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Tony Evers, Governor
Dan Hereth, Secretary

VIRTUAL/TELECONFERENCE
RADIOGRAPHY EXAMINING BOARD
Virtual, 4822 Madison Yards Way, Madison
Contact: Tom Ryan (608) 266-2112
December 3, 2025

The following agenda describes the issues that the Board plans to consider at the meeting. At the time of the meeting, items may be removed from the agenda. Please consult the meeting minutes for a description of the actions of the Board.

AGENDA

9:30 A.M.

OPEN SESSION – CALL TO ORDER – ROLL CALL

A. Adoption of Agenda (1-3)

B. Approval of Minutes of July 9, 2025 (4-6)

C. Introductions, Announcements, and Recognition
1. Introduction: Chad B. Dall, Licensed Radiographer (Succeeds: Borst)
2. Recognition: Donald A. Borst, Licensed Radiographer (Resigned: 8/01/2025)

D. Reminders: Conflicts of Interest, Scheduling Concerns

E. Administrative Matters – Discussion and Consideration
1. Department, Staff and Board Updates
2. Appointment of Liaisons and Alternates
3. Board Members – Term Expiration Dates
   a. Berumen, Blas R. – 7/1/2028
   b. Dall, Chad B. – 7/1/2029
   c. Grebe, Paul J. – 7/1/2027
   d. Julson, Rachael S. – 7/1/2028
   e. Myers, Dennis – 7/1/2027
   f. Szcykutowicz, Timothy P. – 7/1/2024

F. Administrative Rule Matters – Discussion and Consideration (7-42)
1. Rule drafting for RAD 1, 2, and 5 on License Requirements and Continuing Education **(8-40)**
2. Discussion of potential new scope statement on RAD 4 on Scope of Practice **(41-42)**
3. Pending or Possible Rulemaking Items

G. Discussion and Consideration of Items Added After Preparation of Agenda
1. Introductions, Announcements and Recognition
2. Nominations, Elections, and Appointments
3. Administrative Matters
4. Election of Officers

5. Appointment of Liaisons and Alternates
6. Delegation of Authorities
7. Education and Examination Matters
8. Credentialing Matters
9. Practice Matters
10. Legislative and Policy Matters
11. Administrative Rule Matters
12. Liaison Reports
13. Public Health Emergencies
14. Board Liaison Training and Appointment of Mentors
15. Informational Items
16. Division of Legal Services and Compliance (DLSC) Matters
17. Presentations of Petitions for Summary Suspension
18. Petitions for Designation of Hearing Examiner
19. Presentation of Stipulations, Final Decisions and Orders
20. Presentation of Proposed Final Decisions and Orders
21. Presentation of Interim Orders
22. Petitions for Re-Hearing
23. Petitions for Assessments
24. Petitions to Vacate Orders
25. Requests for Disciplinary Proceeding Presentations
26. Motions
27. Petitions
28. Appearances from Requests Received or Renewed
29. Speaking Engagements, Travel, or Public Relation Requests, and Reports

H. Public Comments

CONVENE TO CLOSED SESSION to deliberate on cases following hearing (s. 19.85(1)(a), Stats.); to consider licensure or certification of individuals (s. 19.85(1)(b), Stats.); to consider closing disciplinary investigations with administrative warnings (ss. 19.85(1)(b), and 440.205, Stats.); to consider individual histories or disciplinary data (s. 19.85(1)(f), Stats.); and to confer with legal counsel (s. 19.85(1)(g), Stats.).

I. Deliberation on Division of Legal Services and Compliance Matters

J. Deliberation of Items Added After Preparation of the Agenda
Education and Examination Matters
1. Credentialing Matters
2. DLSC Matters
3. Monitoring Matters
4. Professional Assistance Procedure (PAP) Matters
5. Petitions for Summary Suspensions
6. Petitions for Designation of Hearing Examiner
7. Proposed Stipulations, Final Decisions and Orders
8. Proposed Interim Orders
9. Administrative Warnings
10. Review of Administrative Warnings
11. Case Closings
12. Proposed Final Decisions and Orders
13. Matters Relating to Costs/Orders Fixing Costs
14. Board Liaison Training

15. Petitions for Assessments and Evaluations
16. Petitions to Vacate Orders
17. Remedial Education Cases
18. Motions
19. Petitions for Re-Hearing
20. Appearances from Requests Received or Renewed

K. Consulting with Legal Counsel

RECONVENE TO OPEN SESSION IMMEDIATELY FOLLOWING CLOSED SESSION

L. Vote on Items Considered or Deliberated Upon in Closed Session, if Voting is Appropriate

M. Open Session Items Noticed Above Not Completed in the Initial Open Session

ADJOURNMENT

NEXT MEETING: MARCH 4, 2026

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MEETINGS AND HEARINGS ARE OPEN TO THE PUBLIC, AND MAY BE CANCELLED WITHOUT NOTICE.

Times listed for meeting items are approximate and depend on the length of discussion and voting. All meetings are held virtually unless otherwise indicated. In-person meetings are typically conducted at 4822 Madison Yards Way, Madison, Wisconsin, unless an alternative location is listed on the meeting notice. In order to confirm a meeting or to request a complete copy of the board's agenda, please visit the Department website at https:\\dsps.wi.gov. The board may also consider materials or items filed after the transmission of this notice. Times listed for the commencement of any agenda item may be changed by the board for the convenience of the parties. The person credentialed by the board has the right to demand that the meeting at which final action may be taken against the credential be held in open session. Requests for interpreters for the hard of hearing, or other accommodations, are considered upon request by contacting the Affirmative Action Officer or reach the Meeting Staff by calling 608-267-7213.

VIRTUAL/TELECONFERENCE
RADIOGRAPHY EXAMINING BOARD
MEETING MINUTES
JULY 9, 2025

PRESENT: Blas Berumen, Donald Borst, Paul Grebe, Rachael Julson, Dennis Myers *(arrived at 9:32 a.m.)*, Timothy Szczykutowicz *(arrived at 9:32 a.m.)*

STAFF: Tom Ryan, Executive Director; Jameson Whitney, Legal Counsel; Jake Pelegrin, Administrative Rules Coordinator; Tracy Drinkwater, Board Administration Specialist; and other Department staff

CALL TO ORDER

Donald Borst, Chairperson, called the meeting to order at 9:30 a.m. A quorum of four (4) members was confirmed.

(Dennis Myers arrived at 9:32 a.m.)
(Timothy Szczykutowicz arrived at 9:32 a.m.)

ADOPTION OF AGENDA

Amendments to the Agenda:

- ADD under C.1., Introduction: Dennis Myers, Public Member (Replaces: Frenn)
- ADD under Item E.2., Myers, Dennis – 7/1/2027

MOTION: Paul Grebe moved, seconded by Timothy Szczykutowicz, to adopt the Agenda as amended. Motion carried unanimously.

APPROVAL OF MINUTES OF MARCH 5, 2025

MOTION: Dennis Myers moved, seconded by Rachael Julson, to approve the Minutes of March 5, 2025, as published. Motion carried unanimously.

ADMINISTRATIVE MATTERS

Liaisons Appointments and Alternates

LIAISON APPOINTMENTS	
Credentialing Liaison(s)	Blas Berumen *Alternate:* Timothy Szczykutowicz
Education and Examinations Liaison(s)	Rachael Julson *Alternate:* Timothy Szczykutowicz
Monitoring Liaison(s)	Paul Grebe *Alternate:* Blas Berumen

Professional Assistance Procedure (PAP) Liaison(s)	Paul Grebe *Alternate:* Rachael Julson
Legislative Liaison(s)	Blas Berumen *Alternate:* Paul Grebe
Travel Authorization Liaison(s)	Timothy Szczykutowicz *Alternate:* Rachael Julson
Practice Question Liaison(s)	Rachael Julson *Alternate:* Timothy Szczykutowicz
Website Liaison(s)	Paul Grebe
Screening Panel	Paul Grebe, Blas Berumen *Alternate:* Rachael Julson

PUBLIC HEARING: CLEARINGHOUSE RULE CR 25-036 RAD 1, 2, AND 4, RELATING TO DEFINITIONS AND SCOPE OF PRACTICE

MOTION: Rachael Julson moved, seconded by Dennis Myers, to accept all Clearinghouse comments for rule CR 25-036 relating to Definitions and Scope of Practice. Motion carried unanimously.

MOTION: Timothy Szcykutowicz moved, seconded by Paul Grebe, to authorize the Chair, or in the absence of the Chair, the highest ranked or longest serving member in that succession, to approve the Final Rule Draft and Report to the Legislature for rule CR 25-036 relating to Definitions and Scope of Practice. Motion carried unanimously.

CLOSED SESSION

MOTION: Paul Grebe moved, seconded by Dennis Myers, to convene to Closed Session to deliberate on cases following hearing (s. 19.85(1)(a), Stats.); to consider licensure or certification of individuals (s. 19.85(1)(b), Stats.); to consider closing disciplinary investigations with administrative warnings (s. 19.85(1)(b), and 440.205, Stats.); to consider individual histories or disciplinary data (s. 19.85(1)(f), Stats.); and to confer with legal counsel (s. 19.85(1)(g), Stats.). Donald Borst, Chairperson, read the language of the motion aloud for the record. The vote of each member was ascertained by voice vote. Roll Call Vote: Blas Berumen-yes; Donald Borst-yes; Paul Grebe-yes; Rachael Julson-yes; Dennis Myers-yes; and Timothy Szczykutowicz -yes. Motion carried unanimously.

