



# Fluoroscopy

The purpose of the fluoroscopy examination, which is developed and administered by The American Registry of Radiologic Technologists (ARRT) on behalf of state licensing agencies, is to assess the knowledge and cognitive skills underlying the intelligent performance of the tasks typically required in patient dose reduction, occupational dose reduction, image recording, quality control, and to safely operate a fluoroscopy unit. The fluoroscopy program does not assess the knowledge and cognitive skills required for the performance of fluoroscopic imaging procedures. ARRT administers the examination to state approved candidates under contractual arrangement with the state and provides the results directly to the state. This examination is not associated with any type of certification and registration by the ARRT.

To identify the knowledge and cognitive skills covered by the examination, the ARRT conducted a practice analysis study using input from subject matter experts and related published documents such as the *ASRT Fluoroscopy Educational Framework for Physician Assistants (2009)*.<sup>1</sup> The practice analysis resulted in a task inventory which serves as the basis for these content specifications and appears in *Appendix A* of this document. Every content category can be linked to one or more activities on the task inventory.

This document is not intended to serve as a curriculum guide. The ARRT avoids content when there are multiple resources with conflicting perspectives. Although testing programs and educational programs may have related purposes, their functions are clearly different. Educational programs offer education and experience beyond the minimum requirements specified in the content specifications.

The table below presents the major content categories and subcategories covered on the examination. The number of test questions in each category are listed in bold and number of test questions in each subcategory in parentheses. Specific topics within each category are addressed in the content outline, which makes up the remaining pages of this document.

<b>Content Category</b>	<b>Number of Questions<sup>2</sup></b>
Patient Care	<b>9</b>
<i>Patient Interactions and Management (9)</i>	
Safety	<b>46</b>
<i>Radiation Physics and Radiobiology (22)</i>	
<i>Radiation Protection (24)</i>	
Image Production	<b>35</b>
<i>Equipment Operation (22)</i>	
<i>Image Evaluation and Quality Control (13)</i>	
<b>Total</b>	<b>90</b>

<sup>1</sup>. A special debt of gratitude is due to the hundreds of professionals participating in this project as committee members, survey respondents, and reviewers.

<sup>2</sup>. The exam includes up to an additional 20 unscored (pilot) questions.



## Patient Care

### 1. Patient Interactions and Management

- A. Patient Identification and Procedure Verification
- B. Components of Informed Consent
- C. Risk versus Benefit
- D. Patient Education
  - 1. explanation
  - 2. respond to inquiries (\*e.g., radiation dose, types of radiation)
- E. Procedural Understanding to Reduce Exposure
- F. Procedure Radiation Exposure (NCRP Report #160)
- G. Cumulative Dose Education
- H. Pregnancy Status (e.g., tests and limitations)
- I. Contrast Reactions
  - 1. allergy history (e.g., appropriate pre-medication)
  - 2. types of reactions (mild to severe)
  - 3. respond to allergic reactions
- J. Patient Record Information
  - 1. patient dose/exposure factors
  - 2. adverse events
  - 3. picture archiving and communication system (PACS)
  - 4. hospital information system (HIS)
  - 5. radiology information system (RIS)
  - 6. electronic medical record (EMR) or electronic health record (EHR) systems
  - 7. digital imaging and communications in medicine (DICOM)
- K. HIPAA

\* The abbreviation "e.g.," is used to indicate that examples are listed in parenthesis, but that it is not a complete list of all possibilities.



## Safety

### 1. Radiation Physics and Radiobiology

#### A. Principles of Radiation Physics

1. x-ray production
  - a. source of free electrons (e.g., thermionic emission)
  - b. acceleration of electrons
  - c. focusing of electrons
  - d. deceleration of electrons
2. target interaction
  - a. bremsstrahlung
  - b. characteristic
3. x-ray beam
  - a. frequency and wavelength
  - b. beam characteristics
    1. quality
    2. quantity
    3. primary versus remnant (exit)
  - c. inverse square law
  - d. fundamental properties (e.g., travel in straight lines, ionize matter)
4. photon interactions with matter
  - a. photoelectric
  - b. Compton
  - c. coherent (classical)
  - d. attenuation by various tissues
    1. thickness of body part
    2. type of tissue (atomic number)

