distance, and shielding
 - 3. personnel protection equipment (e.g., gloves, lab coats)
 - 4. personnel monitoring devices
 - a. types
 - b. use, care, and placement
 - 5. ALARA
 - 6. release of patients
- C. NRC Regulations for Radiation Exposure
 - 1. occupational
 - 2. public
 - 3. pregnancy or nursing
 - 4. internal dosimetry and bioassays
 - 5. personnel exposure records
- D. Medical and Recordable Events
 - 1. definition
 - 2. NRC regulations for reporting and notification

II. Area/Facilities Monitoring (5)

- A. Basic Concepts
 - 1. units of measurement
 - 2. exposure rates
 - 3. definition of contaminated area
- B. Survey Equipment and Techniques
 - 1. well counters
 - 2. survey meters
 - 3. wipe test technique
- C. NRC Regulations
 - 1. frequency of surveys and wipes
 - 2. classification of areas
 - a. work
 - b. treatment
 - c. storage
 - 3. posting of signs (e.g., types, locations)
 - 4. documentation of survey and wipes results
 - a. interpretation
 - b. reporting (corrective action)
 - c. record retention
- D. Radioactive Spills
 - 1. major spills
 - 2. minor spills
 - 3. processes for decontamination
 - 4. reporting procedures

III. Radioactive Materials (5)

- A. Inspection of Incoming and Outgoing Materials
 - 1. shipping labels
 - 2. measurement of exposure rate
 - 3. measurement of surface contamination
 - 4. removable contamination limits/trigger levels
- B. Storage
 - 1. radiopharmaceuticals
 - 2. sealed sources
 - 3. consequences of improper storage
- C. Disposal of Radioactive Waste
 - 1. release to environment
 - 2. decay in storage
 - 3. transfer to authorized recipient

B. RADIONUCLIDES AND RADIOPHARMACEUTICALS (24)

I. Physical Properties of Radioactive Materials (4)

- A. Decay of Radioactivity
 - 1. atomic structure
 - 2. decay modes (e.g., alpha, beta, positron, etc.)
 - 3. decay rate
 - 4. half-life
 - 5. parent-daughter relationship
- B. Interaction of Radiation with Matter
 - 1. coherent (i.e., Rayleigh scattering)
 - 2. photoelectric effect
 - 3. Compton scattering
 - 4. pair production and annihilation
 - 5. internal conversion
 - 6. Auger electron
 - 7. bremsstrahlung
- C. Physical Form (e.g., gas, solution, capsule)
- D. Production of Radionuclides
 - 1. methods
 - a. reactor
 - b. accelerator
 - c. generator
 - 2. purity
 - a. radionuclide
 - b. chemical

II. Radiopharmaceutical Characteristics (5)

- A. Method of Localization
 - 1. capillary blockade
 - 2. active transport
 - 3. phagocytosis
 - 4. diffusion
 - 5. compartmentalization
 - 6. chemisorption
 - 7. receptor binding
 - 8. antigen antibody
 - 9. filtration
- B. Half-Life
 - 1. physical
 - 2. biological
 - 3. effective
- C. Biodistribution
 - 1. pharmacokinetics
 - 2. critical organs
 - 3. target organs

III. Preparation and Administration (15)

- A. Kit Preparation
 - 1. labeling process
 - a. principles
 - 1. oxidation/reduction
 - 2. pH
 - 3. time for reaction
 - 4. temperature
 - b. compounding techniques
 - 1. venting
 - 2. heating
 - 3. mixing
 - c. factors that affect labeling quality
 - 2. shelf life and storage
 - 3. quality control
 - a. radiochemical purity
 - b. particle size
- B. Calculation of Radiopharmaceutical and Pharmaceutical Dosage
 - 1. units
 - a. conversions
 - b. calculations
 - 2. volume determination
 - a. formula
 - b. decay tables
 - c. concentration
 - d. activity
- C. Pharmaceutical and Radiopharmaceutical Administration
 - 1. preparation
 - a. syringe, shielding, and needle selection
 - b. administration techniques
 - 1. routes
 - 2. aseptic
 - c. uniform distribution (e.g., mixing, agitation)
 - 2. complications and reactions
 - 3. documentation
- D. Radiopharmaceutical Label
 - 1. date and time
 - 2. lot number and expiration date
 - 3. concentration
 - 4. volume
 - 5. activity

C. INSTRUMENTATION AND QUALITY CONTROL (36)

I. Survey Meter (3)

- A. Operating Principles
 - 1. Geiger Mueller
 - 2. ionization chambers (cutie pies)
- B. Quality Control
 - 1. frequency and types of checks
 - 2. interpretation and record keeping

II. Dose Calibrator (3)

- A. Operating Principles
- B. Quality Control
 - 1. types of checks
 - a. accuracy
 - b. constancy
 - c. linearity (activity)
 - d. geometry
 - 2. frequency of checks
 - 3. source selection
 - a. activity
 - b. energy
 - 4. interpretation and record keeping