The Board convened into Closed Session at 11:25 a.m.

DELIBERATION ON DIVISION OF LEGAL SERVICES AND COMPLIANCE MATTERS

Proposed Stipulation and Final Decision and Orders

24 RAD 0007 – Allyson R. Roehl

MOTION: Dennis Myers moved, seconded by Donald Borst, to adopt the Findings of Fact, Conclusions of Law and Order in the matter of disciplinary proceedings against Allyson R. Roehl, DLSC Case Number 24 RAD 0007. Motion carried.

Administrative Warnings

24 RAD 0011 – A.A.F.

MOTION: Rachael Julson moved, seconded by Donald Borst, to issue an Administrative Warning in the matter of A.A.F., DLSC Case Number 24 RAD 0011. Motion carried unanimously.

RECONVENE TO OPEN SESSION

MOTION: Dennis Myers moved, seconded by Rachael Julson, to reconvene in Open Session. Motion carried unanimously.

The Board reconvened in Open Session at 11:35 a.m.

VOTE ON ITEMS CONSIDERED OR DELIBERATED UPON IN CLOSED SESSION

MOTION: Rachael Julson moved, seconded by Dennis Myers, to affirm all motions made and votes taken in Closed Session. Motion carried unanimously.

(Be advised that any recusals or abstentions reflected in the closed session motions stand for the purposes of the affirmation vote.)

ADJOURNMENT

MOTION: Rachael Julson moved, seconded by Timothy Szczykutowicz, to adjourn the meeting. Motion carried unanimously.

The meeting adjourned at 11:37 a.m.

State of Wisconsin
Department of Safety & Professional Services

AGENDA REQUEST FORM

1) Name and title of person submitting the request:	2) Date when request submitted:
Jake Pelegrin **Administrative Rules Coordinator**	**11/20/25** **Items will be considered late if submitted after 12:00 p.m. on the deadline date which is 8 business days before the meeting**

3) Name of Board, Committee, Council, Sections:

Radiography Examining Board

4) Meeting Date:	5) Attachments:	6) How should the item be titled on the agenda page?
12/3/25	☒ Yes ☐ No	**Administrative Rule Matters – Discussion and Consideration** 1. Rule drafting for RAD 1, 2, and 5 on License Requirements and Continuing Education 2. Discussion of potential new scope statement on RAD 4 on Scope of Practice 3. Pending or possible rulemaking items

7) Place Item in:	8) Is an appearance before the Board being scheduled? *(If yes, please complete Appearance Request for Non-DSPS Staff)*	9) Name of Case Advisor(s), if required:
☒ Open Session ☐ Closed Session	☐ Yes ☒ No	**N/A**

10) **Describe the issue and action that should be addressed:** Attachments:

-Rule drafting materials for RAD 1, 2, and 5
-Potential new scope statement on RAD 4

11) Authorization

Jake Pelegrin 11/20/25

Signature of person making this request **Date**

Supervisor (if required) **Date**

Executive Director signature (indicates approval to add post agenda deadline item to agenda) **Date**

Directions for including supporting documents:
1. This form should be attached to any documents submitted to the agenda.
2. Post Agenda Deadline items must be authorized by a Supervisor and the Policy Development Executive Director.
3. If necessary, provide original documents needing Board Chairperson signature to the Bureau Assistant prior to the start of a meeting.

Radiography

The purpose of the exam 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. The tasks typically performed were determined by administering a comprehensive practice analysis survey to a nationwide sample of radiographers.[1] An advisory committee then determined the knowledge and cognitive skills needed to perform the tasks on the task inventory and these are organized into the content categories within this document. Every content category can be linked to one or more tasks on the task inventory. The document is used to develop the examination. The *Task Inventory for Radiography* may be found on the ARRT's website (www.arrt.org).

The ARRT avoids content when there are multiple resources with conflicting perspectives. Educational programs accredited by a mechanism acceptable to ARRT offer education and experience beyond the minimum requirements specified in the content specifications and clinical competency requirements documents.

This document is not intended to serve as a curriculum guide. Although ARRT programs for certification and registration and educational programs may have related purposes, their functions are clearly different. Educational programs are generally broader in scope and address the subject matter that is included in these content specifications, but do not limit themselves to only this content.

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 the 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.

Content Category	**Number of Scored Questions[2]**
Patient Care	**33**
Patient Interactions and Management (33)	
Safety	**50**
Radiation Physics and Radiobiology[3] (21)	
Radiation Protection (29)	
Image Production	**51**
Image Acquisition and Evaluation (26)	
Equipment Operation and Quality Assurance (25)	
Procedures	**66**
Head, Spine and Pelvis Procedures (18)	
Thorax and Abdomen Procedures (20)	
Extremity Procedures (28)	
Total	**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 30 unscored (pilot) questions.
[3] SI units are the primary (principle) units of radiation measurement used on the radiography examination.

Page 9 and 10 of the NMTCB core certification exam, but it doesn't seem quite as comprehensive as listed here. I'm not sure

Patient Care

RS specialty exam outline - middle of page 2, and some specifics under CT section and X-ray/fluoroscopy section

1. Patient Interactions and Management

A. Ethical and Legal Aspects
   1. patients' rights
      a. consent (*e.g., informed, oral, implied)
      b. confidentiality (HIPAA)
      c. American Hospital Association (AHA) Patient Care Partnership (Patients' Bill of Rights)
         1. privacy
         2. extent of care (e.g., DNR)
         3. access to information
         4. living will, health care proxy, advanced directives
         5. research participation
   2. legal issues
      a. verification (e.g., patient identification, compare order to clinical indication)
      b. common terminology (e.g., battery, negligence, malpractice, beneficence)
      c. legal doctrines (e.g., respondeat superior, res ipsa loquitur)
      d. restraints versus positioning aids used to eliminate motion artifact
      e. manipulation of electronic data (e.g., exposure indicator, processing algorithm, brightness and contrast, cropping or masking off anatomy)
      f. documentation (e.g., changes to order, medical event)
   3. ARRT Standards of Ethics

B. Interpersonal Communication
   1. modes of communication
      a. verbal/written
      b. nonverbal (e.g., eye contact, touching)
   2. challenges in communication
      a. interactions with others
         1. language barriers
         2. cultural and social factors
         3. physical, sensory, or cognitive impairments
         4. age
         5. emotional status, acceptance of condition (e.g., stage of grief)
      b. explanation of medical terms
      c. strategies to improve understanding
   3. patient education
      a. explanation of current procedure (e.g., purpose, length of time, radiation dose)
      b. pre- and post-examination instructions (e.g., preparation, diet, medications and discharge instructions)
      c. respond to inquiries about other imaging modalities (e.g., dose differences, types of radiation, patient preps)

C. Ergonomics and Monitoring
   1. body mechanics (e.g., balance, alignment, movement)
      a. patient transfer techniques
      b. safe patient handling devices (e.g., transfer board, Hoyer lift, gait belt)
   2. assisting patients with medical equipment
      a. infusion catheters and pumps
      b. oxygen delivery systems
      c. other (e.g., nasogastric tubes, urinary catheters, tracheostomy tubes)
   3. patient monitoring and documentation
      a. vital signs
      b. physical signs and symptoms (e.g., motor control, severity of injury)
      c. fall prevention

D. Medical Emergencies
   1. non-contrast allergic reactions (e.g., latex)
   2. cardiac/respiratory arrest (e.g., CPR, AED)
   3. physical injury or trauma
   4. other medical disorders (e.g., seizures, diabetic reactions)

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

(Patient Care continues on the following page.)

Patient Care (continued)

E. Infection Control **PAGE 10 of the core certification, but again, their infection control is not nearly as comprehensive as listed here**
   1. chain of infection (cycle of infection)
      a. pathogen
      b. reservoir
      c. portal of exit
      d. mode of transmission
         1. direct
            a. droplet
            b. direct contact
         2. indirect
            a. airborne
            b. vehicle borne (fomite)
            c. vector borne (mechanical or biological)
      e. portal of entry
      f. susceptible host
   2. asepsis
      a. equipment disinfection
      b. equipment sterilization
      c. medical aseptic technique
      d. sterile technique
   3. CDC Standard Precautions
      a. hand hygiene
      b. use of personal protective equipment (e.g., gloves, gowns, masks)
      c. safe handling of contaminated equipment/surfaces
      d. disposal of contaminated materials
         1. linens
         2. needles
         3. patient supplies
         4. blood and body fluids
      e. safe injection practices
   4. transmission-based precautions
      a. contact
      b. droplet
      c. airborne
   5. additional precautions
      a. neutropenic precautions (reverse isolation)
      b. healthcare-associated (nosocomial) infections

F. Handling and Disposal of Toxic or Hazardous Material **PAGE 10**
   1. types of materials
      a. chemicals
      b. chemotherapy
   2. safety data sheet (material safety data sheet)

G. Pharmacology **PAGE 5 AND TOP OF PAGE 11 for NMTCB core certification**
   1. patient history
      a. medication reconciliation (current medications)
      b. premedications
      c. contraindications
      d. scheduling and sequencing examinations
   2. administration
      a. routes (e.g., IV, oral)
      b. supplies (e.g., enema kits, needles)
      c. procedural technique (e.g., venipuncture)
      d. contrast media dose calculation
   3. contrast media types and properties (e.g., iodinated, water soluble, barium, ionic versus non-ionic)
   4. appropriateness of contrast media to examination
      a. patient condition (e.g., perforated bowel)
      b. patient age and weight
      c. laboratory values (e.g., BUN, creatinine, eGFR)
   5. complications/reactions
      a. local effects (e.g., extravasation/infiltration, phlebitis)
      b. systemic effects
         1. mild
         2. moderate
         3. severe
      c. emergency medications
      d. radiographer's response and documentation

Page 1 and 2 of the NMTCB core certification exam

Safety

Page 1, 2, and top of 3 of RS specialty exam

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 interactions
      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 #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_{50})
      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
      h. acute radiation syndromes
         1. hemopoietic
         2. gastrointestinal (GI)
         3. central nervous system (CNS)

(Safety continues on the following page.)