#### B. Biological Effects of Radiation

1. SI units of measurement (NCRP Report #160)
  - a. absorbed dose (Gy)
  - b. dose equivalent (Sv)
  - c. exposure (C/kg)
  - d. effective dose (Sv)
  - e. air kerma (Gy)
2. radiosensitivity
  - a. dose-response relationships
  - b. relative tissue radiosensitivities (e.g., LET, RBE)
  - c. cell survival and recovery (LD<sub>50</sub>)
  - d. oxygen effect
3. somatic effects
  - a. cells
  - b. tissue (e.g., eye, thyroid, breast, skin, marrow, gonad)
  - c. embryo and fetus
  - d. carcinogenesis
  - e. early versus late or acute versus chronic
  - f. deterministic (tissue reactions) versus stochastic
  - g. short-term versus long-term exposure

(Safety section continues on the following page.)



## Safety (continued)

### 2. Radiation Protection

#### A. Minimizing Patient Exposure

1. exposure factors
  - a. kVp
  - b. mA
  - c. fluoroscopy time
  - d. automatic brightness control (ABC) and/or automatic exposure rate control (AERC)
2. beam restriction
  - a. purpose of primary beam restriction
  - b. collimators
3. patient considerations
  - a. positioning
  - b. communication
  - c. pediatric
  - d. morbid obesity
4. filtration
  - a. effect on skin and organ exposure
  - b. effect on average beam energy
  - c. NCRP recommendations (NCRP Report #102, minimum filtration in useful beam)
5. dose or time documentation
6. equipment features
  - a. pulsed
  - b. exposure factors
  - c. grids
  - d. positioning
  - e. cumulative timer
  - f. automatic brightness control (ABC) and/or automatic exposure rate control (AERC)
  - g. receptor positioning
  - h. magnification mode
  - i. air kerma display
  - j. last image hold
  - k. minimum source-to-skin distance (21 CFR)
- l. dose mode
  1. low dose
  2. cine (e.g., digital subtraction angiography (DSA))
  3. high-level control
  4. pulsed
  5. continuous
7. patient positioning
  - a. impact on dose
  - b. positioning aids
8. dose area product (DAP) meter

#### B. Personnel Protection (ALARA)\*

1. sources of radiation exposure
  - a. primary x-ray beam
  - b. secondary radiation
    1. scatter
    2. leakage
  - c. patient as source
2. basic methods of protection
  - a. time
  - b. distance
  - c. shielding
3. protective devices
  - a. types (e.g., aprons, barriers)
  - b. attenuation properties
  - c. minimum lead equivalent (NCRP Report #102)
  - d. protective drapes
  - e. protective Bucky slot cover
  - f. cumulative timer
  - g. remote-controlled fluoroscopy
4. guidelines for fluoroscopy and mobile units (NCRP Report #102, 21 CFR)
  - a. fluoroscopy exposure rates (normal and high-level control)
  - b. exposure switch guidelines
5. radiation exposure and monitoring
  - a. dosimeters
    1. types
    2. proper use
  - b. NCRP recommendations for personnel monitoring (NCRP Report #116)
    1. occupational exposure
    2. public exposure
    3. embryo/fetus exposure
    4. dose equivalent limits
    5. evaluation and maintenance of personnel dosimetry records

\* Note: Although it is the fluoroscopist's responsibility to apply radiation protection principles to minimize bioeffects for both patients and personnel, the ALARA concept is specific to personnel protection and is listed only for that section.



## Image Production

### 1. Equipment Operation

- A. Technical Factors
  - 1. kVp
  - 2. mA
  - 3. object-to-image distance (OID)
  - 4. source-to-image distance (SID)
  - 5. focal spot size
  - 6. grids
  - 7. filtration
  - 8. beam restriction
  - 9. automatic brightness control (ABC) and/or automatic exposure rate control (AERC)
  - 10. anatomic alignment
  - 11. exposure compensation
  - 12. magnification mode
  - 13. high level control (e.g., boost, high dose rate)
  - 14. pulse rate
- B. Image Receptors
  - 1. image intensifier
  - 2. flat panel detector
- C. Image Display
  - 1. viewing conditions (e.g., luminance, ambient lighting, ergonomics)
  - 2. spatial resolution (e.g., pixel size, pixel pitch)
  - 3. contrast resolution/dynamic range
  - 4. DICOM gray scale function
  - 5. brightness and contrast
- D. Recording Systems
  - 1. digital subtraction angiography (DSA)
  - 2. image capture
  - 3. spot imaging (digital spot)

