Preparing for Parts 2 & 3 of the ABR Nuclear Medical Physics Exam

Robert MacDougall, M.Sc., DABR
Boston Children's Hospital
Harvard Medical School

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Background

- DX and NM Physicist at Boston Children's Hospital
- CAMPEP Residency Henry Ford Health System (Completed 2010)
- Passed ABR Diagnostic Med Phys (2011)
- Passed ABR Nuclear Med Phys (2015)

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Outline

- Requirements for Initial and Additional certification
- Focus of Part 2 and Part 3
- Part 2 – Study Material, Time Management
- Part 3 (Oral) – Preparation, Exam Day

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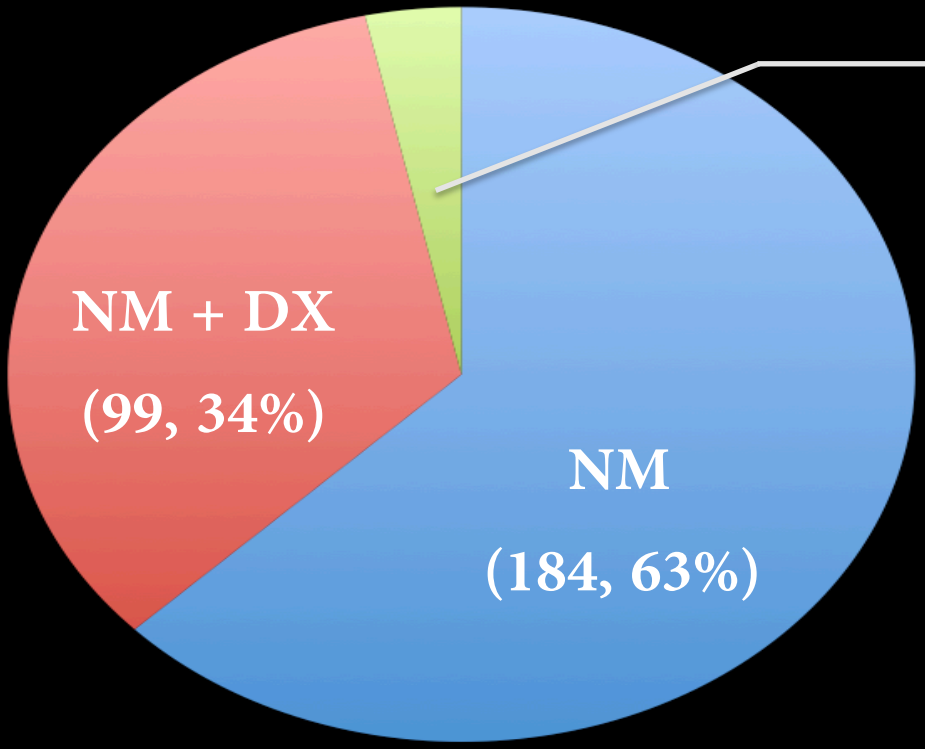
ABR – Certified NM Physicists



Total = 294

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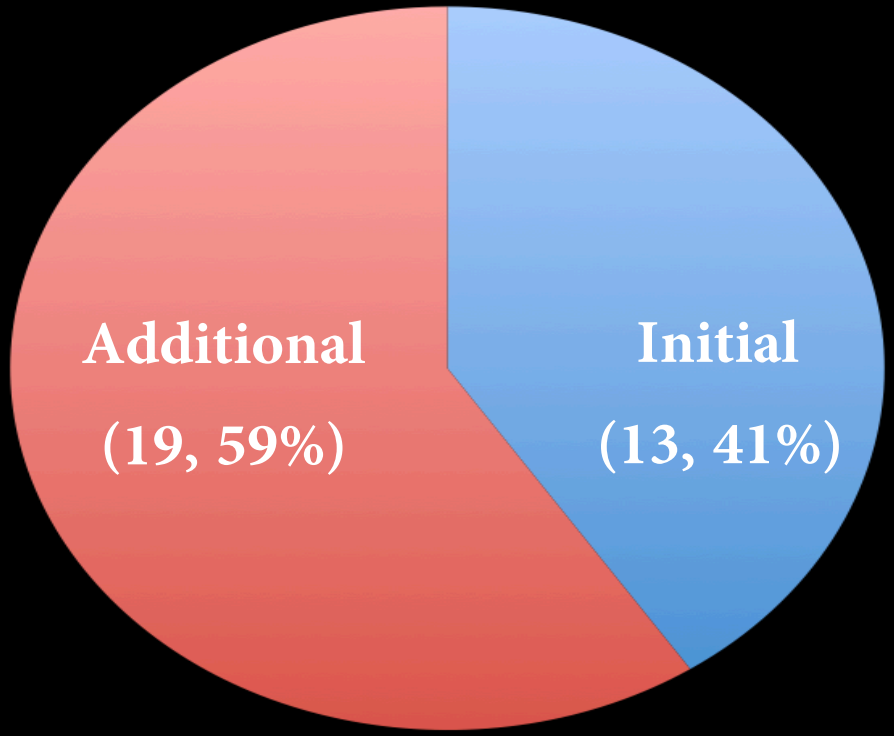
NM Certification Since May 2010

Total = 32



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Process for initial certification

1. Completed CAMPEP-accredited residency and passed Part 1
2. Obtained clinical experience in nuclear medicine during residency
3. Program director attestation of appropriate didactic and clinical training

Process for additional certification

1. Any ABR diplomate certified in one medical physics specialty pay pursue certification in additional specialties

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2. Cannot pursue *two additional* certicates simultaneously

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4. At least *one year equivalent* (0.8 FTE) of clinical experience in additional specialty *after previous certification*

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2. Cannot pursue *two additional* certicates simultaneously
3. Must be meeting MOC
4. At least *one year equivalent* (0.8 FTE) of clinical experience in additional specialty *after previous certification*
5. Experience attested by individual certified by ABR or AMBP in specialty

Beginning 2019

1. Clinical experience must be prospective.

Beginning 2019

1. Clinical experience must be prospective.
2. Clinical experience and supervision plans must be developed prior to initiation of clinical experience

Beginning 2019

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2. Clinical experience and supervision plans must be developed prior to initiation of clinical experience
3. Supervisor must be ABR-certified in specialty

Beginning 2019

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…Details to come in 2016

Beginning 2019

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…Details to come in 2016 ~~2017~~

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“If you don’t know where you are going, you’ll end up someplace else”

-Yogi Berra

ABR NEWS

Jerry D. Allison, Geoffrey S. Ibbott and J. Anthony Seibert
ABR Physics Trustees

The Purpose and Scope of the ABR Oral Exam

The Oral Exam in Medical Physics is designed to test the clinical skills of the candidate and assess the candidate's readiness to practice medical physics independently. The exam includes a broad range of topics that provide the candidate an opportunity to:

- demonstrate that he or she understands how common medical physics equipment performance evaluations are conducted,
- analyze the results of medical physics evaluations and make appropriate recommendations,
- explain how the performance of clinical equipment may affect patient care,
- analyze uncommon situations and explain how he or she would approach them, and
- communicate the results of medical physics evaluations.

