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# CONTENT SPECIFICATIONS FOR THE EXAMINATION IN RADIATION THERAPY



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The purpose of the ARRT Examination in Radiation Therapy is to assess the knowledge and cognitive skills underlying the intelligent performance of the tasks typically required of the staff radiation therapist 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 technologists<sup>1</sup>. 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](http://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.

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CONTENT CATEGORY	PERCENT OF TEST	NUMBER OF QUESTIONS <sup>2</sup>
A. Radiation Protection and Quality Assurance	17.5%	35
B. Clinical Concepts in Radiation Oncology	27.5%	55
C. Treatment Planning	27.5%	55
D. Treatment Delivery	12.5%	25
E. Patient Care and Education	<u>15.0%</u>	<u>30</u>
	100%	200

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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 AND QUALITY ASSURANCE (35)**

### **1. Radiation Physics and Biology (15)**

- A. Sources of Radiation
  - 1. radioactive material
  - 2. machine-produced radiation
- B. Basic Properties of Radiation
  - 1. wave characteristics
  - 2. exponential attenuation
  - 3. inverse-square law
  - 4. x-ray beam quality
- C. Interactions with Matter
  - 1. photon interactions (Compton, photoelectric effect, etc.)
  - 2. electron interactions
  - 3. particle interactions (proton, neutron, etc.)
- D. Biological Effects of Radiation
  - 1. radiosensitivity
  - 2. dose-response relationships
  - 3. somatic effects
    - a. cellular
    - b. tissue (hemopoietic, skin, reproductive organs, etc.)
    - c. embryonic and fetal risks
    - d. carcinogenesis
    - e. early versus late effects
    - f. acute versus chronic effects
- E. Measurement of Radiation
  - 1. units of measurement
    - a. absorbed dose (gray)
    - b. dose equivalent (rem)
    - c. exposure (Roentgen)
  - 2. instrumentation
    - a. ionization chamber
    - b. Geiger-Muller detector
    - c. TLD/OSL (Optically Stimulated Luminescence)
    - d. diodes
    - e. neutron detectors

### **2. Radiation Protection (8)**

- A. Fundamental Principles
  - 1. ALARA
  - 2. basic methods of protection (time, distance, shielding)
- B. Personnel Monitoring
  - 1. NCRP recommendations for personnel monitoring (report #116)
    - a. occupational exposure (sievert)
    - b. public exposure
    - c. embryo/fetus exposure
  - 2. maintenance and evaluation of personnel dosimetry records
- C. Facilities and Area Monitoring
  - 1. NRC regulations (10 CFR, parts 20 and 35)
    - a. classification of areas (restricted, controlled, unrestricted)
    - b. required postings (signs)
    - c. area monitoring devices
  - 2. barrier requirements
    - a. primary
    - b. secondary

### **3. Environmental Protection (3)**

- A. Toxic or Hazardous Material
  - 1. metals (shielding alloy, etc.)
  - 2. chemicals (film processing, etc.)
  - 3. radioactive materials
  - 4. chemotherapy
- B. Handling and Disposal
- C. Material Safety Data Sheet (MSDS)

(Section A continues on the following page)

## **A. RADIATION PROTECTION AND QUALITY ASSURANCE (cont.)**

### **4. Equipment Use and Quality Assurance (9)**

#### **A. Components and Operation**

- 1. linear accelerator
- 2. fluoroscopic simulator
- 3. CT simulator

#### **B. Quality Control Procedures**

- 1. warm up and inspection of linear accelerators, simulators, and CT simulators
  - a. interlock systems
  - b. safety lights
  - c. emergency switches
  - d. critical machine parameters (pressure, temperature, etc.)
  - e. electrical and mechanical hazards
- 2. radiation output verification
  - a. methods
  - b. frequency
  - c. effect of environment (humidity, etc.) on measurements