### 2. Image Evaluation and Quality Control

- A. Digital Image Characteristics
  - 1. spatial resolution (equipment related)
    - a. sampling frequency
    - b. detector element size (DEL) (e.g., size, pitch, fill factor)
    - c. receptor size and matrix size
    - d. pixel characteristics (e.g., size, pitch)
    - e. modulation transfer function (MTF)
  - 2. image signal (exposure related)
    - a. quantum mottle (quantum noise)
    - b. dynamic range
    - c. signal to noise ratio (SNR)
  - 3. contrast resolution (equipment related)
    - a. bit depth
    - b. detective quantum efficiency (DQE)
- B. Criteria for Image Evaluation
  - 1. demonstration of anatomical structures (e.g., positioning, motion)
  - 2. identification markers (radiographic or electronic) (e.g., anatomical, patient, date)
  - 3. patient considerations (e.g., pathologic conditions)
  - 4. quantum mottle (quantum noise)
  - 5. gross exposure error (e.g., loss of contrast, saturation)
  - 6. contrast
  - 7. spatial resolution
  - 8. distortion (e.g., size, shape)
  - 9. image artifacts (e.g., grid lines, dead pixels)
- C. Recognition and Reporting of Malfunctions
  - 1. quality control
    - a. display monitor (e.g., grayscale standard display function, luminance)
    - b. shielding accessory testing (e.g., lead apron and glove testing)
    - c. exposure rate output
    - d. spot imager
    - e. image quality (e.g., resolution)
  - 2. recording and reporting of high exposure



## Attachment A

### Task Inventory for Fluoroscopy Examination

Activity	Content Categories
1. Verify the patient's identity.	PC.1.A.
2. Advocate radiation safety and protection.	PC., S., S.1.B., S.2., IP.1.
3. Assess the patient's radiation dose history.	PC., PC.1.E., PC.1.F., PC.1.G., PC.1.J., S.2.A.5.
4. Assess alternative procedures.	PC.1.C., PC.1.D.2., PC.1.E.
5. Assess risk factors that may contraindicate the procedure (e.g., health history, medications, pregnancy, psychological indicators, alternative medicines).	PC.1.A., PC.1.H., PC.1.I., PC.1.J.6.
6. Evaluate the patient's ability to understand and comply with requirements for the requested examination.	PC.1.D.
7. Obtain pertinent medical history.	PC.1.J.
8. Screen female patients of childbearing age for the possibility of pregnancy and take appropriate action (e.g., document response, contact physician).	PC.1.H.
9. Review examination requisition to verify accuracy, completeness of information, and exam appropriateness (e.g., patient history, clinical diagnosis, physician's orders).	PC.1.A., PC.1.I., PC.1.J.
10. Verify and/or obtain patient consent as necessary (e.g., contrast studies).	PC.1.B.
11. Respond as appropriate to procedure inquiries from the patient, patient's family, or authorized representative (e.g., scheduling delays, exam duration).	PC.1.D.
12. Explain to the patient potential side effects of the radiation required for the examination.	PC.1.G., S.1.B.3.
13. Use positioning aids, as needed, to reduce patient movement, and/or promote patient safety.	S.2.A.7.
14. Remove radiopaque materials that could interfere with the image from the exposure field (e.g., clothing, jewelry, prosthesis).	PC.1.D., PC.1.E., IP.2.B.
15. Select imaging accessories (e.g., grid) for the examination requested.	S.2.A.2., S.2.A.4., S.2.A.6.C., IP.1.A.6., IP.1.A.7., IP.1.A.8.
16. Prior to administration of a contrast agent, determine if patient is at increased risk for an adverse reaction.	PC.1.I., PC.1.J.2.
17. Assess the patient after administration of contrast agent to detect adverse reactions.	PC.1.I., PC.1.J.2.
18. Recognize and communicate the need for prompt medical attention.	PC.1.I., PC.1.J.2.