The focus of the oral exam is on clinical competence, which is a factor distinguishing it from the Part 1 and Part 2 exams that focus on the fundamental concepts of medical physics and include detailed calculations.

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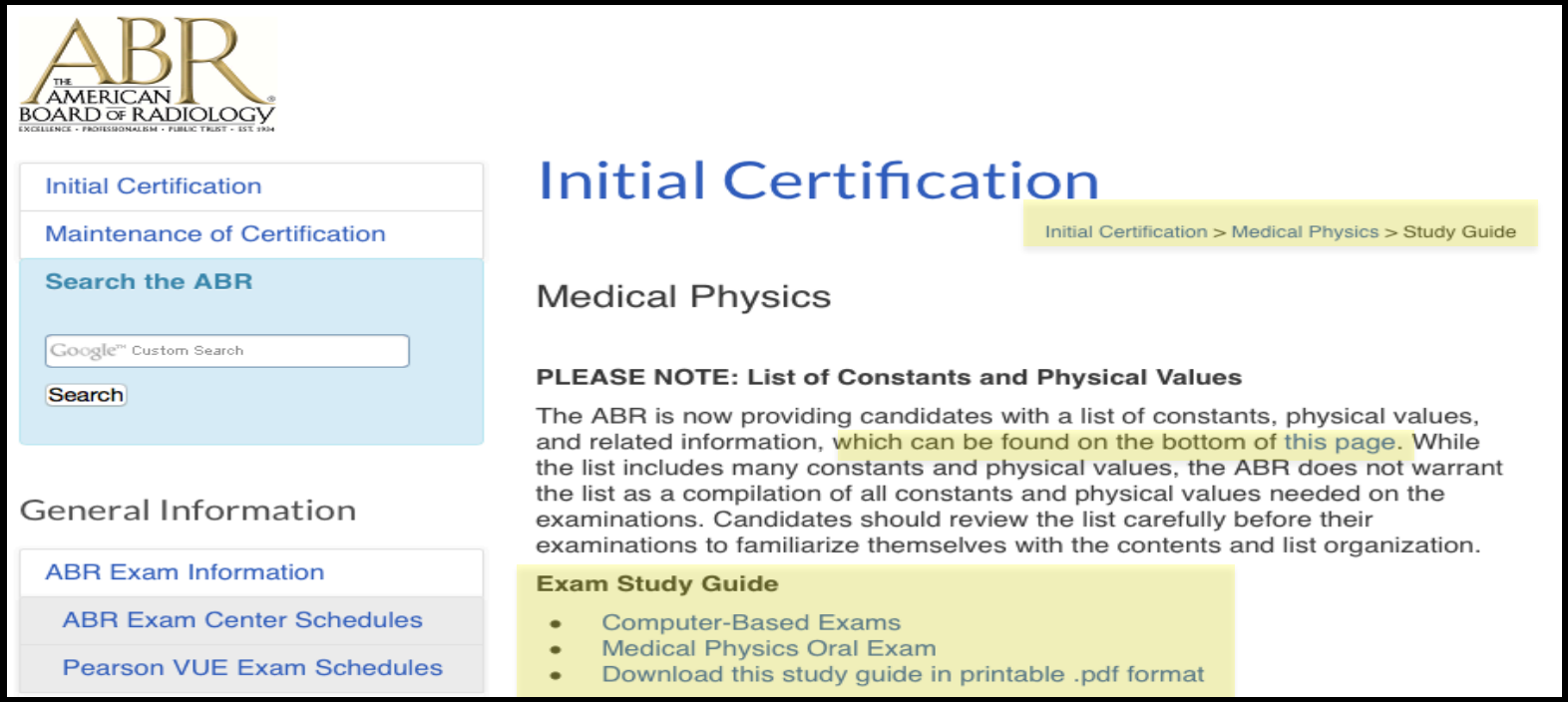
Part 2 - Required Reading



Sample Question

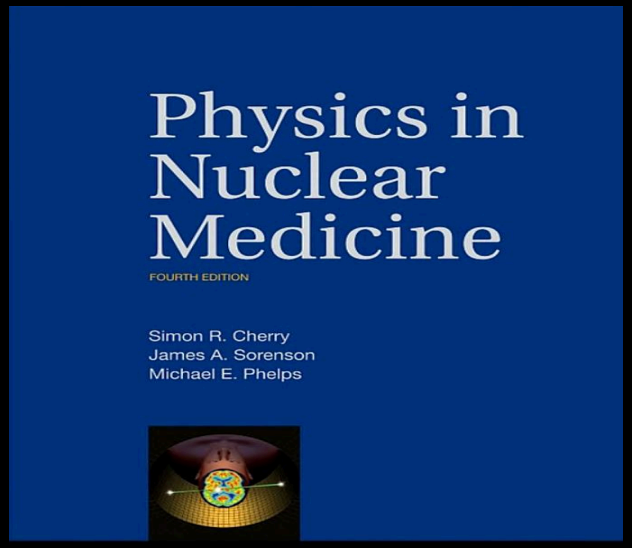
PART 2: Nuclear Medical Physics

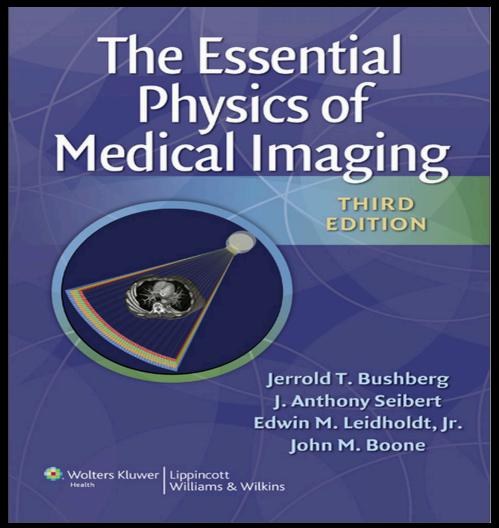
Radioactive sources for diagnosis and therapy
Dosimetry
Clinical nuclear medicine physics
Radiation measuring and imaging equipment
Calibration of nuclear medicine equipment and devices
Magnetic resonance imaging (MRI) as it applies to nuclear medicine
Computed tomography (CT) as it applies to nuclear medicine
Informatics
Digital techniques and image processing
Picture archiving and communication systems
SPECT: Single photon emission computed tomography
PET: Positron emission tomography
Statistics of counting
Anatomical and physiological considerations
Quality assurance
Radiation protection (including survey techniques and installation design)
Radiation safety

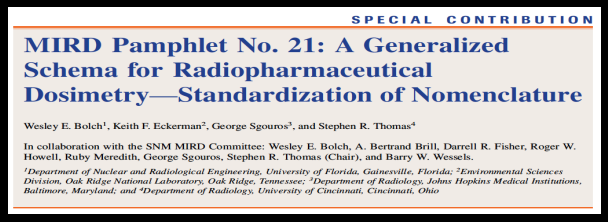
4. If the minimum, mean, and maximum pixel counts in the central field of view of a smoothed intrinsic flood image are 4500, 5200, and 5500, respectively, what is the integral uniformity?

