



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 to safely operate a fluoroscopy unit. 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)*.¹ 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.

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.

This document is not intended to serve as a curriculum guide. Although testing 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 | Number of Questions² |
|--|--|
| Patient Care | 9 |
| <i>Patient Interactions and Management (9)</i> | |
| Safety | 46 |
| <i>Radiation Physics and Radiobiology³ (22)</i> | |
| <i>Radiation Protection (24)</i> | |
| Image Production | 35 |
| <i>Equipment Operation (22)</i> | |
| <i>Image Evaluation and Quality Control (13)</i> | |
| Total | 90 |

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. The exam includes up to an additional 30 unscored (pilot) questions.

³. SI units will become the primary (principle) units of radiation measurement used on the fluoroscopy examination in 2018.



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 #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)
- J. Patient Record Information
 - 1. patient dose/technical factors
 - 2. adverse reactions
 - 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
- K. Standards of Care
- L. 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. Radiation Physics

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

B. Radiation Biology

1. radiosensitivity
 - a. dose-response relationships
 - b. relative tissue radiosensitivity (e.g., LET, RBE)
 - c. cell survival and recovery
 - d. oxygen effect
2. somatic effects
 - a. short-term versus long-term effects
 - b. acute versus chronic effects
 - c. carcinogenesis
 - d. organ and tissue response (e.g., eye, thyroid, breast, bone marrow, skin, gonadal)
3. embryonic and fetal risks
4. genetic effects

(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)
 - e. automatic exposure rate control (AERC)
2. shielding
 - a. rationale for use
 - b. types
 - c. placement
3. beam restriction
 - a. purpose of primary beam restriction
 - b. collimators
4. filtration
 - a. effect on skin and organ exposure
 - b. effect on average beam energy
 - c. NCRP recommendations (NCRP #102, minimum filtration in useful beam)
5. equipment features
 - a. last image hold
 - b. cumulative timer
 - c. magnification mode
 - d. dose mode
 1. low dose
 2. cine
 3. high-level control
 4. pulsed
6. pediatric dose reduction
7. grids
8. receptor positioning
9. patient positioning
 - a. impact on dose
 - b. patient immobilization devices
10. dose or time documentation
11. dose area product (DAP) meter
12. air kerma display
13. minimum source-to-skin distance (21 CFR)

B. Personnel Protection

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. protective drapes
 - b. Bucky slot cover
 - c. shields (e.g., aprons, gloves, eye, face, floating, thyroid)
 - d. attenuation properties
 - e. cumulative timer
 - f. remote-controlled fluoroscopy
4. minimum lead equivalent (NCRP #102)
5. guidelines for fluoroscopy and mobile units (NCRP #102, 21 CFR)
 - a. fluoroscopy exposure rates (e.g., normal, high-level control)
 - b. exposure switch guidelines
6. recommendations for personnel monitoring (NCRP #116)
 - a. occupational exposure
 - b. public exposure
 - c. embryo/fetus exposure
 - d. ALARA and dose equivalent limits
 - e. evaluation and maintenance of personnel dosimetry records
7. units of measurement
 - a. absorbed dose
 - b. dose equivalent
 - c. exposure
 - d. effective dose
 - e. air kerma
8. dosimeters
 - a. types
 - b. proper use



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)
 - 10. automatic exposure rate control (AERC)
 - 11. anatomic alignment
 - 12. exposure compensation
 - 13. magnification mode
 - 14. spot imaging (digital spot)
 - 15. high level control (e.g., boost, high dose rate)
 - 16. pulse rate
- B. Image Receptors
 - 1. image intensifier
 - 2. flat panel detector
- C. Image Display
 - 1. viewing conditions (e.g., luminance, ambient lighting, eye physiology, 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)
- E. Imaging Informatics
 - 1. digital imaging and communications in medicine (DICOM)
 - 2. picture archiving and communication systems (PACS)
 - 3. radiology information system (RIS) (e.g., modality worklist)
 - 4. hospital information system (HIS)
 - 5. electronic medical records (EMR) or electronic health records (EHR)

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)
 - 2. image signal (exposure related)
 - a. quantum mottle (quantum noise)
 - b. dynamic range
 - c. signal to noise ratio (SNR)
 - d. contrast to noise ratio (CNR)
 - 3. contrast resolution (equipment related)
 - a. bit depth
 - b. modulation transfer function (MTF)
 - c. 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, distortion)
- 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 overexposure