III. Scintillation Detector System (3)

- A. Operating Principles
 - 1. well counter
 - 2. uptake probe
- B. Quality Control
 - 1. radionuclide source
 - a. energies
 - b. type of source
 - 2. parameters
 - a. energy resolution
 - b. efficiency
 - c. high voltage calibration
 - d. resolving time
 - e. sensitivity
 - f. energy linearity
 - 3. interpretation and record keeping

IV. Gamma Camera (10)

- A. Operating Principles
- B. Quality Control
 - 1. frequency and types of checks
 - 2. performance characteristics
 - a. flood field uniformity
 - b. spatial linearity
 - c. spatial resolution
 - d. detector sensitivity
 - e. energy resolution (e.g., FWHM)
 - f. extrinsic versus intrinsic methods
 - g. center of rotation
 - h. SPECT phantom measurements
 - 3. interpretation and record keeping

V. PET Scanner (2)

- A. Operating Principles
- B. Quality Control
 - 1. frequency and types of checks
 - 2. performance characteristics
 - a. blank and/or daily check
 - b. normalization
 - c. gain update
 - 3. interpretation and record keeping

VI. Gas and Aerosol Delivery Systems (2)

- A. Operating Principles
- B. Exhaust System (e.g., negative pressure, gas traps)
- C. Interpretation and Record Keeping

(Section C continues on the following page)

C. INSTRUMENTATION AND QUALITY CONTROL (cont.)

VII. Image Acquisition (9)

- A. Detector System
 - 1. count or time mode
 - 2. detector orientation
 - 3. photopeak energy setting and window width
 - 4. multi-energy acquisition
- B. Collimator Selection
 - 1. parameters (e.g., energy, resolution)
 - 2. types (e.g., parallel hole, pinhole)
- C. Dynamic/Static Acquisition
 - 1. matrix selection
 - 2. framing (e.g., number and length)
 - 3. gating
- D. SPECT Acquisition
 - 1. angular sampling (e.g., 180° versus 360°)
 - 2. matrix selection
 - 3. attenuation correction
 - 4. duration of acquisition
 - 5. mode of acquisition (e.g., continuous, step and shoot, gated)

VIII. Data Processing (4)

- A. Quantitative Analysis (e.g., region of interest selection, ejection fraction, time activity curves)
- B. SPECT Reconstruction
 - 1. orientation
 - 2. filter parameters
 - 3. attenuation correction
 - 4. gated images
 - 5. motion correction
- C. Image Management
 - 1. archiving
 - 2. PACS
 - 3. RIS

D. DIAGNOSTIC AND THERAPEUTIC PROCEDURES (100)

I. Positioning (5)

- A. Patient/Detector Orientation
- B. Anatomical Landmarks
- C. Immobilization Techniques
 - 1. physical devices
 - 2. sedation
 - 3. effects (e.g., restriction of circulation, attenuation, patient motion)

II. Factors Affecting Image Quality (5)

- A. Equipment
- B. Patient
- C. Radiopharmaceutical

III. Specific Procedures (90)

<u>TYPE OF STUDY</u>	<u>APPROX. # QUESTIONS</u>	<u>FOCUS OF QUESTIONS</u>
A. Abscess/Infection/Inflammation	5	<p><i>Questions about a specific study or procedure may address any of the following factors:</i></p> <ul style="list-style-type: none"> A. Instrumentation <ul style="list-style-type: none"> • detector system • data acquisition • data analysis • ancillary equipment B. Radiopharmaceuticals <ul style="list-style-type: none"> • selection • dosage • administration • biodistribution C. Patient Preparation, Monitoring, and Education <ul style="list-style-type: none"> • indications and contraindications • pregnancy, nursing • dietary restrictions • adverse reactions • medications D. Imaging Techniques <ul style="list-style-type: none"> • views • patient-detector orientation • fusion imaging E. Anatomy and Pathophysiology <ul style="list-style-type: none"> • general anatomy • cross-sectional anatomy
B. Bone <ul style="list-style-type: none"> 1. limited 2. 3-phase 3. whole body 4. SPECT 	12	
C. Central Nervous System <ul style="list-style-type: none"> 1. brain death 2. brain SPECT 3. brain PET 4. cisternography/CSF leak 	2	
D. Cardiac <ul style="list-style-type: none"> 1. first pass 2. gated blood pool 3. myocardial perfusion 4. PET 	18	
E. Endocrine <ul style="list-style-type: none"> 1. thyroid uptake/imaging 2. parathyroid 3. neuroendocrine 4. adrenal imaging 	7	
F. Gastrointestinal <ul style="list-style-type: none"> 1. esophageal transit/reflux 2. gastric emptying/reflux 3. Meckel's diverticulum 4. GI bleed 5. H. pylori 6. hepatobiliary 7. RBC hemangioma 8. liver/spleen 	15	

(Section D continues on the following page)