A. 5%
B. 6%
C. 10%
D. 14%
E. 15%

Part 2 - Required Reading





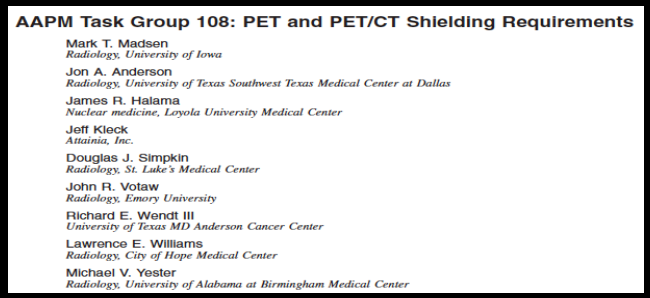

SPECIAL CONTRIBUTION

MIRD Pamphlet No. 21: A Generalized Schema for Radiopharmaceutical Dosimetry—Standardization of Nomenclature

Wesley E. Bolch[1], Keith F. Eckerman[2], George Sgouros[3], and Stephen R. Thomas[4]

In collaboration with the SNM MIRD Committee: Wesley E. Bolch, A. Bertrand Brill, Darrell R. Fisher, Roger W. Howell, Ruby Meredith, George Sgouros, Stephen R. Thomas (Chair), and Barry W. Wessels.

[1]Department of Nuclear and Radiological Engineering, University of Florida, Gainesville, Florida; [2]Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee; [3]Department of Radiology, Johns Hopkins Medical Institutions, Baltimore, Maryland; and [4]Department of Radiology, University of Cincinnati, Cincinnati, Ohio


AAPM Task Group 108: PET and PET/CT Shielding Requirements

Mark T. Madsen
Radiology, University of Iowa

Jon A. Anderson
Radiology, University of Texas Southwest Texas Medical Center at Dallas

James R. Halama
Nuclear medicine, Loyola University Medical Center

Jeff Kleck
Attainia, Inc.

Douglas J. Simpkin
Radiology, St. Luke's Medical Center

John R. Votaw
Radiology, Emory University

Richard E. Wendt III
University of Texas MD Anderson Cancer Center

Lawrence E. Williams
Radiology, City of Hope Medical Center

Michael V. Yester
Radiology, University of Alabama at Birmingham Medical Center

Sections 15-21
Suggested Reading
Appendices

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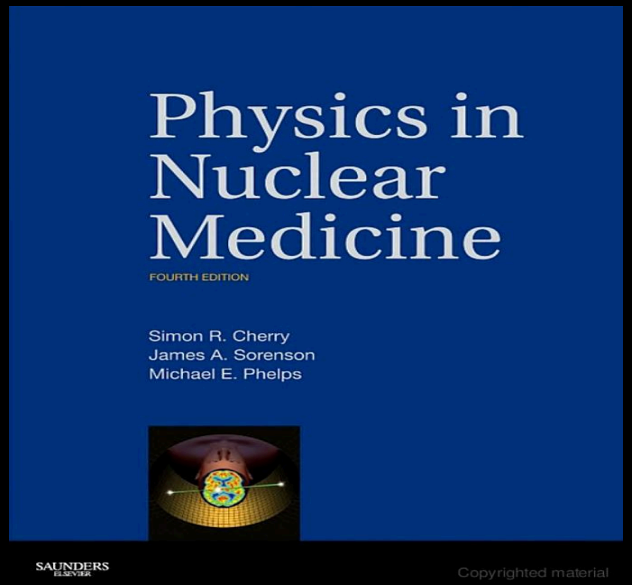
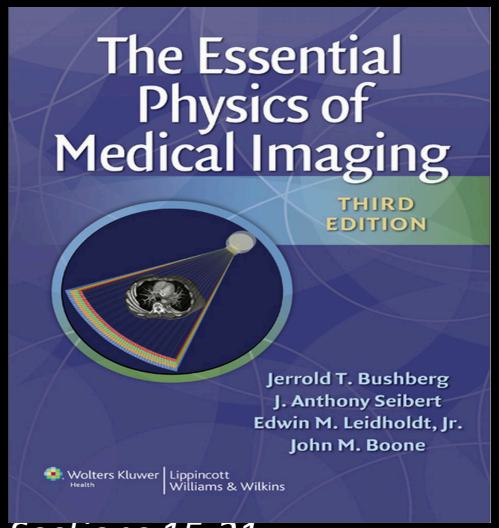
Part 2 - Required Reading





Sections 15-21
Suggested Reading
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Complete Practice Questions!

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Part 3 Preparation

NMP	Category Description
Radiation protection	Internal dosimetry, including MIRD; fetal dose; units; personnel safety, including facility surveys and occupational dose limits; radiation protection principles; patient safety, including breastfeeding and pregnancy; shielding, including facility and personnel protection; regulations and regulatory bodies, including shipping and waste disposal; ALARA; time, distance, and shielding; and radiation surveys
PET and hybrids	Radionuclide production, assay, and characteristics; QC procedures, including ACR and acceptance testing; artifacts; system principles; image fusion; quantitative PET; image reconstruction, including attenuation correction, random coincidences, scattered radiation, deadtime, and 2D versus 3D
SPECT and hybrids, including gamma cameras	SPECT radionuclide production, assay, and characteristics; QC procedures, including ACR and acceptance testing; artifacts; system principles, including gamma cameras and collimators; deadtime; image fusion; dynamic imaging; renograms; cardiac function, ejection fraction, and tracer kinetics; image reconstruction, including scanograms, attenuation correction, and filters; edge enhancement; smoothing; unsharp masking; and segmentation
Radiation measurements	Radioactivity measurement, including dose calibrators and well counters; statistics, including minimum detectable activity; radiation detectors, including survey meters, personnel monitoring, and deadtime; quantitative measurements, including calibration; and QC procedures
Clinical procedures	Radionuclide therapy, including facilities, dosimetry, radiation protection, and release criteria; PET and hybrids; SPECT and hybrids, including gamma cameras; radiation dose, including risk; radiopharmaceutical usage; thyroid imaging/uptake; informatics and display performance; misc.

