

Accreditation of Nuclear Medicine Facilities

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Thanks

- Nathaniel Roth, PhD – D-SPECT images
- Mayur Vaya, CNMT – GE Hawkeye images
- John Holliday, CNMT and Dr. Sabarwahl – c.cam imaging
- The technologists of Henry Ford Hospital for performing ACR imaging every quarter.
- Jeanne Mocerri, CNMT – assists with the ACR process at HFH.
- Rosemary Gallagher, PhD – Digirad information

Disclaimer

- ACR physics subcommittee for nuclear medicine accreditation.
- My facility is ACR accredited for nuclear medicine, nuclear cardiology, and PET.
- I have attempted to provide accurate information. The ACR should be contacted for the most current and correct information.

Nuclear Medicine Clinical Exams Required by ACR Module 1, Module 2, and Module 3

Module 1 Planar	Module 2 SPECT	Module 3 Nuclear Cardiology
Required Studies		
■ Whole body or spot bone	■ Bone SPECT	■ SPECT myocardial perfusion
Select one additional study for each module		
<ul style="list-style-type: none"> ■ Whole body bone ■ Spot bone ■ Hepatobiliary ■ Perfusion lung ■ MUGA 	<ul style="list-style-type: none"> ■ Bone SPECT ■ Brain SPECT ■ Hepatic blood pool ■ Liver SPECT ■ SPECT myocardial perfusion 	<ul style="list-style-type: none"> ■ MUGA ■ Gated SPECT

QC and Phantom Data Required by the ACR for Accreditation		
Module 1 Planar	Module 2 SPECT	Module 3 Myocardial Perfusion
<ul style="list-style-type: none"> ■ Planar uniformity ■ Planar resolution 	<ul style="list-style-type: none"> ■ Planar uniformity ■ Planar resolution ■ SPECT <ul style="list-style-type: none"> ■ Uniformity ■ Resolution ■ Contrast 	<ul style="list-style-type: none"> ■ Planar uniformity ■ Planar resolution ■ SPECT <ul style="list-style-type: none"> ■ Uniformity ■ Resolution ■ Contrast

- ## Common Pitfalls
- Incomplete paperwork
 - Failure to read and then follow instructions
 - Acquisition of data for too many counts or
 - Wrong matrix size
 - Etc.
 - Incomplete submission of data
 - Submission of data that is uninterpretable
 - Overexposed
 - Color

- ## Plan for a Successful Experience
- Go to the website and review the process and standards.
 - Review your policies and procedures.
 - Are they current
 - Do they meet the accrediting organizations standards.
 - Start the application process
 - Make a list of what needs to be done and assign a person to follow each task.
 - Make a list of questions.
 - Set a timeline for completing the application

- ## Plan for a Successful Experience
- Make sure that all routine maintenance and SPECT quality control are done prior to starting phantom studies.
 - Remember that if the camera is not capable of performing a certain function, it is not required.
 - Attenuation correction on systems that only acquire 180° data
 - Planar images on the new special purpose cameras, i.e. D-SPECT and CardiArc.
 - Note any deviations from the standard protocol on the camera data sheet.

ACR Quality Control Requirements

- Acceptance and annual tests
 - Performed at installation and yearly
 - May be performed by the medical physicist.
 - Alternatively, may be performed by a qualified nuclear medicine technologist or a physicist in training
 - Use protocols NEMA protocols, or
 - Protocols approved by the qualified medical physicist and the results documented in the annual report.