D. DIAGNOSTIC AND THERAPEUTIC PROCEDURES (cont.)

III. Specific Procedures (cont.)

<u>TYPE OF STUDY</u>	<u>APPROX. # QUESTIONS</u>	<u>FOCUS OF QUESTIONS</u>
G. Genitourinary 1. renal function 2. renal perfusion 3. renal morphology 4. cystography	6	<p><i>Questions about a specific study or procedure may address any of the following factors:</i></p> <p>A. Instrumentation</p> <ul style="list-style-type: none"> • detector system • data acquisition • data analysis • ancillary equipment <p>B. Radiopharmaceuticals</p> <ul style="list-style-type: none"> • selection • dosage • administration • biodistribution <p>C. Patient Preparation, Monitoring, and Education</p> <ul style="list-style-type: none"> • indications and contraindications • pregnancy, nursing • dietary restrictions • adverse reactions • medications <p>D. Imaging Techniques</p> <ul style="list-style-type: none"> • views • patient-detector orientation • fusion imaging <p>E. Anatomy and Pathophysiology</p> <ul style="list-style-type: none"> • general anatomy • cross-sectional anatomy
H. Lung 1. perfusion 2. ventilation – gas and aerosol 3. quantitative	5	
I. Lymphoscintigraphy 1. breast 2. melanoma	4	
J. Tumor 1. gallium 2. antibodies 3. I-131 whole body 4. thallium 5. sestamibi 6. PET 7. peptide receptor imaging	11	
K. Shunt Studies	1	
L. Therapy 1. procedures a. palliative bone b. thyroid ablation c. hyperthyroidism d. non-Hodgkin's lymphoma 2. regulations	4	

E. PATIENT CARE AND EDUCATION (20)

I. Ethical and Legal Aspects (5)

- A. Patient's Rights
 - 1. informed consent (e.g., written, oral, implied)
 - 2. confidentiality (HIPAA)
 - 3. additional rights (e.g., Patient's Bill of Rights)
 - a. privacy
 - b. extent of care (e.g., DNR)
 - c. access to information
 - d. living will; health care proxy
 - e. research participation
 - 4. patient safety standards (e.g., patient identification)
- B. Legal Issues
 - 1. examination requisition
 - 2. common terminology (e.g., battery, negligence, malpractice)
 - 3. legal doctrines (e.g., *respondeat superior*, *res ipsa loquitur*)
- C. ARRT Standards of Ethics

II. Interpersonal Communication (3)

- A. Modes of Communication
 - 1. verbal/written
 - 2. nonverbal (e.g., eye contact, touching)
- B. Challenges in Communication
 - 1. patient characteristics
 - 2. explanation of medical terms
 - 3. strategies to improve understanding
 - 4. language barrier
 - 5. cultural differences
- C. Patient Education
 - 1. explanation of current procedure
 - 2. respond to inquiries about other health care related services (e.g., CT, MRI, mammography, sonography, radiography, bone densitometry, clergy, social services, and rehabilitation)

III. Infection Control (8)

- A. Terminology and Basic Concepts
 - 1. asepsis
 - a. medical
 - b. surgical
 - c. sterile technique
 - 2. pathogens
 - a. fomites, vehicles, vectors
 - b. nosocomial infections
- B. Cycle of Infection
 - 1. pathogen
 - 2. source or reservoir of infection
 - 3. susceptible host
 - 4. method of transmission
 - a. contact (direct, indirect)
 - b. droplet
 - c. airborne/suspended
 - d. common vehicle
 - e. vector-borne
- C. Standard Precautions
 - 1. handwashing
 - 2. gloves, gowns
 - 3. masks
 - 4. medical asepsis (e.g., equipment disinfection)
- D. Additional or Transmission-Based Precautions (e.g., hepatitis B, HIV, rubella, tuberculosis)
 - 1. airborne (e.g., respiratory protection, negative ventilation)
 - 2. droplet (e.g., particulate mask, restricted patient placement)
 - 3. contact (e.g., gloves, gown, restricted patient placement)
- E. Disposal of Contaminated Materials
 - 1. linens
 - 2. needles
 - 3. patient supplies (e.g., tubes, emesis basin)

(Section E continues on the following page)

E. PATIENT CARE AND EDUCATION (cont.)

IV. Physical Assistance and Transfer (2)

- A. Patient Transfer and Movement
 - 1. body mechanics (balance, alignment, movement)
 - 2. patient transfer
- B. Assisting Patients with Medical Equipment
 - 1. infusion catheters and pumps
 - 2. oxygen delivery systems
 - 3. other (e.g., nasogastric tubes, urinary catheters, tracheostomy tubes)
- C. Routine Monitoring
 - 1. equipment (e.g., stethoscope, sphygmomanometer)
 - 2. vital signs (e.g., blood pressure, pulse, respiration, temperature)
 - 3. physical signs and symptoms (e.g., motor control, severity of injury)
 - 4. documentation

V. Medical Emergencies (2)

- A. Allergic Reactions (e.g., pharmaceuticals, latex)
- B. Cardiac or Respiratory Arrest (e.g., CPR)
- C. Physical Injury or Trauma
- D. Other Medical Disorders (e.g., seizures, diabetic reaction)