The Design and Delivery of the Oral Exam

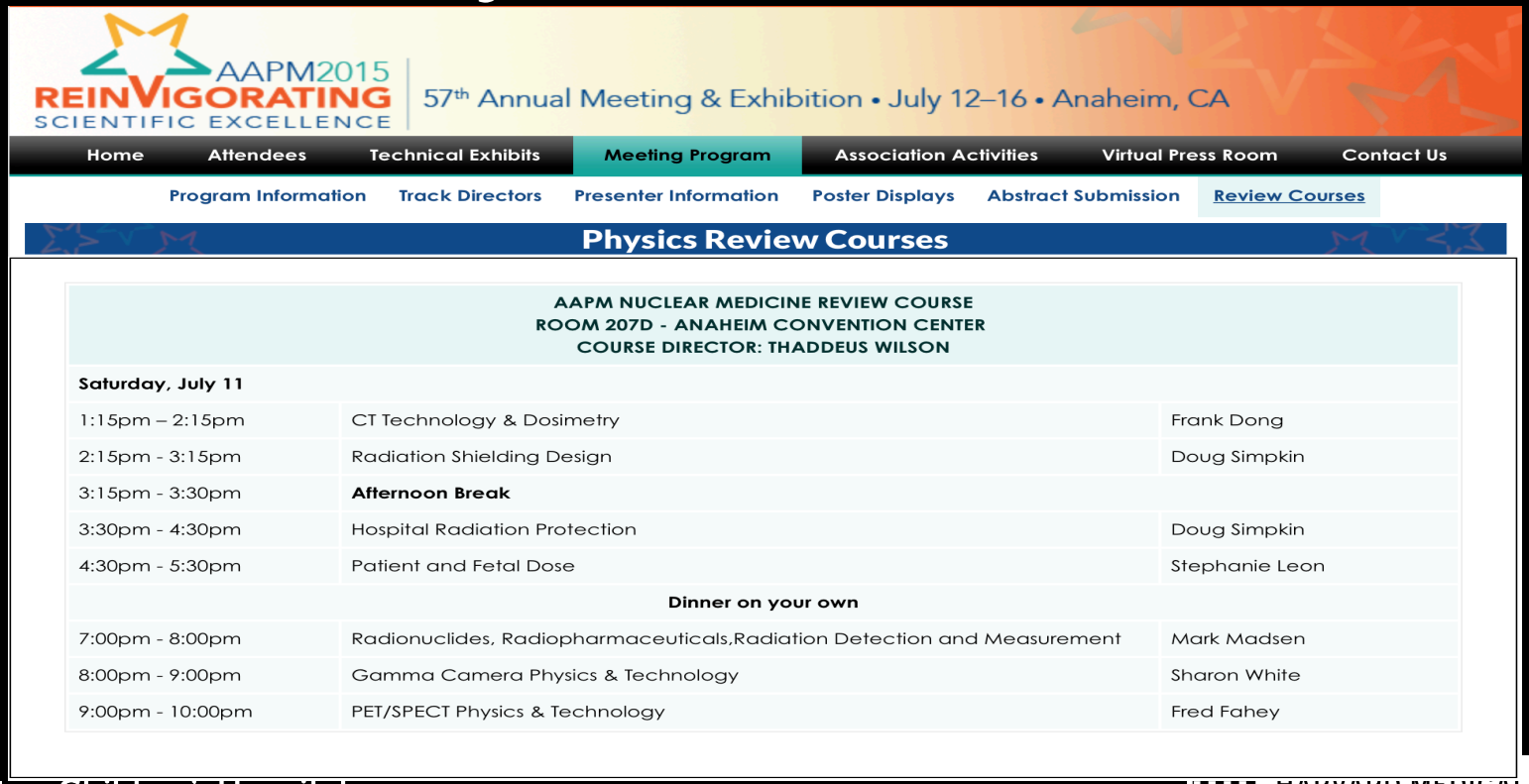
The oral exam consists of 25 questions in five categories. Each candidate is examined by five examiners, each of whom asks one question in each of the five categories.

	Examiner 1	Examiner 2	Examiner 3	Examiner 4	Examiner 5
Category 1	Cat 1 – Q 1	Cat 1 – Q 2	Cat 1 – Q 3	Cat 1 – Q 4	Cat 1 – Q 5
Category 2	Cat 2 – Q 1	Cat 2 – Q 2	Cat 2 – Q 3	Cat 2– Q 4	Cat 2 – Q 5
Category 3	Cat 3 – Q 1	Cat 3 – Q 2	Cat 3 – Q 3	Cat 3 – Q 4	Cat 3 – Q 5
Category 4	Cat 4 – Q 1	Cat 4 – Q 2	Cat 4 – Q 3	Cat 4 – Q 4	Cat 4 – Q 5
Category 5	Cat 5 – Q 1	Cat 5 – Q 2	Cat 5 – Q 3	Cat 5 – Q 4	Cat 5 – Q 5

Part 3: 1 year out

- Practice *Independently*
  - Acceptance testing of new equipment
  - Physics surveys
  - Accreditation procedures, pass/fail criteria
  - Technologist QC
  - Radiation safety policies and procedures

AAPM Physics Review Course



AAPM2015 REINVIGORATING SCIENTIFIC EXCELLENCE | 57th Annual Meeting & Exhibition • July 12–16 • Anaheim, CA

Home | Attendees | Technical Exhibits | Meeting Program | Association Activities | Virtual Press Room | Contact Us

Program Information | Track Directors | Presenter Information | Poster Displays | Abstract Submission | Review Courses

Physics Review Courses

AAPM NUCLEAR MEDICINE REVIEW COURSE
ROOM 207D - ANAHEIM CONVENTION CENTER
COURSE DIRECTOR: THADDEUS WILSON

Saturday, July 11		
1:15pm – 2:15pm	CT Technology & Dosimetry	Frank Dong
2:15pm - 3:15pm	Radiation Shielding Design	Doug Simpkin
3:15pm - 3:30pm	**Afternoon Break**	
3:30pm - 4:30pm	Hospital Radiation Protection	Doug Simpkin
4:30pm - 5:30pm	Patient and Fetal Dose	Stephanie Leon
	Dinner on your own	
7:00pm - 8:00pm	Radionuclides, Radiopharmaceuticals,Radiation Detection and Measurement	Mark Madsen
8:00pm - 9:00pm	Gamma Camera Physics & Technology	Sharon White
9:00pm - 10:00pm	PET/SPECT Physics & Technology	Fred Fahey