<b>Activity</b>	<b>Content Categories</b>
19. Take appropriate precautions to minimize occupational radiation exposure.	S.1., S.2.B., IP.2.C.
20. Keep all unnecessary persons out of the immediate area during radiation exposure.	S.1., S.2.B.
21. Take appropriate precautions to minimize radiation exposure to the patient.	S.1., S.2.A.
22. Set kVp, mA, and time or automatic exposure system to achieve optimum image quality, safe operating conditions, and minimum radiation dose.	PC.1.J.1., S.2.A., IP.1.A., IP.2.B.
23. Select appropriate geometric factors (e.g., SID, OID, focal spot size, magnification).	IP.1.A.3.-A.5., IP.1.A.12.
24. Position patient to demonstrate the desired anatomy using anatomical landmarks.	S.2.A.7., IP.2.B.1.
25. Explain breathing instructions prior to making the exposure.	PC.1.D.1., PC.1.E., IP.2.B.3.
26. Operate a fluoroscopic unit and accessories including: a. fixed fluoroscopic unit b. mobile fluoroscopic unit (e.g., C-arm, O-arm)	S.1., S.2.A., S.2.B., IP.1.
27. Operate fluoroscopic equipment in compliance with regulatory requirements and medical ethics.	PC.1.K., S.2.A.4., S.2.B.4., S.2.B.5., IP.2.C.
28. Modify exposure factors for circumstances such as involuntary motion, pathological conditions, contrast agent, or patient's inability to cooperate.	S.2.A.7., IP.1.A., IP.2.B.1.-B.3.
29. Adapt fluoroscopic procedures for patient condition (e.g., age, size, trauma, pathology) and location (e.g., mobile, surgical, isolation).	PC.1.E., S.2.A.3., IP.1.A.-C.
30. Modify exposure factors for pediatric patients.	PC.1.E., S.2.A., IP.1.A.-C.
31. Determine corrective measures if image is not of diagnostic quality and take appropriate action.	IP.1.A., IP.2.A., IP.2.B.
32. Take appropriate action to minimize fluoroscopy dose.	PC.1.E., S.2.A., IP.1.A.9-14.
33. Restrict beam to the anatomical area of interest to limit exposure, improve image quality, and reduce radiation dose.	S.2.A.2., IP.1.A.8.
34. Verify accuracy of patient identification associated with images.	PC.1.A., IP.2.B.2.
35. Evaluate images for diagnostic quality.	IP.1.C., IP.2.B.
36. Identify image artifacts and make appropriate corrections as needed.	IP.1.B - D., IP.2.B.9., IP.2.C.1.
37. Add electronic annotations on images to indicate position or other relevant information (e.g., time, upright, decubitus, post-void).	PC.1.J., IP.2.B.2.
38. Perform post-processing on digital images in preparation for interpretation.	IP.1.D.1.



<b>Activity</b>	<b>Content Categories</b>
39. Operate digital imaging devices and information technology systems. a. picture archival and communication system (PACS) b. hospital information system (HIS) c. radiology information system (RIS) (e.g., modality worklist) d. electronic medical record (EMR) system e. electronic health record (EHR) system	PC.1.J.3.-J.6.
40. Document required information on the patient's medical record (e.g., imaging procedure documentation, images, adverse events).	PC.1.J., S.2.A.5.
41. Document fluoroscopy time.	PC.1.J., S.2.A.5., IP.2.C.2.
42. Document fluoroscopy dose.	PC.1.J., S.2.A.5., IP.2.C.2.
43. Demonstrate and promote professional and ethical behavior (e.g., confidentiality, regulation compliance).	PC.1.K.
44. Store and handle imaging equipment in a manner which will reduce the possibility of artifact production.	IP.1.B., IP.1.D., IP.2.C.1.
45. Recognize and report malfunctions in the imaging unit and accessories.	IP.2.C.
46. Recognize the need for periodic maintenance and evaluation of radiographic equipment affecting image quality and radiation safety (e.g., shielding, image display monitor, exposure rate).	IP.2.C.
47. Appropriately report high exposure.	IP.2.C.2.
48. Wear a radiation monitoring device while on duty.	S.2.B.5.
49. Evaluate individual occupational exposure reports to determine if values for the reporting period are within established limits.	S.2.B.5.