Bottom of page 1, page 2 and 3

Safety (continued)

Page 1, 2, and top of 3 of RS specialty exam

2. Radiation Protection

A. Minimizing Patient Exposure
   1. exposure factors
      a. kVp
      b. mAs
      c. automatic exposure control (AEC)
   2. beam restriction
      a. purpose of primary beam restriction
      b. types (e.g., 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 #102, minimum filtration in useful beam)
   5. radiographic dose documentation
   6. image receptors
   7. grids
   8. fluoroscopy
      a. pulsed
      b. exposure factors
      c. grids
      d. positioning
      e. fluoroscopy time
      f. automatic brightness control (ABC) or automatic exposure rate control (AERC)
      g. receptor positioning
      h. magnification mode
      i. air kerma display
      j. last image hold
      k. dose or time documentation
      l. minimum source-to-skin distance (21 CFR)
   9. 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 #102)
   4. special considerations
      a. mobile units
      b. fluoroscopy
         1. protective drapes
         2. protective Bucky slot cover
         3. cumulative timer
         4. remote-controlled fluoroscopy
      c. guidelines for fluoroscopy and mobile units (NCRP #102, 21 CFR)
         1. fluoroscopy exposure rates (normal and high-level control)
         2. exposure switch guidelines
   5. radiation exposure and monitoring
      a. dosimeters
         1. types
         2. proper use
      b. NCRP recommendations for personnel monitoring (NCRP #116)
         1. occupational exposure
         2. public exposure
         3. embryo/fetus exposure
         4. dose equivalent limits
         5. evaluation and maintenance of personnel dosimetry records
   6. handling and disposal of radioactive material

* (August 24, 2016) Note: Although it is the radiographer'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.

Page 6, 7, 8, 9 of the NMTCB® core certification, but it doesn't go into nearly as much detail as ARRT for image production

Image Production

Same comment as it applies to the RS specialty exam - some parts are scattered in the CT and x-ray/fluoroscopy section, but not nearly as much detail as here

1. Image Acquisition and Evaluation

A. Factors Affecting Radiographic Quality
(X indicates topics covered on the examination.)

	1. Receptor Exposure	2. Spatial Resolution	3. Distortion
a. mAs	X		
b. kVp	X		
c. OID		X	X
d. SID	X	X	X
e. focal spot size		X	
f. grids*	X		
g. tube filtration	X		
h. beam restriction	X		
i. motion		X	
j. anode heel effect	X		
k. patient factors (size, pathology)	X	X	X
l. angle (tube, part, or receptor)		X	X

* Includes conversion factors for grids

B. Technique Charts
   1. anatomically programmed technique
   2. fixed versus variable kVp
   3. special considerations
      a. casts
      b. pathologic factors
      c. age (e.g., pediatric, geriatric)
      d. body mass index (BMI)
      e. contrast media
      f. grids
      g. OID

C. Automatic Exposure Control (AEC)
   1. effects of changing exposure factors on radiographic quality
   2. detector selection
   3. anatomic alignment
   4. exposure adjustment (e.g., density, +1 or –1)

D. Digital Imaging Characteristics
   1. spatial resolution
      a. pixel characteristics (e.g., size, pitch)
      b. detector element (DEL) (e.g., size, pitch, fill factor) CCD, CMOS (e.g., size, pitch)
      c. sampling frequency (CR)
      d. matrix size
      e. modulation transfer function (MTF)
   2. contrast resolution
      a. bit depth
      b. detective quantum efficiency (DQE)
      c. grids
   3. image signal
      a. dynamic range
      b. quantum noise (quantum mottle)
      c. signal to noise ratio (SNR)

E. Image Identification
   1. methods (e.g., radiographic, electronic)
   2. legal considerations (e.g., patient data, examination data)

F. Criteria for Image Evaluation
   1. exposure indicator
   2. quantum noise (quantum mottle)
   3. gross exposure error (e.g., loss of contrast, saturation)
   4. contrast
   5. spatial resolution
   6. distortion (e.g., size, shape)
   7. identification markers (e.g., anatomical side, patient, date)
   8. image artifacts
   9. radiation fog (CR)

Image Production (continued)

2. Equipment Operation and Quality Assurance

A. Imaging Equipment
1. x-ray generator, transformers and rectification system
   a. basic principles
   b. phase, pulse and frequency
   c. tube loading
2. components of radiographic unit (fixed or mobile)
   a. operating console
   b. x-ray tube construction
      1. electron source
      2. target materials
      3. induction motor
      4. filtration
   c. automatic exposure control (AEC)
      1. radiation detectors
      2. back-up timer
      3. exposure adjustment (e.g., density, +1 or -1)
      4. minimum response time
   d. manual exposure controls
   e. image receptors
      1. computed radiography (CR)
         a. plate (e.g., photo-stimulable phosphor (PSP))
         b. plate reader
      2. digital radiography (DR)
         a. direct conversion
         b. indirect conversion
            1. amorphous silicon (a-Si)
            2. charge coupled device (CCD)
            3. complementary metal oxide semiconductor (CMOS)
   f. beam restriction
3. components of fluoroscopic unit (fixed or mobile)
   a. image receptors
      1. image intensifier
      2. flat panel
   b. viewing systems
   c. recording systems
   d. automatic brightness control (ABC) or automatic exposure rate control (AERC)
   e. magnification mode
   f. table
4. accessories
   a. stationary grids
   b. Bucky assembly
   c. compensating filters

B. Image Processing and Display
1. raw data (pre-processing)
   a. analog-to-digital converter (ADC)
   b. quantization
   c. corrections (e.g., rescaling, flat fielding, dead pixel correction)
   d. histogram
2. corrected data for processing
   a. grayscale
   b. edge enhancement
   c. equalization
   d. smoothing
3. data for display
   a. values of interest (VOI)
   b. look-up table (LUT)
4. post-processing
   a. brightness
   b. contrast
   c. region of interest (ROI)
   d. electronic cropping or masking
   e. stitching
5. display monitors
   a. viewing conditions (e.g., viewing angle, ambient lighting)
   b. spatial resolution (e.g., pixel size, pixel pitch)
   c. brightness and contrast
6. imaging informatics
   a. information systems, (e.g., HIS, RIS, EMR, EHR)
   b. networking
      1. PACS
      2. DICOM
   c. downtime procedures

Image Production (continued)

C. Quality Control of Imaging Equipment and Accessories
   1. beam restriction
      a. light field to radiation field alignment
      b. central ray alignment
   2. recognition and reporting of malfunctions
   3. digital imaging receptor systems
      a. maintenance (e.g., detector calibration, plate reader calibration)
      b. QC tests (e.g., erasure thoroughness, plate uniformity, spatial resolution)
      c. display monitor quality assurance (e.g., grayscale standard display function, luminance)
   4. shielding accessories (e.g., testing lead apron, gloves)

Second half of page 7, all of 8 and 9 for core certification

And, RS specialty exam outline®, bottom of page 5 and middle of 7

Procedures

This section addresses imaging procedures for the anatomic regions listed below. Questions will cover the following topics:

1. Positioning (e.g., topographic landmarks, body positions, path of central ray, positioning aids, respiration).
2. Anatomy (e.g., including physiology, basic pathology, related medical terminology).
3. Procedure adaptation (e.g., body habitus, body mass index, trauma, pathology, age, limited mobility).
4. Evaluation of displayed anatomical structures (e.g., patient positioning, tube-part-image receptor alignment).

The specific radiographic positions and projections within each anatomic region that may be covered on the examination are listed in *Attachment A*. A guide to positioning terminology appears in *Attachment B*.