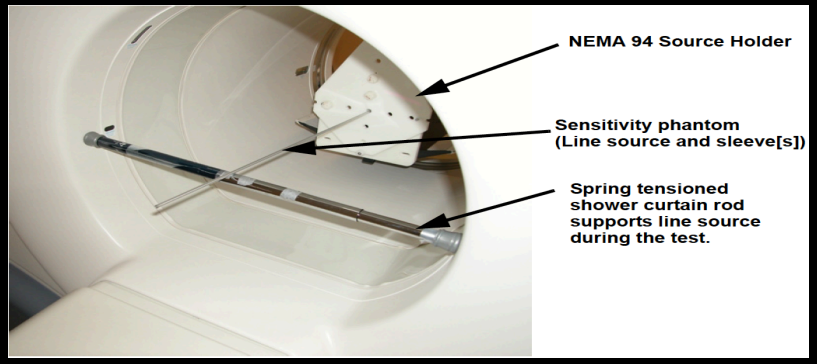
Acceptance Testing

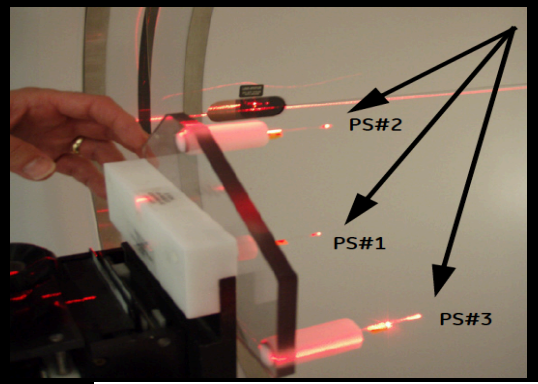
NEMA NU 1

PERFORMANCE MEASUREMENTS OF GAMMA CAMERAS

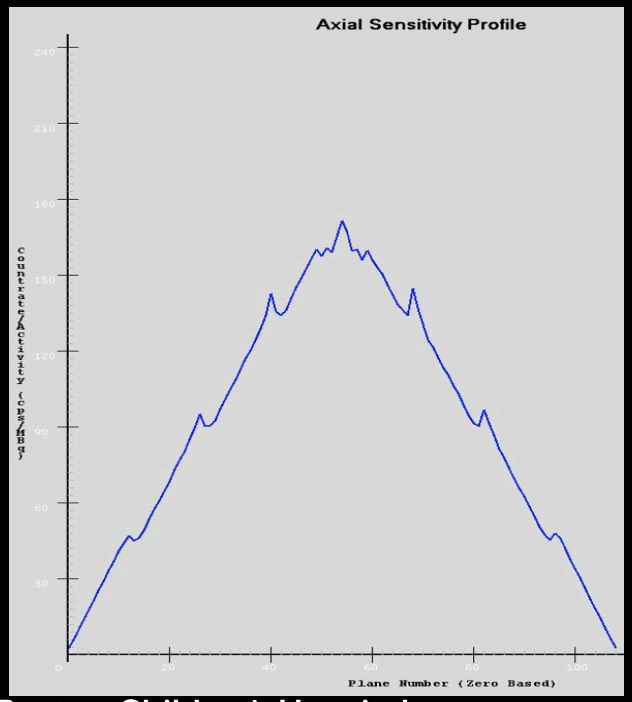
NEMA NU 2-2007

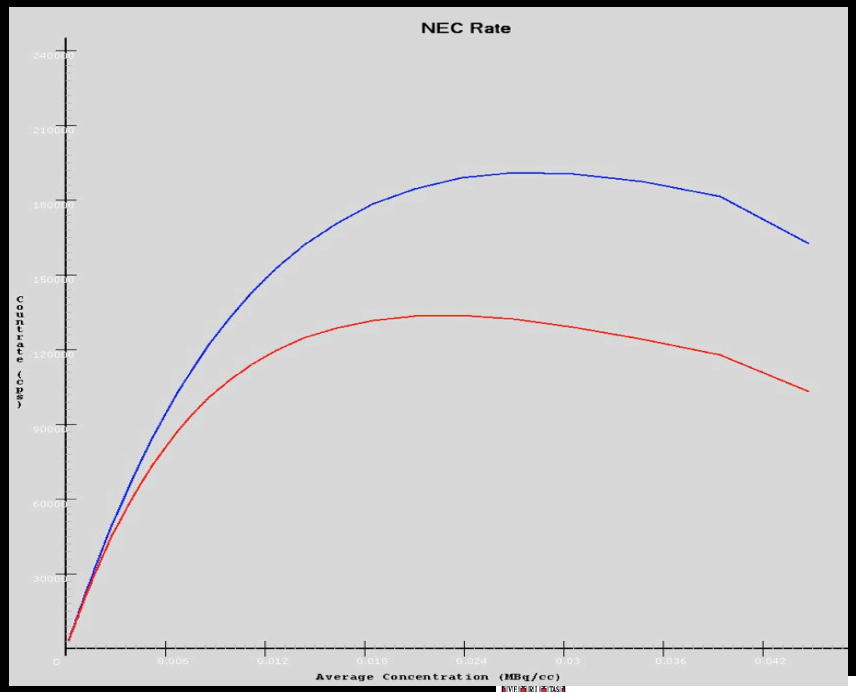
PERFORMANCE MEASUREMENTS OF POSITRON EMISSION TOMOGRAPHS





Acceptance Testing





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Acceptance Testing

NEMA 2007 TESTS	RESULTS	ACCEPTANCE	Typical	Impression
RESOLUTION **256 x 256**				
1 cm transverse FWHM [cm]	**4.6**	≤ 6.5	5.9	PASS
1 cm axial FWHM [cm]	**4.3**	≤ 6.0	5.5	PASS
10 cm transverse FWHM [cm]	**5.4**	≤ 6.5	6.0	PASS
10 cm axial FWHM [cm]	**5.6**	≤ 6.5	6.0	PASS
RESOLUTION **400 x 400**				
1 cm transverse FWHM [cm]	**4.2**	≤ 4.7	4.4	PASS
1 cm axial FWHM [cm]	**4.2**	≤ 4.8	4.5	PASS
10 cm transverse FWHM [cm]	**4.8**	≤ 5.2	4.9	PASS
10 cm axial FWHM [cm]	**5.9**	≤ 6.2	5.9	PASS
SENSITIVITY				
0 cm [cps/MBq]	**9806**			
10 cm [cps/MBq]	**10065**			
AVERAGE Sensitivity	**9935.5**	≥ 8500	9500	PASS
SCATTER				
Scatter Fraction	**34**	< =40	< =34	PASS
Peak trues rate [kcps] Measured <=36 kBq/cc	600 kcps @36 544 kcps @27	500	550	PASS
Peak NEC rate [kcps] Measured <=28 kBq/cc	191 kcps @27	>=155	175	PASS
ACCURACY				
Count rate accuracy Mean bias <=22 kBq/cc	**3.20**	<=+/- 5%	<=+/- 4%	PASS
Count rate accuracy Mean bias @ peak NEC	**3.10**	<=+/- 6%	<=+/- 5%	PASS