Attachment A

Task Inventory for Fluoroscopy Examination

| Activity | Content Categories |
|---|---|
| | Legend: PC = Patient Care, S = Safety, IP = Image Production |
| 1. Confirm 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 and history. | PC., PC.1.F., PC.1.G., PC.1.J. |
| 4. Assess alternative procedures based on patient dose. | PC.1.C. |
| 5. Assess risk factors that may contraindicate the procedure (e.g., health history, medications, pregnancy, psychological indicators, alternative medicines). | PC.1.A., PC.1.G., PC.1.I., S.1.B.3. |
| 6. Evaluate 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. Question female patient of child-bearing age about date of last menstrual period or possible pregnancy and take appropriate action (e.g., document response, contact physician). | PC.1.H. |
| 9. Examine imaging 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.L. |
| 10. Verify or obtain patient consent as necessary (e.g., contrast studies). | PC.1.B. |
| 11. Respond as appropriate to imaging study inquiries from patients. | PC.1.D.2. |
| 12. Explain effects and potential side effects to the patient regarding the radiation required for the examination. | PC.1.G., S.1.B.2.D. |
| 13. Select immobilization devices, when indicated, to prevent patient's movement and/or ensure patient's safety. | S.2.A.9.B. |
| 14. Remove all radiopaque materials from patient or table that could interfere with the image (e.g., clothing, jewelry, prosthesis). | PC.1.E., IP.2.B. |
| 15. Select equipment and accessories (e.g., grid, shielding) for the examination requested. | S.2.A.2., S.2.A.4., IP.1.A.6., IP.1.A.7. |
| 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. Observe patient after administration of contrast media to detect adverse reactions. | PC.1.I.2. |
| 18. Recognize and communicate the need for prompt medical attention. | PC.1.I.2. |
| 19. Take appropriate precautions to minimize occupational radiation exposure. | S.1., S.2.B., S.2.B.8., IP.2.C. |
| 20. Prevent all unnecessary persons from remaining in area during radiation exposure. | S.1., S.2.B. |



| Activity | Content Categories |
|---|---|
| | Legend: PC = Patient Care, S = Safety, IP = Image Production |
| 21. Take appropriate precautions to minimize radiation exposure to 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., S.2.A.5., IP.1.A. |
| 23. Select appropriate geometric factors (e.g., SID, OID, focal spot size, magnification). | IP.1.A.3.-A.5., IP.1.A.13. |
| 24. Position patient to demonstrate the desired anatomy using anatomical landmarks. | S.2.A.9., IP.2.B.2. |
| 25. Explain breathing instructions prior to making the exposure. | PC.1.D.1., PC.1.E., IP.2.B.2. |
| 26. Operate a fluoroscopic unit and accessories including: a. fixed unit b. mobile fluoroscopic unit (C-arm) | S.1., S.2.A., S.2.B., IP.1. |
| 27. Operate fluoroscopic equipment in compliance with Standards of Care, regulatory requirements, and medical ethics. | PC.1.K., S.2.A.4., S.2.B.4., S.2.B.5. |
| 28. Modify technical factors for circumstances, such as involuntary motion, contrast media, pathological conditions, or patient's inability to cooperate. | 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). | IP.1.A.-C. |
| 30. Modify technical factors for pediatric patients. | S.2.A., S.2.A.6., IP.1.A. |
| 31. Modify technical factors to correct for noise in a digital image. | IP.1.A., IP.2.A.2., IP.2.B.4. |
| 32. Select continuous or pulsed fluoroscopy. | IP.1.A.16. |
| 33. Restrict beam to limit exposure area, improve image quality, and reduce radiation dose. | S.2.A.3., IP.1.A.8. |
| 34. Verify accuracy of patient identification on image. | IP.2.B.2. |
| 35. Evaluate images for diagnostic quality. | IP.1.C., IP.2.B. |
| 36. Determine corrective measures if image is not of diagnostic quality and take appropriate action. | IP.1.A., IP.2.A. |
| 37. Identify image artifacts and make appropriate corrections as needed. | IP.1.B., IP.1.D., IP.2.C.1. |
| 38. Add electronic annotations/radiopaque markers on images to indicate anatomical side, position, and other relevant information. | IP.2.B.2. |
| 39. Perform post-processing on digital images in preparation for interpretation. | IP.1.D.1. |
| 40. Operate electronic imaging and record keeping 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. |
| 41. Document required information on patient's medical record (e.g., imaging procedure documentation, images, adverse reactions). | PC.1.J. |



| Activity | Content Categories |
|--|---------------------------|
| 42. Document fluoroscopy time and/or technical factors. | PC.1.J., IP.2.C.2. |
| 43. Document fluoroscopy dose when available. | PC.1.J., S.2.A.10. |
| 44. Maintain confidentiality of patient information. | PC.1.L. |
| 45. Store and handle imaging equipment in a manner which will reduce the possibility of artifact production. | C.1.B., C.1.D., IP.2.C.1. |
| 46. Visually inspect, recognize, and report malfunctions in the imaging unit and accessories. | IP.2.C. |
| 47. Recognize the need for periodic maintenance and evaluation of radiographic equipment affecting image quality and radiation safety (e.g., shielding accessories, image display monitor, exposure rate). | IP.2.C. |
| 48. Appropriately report overexposure. | IP.2.C.2. |
| 49. Wear a personnel monitoring device as required. | S.2.B.8. |
| 50. Evaluate individual occupational exposure reports to determine if values for the reporting period are within established limits. | S.2.B.6-B.8. |