ACR Quality Control Requirements

- Annual performance tests for gamma cameras
 - Intrinsic and system uniformity
 - Intrinsic or system spatial resolution
 - Sensitivity
 - Energy resolution
 - Count rate parameters
 - Multiple window spatial registration
 - Formatter/Video display
 - SPECT performance
 - System interlocks

ACR Quality Control Requirements

- Dose Calibrator Performance Tests
 - “Test” measurement of battery voltage (if applicable)
 - Zero adjustment (if applicable)
 - Background adjustment
 - Constancy
 - Linearity
 - Accuracy with NIST traceable standards
 - Geometry

ACR Quality Control Requirements

- Thyroid Uptake and Counting Systems
 - ^{123}I capsule or long-lived standard calibration check
 - Count of background
 - High voltage/gain checks
 - Energy resolution
 - Chi-square test

Phantom Name: _____

ACR
ACCREDITED
RAZOR-EDGE
Nuclear Medicine Accreditation Program
 1000 Princeton Avenue, Princeton, NJ 08542-1200

Nuclear Medicine Phantom - Site Scanning Data Form

Please complete this form for every phantom used for accreditation. Phantoms with other nuclear medicine capabilities, including a dedicated SPECT or PET/CT system, should be submitted to the Nuclear Medicine Accreditation Program, 1000 Princeton Avenue, Princeton, NJ 08542-1200. Please refer to the Phantom Data Form Label for the correct values. <http://www.aacr.org/phantom>

CAMERA SYSTEM INFORMATION

Camera Model	Year of Manufacture	Year of Installation	Model of Last Upgrade	Serial Number
GE	2010	2010	2010	123456789
GE	2010	2010	2010	987654321
GE	2010	2010	2010	111111111
GE	2010	2010	2010	222222222
GE	2010	2010	2010	333333333
GE	2010	2010	2010	444444444
GE	2010	2010	2010	555555555
GE	2010	2010	2010	666666666
GE	2010	2010	2010	777777777
GE	2010	2010	2010	888888888
GE	2010	2010	2010	999999999
GE	2010	2010	2010	000000000

Model Name: _____ Year of Manufacture: _____ Year of Installation: _____ Model of Last Upgrade: _____ Serial Number: _____

Collimator Manufacturer	Model	Year of Manufacture	Year of Installation	Model of Last Upgrade	Serial Number
GE	2010	2010	2010	2010	123456789
GE	2010	2010	2010	2010	987654321
GE	2010	2010	2010	2010	111111111
GE	2010	2010	2010	2010	222222222
GE	2010	2010	2010	2010	333333333
GE	2010	2010	2010	2010	444444444
GE	2010	2010	2010	2010	555555555
GE	2010	2010	2010	2010	666666666
GE	2010	2010	2010	2010	777777777
GE	2010	2010	2010	2010	888888888
GE	2010	2010	2010	2010	999999999
GE	2010	2010	2010	2010	000000000

Model Name: _____ Collimator Type: _____ Year Acquired: _____

Computer Model	Year of Manufacture	Year of Installation	Model of Last Upgrade	Serial Number
GE	2010	2010	2010	123456789
GE	2010	2010	2010	987654321
GE	2010	2010	2010	111111111
GE	2010	2010	2010	222222222
GE	2010	2010	2010	333333333
GE	2010	2010	2010	444444444
GE	2010	2010	2010	555555555
GE	2010	2010	2010	666666666
GE	2010	2010	2010	777777777
GE	2010	2010	2010	888888888
GE	2010	2010	2010	999999999
GE	2010	2010	2010	000000000

Model Name: _____ Computer Software Version: _____ Date of Last Software Upgrade: _____

Has all data submitted for the camera system been processed with this computer system? Y N

Other information or comments: _____

1000 Princeton Avenue, Princeton, NJ 08542-1200

- ## Radionuclides
- Most facilities will have to perform phantom studies for 2 isotopes
 - ^{99m}Tc
 - ^{201}Tl or ^{67}Ga
 - If only licensed for ^{99m}Tc or only using ^{99m}Tc
 - AU send letter stating that only ^{99m}Tc is used
 - New data must be submitted if a second isotope is added.