Physics Surveys

Nuclear Medicine Accreditation Program Requirements

ACR® AMERICAN COLLEGE OF RADIOLOGY

Nuclear Medicine Performance Tests – At Least Annually

1. **Intrinsic Uniformity** - Performed to ensure that the intrinsic detector integral and differential uniformity are sufficient to minimize the production of artifacts and ensure that patient abnormalities can be visualized without interference from the imaging system. These tests also monitor a scintillation unit for electronic problems and crystal deterioration (hydration).
2. **System Uniformity** - Performed to check all commonly used collimators for defects that might produce artifacts in planar and tomographic studies.
3. **Intrinsic or System Spatial Resolution** - Performed to ensure that the detector resolution is sufficient to provide satisfactory detection of lesions and delineate detail in clinical images.
4. **Relative Sensitivity** - Performed to verify that count rate per time between the two heads is within 5%.
5. **Energy Resolution** - Performed to verify that scatter rejection is sufficient to provide optimal contrast in clinical studies. *Note: On some systems, energy resolution is very difficult to measure precisely.*
6. **Count Rate Parameters** - Performed to ensure that the time to process an event is sufficient to maintain spatial resolution and uniformity in clinical images acquired at high count rates.
7. **Formatter/Video Display** - Performed to ensure that systems used to produce hard copy and monitors that are used for interpretation of clinical studies provide satisfactory image quality in terms of uniformity and spatial resolution.
8. **Overall System Performance for SPECT Systems** - Performed to quantitatively verify that SPECT systems provide satisfactory tomographic uniformity, contrast, and spatial resolution.
9. **System Interlocks** - Performed to verify that all system interlocks are operating as designed and that the system is safe and reliable for the nuclear medicine technologist to operate and for imaging patients.
10. **Dose Calibrators** - Performed annually to verify that readings from this instrument are accurate (accuracy test). All basic measurements of performance must be done at the time of installation and repeated after major repair. This test must be done according to protocols accepted by the appropriate state regulatory agencies or the NRC.
    - "Test" measurement of battery voltage (if applicable)
    - Zero adjustment (if applicable)
    - Background adjustment
    - Accuracy with NIST traceable standard
    - Linearity
    - Constancy test
11. **Thyroid Uptake and Counting Systems** - Performed to verify energy calibration, energy linearity, energy resolution, sensitivity, and reliability (Chi-squared test) for the measurement of organ function and the assay of patient samples.
    - I-123 capsule or long-lived standard calibration check
    - Count of background
    - High voltage/gain checks
    - Energy resolution
    - Chi-square test

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Physics Surveys

Test Performed	Result			Acceptable Performance			Pass/Fail
Intrinsic Uniformity Tc 99m 30M Counts 5FOV 1024 Matrix	Det 1	CFOV	UFOV				
	Integral			<2.9%	<3.7%		Pass
	Diff			<2.5%	<2.7%		Pass
	Det 2	CFOV	UFOV				
	Integral			<2.9%	<3.7%		
	Diff			<2.5%	<2.7%		
System Uniformity Co-57 10M 1024 Matrix LEHR	Det 1	CFOV	UFOV				
	Integral			<5%	<5%		Pass
	Diff			<5%	<5%		Pass
	Det 2	CFOV	UFOV				
	Integral			<5%	<5%		Pass
	Diff			<5%	<5%		Pass
System Uniformity Co-57 10M 1024 Matrix LEHS	Det 1	CFOV	UFOV				
	Integral	4.61%	7.73%	<5%			Pass
	Diff	3.80%	5.13%	<5%			Pass
	Det 2	CFOV	UFOV				
	Integral			<5%			Pass
	Diff			<5%			Pass
10M Counts							
Intrinsic/System Spatial Resolution	Det 1 = 2.5 mm bars resolved			≤ 2.5 mm			Pass
	Det 2 = 2.5 mm bars resolved						Pass
System Sensitivy (LEHR)	Det 1 = 207 CPM/uCi			≥ 202 CPM/uCi (LEHR) +/-10%			Pass
				Both heads within 5%			
System Sensitivy (LEHS)	Det 1 = 919 CPM/uCi			≥ 1020 CPM/uCi (LEHR) +/-10%			Pass
				Both heads within 5%			
Energy Resolution	Det 1 = 9.2%			≤ 9.9% (10% Tolerance)			Pass
Count Rate Performance	Det 1 = 267 kcps max			≥ 240 kcps			Pass
Video Display	All monitors used for interpretation of clinical images undergo routine auto-calibration bi-annually and verification daily by Barco MediCAL QA Web			No artifacts or non-uniformities, Line pairs visible at Nyquist frequency at center and corners			Pass