---

1. Head, Spine and Pelvis Procedures

A. Head
1. skull
2. facial bones
3. mandible
4. temporomandibular joints
5. nasal bones
6. orbits
7. paranasal sinuses

B. Spine and Pelvis
1. cervical spine
2. thoracic spine
3. scoliosis series
4. lumbar spine
5. sacrum and coccyx
6. myelography
7. sacroiliac joints
8. pelvis and hip

2. Thorax and Abdomen Procedures

A. Thorax
1. chest
2. ribs
3. sternum
4. soft tissue neck
5. sternoclavicular joints

B. Abdomen and GI Studies
1. abdomen
2. esophagus
3. swallowing dysfunction study
4. upper GI series, single or double contrast
5. small bowel series
6. contrast enema, single or double contrast
7. surgical cholangiography
8. ERCP

C. GU Studies
1. cystography
2. cystourethrography
3. intravenous urography
4. retrograde urography
5. hysterosalpingography

3. Extremity Procedures

A. Upper Extremities
1. fingers
2. hand
3. wrist
4. forearm
5. elbow
6. humerus
7. shoulder
8. scapula
9. clavicle
10. acromioclavicular joints

B. Lower Extremities
1. toes
2. foot
3. calcaneus
4. ankle
5. tibia/fibula
6. knee/patella
7. femur
8. long bone measurement

C. Other
1. bone age
2. bone survey (e.g., metastatic, non-accidental trauma)
3. arthrography

I couldn't find anything in the NMTCB core that goes into this much detail for radiographic positions and projections. Maybe some of it is mixed in with "V. Clinical Procedures and Therapies", which starts on page 7 of the NMTCB core outline, but I'm not sure. You'll have to look at these and see if they are covered anywhere in NMTCB

"Patient positioning" is also specifically mentioned on page 10, but again, it is not nearly as much detail as here

Attachment A

Same comment on RS specialty certification

Radiographic Positions and Projections

1. **Head, Spine and Pelvis**
   - **A. Head**
     1. Skull
        a. AP axial (Towne)
        b. lateral
        c. PA axial (Caldwell)
        d. PA
        e. submentovertex (full basal)
        f. trauma cross-table (horizontal beam) lateral
        g. trauma AP axial (reverse Caldwell)
        h. trauma AP
        i. trauma AP axial (Towne)
     2. Facial Bones
        a. lateral
        b. parietoacanthial (Waters)
        c. PA axial (Caldwell)
        d. modified parietoacanthial (modified Waters)
     3. Mandible
        a. axiolateral oblique
        b. PA
        c. AP axial (Towne)
        d. PA axial
        e. PA (modified Waters)
        f. submentovertex (full basal)
     4. Temporomandibular Joints
        a. axiolateral oblique (modified Law)
        b. axiolateral (modified Schuller)
        c. AP axial (modified Towne)
     5. Nasal Bones
        a. parietoacanthial (Waters)
        b. lateral
        c. PA axial (Caldwell)
     6. Orbits
        a. parietoacanthial (Waters)
        b. lateral
        c. PA axial (Caldwell)
        d. modified parietoacanthial (modified Waters)
     7. Paranasal Sinuses
        a. lateral, horizontal beam
        b. PA axial (Caldwell), horizontal beam
        c. parietoacanthial (Waters), horizontal beam
        d. submentovertex (full basal), horizontal beam
   - **B. Spine and Pelvis**
     1. Cervical Spine
        a. AP axial
        b. AP open mouth
        c. lateral
        d. cross-table (horizontal beam) lateral
        e. PA axial obliques
        f. AP axial obliques
        g. lateral swimmers
        h. lateral flexion and extension
        i. AP dens (Fuchs)
     2. Thoracic Spine
        a. AP
        b. lateral, breathing
        c. lateral, expiration
     3. Scoliosis Series
        a. AP or PA
        b. lateral
     4. Lumbar Spine
        a. AP
        b. PA
        c. lateral
        d. L5-S1 lateral spot
        e. posterior oblique
        f. anterior oblique
        g. AP axial L5-S1
        h. AP right and left bending
        i. lateral flexion and extension
     5. Sacrum and Coccyx
        a. AP axial sacrum
        b. AP axial coccyx
        c. lateral sacrum and coccyx, combined
        d. lateral sacrum or coccyx, separate
     6. Myelography
     7. Sacroiliac Joints
        a. AP axial
        b. posterior oblique
        c. anterior oblique
     8. Pelvis and Hip
        a. AP hip only
        b. cross-table (horizontal beam) lateral hip
        c. unilateral frog-leg, non-trauma
        d. axiolateral inferosuperior, trauma (Clements-Nakayama)
        e. AP pelvis
        f. AP pelvis, bilateral frog-leg
        g. AP pelvis, axial anterior pelvic bones (inlet, outlet)
        h. posterior oblique pelvis, acetabulum (Judet)
2. **Thorax and Abdomen**
   - **A. Thorax**
     1. Chest
        a. PA or AP upright
        b. lateral upright
        c. AP lordotic
        d. AP supine
        e. lateral decubitus
     2. Ribs
        a. AP and PA, above and below diaphragm
        b. anterior and posterior obliques
     3. Sternum
        a. lateral
        b. RAO
     4. Soft Tissue Neck
        a. AP upper airway
        b. lateral upper airway
     5. Sternoclavicular joints
        a. PA
        b. LAO and RAO
   - **B. Abdomen and GI Studies**
     1. Abdomen
        a. AP supine
        b. AP upright
        c. lateral decubitus
        d. dorsal decubitus
     2. Esophagus
        a. RAO
        b. left lateral
        c. AP
        d. PA
        e. LAO
     3. Swallowing Dysfunction Study
     4. Upper GI series*
        a. AP or PA scout
        b. RAO
        c. PA
        d. right lateral
        e. LPO
        f. AP
     5. Small Bowel Series
        a. PA scout
        b. PA (follow through)
        c. ileocecal spots
     6. Contrast Enema*
        a. left lateral rectum
        b. left lateral decubitus
        c. right lateral decubitus
        d. LPO and RPO
        e. PA
        f. RAO and LAO
        g. AP axial (sigmoid)
        h. PA axial (sigmoid)
        i. PA or AP post-evacuation
     7. Surgical Cholangiography
     8. ERCP

*single or double contrast

C. GU Studies
1. Cystography
   a. AP
   b. LPO and RPO
   c. lateral
   d. AP axial
2. Cystourethrography
   a. AP voiding cystourethrogram female
   b. RPO voiding cystourethrogram male
3. Intravenous Urography
   a. AP, scout, and series
   b. RPO and LPO
   c. post-void
4. Retrograde Urography
   a. AP scout
   b. AP pyelogram
   c. AP ureterogram
5. Hysterosalpingography

3. Extremities

A. Upper Extremities

I. Fingers
   a. PA entire hand
   b. PA finger only
   c. lateral
   d. medial and/or lateral oblique
   e. AP thumb
   f. medial oblique thumb
   g. lateral thumb
2. Hand
   a. PA
   b. lateral
   c. lateral oblique
3. Wrist
   a. PA
   b. lateral oblique
   c. lateral
   d. PA–ulnar deviation
   e. PA axial (Stecher)
   f. tangential carpal canal (Gaynor-Hart)
4. Forearm
   a. AP
   b. lateral
5. Elbow
   a. AP
   b. lateral
   c. lateral oblique
   d. medial oblique
   e. AP partial flexion
   f. trauma axial laterals (Coyle)
6. Humerus
   a. AP
   b. lateral
   c. neutral
   d. transthoracic lateral
7. Shoulder
   a. AP internal and external rotation
   b. inferosuperior axial (Lawrence)
   c. posterior oblique (Grashey)
   d. AP neutral
   e. PA oblique (scapular Y)
   f. supraspinatus outlet (Neer)
8. Scapula
   a. AP
   b. lateral
9. Clavicle
   a. AP or PA
   b. AP axial
   c. PA axial
10. Acromioclavicular Joints – AP bilateral with and without weights

B. Lower Extremities

1. Toes
   a. AP, entire forefoot
   b. AP or AP axial toe
   c. oblique toe
   d. lateral toe
   e. sesamoids, tangential
2. Foot
   a. AP axial
   b. medial oblique
   c. lateral oblique
   d. lateral
   e. AP axial weight bearing
   f. lateral weight bearing
3. Calcaneus
   a. lateral
   b. plantodorsal, axial
   c. dorsoplantar, axial
4. Ankle
   a. AP
   b. mortise
   c. lateral
   d. medial oblique
   e. AP stress
   f. AP weight bearing
   g. lateral weight bearing
5. Tibia/Fibula
   a. AP
   b. lateral
6. Knee/patella
   a. AP
   b. lateral
   c. AP weight bearing
   d. lateral oblique
   e. medial oblique
   f. PA axial–intercondylar fossa (Holmblad)
   g. PA axial–intercondylar fossa (Camp Coventry)
   h. AP axial–intercondylar fossa (Béclère)
   i. PA patella
   j. tangential (Merchant)
   k. tangential (Settegast)
7. Femur
   a. AP
   b. lateral
8. Long Bone Measurement

C. Other
1. Bone Age
2. Bone Survey
3. Arthrography

Same comment as above; the NMTCB doesn't go into nearly this much detail with positioning and projection

Same comment on RS specialty certification

Attachment B

Standard Terminology for Positioning and Projection

Radiographic View: Describes the body part as seen by the image receptor. Restricted to the discussion of a *radiograph* or *image*.

Radiographic Position: Refers to a specific body position, such as supine, prone, recumbent, erect or Trendelenburg. Restricted to the discussion of the *patient's physical position*.

Radiographic Projection: Restricted to the discussion of the *path of the central ray*.