- 3. light and treatment field checks
  - a. light and radiation field agreement
  - b. collimator indicator agreement
  - c. multileaf collimator performance
  - d. sidelight/laser accuracy check (isocenter)
- 4. rotation check
  - a. safety procedures
  - b. operation of gantry/console
- 5. evaluation of quality assurance results
  - a. interpretation
  - b. course of action
  - c. documentation

## B. CLINICAL CONCEPTS IN RADIATION ONCOLOGY (55)

### 1. Patient Evaluation (9)

- A. Epidemiology and Etiology
  - 1. cancer risk factors
  - 2. prevalence and incidence
- B. Cancer Screening
- C. Signs and Symptoms
- D. Physical Examination
- E. Imaging Studies (CT, MRI, etc.)
- F. Other Diagnostic Studies
  - 1. lab results
  - 2. surgical reports

### 2. Anatomy, Physiology, Pathophysiology, Pathology, Lymphatic Drainage, and Metastatic Patterns related to the following: (20)

- A. Brain and Spinal Cord
- B. Head and Neck (includes thyroid and salivary glands)
- C. Breast
- D. Lung
- E. Abdomen, Pelvis, GI, and GU
  - 1. esophagus, stomach, small bowel, large bowel, rectum, and anus
  - 2. pancreas, adrenal, liver, and gallbladder
  - 3. ureters, kidney, bladder, and urethra
- F. Reproductive
  - 1. prostate, testes
  - 2. endometrium, cervix, ovaries, uterus, vagina, and vulva
- G. Skeletal
- H. Miscellaneous
  - 1. lymphoma (Hodgkin's and non-Hodgkin's)
  - 2. sarcomas (bone and soft tissue)
  - 3. multiple myeloma
  - 4. skin
  - 5. leukemia
  - 6. mycosis fungoides
  - 7. bone marrow transplant
  - 8. benign (heterotopic bone, keloid, AVM, etc.)

### 3. Tumor Classification (6)

- A. Histopathologic Types (benign, sarcomas, carcinomas, etc.)
- B. Histopathologic Grade
  - 1. purpose (differentiation and growth rate)
  - 2. grading system (GX, G1-G4, etc.)
- C. Staging (basic concepts; not specific sites)
  - 1. purpose
  - 2. components (TNM, I-IV, etc.)

### 4. Treatment Options (indications, benefits, risks) (6)

- A. Chemotherapy
- B. Surgery
- C. Radiation Therapy
  - 1. external beam
  - 2. brachytherapy \*
- D. Multimodality treatment

### 5. Radiation Tissue Tolerance (14)

- A. Tolerance Levels ( $TD_{5/5}$ )
- B. Adverse Effects
- C. Dose to Critical Structures
- D. Radiobiological Factors (dose, fractionation, volume, etc.)
- E. Biological Factors (age, anatomic variation, medical conditions, etc.)
- F. Medical Factors (concurrent medications, prior surgery, pacemakers, etc.)
- G. Other Factors (radiosensitizers, radioprotectors, etc.)
- H. Contribution from Other Sources
  - 1. chemotherapy
  - 2. brachytherapy \*
  - 3. other fields (prior or abutting, etc.)
  - 4. radiation effect modifiers

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\* Only basic concepts related to common uses of brachytherapy are covered, including dose to surrounding tissue and radiation protection issues. Specific procedures and isotope characteristics are not covered.