- ## ACR Phantom Procedure
- Planar only
 - SPECT and planar

- ## Planar Only
- Acquisition of flood and resolution phantom
 - Intrinsic or extrinsic
 - Static acquisition
 - 5 M counts for FOV > 40 cm
 - 3 M counts for FOV < 40 cm
 - Recommended Matrix
 - Uniformity: 256x256
 - Resolution: 512x512
 - Display in gray scale using the full range.

Extrinsic Flood



PLANAR SYSTEM IMAGES ONLY

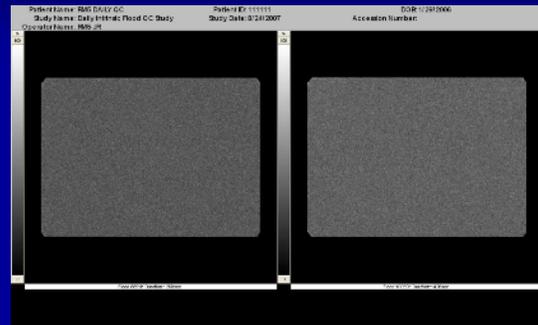
A. Field Uniformity (check only one)

Acquisition One - Tc-99m or Co-57 (if covered by State License)			
Tc-99m <input type="checkbox"/>	Co-57 <input type="checkbox"/>	Time for acquisition: _____ sec	
Intrinsic <input type="checkbox"/>	System <input type="checkbox"/>	Analyzer 1: _____ (peak) %	
Total Counts: 5M <input type="checkbox"/>	3M <input type="checkbox"/>	Occluder: _____ (if used)	
Matrix: 128 <input type="checkbox"/>	256 <input type="checkbox"/>	512 <input type="checkbox"/>	1024 <input type="checkbox"/>
Analog <input type="checkbox"/>			
Acquisition Two - Tl-201 or Ga-67 (not required if checked for Tc-99m only)			
Tl-201 <input type="checkbox"/>	Ga-67 <input type="checkbox"/>	N/A <input type="checkbox"/>	Analyzer 1: _____ (peak) %
Intrinsic <input type="checkbox"/>	System <input type="checkbox"/>	N/A <input type="checkbox"/>	Analyzer 2: _____ (peak) %
Total Counts: 5M <input type="checkbox"/>	(large rect.) 3M <input type="checkbox"/>	(other) _____ (peak) %	Analyzer 3: _____ (peak) %
Matrix: 128 <input type="checkbox"/>	256 <input type="checkbox"/>	512 <input type="checkbox"/>	1024 <input type="checkbox"/>
Analog <input type="checkbox"/>			
Occluder: _____ (if used)			

Intrinsic Flood

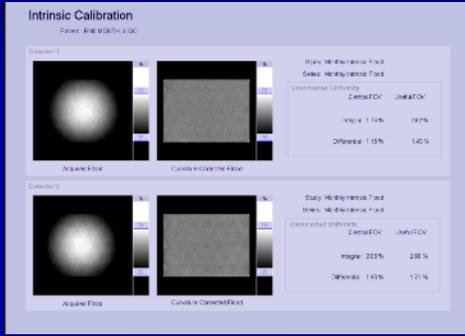


Planar Uniformity



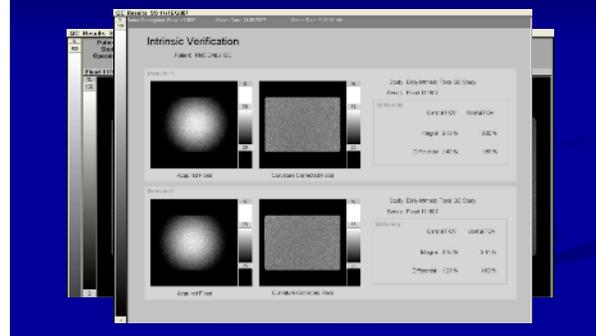
Pitfalls

Wrong Number of Counts



Pitfalls

Wrong Window and No Curvature Correction



B. Spatial Resolution

Fill in the appropriate fields based on the resolution test pattern that is used:

Four Quadrant (smallest to largest): 4.0 3.1 2.6 2.1 mm

PLES Phantom: _____ mm

Orthogonal Hole Pattern: _____ mm (diameter)

Orthogonal In-Hole: _____ mm

Hine Duley Phantom: _____ mm

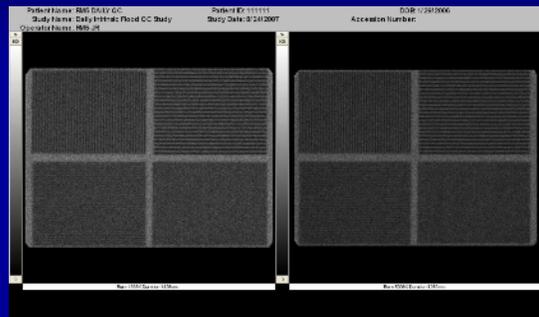
Acquisition Three - Tc-99m or Co-57

To-99m Co-57 Time for acquisition: _____ sec
 Intrinsic System Analyzer 1: _____ peakV _____ %
 Total Counts: 5M 3M Colimator: _____ (F usec)
 Matrix: 128 256 512 1024 Analog

Acquisition Four - Tl-201 or Ga-67 (Not required if bonded by To-99m only)

Tl-201 Ga-67 N/A Time for acquisition: _____ sec
 Intrinsic System Analyzer 1: _____ peakV _____ %
 Total Counts: 5M 3M Analyzer 2: _____ peakV _____ %
 Matrix: 128 256 512 1024 Analog Colimator: _____

Resolution



Scoring Criteria

Nuclear Medicine Planar Only Images:

(4-quadrant test phantom)

1890m or Cs-57:

Intrinsic spatial resolution images:

Satisfactory: 2.5 to 2.9 mm bars are resolved in one quadrant of a four quadrant pattern and they have low contrast.
Marginal: 3.0 to 3.4 mm bars resolved in one quadrant of a four quadrant pattern.

System spatial resolution images:

Satisfactory: 3.0 to 3.4 mm bars are resolved in one quadrant of a four quadrant pattern.
Marginal: 3.5 to 3.9 mm bars resolved in one quadrant of a four quadrant pattern.

123I or Tc-99m:

Intrinsic spatial resolution images:

Satisfactory: 3.0 to 3.4 mm bars are resolved in one quadrant of a four quadrant pattern and they have low contrast.
Marginal: 3.5 to 3.9 mm bars resolved in one quadrant of a four quadrant pattern.

System spatial resolution images:

Satisfactory: 3.5 to 3.9 mm bars are resolved in one quadrant of a four quadrant pattern.
Marginal: 4.0 to 4.4 mm bars resolved in one quadrant of a four quadrant pattern.

Planar and SPECT Imaging

- Uniformity as previously described
- Planar resolution using the ACR phantom
 - 256 x 256 matrix
 - Zoom factor of 1.33 to 1.46
 - 500 k Counts
- SPECT acquisition
 - 24 M total counts
 - Recommended Matrix: 128 x 128
 - Zoom factor of 1.33 to 1.46
 - 120-128 images over 360°; 60-64 images over 180°
- Display in gray scale using the full range.
 - Planar uniformity
 - Planar resolution
 - Composite images for uniformity, resolution and contrast
 - All reconstructed SPECT slices

ACR Approved SPECT Phantom



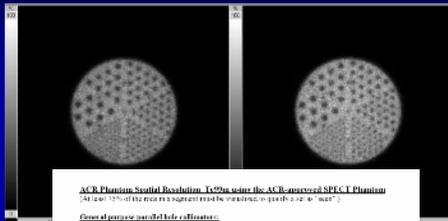
Deluxe Phantom

- Cylindrical phantom
 - Internal radius 10.8 cm
 - Internal length 20 cm
- Lower half
 - 6 pie-shaped sections of Lucite rods.
 - Rod diameters: 4.8, 6.4, 7.9, 9.5, 11.1, and 12.7 mm
- Upper half
 - 6 Lucite spheres
 - Sphere diameters: 9.5, 12.7, 15.9, 19.1, 25.4, and 31.8 mm