POSITIONING TERMINOLOGY

A. Lying Down

1. *supine* – lying on the back
2. *prone* – lying face downward
3. *decubitus* – lying down with a horizontal x-ray beam
4. *recumbent* – lying down in any position

B. Erect or Upright

1. *anterior position* – facing the image receptor
2. *posterior position* – facing the radiographic tube

C. Either Upright or Recumbent

1. oblique torso positions

   a. anterior oblique (facing the image receptor)

      i. *left anterior oblique (LAO)* — body rotated with the left anterior portion closest to the image receptor

      ii. *right anterior oblique (RAO)* — body rotated with the right anterior portion closest to the image receptor

   b. posterior oblique (facing the radiographic tube)

      i. *left posterior oblique (LPO)* — body rotated with the left posterior portion closest to the image receptor

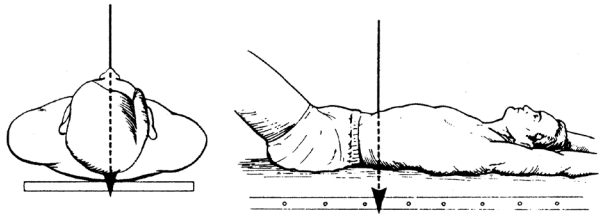
      ii. *right posterior oblique (RPO)* — body rotated with the right posterior portion closest to the image receptor

2. oblique extremity positions

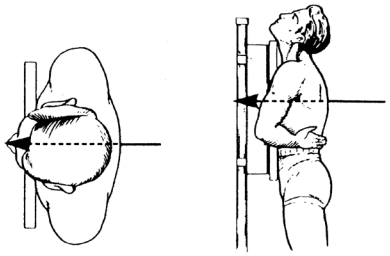
   a. lateral (external) rotation — from either prone or supine, outward rotation of the extremity

   b. medial (internal) rotation — from either prone or supine, inward rotation of the extremity

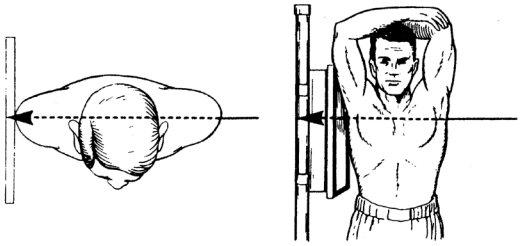
Anteroposterior Projection



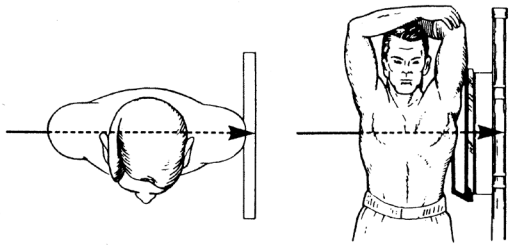
Posteroanterior Projection



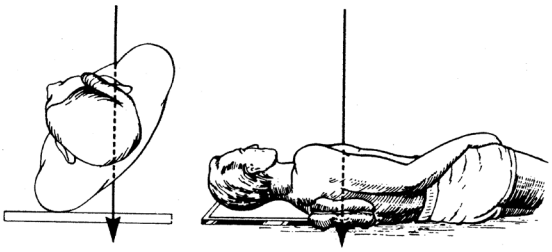
Right Lateral Position



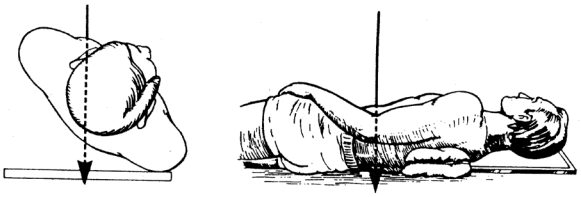
Left Lateral Position



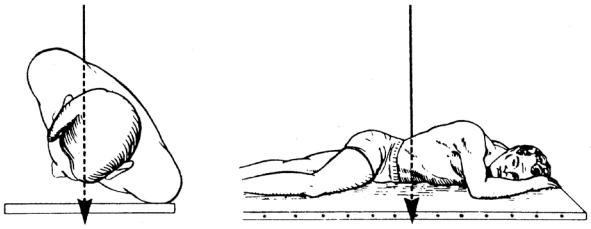
Left Posterior Oblique Position



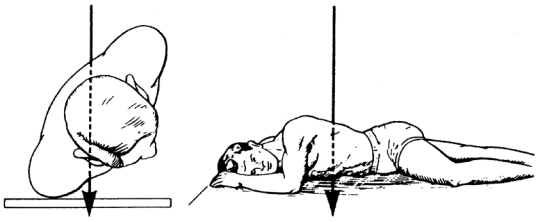
Right Posterior Oblique Position



Left Anterior Oblique Position



Right Anterior Oblique Position



Nuclear Medicine Technology Certification Board

CNMT Certification Examination Content Outline

Components of Preparedness

Domain I: Radiation Physics & Detection – 7%
Domain II: Radiation Safety & Regulations – 13%
Domain III: Pharmaceutical & Radiopharmaceutical Agents – 25%
Domain IV: Instrument Operations & Quality Control – 15%
Domain V: Clinical Procedures – 40%

I. Radiation Physics and Detection 7%

A. Understand the fundamentals of radiation physics and detection

1. Physical properties
   a. Radioactive materials
      i. Isotopes and their properties (e.g., half-life, energy)
      ii. Modes of decay (e.g., gamma emitters, beta emitters, alpha emitters, positron emitters)
   b. X-ray production
      i. Bremsstrahlung
      ii. Characteristic x-ray
2. Decay calculations and Counting statistics
3. Interactions of radiation with matter
   a. Compton scatter
   b. Photoelectric effect
4. Radiation detector types and basic principles
   a. NaI well
   b. Ion chamber
   c. Solid state detector
   d. GM meter

II. Radiation Safety and Regulations 13%

A. Identify biological effects of radiation exposure

1. Deterministic (e.g., due to amount, radiation burns)
2. Stochastic (e.g., cancer)
3. Exposure
   a. Patient (e.g., imaging, treatment, diagnostic)
   b. Technologist (e.g., imaging, treatment, diagnostic)
4. Short-term vs Long-term effects of radiation
5. Radiosensitivity (e.g., effects on the cell)

B. Recognize protection techniques and calculations

1. ALARA
   a. Time
   b. Distance (inverse square law)
   c. Shielding (shielding equations)

C. Perform survey protocols and requirements (e.g., timing and frequency)

1. Radiation surveys (area monitoring) including:
   a. Survey meters and well counters
   b. Choice of radiation detection devices (e.g., Geiger Counters, sodium iodide detectors)
   c. Frequency of surveys
   d. Trigger limits of surveys
2. Personal monitoring devices
   a. Types (e.g., ring badge vs collar badge)
   b. Dosimeter report
   c. Declaration of pregnancy
3. Personal protective equipment (e.g., lab coat, gloves, syringe shields)
4. Effective dose equivalent limits for:
   a. Radiation workers
   b. Declared pregnant radiation workers
   c. General public

D. Comply with Nuclear Regulatory Commission (NRC) Regulations

1. Posted warnings and informational signs delineating restricted and unrestricted areas
2. Surveying and inventorying radioactive materials
3. Adverse event response
   a. Trigger levels and monitoring methods
   b. Radiation exposure
   c. Radiation spills (e.g., major vs minor)
   d. Protection during adverse events
   e. Personnel, patient and/or public decontamination
   f. Area/equipment decontamination
   g. Recordable and reportable events
4. Adherence to radioactive waste storage requirements
5. Radioactive material disposal (e.g., liquids, solids, gasses, contaminated materials)
6. Record maintenance
   a. Receipt, storage, and disposal of radioactive materials
   b. Radiation monitoring and reporting
   c. Equipment calibration and maintenance
   d. Staff, patient, occupational and public exposure
   e. Nuclear medicine diagnostic and therapeutic procedures
   f. Leak test
7. Written directives
8. Shipping and Packaging Regulations
   a. Department of Transportation (DOT)
   b. Types of shielding containers

c. Label requirements (e.g., transportation index, name, concentration, expiration date/time, total activity, assay date/time, limits)
d. Types of packages (e.g., exempt, non-exempt)
e. Package monitoring/receiving/returning

E. Comply with Other Regulations and Guidelines

1. Environmental Protection Agency (EPA)
2. Occupational Safety and Health Administration (OSHA)
3. Health and Human Services (HHS)/Health Insurance Portability and Accountability Act (HIPAA)
   a. Protecting patient rights and privacy
   b. Maintaining patient records
   c. Releasing information to authorized parties
4. Food and Drug Administration (FDA)
5. United States Pharmacopeia (USP)
   a. USP<797>
   b. USP<825>
6. Institutional and Departmental Accreditation Organizations (e.g., SOP documents)

III. Pharmaceutical and Radiopharmaceutical Agents 25%

A. Elute radionuclide generator, perform, and evaluate quality control tests

1. Types of generators (e.g., 99Mo/99mTc, 82Sr/82Rb)
   a. Transient and secular
   b. Eluate
   c. Generator yield – volume and activity
   d. Quality control procedures
      i. Radionuclidic breakthrough (e.g., 99Mo breakthrough)
      ii. Chemical (e.g., Al+3 breakthrough)
2. Dose calibrator operation /units of radioactivity

B. Prepare radiopharmaceutical kits, perform quality control, and evaluate results

1. Radiopharmaceutical kits
   a. Preparation techniques
   b. Activity and volume limitations
   c. Activity calculations
   d. Particle size and number (e.g., MAA kit)
2. Radiopharmaceutical quality control
   a. Visual inspection - color and clarity
   b. Radiochemical purity (e.g., ITLC)
3. Labeling kits
4. Storage of kits before and after reconstitution
   a. Expiration
   b. Temperature requirements

C. Understand the characteristics (i.e., mechanism of localization), indications, contraindications, and administration of diagnostic radiopharmaceuticals