## C. TREATMENT PLANNING (55)

### 1. Treatment Volume Localization (20)

- A. Treatment Techniques and Anatomic Relationships
  - 1. radiation therapy techniques
  - 2. sectional and topographic anatomy
  - 3. critical organs
  - 4. patient positioning and immobilization
- B. Fluoroscopic Simulation
  - 1. image receptors
  - 2. exposure factors
  - 3. image processing
  - 4. image labeling
  - 5. magnification factors
  - 6. contouring (purpose, devices, materials, technique, etc.)
  - 7. volume and isocenter determination
  - 8. image storage and retrieval
- C. CT Simulation
  - 1. CT image acquisition (mA, slice thickness and spacing, etc.)
  - 2. CT image processing and display (reconstruction, window level, field of view, CT number, etc.)
  - 3. contour volume and isocenter determination
  - 4. image transmission, storage, and retrieval
  - 5. programmable lasers
- D. Contrast Media
  - 1. types and techniques
  - 2. contraindications
  - 3. adverse reactions
- E. Documentation of Simulation Procedure
  - 1. anatomic position
  - 2. equipment orientation
  - 3. accessory equipment
  - 4. field parameters
  - 5. set-up diagrams or photographs

### 2. Prescription and Dose Calculation (24)

- A. Treatment Prescription
  - 1. total tumor dose
  - 2. fractionation schedules
  - 3. radiation energy
  - 4. types of radiation
  - 5. treatment volume (GTV, CTV, PTV, etc.)
  - 6. number of fields
  - 7. fixed versus rotational fields
  - 8. field weighting
  - 9. field orientation
  - 10. treatment unit capabilities and limitations
  - 11. modifications
- B. Geometric Parameters and Patient Measurements
  - 1. field size and shape
  - 2. tumor depth
  - 3. patient thickness
  - 4. SSD, SAD
  - 5. collimator setting
  - 6. abutting fields (gap calculations, etc.)
- C. Dose Calculation and Verification
  - 1. selection of energy
  - 2. equivalent square (open and blocked field)
  - 3. scatter factors (collimator, phantom, etc.)
  - 4. percentage depth dose
  - 5. TAR, TMR
  - 6. SSD, SAD
  - 7. inverse square
  - 8. extended distance factors
  - 9. wedges (wedge angle or factor, etc.)
  - 10. off-axis calculation
  - 11. isodose curves and their characteristics (penumbra, DVH, etc.)
  - 12. factors for beam modifiers (tray factor, bolus, compensator, etc.)
  - 13. inhomogeneity correction factors
  - 14. rotational factors
  - 15. machine output data (cGy/min, etc.)
  - 16. verification and documentation

## C. TREATMENT PLANNING (cont.)

### 3. Treatment Accessories (11)

#### A. Types of Devices

1. immobilization
2. compensating filters
3. shielding (blocks, multileaf collimation, etc.)
4. bolus

#### B. Design Methods and Materials

1. custom beam shaping devices
  - a. photon
  - b. electron
2. custom immobilization devices
3. bolus

#### C. Parameters

1. SSD, SAD
2. source-film distance (SFD)
3. image magnification factor
4. collimator settings
5. source-to-block tray distance (STD)
6. patient thickness
7. block thickness, half value layer (HVL), half-value thickness (HVT)
8. beam energy and type

## **D. TREATMENT DELIVERY (25)**

### **1. Verification and Application of the Treatment Plan (4)**

- A. Patient Position
- B. Isocenter (x, y, z coordinates, etc.)
- C. Treatment Parameters (beam orientation, energy, etc.)
- D. Prescription
- E. Modality
  - 1. 2D
  - 2. 3D
  - 3. 4D
  - 4. IMRT
  - 5. stereotactic

### **2. Treatment Machine Set-Up (8)**

- A. Auxiliary Set-Up Devices
  - 1. couch indexing
  - 2. positioning aids
  - 3. alignment lasers
- B. Machine Operation
  - 1. SSD, SAD
  - 2. collimator or cone settings
  - 3. optical or mechanical distance indicator
  - 4. gantry angle
  - 5. collimator angle
  - 6. field light
  - 7. treatment couch
  - 8. console controls
- C. Beam Modifiers
  - 1. wedges (enhanced dynamic wedge, physical wedge)
  - 2. bolus
  - 3. compensators
  - 4. blocks
  - 5. multileaf collimation