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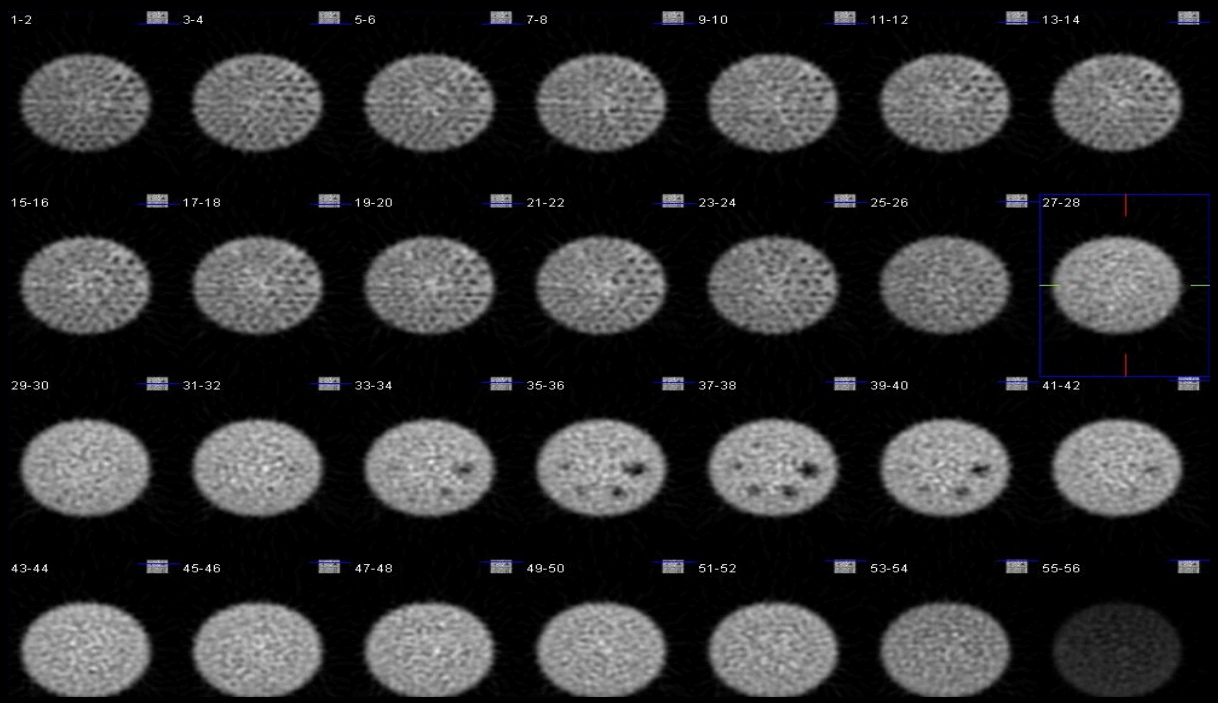
ACR Accreditation



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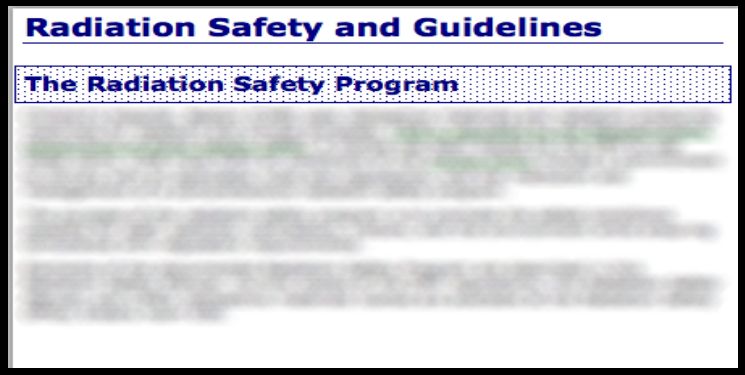
Technologist QC

Test	Performed By	Frequency
System Shutdown	Nuclear Medicine Technologist	Daily
CT Tube Warm-Up	Nuclear Medicine Technologist	Daily
CT Fast Calibrations	Nuclear Medicine Technologist	Daily
PET Daily QA	Nuclear Medicine Technologist	Daily
Update Gain	Nuclear Medicine Technologist	Weekly
CTC	Nuclear Medicine Technologist	Weekly
Well Counter	Nuclear Medicine Technologist	Monthly
System Back-Up	Nuclear Medicine Technologist	Monthly
Preventative Maintenance	Biomedical Engineering Staff	Bi-annually
Physicist Survey	Qualified Physicist	Quarterly/Annually*

Radiation Safety Policies and Procedures



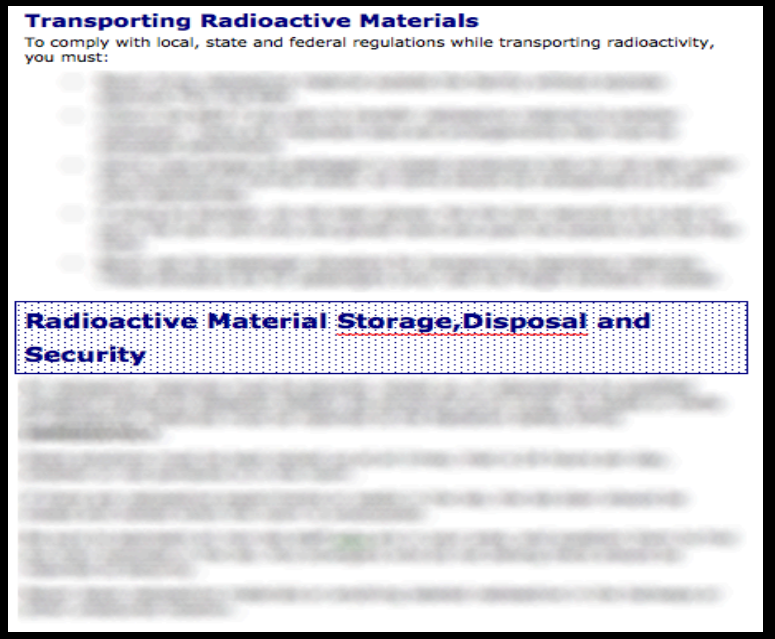
Radiation Safety and Guidelines

The Radiation Safety Program

Signs, Posting and Labeling

To indicate that an item is radioactive, or that there is radioactive material used or stored in that area a "CAUTION RADIOACTIVE MATERIALS" sign must be posted, This includes:

- Doors to all areas where radioactive materials are used, stored, and/or handled.
- Refrigerators, centrifuges, incubators, hoods, sinks, and any other equipment in which radioactive material is used or stored.



Transporting Radioactive Materials

To comply with local, state and federal regulations while transporting radioactivity, you must:

Radioactive Material Storage,Disposal and Security

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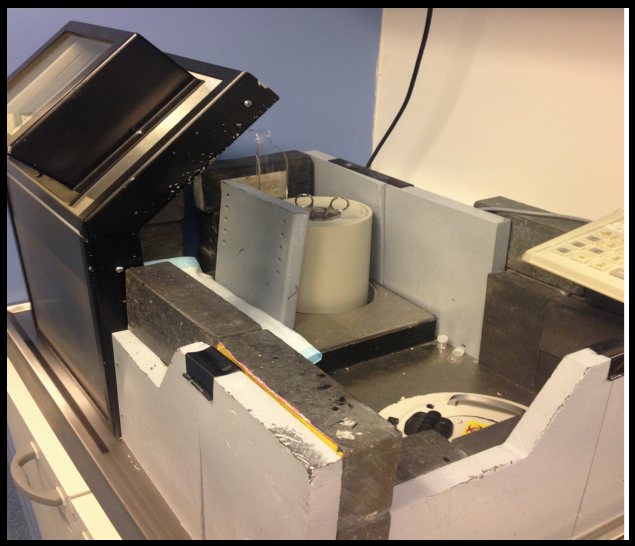
Part 3: 6 months out

Spend time with technologists!