1. Tc-99m labeled radiopharmaceuticals
   a. Tc-99m sodium pertechnetate

b. Tc-99m oxidronate/HDP
c. Tc-99m medronate/MDP
d. Tc-99m pentetate/DTPA
e. Tc-99m macroaggregated albumin/MAA
f. Tc-99m sulfur colloid (e.g., filtered, unfiltered)
g. Tc-99m mebrofenin (Choletec®)
h. Tc-99m mertiatide/MAG3®
i. Tc-99m pyrophosphate/PYP
j. Tc-99m sestamibi/MIBI (Cardiolite®)
k. Tc-99m tetrofosmin (Myoview®)
l. Tc-99m succimer/DMSA (Nephroscan®)
m. Tc-99m exametazime/HMPAO (Ceretec®)
n. Tc-99m bicisate/ECD (Neurolite®)
o. Tc-99m labeled RBCs (UltraTag®/PYP)
p. Tc-99m HMPAO tagged WBCs
q. Tc-99m tilmanocept (Lymphoseek®)

2. Iodine labeled radiopharmaceuticals
   a. I-123 sodium iodide
   b. I-131 sodium iodide
   c. I-123 Iobenguane (MIBG) (AdreView®)
   d. I-123 Ioflupane (DaTscan®)
3. Indium labeled radiopharmaceuticals
   a. In-111 chloride
   b. In-111 oxine labeled WBCs
   c. In-111 pentetate (DTPA)
   d. In-111 pentetreotide (Octreoscan®)
4. Miscellaneous diagnostic radiopharmaceuticals
   a. Ga-67 gallium citrate
   b. Tl-201 thallous chloride
   c. Xe-133 gas
5. Positron Emission Tomography
   a. Cu-64 Dotatate (Detectnet®)
   b. F-18 FDG
   c. F-18 Florbetaben (Neuraceq®)
   d. F-18 Florbetapir (Amyvid®)
   e. F-18 Flutemetamol (Vizamyl®)
   f. F-18 Sodium Fluoride (NaF)
   g. F-18 Fluciclovine (Axumin®)
   h. F-18 Flortaucipir (Tauvid®)
   i. F-18 Piflufolastat (Pylarify®)
   j. F-18 Fluorodopa
   k. F-18 Fluoroestradiol (Cerianna®)
   l. Ga-68 Dotatate (Netspot®)
   m. Ga-68 Dotatoc
   n. Ga-68 Gozetotide (Illuccix®, Locametz®)

o. N-13 ammonia
p. Rb-82 chloride (Rubyfill®, Cardiogen®)

D. Understand the characteristics (i.e., mechanism of localization), indications, contraindications, and administration of therapeutic radiopharmaceuticals

1. I-131 sodium iodide
2. Lu-177 dotatate (Lutathera®)
3. Lu-177 Vipivotide tetraxetan (Pluvicto®)
4. Ra-223 Radium dichloride (Xofigo®)
5. Sr-89 chloride (Metastron®)
6. Y-90 microspheres (SIR-Spheres®, TheraSphere®)

E. Understand the indications, contraindications, and administration of interventional and adjunct pharmaceutical agents used in conjunction with nuclear medicine procedures

1. Dipyridamole (Persantine®)
2. Adenosine
3. Dobutamine
4. Aminophylline
5. Regadenoson (Lexiscan®)
6. Captopril
7. Enalaprilat
8. Furosemide (Lasix®)
9. Insulin
10. Acetazolamide (Diamox®)
11. Cholecystokinin/ sincalide/CCK
12. Morphine
13. Cimetidine/famotidine
14. ACD solution
15. Heparin
16. Contrast media (oral and IV)
17. Lugol's solution/SSKI
18. Thyroid Stimulating Hormone (TSH)
19. Lidocaine
20. Lidocaine (EMLA®) cream
21. Atropine
22. Recombinant human TSH (Thyrogen®)
23. Amino acids (e.g., lys-arg)
24. Zofran/Emend
25. Beta blockers (e.g., Metoprolol)
26. Boost®/Ensure®

F. Radiolabel blood components with radiopharmaceutical according to protocol

1. Labeling procedures
   a. Required lab equipment and supplies
   b. Anticoagulants and other additives
   c. Chemical reactions
   d. Cell washing
   e. Required radiopharmaceuticals

f. Method (e.g., in vivo, in vitro)

2. Calculation of labeling efficiency and administered dosage
3. Reinjection patient and sample verification

G. Administer radiopharmaceuticals and non-radioactive agents

1. Administration routes (e.g., IV, oral, intrathecal)
2. Administration techniques (e.g., bolus, infusion, aseptic)

IV. Instrument Operations and Quality Control 15%

A. Operate Non-imaging equipment and components

1. Quality control and calibration for well counters and probes
   a. Quality control and calibration for the sodium iodide scintillation detector
   b. Gamma ray spectra and pulse height analysis
   c. Formulas (e.g., energy resolution, sensitivity, Chi-square statistics)
2. Operational status of survey meter
   a. Survey meter operations and components
   b. Survey meter quality control and calibration
3. Dose calibrator constancy, accuracy, linearity, and geometry tests

B. Operate Imaging equipment and components

1. Gamma Camera quality control
   a. Uniformity
   b. Spatial resolution and linearity
   c. Visual image quality
   d. Phantoms
   e. Artifacts
   f. System sensitivity
   g. Pulse height analysis
2. SPECT and SPECT/CT imaging system
   a. Attenuation correction
   b. SPECT camera quality control
      i. Center of rotation
      ii. Field uniformity requirements
      iii. Pixel calibration
      iv. 3-D uniformity and resolution (e.g., Jaszczak phantom)
      v. Artifacts
3. PET and PET/CT imaging systems
   a. Application of attenuation corrections
   b. PET quality control (e.g., daily blank scan, normalization scan, 2-D/3- D well counter, artifacts)
4. CT imaging systems
   a. Co-registration of images
   b. CT quality control (e.g., contrast and spatial resolution, noise, uniformity, artifacts)
   c. Safety alerts (e.g., pre-scan notification)
5. Computer equipment (e.g., monitors, matrix sizes, printers)
6. Networking and information systems (e.g., PACS and RIS)

C. Operate Auxiliary equipment

1. Laboratory equipment (e.g., pipette, fume hoods)
2. Patient care equipment
   a. Intravenous infusion pump
   b. ECG monitor
   c. Pulse oximeter
   d. Defibrillator
   e. Glucose meter
   f. Blood pressure equipment
   g. Oxygen delivery equipment
   h. Patient lifts
   i. Lateral transfer equipment
3. Non-imaging equipment
   a. Xenon delivery system and trap
   b. Aerosol delivery system
   c. Treadmill
   d. Liquid scintillation counter
   e. Rb delivery system (e.g. Rubyfill®, Cardiogen®)

V. Clinical Procedures and Therapies 40%

A. Perform nuclear medicine procedures

1. Pulmonary
   a. Radioaerosol ventilation
   b. Gas ventilation
   c. Perfusion
      i. SPECT
      ii. SPECT/CT
   d. Perfusion/Ventilation quantitation
2. Bone/Musculoskeletal scans
   a. Limited
   b. Whole-body
   c. 3-phase
   d. 4-phase
   e. SPECT
   f. SPECT/CT
   g. NaF PET
3. Oncology
   a. Ga-67 tumor imaging, planar and/or SPECT
   b. SPECT/CT
   c. Peptide imaging
   d. Molecular breast imaging
   e. Lymphoscintigraphy/sentinel lymph node localization
   f. Tumor imaging, PET
      i. Melanoma (e.g., whole body)
      ii. PSMA

iii. Neuroendocrine
iv. Neurology
v. General (e.g., skull-base to mid-thigh)

g. Neuroendocrine tumor imaging

4. Infection
   a. Ga-67 infection imaging
   b. Tagged WBC imaging
5. Renal/Genitourinary
   a. Cystogram, direct
   b. Effective renal plasma flow (ERPF)
   c. Glomerular filtration rate (GFR) imaging
   d. Glomerular filtration rate (GFR) non-imaging
   e. Renal anatomy, planar, SPECT (e.g., DMSA)
   f. Renal flow
   g. Renogram (Lasix®)
   h. Renogram with ACE inhibitors
6. Endocrine
   a. Adrenal imaging
   b. Parathyroid imaging, planar and SPECT
   c. SPECT/CT
   d. Thyroid imaging
   e. Thyroid uptake
   f. Whole body survey for thyroid metastases
7. Hematopoietic
   a. Bone marrow imaging
8. Cardiovascular
   a. Myocardial perfusion, planar
   b. Myocardial perfusion (gated and non-gated)
      i. SPECT (e.g., supine, prone)
      ii. SPECT/CT
      iii. CT attenuation
      iv. PET
   c. Cardiac sarcoidosis
      i. PET
   d. First pass for EF and wall motion
   e. Gated cardiac blood pool, rest
   f. Gated cardiac blood pool, stress
   g. Gated cardiac blood pool, SPECT
   h. Cardiac shunt
   i. Cardiac Amyloidosis
   j. MIBG
   k. Myocardial viability
      i. Thallium
      ii. FDG
9. Gastrointestinal

a. Gastric emptying (liquid/solid)
b. Gastroesophageal reflux
c. Gastrointestinal bleeding
d. Hemangioma
e. Hepatobiliary with and without GBEF
f. Liver-lung shunt mapping (arterial)
g. Liver-spleen imaging, planar and SPECT
h. SPECT/CT
i. Meckel's diverticulum