Planar Resolution Acquisition



Resolution Data – ^{99m}Tc



ACR Phantom Spatial Resolution: ^{99m}Tc using the ACR approved SPECT Phantom
(All Lead 50% of the points in a square must be reconstructed to give a 0.25 "star")

General purpose parallel hole collimators:

Satisfactory: 5.5 mm rods resolved with high contrast

Marginal: 5.0 mm rods resolved with high contrast

High resolution parallel hole collimators:

Satisfactory: 7.0 mm rods resolved with high contrast

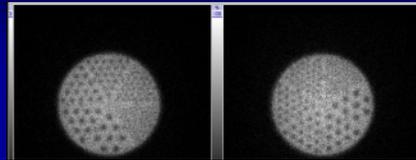
Marginal: 6.5 mm rods resolved with high contrast

Ultra high resolution parallel hole collimators:

Satisfactory: 8.0 mm rods resolved with high contrast

Marginal: 7.5 mm rods resolved with high contrast

Resolution Data – ^{201}Tl



ACR Phantom Spatial Resolution: Tl 201 or Ga 67 using the ACR approved SPECT Phantom
(All Lead 50% of the points in a square must be reconstructed to give a 0.25 "star")

General purpose parallel hole collimators (12541)

or
Medium energy general purpose parallel hole collimators (62-67)

Satisfactory: 12.1 mm rods resolved

Marginal: 11.7 mm rods resolved

High resolution parallel hole collimators (11-201)

Satisfactory: 9.5 mm rods resolved

Marginal: 9.1 mm rods resolved

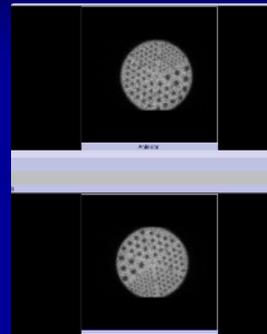
Planar Resolution Acquisition



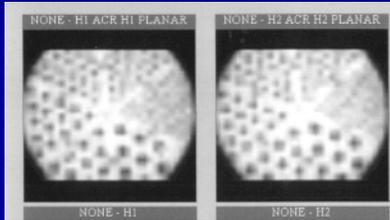
Siemens Cardiac Camera



Planar Resolution Cardiac Camera



Digirad Planar Resolution



Phantom Set-up e.cam

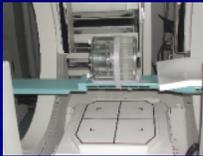


- Option 1 – Pediatric Pallet
 - Circular orbit
 - Radius of rotation: 20 cm
 - Table height -13.3



- Option 2 – Imaging Table
 - Circular orbit
 - Radius of rotation 21 cm

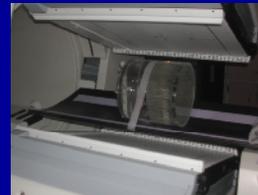
SPECT Phantom Set-up



- Vertex Plus
 - Circular orbit
 - Radius of rotation: 20 cm
 - Table height: -9.8 cm
- Forte
 - Circular orbit
 - Radius of rotation: 21 cm
 - Table height: -9.7 cm
- Vertex Cardio
 - Roving FOV
 - Table height: -0.4 cm
 - Lateral translation: -8.2 cm