Attend Resident Lectures

Joint Program in Nuclear Medicine

Tuesday Morning Clinical Conferences

April 21, 2015

Abrams Conference Room

Brigham & Women's Hospital, L1

Topic:

"Hyperthyroidism"

Presenter:

Mark Mingos, M.D.

JPNM Resident

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Shadow Radiologist

- Protocoling/Dosage
- Patient Communication
- Interpretation

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Identify areas of Weakness

- e.g. Cardiac studies in a pediatric hospital

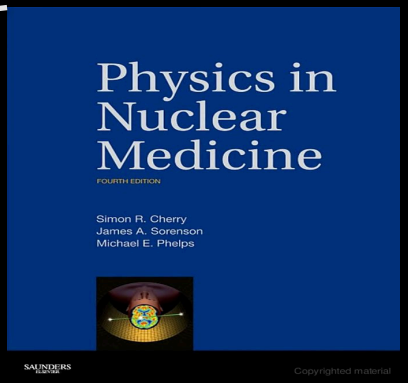
- Look to other hospitals

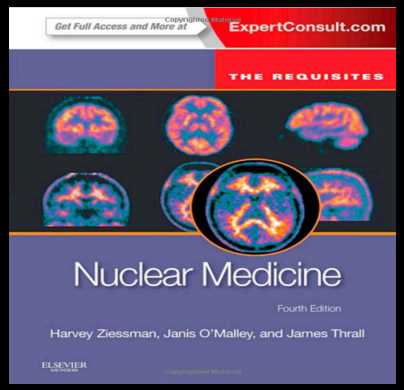
Part 3: 3 months out

Form a Study Group

- Devise schedule for required reading (e.g. books, TG reports, regulations)
- Meet weekly and Quiz Each Other on previous reading
- Ask difficult questions you can't easily answer

NMP	Category Description
Radiation protection	Internal dosimetry, including MIRD; fetal dose; units; personnel safety, including facility surveys and occupational dose limits; radiation protection principles; patient safety, including breastfeeding and pregnancy; shielding, including facility and personnel protection; regulations and regulatory bodies, including shipping and waste disposal; ALARA; time, distance, and shielding; and radiation surveys
PET and hybrids	Radionuclide production, assay, and characteristics; QC procedures, including ACR and acceptance testing; artifacts; system principles; image fusion; quantitative PET; image reconstruction, including attenuation correction, random coincidences, scattered radiation, deadtime, and 2D versus 3D
SPECT and hybrids, including gamma cameras	SPECT radionuclide production, assay, and characteristics; QC procedures, including ACR and acceptance testing; artifacts; system principles, including gamma cameras and collimators; deadtime; image fusion; dynamic imaging; renograms; cardiac function, ejection fraction, and tracer kinetics; image reconstruction, including scanograms, attenuation correction, and filters; edge enhancement; smoothing; unsharp masking; and segmentation
Radiation measurements	Radioactivity measurement, including dose calibrators and well counters; statistics, including minimum detectable activity; radiation detectors, including survey meters, personnel monitoring, and deadtime; quantitative measurements, including calibration; and QC procedures
Clinical procedures	Radionuclide therapy, including facilities, dosimetry, radiation protection, and release criteria; PET and hybrids; SPECT and hybrids, including gamma cameras; radiation dose, including risk; radiopharmaceutical usage; thyroid imaging/uptake; informatics and display performance; misc.





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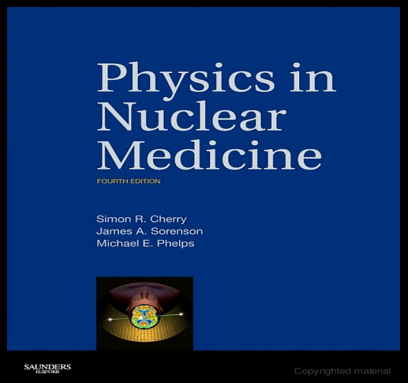

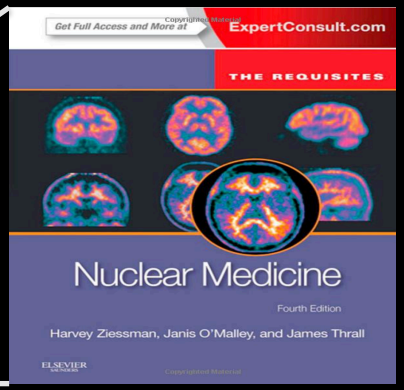

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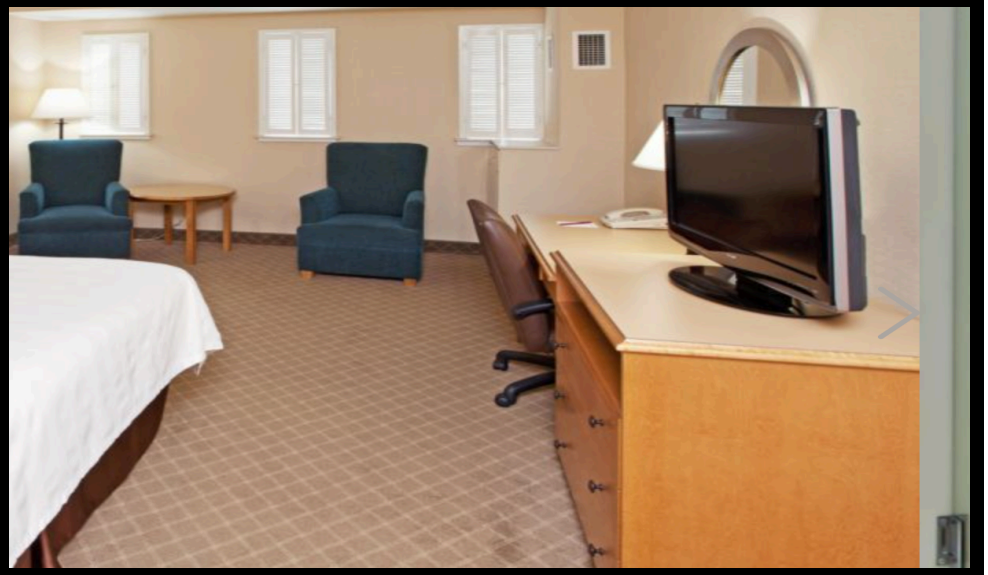
Part 3: Exam Day

Relax!

- Examiners want you to succeed
- Evaluating competency to practice independently
- Do not guess
- Explain reasoning



Thank You and Good Luck!

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