10. Central Nervous System
a. Brain flow, brain death
b. Brain imaging, planar and SPECT
i. Brain perfusion SPECT (Acetazolamide)
ii. Viability SPECT
iii. Tumor SPECT
c. SPECT/CT
d. Dopamine transporter DaTscan®
e. Cisternogram
f. CSF leak
g. CSF shunt patency
h. Amyloid
i. Ictal and interictal (e.g., SPECT/planar, PET)

11. Radionuclide Therapy
a. I-131 sodium iodide for ablation
b. I-131 sodium iodide for hyperthyroid
c. Lu-177 Dotatate (Lutathera®)
d. Lu-177 PSMA (Pluvicto®)
e. Ra-223 Dichloride (Xofigo®)
f. Sr-89 Chloride (Metastron®)
g. Y-90 labeled microspheres

12. CT Imaging Procedures
a. Attenuation correction
b. Anatomical localization
c. Diagnostic vs non-diagnostic

B. Schedule patient studies

1. Camera duration
2. Multiple radionuclide procedures for a single patient
3. Same-day multiple modality procedures for a single patient

C. Procure supply of radiopharmaceuticals

1. License parameters and limits (i.e., Institutional)
2. Reconciliation of schedule with radiopharmaceutical/adjunct pharmaceutical procurement

D. Educate patient, family, and personnel

1. Procedures
2. Precautions

3. Restrictions
4. Release criteria (e.g., inpatient, travel, therapy)
5. Consent (e.g., written and verbal)

E. Obtain patient information and provide patient care

1. Patient information and privacy (e.g., Healthcare Insurance Portability and Accountability Act (HIPAA))
2. Basic patient care (e.g., vital signs, basic first aid, infection control)
3. Patient transferring techniques
4. Patient support devices (e.g., Foley catheter and drainage bag)
5. Patient identification (e.g., armband, verbal, scan)
6. Orders for study
7. Pre-examination screening
   a. Patient preparations and contraindications
   b. Medical history
   c. Current medications
   d. Allergic and adverse reaction history
   e. Review relevant lab values
8. Informed consent
9. Disposal of supplies and biohazardous material
10. Emergency procedures (e.g., fainting, seizure, cardiopulmonary arrest)
11. Post-procedure assessment

F. Select and administer prescribed radiopharmaceuticals

1. Patient/ radiopharmaceutical reconciliation
2. Calculation of appropriate volume to deliver prescribed dosage when needed
3. Radiopharmaceutical administration using appropriate route and technique

G. Prepare equipment and perform examinations

1. Patient positioning (e.g., anatomical markers, immobilization techniques)
2. Imaging parameters for data acquisition

H. Evaluate image quality

1. Normal and abnormal scan patterns
2. Artifacts and causes
3. Co-registration of images (SPECT/CT and PET/CT)
4. Study repetition and additional views

I. Perform image processing

1. Data storage, transfer, and retrieval
2. Image formation (e.g., static, dynamic, gating, list mode)
3. Image reconstruction (e.g., SPECT, PET/CT)
4. Image enhancement (e.g., filters, matrix, intensity)
5. Quantitative analysis
   a. Regions of interest and quantification
   b. Curve generation and analysis
   c. Image normalization and subtraction
6. Display formatting (image size, number of images, intensity adjustments)

J. Prepare/perform stress testing

1. Basic electrocardiography (ECG) (e.g., cardiac monitoring)

a. Cardiac conduction system
b. Components of a normal ECG wave form
c. Recognizing and responding to changes on a resting or stress ECG

2. ECG lead placements
3. Treadmill stress techniques (e.g., Bruce and modified Bruce) and bicycle stress techniques
   a. Contraindications
   b. Duration/termination parameters
4. Pharmacological stress protocols
   a. Contraindications
   b. Timing of pharmacological stress agent
   c. Timing of radiopharmaceutical injection
   d. Duration/termination parameters
   e. Drug side-effects and appropriate treatment
   f. Reversal agents and techniques

K. Obtain samples and/or data for non-imaging studies

1. Data specimen collection techniques, including timing, methods, containers, and storage
2. Background correction
3. External counting techniques

L. Evaluate the results of non-imaging studies

1. Error analysis
2. Calculations

M. Administer radiopharmaceutical therapies

1. Isolation room requirements
2. Surveys
3. Inpatient vs outpatient
4. Storage and waste disposal
5. Documentation and record keeping
6. Post-therapy scanning
7. Dosimetry

NMTCB RADIATION SAFETY
CERTIFICATION EXAMINATION
CONTENT OUTLINE

I. Content Pertaining to a RAM License: **(Expertise Area)**

A. Radiation physics and instrumentation

1. Basic radiation physics

   - atomic structure
   - definitions – radiation, radioactivity, half life
   - modes of radioactive decay
   - units and quantities of radioactivity
   - decay calculations
   - interactions of radiation with matter

2. Radiation detection and measurement
   - detector types and uses (survey meters, dose calibrator, well counters, probes, gamma camera, PET Scanner)
   - Detector / Instrument Selection
     - Detection efficiency
     - Energy Response
   - statistics of counting
   - detector use, calibration, quality control requirements and regulations

3. Production of Radionuclides
   - reactors (basic principles and radionuclides)
   - accelerators (basic principles and radionuclides)
   - generators (column breakthrough limits, shielding, proper disposal)
     - ^{99}Mo/^{99m}Tc generator (LEU & HEU)
     - ^{82}Sr/^{82}Rb generator
     - ^{68}Ge/^{68}Ga generator
     - Others

4. Production of x-rays

B. Radiation dosimetry

1. Units of radiation exposure and dose – US and SI (definitions and conversions)
2. Personal monitoring devices
3. Bioassays

4. Area monitoring – room surveys
5. Effluent Monitoring
   - Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage
6. Sealed source monitoring
7. Basic concept of MIRD

C. Radiation protection and ALARA
1. Time, distance and shielding
2. Regulations – personnel and the general public
3. Dose and exposure Limits
   - Radiation workers
   - Pregnant radiation workers
   - The public
4. Personnel monitoring and records
   - Periodic review and annual reports
   - Employer responsibilities
   - Action limits and notifications level
   - Lead apron inspection and inventory
   - Dosimeter badge types (assigned badge position, electronic dosimeters, EDE1, EDE2, Webster, etc)
   - SDE, DDE, LDE, TEDE, Extremities
5. Restricted and unrestricted areas (definitions and sign posting)
6. Work place rules – best practices
7. ALARA philosophy
8. Patient radiation safety & instructions
   - Factors affecting patient dose
   - Pregnancy and breast feeding
   - Patient release rule and underlying theory

D. Mathematics pertaining to the use and measurement of radioactivity
1. Decay equation & tables
2. Counter efficiency / cpm to dpm
3. Exposure calculations based on time, distance and shielding
   - Time
   - Distance – inverse square law
   - HVL definition, concept and calculation
4. Effective Half Life
5. Dose calibrator tests
   - Accuracy Test (percentage error calculations)

- Geometry
- Constancy
- Linearity
- Measurement of betas

Energy resolution calculation and window setting

E. Radiation biology

F. Security and control of radioactive materials

1. Room security and access
2. Signs & Sign Posting
3. Proper storage and shielding
4. Inventory and record keeping
5. Security of a “spill area”

G. Shipping & receiving of radioactive materials *(air and ground)*

1. Related radiation surveys and records
2. Regulations
3. Package labeling
4. Internal Transport of Radiation within the facility

H. Disposal of byproduct material (and all required records)

1. General trash
2. Sewer
3. Biohazard trash
4. Decay in storage
5. Return to the manufacturer
6. Shipment for offsite disposal

I. Administrative controls to avoid a medical event

J. Emergency procedures

1. Major and minor spill – definitions and procedures
2. Lost or stolen radioactive source
3. Medical event – definitions and procedures
4. Radio-iodine therapy patient (or other therapy patient) requiring emergency care
5. Death of therapy patient (soon after therapy)
6. Community radiation emergency response.

K. Regulations & resources

1. License requirements, applications and amendments
   - Facility design shielding requirements
   - Broad scope / limited scope
2. Agreement and non-agreement states
3. Authorized user, training / experience requirements
4. NRC Regulations:

-NRC Title **10CFR19** Notices, Instructions and Reports to Workers)
-NRC Title **10CFR20** (Standards for Protection Against Radiation)
-NRC Title **10CFR35** (Medical Use of Byproduct Material)
-NRC Title **10CFR71** (Transportation of Radioactive Materials)

5. Department of Transportation Regulations

-Title 49CFR170 (Hazardous Materials)
-Training requirements for medical licenses
-White I, Yellow II, Yellow III, UN2910, UN2908, TI
-Exempt quantities and limited quantities

6. Other agencies

-Environmental Protection Agency (EPA)
-FDA CDRH

L. Radionuclide therapy best practices

1. Radio-iodine therapy
    - Handling of doses
    - Patients receiving less than 33 mCi
        - Inpatients – instructions for patients and nursing staff
        - Outpatients – instructions for patients and family members
    - Patients receiving more than 33 mCi
        - Regulatory requirements for hospitalization and release from the hospital
        - Room preparation and cleanup for hospitalized patients
        - Inpatients – instructions for patients and nursing staff
        - Outpatients – instructions for patients and family members
    - Storage and disposal of radio-iodine waste
2. Emergency care of radio-iodine therapy patients
3. Other radionuclide therapy (with P-32, Sr-89, Sm153, Ra-223, Lu-177)
4. Brachytherapy