### **3. Treatment Administration (8)**

- A. Patient Monitoring Systems
  - 1. direct visual
  - 2. indirect visual (mirror; TV monitor)
  - 3. two-way voice communication system
  - 4. back-up systems
  - 5. monitoring regulations
  - 6. emergency situations
- B. Record and Verify Systems
- C. Portal Imaging
- D. Site Verification
- E. Dose Verification (diodes, film, etc.)
- F. Equipment Malfunctions
  - 1. types (radiation, electrical, mechanical, etc.)
  - 2. documentation and reporting

### **4. Documentation (5)**

- A. Information Included in Treatment Record
  - 1. prescription
  - 2. monitor units or time
  - 3. tumor dose (daily and accumulated)
  - 4. energy and type of radiation
  - 5. date
  - 6. time of day for b.i.d. treatment
  - 7. fraction
  - 8. elapsed days
  - 9. field number and description
  - 10. doses to other points of interest
  - 11. set-up instructions
- B. Elements of Record Keeping
  - 1. patient identification
  - 2. accountability (signatures, etc.)
  - 3. accuracy and legibility
  - 4. correction of errors
  - 5. reconstruction of treatment
  - 6. variance from prescription (errors, prescription changes)
  - 7. medical events (i.e., definition and required documentation)
- C. Charge Capture Terminology
  - 1. professional and technical components
  - 2. CPT® principles

## **E. PATIENT CARE AND EDUCATION (30)**

### **1. Ethical and Legal Aspects (5)**

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

### **2. Interpersonal Communications (2)**

- A. Modes of Communication
  - 1. verbal/written
  - 2. nonverbal (eye contact, touching, etc.)
  - 3. professional communication
- B. Patient characteristics
  - 1. cultural and social factors
  - 2. emotional status; acceptance of condition (stage of grief, etc.)
  - 3. physical or sensory impairments
  - 4. age
  - 5. explanation of medical terms
- C. Patient Education
  - 1. explanation of treatment
  - 2. treatment compliance (positioning, skin marks, etc.)
  - 3. support services
    - a. hospice
    - b. other professionals (clergy, social services, etc.)

### **3. Patient Assessment and Management (8)**

- A. Treatment Side Effects
  - 1. signs and symptoms
  - 2. causes
  - 3. management
- B. Blood Studies
  - 1. types of studies (CBC, BUN, creatinine, etc.)
  - 2. factors affecting blood values
- C. Dietary Counseling
  - 1. common problems
  - 2. causes
  - 3. dietary management

### **4. Physical Assistance and Transfer (4)**

- A. Patient Transfer and Movement
  - 1. body mechanics
  - 2. transfer techniques
- B. Assisting Patients with Medical Equipment
  - 1. infusion catheters and pumps
  - 2. oxygen delivery systems
  - 3. other (nasogastric tubes, urinary catheters, tracheostomy tubes, etc.)

(Section E continues on the following page)

## **E. PATIENT CARE AND EDUCATION (cont.)**

### **5. Medical Emergencies (4)**

- A. Allergic Reactions (contrast, latex, etc.)
- B. Cardiac or Respiratory Arrest (CPR, etc.)
- C. Physical Injury or Trauma
- D. Other Medical Disorders (seizures, diabetic reactions, etc.)

### **6. Infection Control (7)**

- 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/Universal Precautions (general patient contact; blood, body fluids, non-intact skin)

- 1. handwashing
- 2. gloves, gowns
- 3. masks
- 4. medical asepsis (equipment disinfection, etc.)

- D. Additional or Transmission-Based Precautions (hepatitis B, HIV, rubella, tuberculosis, etc.)

- 1. airborne (respiratory protection, negative ventilation, etc.)
- 2. droplet (particulate mask, restricted patient placement, etc.)
- 3. contact (gloves, gown, restricted patient placement, etc.)

- E. Disposal of Contaminated Materials

- 1. linens
- 2. needles
- 3. patient supplies (tubes, emesis basin, etc.)