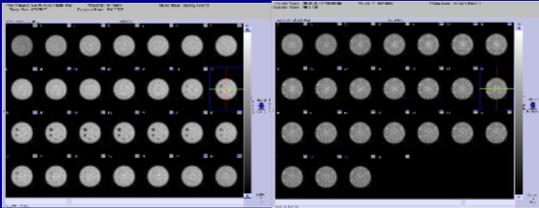


SPECT Phantom Set-up

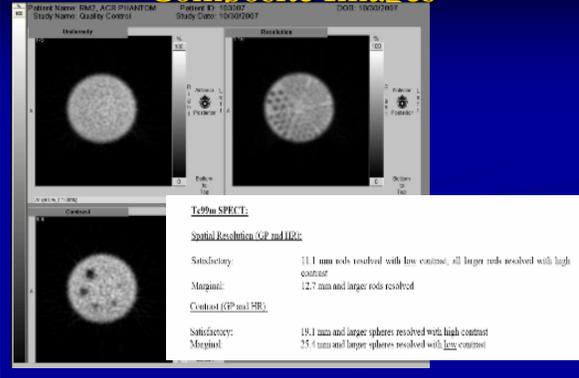


- GE Hawkeye
 - Table height: 77
 - Radius of rotation: 21 cm
 - Circular orbit

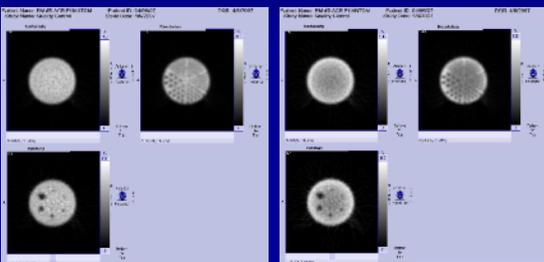
SPECT Reconstructed Data



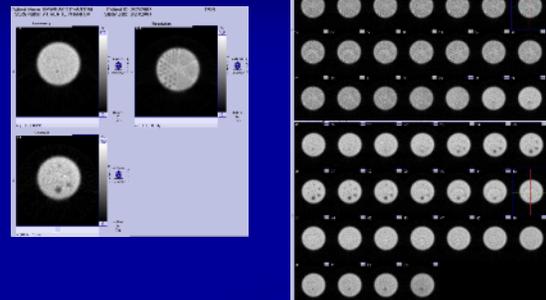
Composite Images



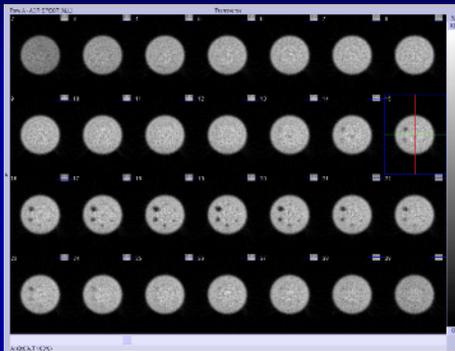
With and Without Attenuation Correction



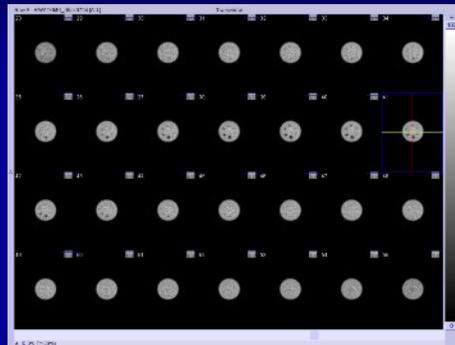
Unacceptable Data



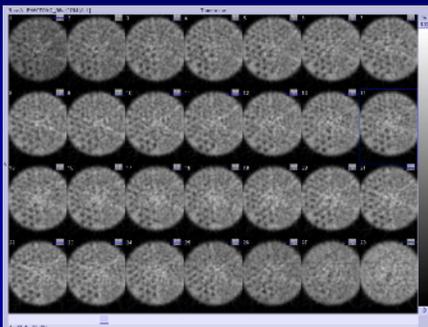
Images Correctly Sized



Images too Small



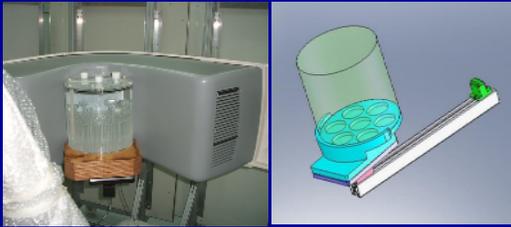
Images too Large



Special Purpose Imaging Devices

- Currently 2 cameras in this category
 - Spectrum Dynamics: D-SPECT
 - CardiArc: CardiARC camera
- Work with members of the committee to obtain images that are acceptable.
- Spectrum Dynamics has completed their protocol.
- CardiArc is just beginning.

D-SPECT Set-up



D-SPECT Set-up



DSPECT Results



Tc-99m SPECT:

Spatial Resolution (CP and HR):

Satisfactory: 11.1 mm rods resolved with low contrast; all larger rods resolved with high contrast
Marginal: 12.7 mm and larger rods resolved

Contrast (CP and HR):

Satisfactory: 19.1 mm and larger spheres resolved with high contrast
Marginal: 25.4 mm and larger spheres resolved with low contrast

Planar Only

Current Protocol

- Flood
 - Tc-99m
 - Tl-201 or Ga-67
 - Counts to acquire
 - 5 M counts for FOV > 40 cm
 - 3 M counts for FOV < 40 cm
 - Recommended Matrix
 - Uniformity: 256x256
 - Resolution: 512x512
- Display in gray scale using the full range.