M. Reference Documents: NUREG 1556 – Volume 9 and 10 CFR Part 37

II. Content Pertaining to CT: **(Expertise Area)**

A. CT Basics and Physics

1. Production of x-rays
2. X-ray detection
3. Shielding of poly-energetic beams
4. Scan Mode
    - Helical
    - Axial
5. MDCT/Single slice/CBCT

6. AEC Tube current modulation
7. CT scatter iso-dose map application
8. Reconstruction methods- filter back projection, iterative

B. CT Dose Metrics
   1. CTDI
   2. DLP
   3. Effective Dose
   4. SSDE Size Specific Dose Estimate

C. CTDI Diagnostic Reference Levels
   1. ACR values
      - Adult
      - Pediatric
   2. NCRP Report 172
   3. CRCPD NEXT Data
   4. CTDI Phantom size

D. Dose optimization
   - Protocol review
   - With or without contrast use

E. Radiation Dose Management
   1. Equipment Factors
      - kVp
      - mA
        - Fixed mAs
        - Tube current modulated mAs
      - Rotation time
      - Slice thickness
      - Pitch
      - Beam collimation
      - Resolution settings
      - Scan lengths
      - Bolus tracking
      - Delayed scans
      - Repeat scans

   2. Patient Factors
      - Body Habitus
      - Centering
      - Motion
      - General patient positioning
      - Increased attenuation

   3. Other Factors
      - Patient Shielding

- Holding patients
- Facility Shielding
- PPE for staff
- CT Fluoro

F. Deterministic vs. Stochastic Effects

G. High Radiation Dose CT Settings
   - CT Brain Perfusion, CT Fluoro, Bolus tracking

III. Content Pertaining to X-ray & Fluoroscopy (Competence but not expertise)

A. X-ray and Fluoroscopy Physics
   1. Production of X-rays
   2. Detection of X-rays
   3. Fluoroscopy Units
      - Fixed
      - C-Arm, Cone beam CT with fluoro, Mini
      - Bi-Plane

B. Fluoroscopy Dose Metric
   1. Fluoroscopy time
   2. Air kerma at the reference point (Ka,r)
   3. Dose Area Product (P_{KA})
   4. Peak skin dose (Dskin,max)

C. Patient risk factors for hypersensitivity to radiation exposure

D. High dose fluoroscopically guided intervention
   - Interventional Radiology
   - Cardiac Catheterization Lab
   - Operating Room

E. Radiation Dose Management
   1. ALARA
      - Time
      - Distance
      - Shielding
        - Types
          - Patient
          - Staff
        - Equipment
        - Thickness
        - Storage
        - Inspections
      - ALARA action levels

- Room Shielding
- Reporting requirements

2. Equipment Factors
    - kVp
    - mA
    - Time
    - Field size
    - Quality control frequency
    - Equipment Geometry
        - X-ray tube position
        - Image receptor
        - Table height
    - Grids
    - Magnification
    - Collimation
    - Filtration
        - inherent vs. added
    - last Image Hold
    - Pulse fluoroscopy
    - Cine Mode
        - fluoroscopy frames rates
    - Low verses normal detail mode
    - Beam angle
3. Patient Factors
    - Body habitus
    - Scatter
    - Entrance versus exit exposure ratios
    - Dose notifications levels
        - Fluoroscopy time
        - Air kerma at the reference point (Ka,r)
        - DAP (P_{KA})
4. Staff Factors
    - Position, training, apparel, PPE

F. Deterministic Exposure Levels
    - Substantial radiation dose level (SRDL) and time to onset
        - Erythema
            - Early transient
            - Main erythema
            - Late erythema
        - Epilation
        - Dermal Atrophy
        - Dermal Necrosis
        - Secondary Ulceration
    - Patient follow up after a Substantial radiation dose level (SRDL)

IV. Content Pertaining to MRI Safety: (Competence, but not expertise)

A. Magnetic field units of measure
- Gauss
- Tesla

B. Magnet types in MRI
- Superconducting, Permanent, Resistive
- Magnetic Susceptibility (Diamagnetic, Paramagnetic, Superparamagnetic, Ferromagnetic)

C. Magnetic Fields
- Static magnetic fields
- Static magnetic field issues: Site Access Restriction Zoning
- Gradient magnetic fields
- Slew Rate
- Spatial Gradient
- Active vs. Passive Shielding
- Fringe Field (Importance of 5 Gauss line)

D. MRI Safety
- Ferromagnetic objects/detectors
- Codes in a MRI environment
- Emergency responders (fire, police)
- Define Zones I, II, III, & IV.
- Personnel training levels
- Screening (Patient, Staff, Equipment)
- Appropriate MRI labeling (MR safe vs. MR conditional vs. MR unsafe)
- MRI Quenching
- Hazards associated with liquid Helium
  -Thermal Hazards
  -Fire Hazards
  -Asphyxiation Hazards
- Hazards associated with strong radio frequency fields
  -(SAR)
  -Burns caused by Loops
  -Operating modes for MR systems
- Sequences looping
- Padding
- Coils
- Acoustic noise
- Explosive decompression

E. Contrast Agent Safety

V. Optimizing Radiation Exposure / Other Topics

A. Appropriateness Criteria
B. Image Wisely
C. Image Gently
D. Protocols
E. Considerations for pregnant and/or pediatric patient
   - Alternative exams
   - Benefit vs. risk
F. Regulations around Brachytherapy
   HDR, LDR, permanent
G. Microspheres
H. Mammography
I. DEXA / Bone density
J. Research with Radioactive Materials
K. Radioactive Seed Localization
L. Linac – linear accelerator
M. Blood irradiator

Related Guidelines & References:

- AAHP/HPS Qualifications for Health Care Facility Radiation Safety Officer (Jan 2003)
- National Council on Radiation Protection and Measurements (NCRP) - Publications
- ACR – Disaster Preparedness for Radiology Professionals
- NRC: 10 CFR Part 35, "Medical Use Licenses"
- AAPM Report No. 124 - A Guide for Establishing a Credentialing and Privileging Program for Users of Fluoroscopic Equipment in Healthcare Organizations (2012)
- AAPM Report No. 160 - Radiation Safety Officer Qualifications for Medical Facilities: Report of Task Group 160;
- AAPM Report No. 204- Size-Specific Dose Estimates (SSDE) in Pediatric and Adult Body CT Examinations
- ACR-SPR Practice Parameter For Imaging Pregnant or Potentially Pregnant Adolescent and Women with Ionizing Radiation
- ACR Guidance Document on MR Safety Practices: 2013. Journal of Magnetic Resonance Imaging 37:501–530 (2013) Authors: E. Kanal, AJ Barkovich, C Bell et al.
- Image Gently® - The Alliance for Radiation Safety in Pediatric Imaging
- Image Wisely® - Radiation Safety in Adult Medical Imaging

STATEMENT OF SCOPE

Radiography Examining Board

Rule No.: Chapter RAD 4

Relating to: Scope of Practice

Rule Type: Permanent

1. Finding/nature of emergency (Emergency Rule only):

N/A

2. Detailed description of the objective of the proposed rule:

The objective of the proposed rule is to review the scope of practice for radiographers and limited x-ray machine operators, and to consider clarifying when a radiographer license is required in various medical roles and in the use of various medical technologies.

3. Description of the existing policies relevant to the rule, new policies proposed to be included in the rule, and an analysis of policy alternatives:

Current rules concerning scope of practice for radiographers and limited x-ray machine operators are in Wis. Admin. Code ch. RAD 4. A previous rule updated the radiography code to clarify regulations on the use of various medical imaging technologies that are commonly used in the field. The previous rule clarified the scope of practice for radiographers and limited x-ray machine operators in the use of various medical technologies, and clarified when a radiographer license or limited x-ray machine operator permit is required. The board would like to continue discussing the same topics and consider making further rule updates on the same topics in ch. RAD 4.

If the rules are not updated, these requirements could be unclear to patients, regulators, and those in the profession.

4. Detailed explanation of statutory authority for the rule (including the statutory citation and language):

Section 15.08 (5) (b), Stats., states that “[each examining board] [s]hall promulgate rules for its own guidance and for the guidance of the trade or profession to which it pertains and define and enforce professional conduct and unethical practices not inconsistent with the law relating to the particular trade or profession.

Section 227.11 (2) (a), Stats., states that an agency, “may promulgate rules interpreting the provisions of any statute enforced or administered by the agency, if the agency considers it necessary to effectuate the purpose of the statute, but a rule is not valid if the rule exceeds the bounds of correct interpretation.”

Section 462.06 (2), Stats.: “The board may promulgate rules that establish a code of ethics for persons who hold a license or limited X-ray machine operator permit under s. 462.03.”

5. Estimate of amount of time that state employees will spend developing the rule and of other resources necessary to develop the rule:

70 hours

6. List with description of all entities that may be affected by the proposed rule:

Radiographer licensees and limited x-ray machine operator permit holders.

7. Summary and preliminary comparison with any existing or proposed federal regulation that is intended to address the activities to be regulated by the proposed rule:

None.

8. Anticipated economic impact of implementing the rule (note if the rule is likely to have a significant economic impact on small businesses):

The proposed rule will have minimal to no economic impact on small businesses and the state's economy as a whole.

Contact Person: Jake Pelegrin, Administrative Rules Coordinator, DSPSAdminRules@wisconsin.gov, (608) 267-0989

Approved for publication:

Authorized Signature

Date Submitted

Approved for implementation:

Authorized Signature

Date Submitted