January 2010

- Flood
 - Tc-99m
 - Tl-201 and Ga-67 if both are used.
 - Counts to Acquire
 - 10 M counts for FOV > 32 cm
 - 5 M counts for FOV < 32 cm
 - Recommended Matrix
 - Uniformity: 256 x 256
 - Resolution: 512 x 512
- Display in gray scale using the full range.

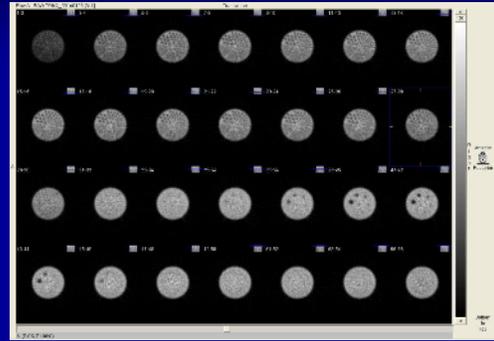
Planar and SPECT Imaging

Current Protocol

January 2010

- Planar resolution using the ACR phantom
 - 256 x 256 matrix
 - Zoom factor of 1.33 to 1.46
 - 500 k Counts
- SPECT acquisition
 - 24 M total counts
 - Recommended Matrix: 128 x 128
 - Zoom factor of 1.33 to 1.46
 - < 30 k cps
- Display in gray scale using the full range.
 - Planar uniformity
 - Planar resolution
 - Composite images for uniformity, resolution and contrast
 - All reconstructed SPECT slices
- Planar Resolution
 - 256 x 256 matrix
 - Zoom factor of 1.0
 - 600 k Counts
- SPECT Acquisition
 - 32 M total counts
 - 128 x 128 matrix
 - Zoom factor of 1.0
- Display in gray scale using the full range.
 - Planar uniformity
 - Planar resolution
 - All reconstructed SPECT slices with a thickness of 0.6 cm (2 slices)

24 M Ct Data – 2 slices



Summary

- The accreditation process is a learning process.
- Attention to detail is key for a successful application.
 - Physicist should review all the phantom data
- Accreditation is useful for both the accredited facility and the patients seen in that facility.
- All of the forms and criteria shown here are available on the ACR website.

References

- American College of Radiology, Accreditation website. www.acr.org
- MacFarlane CR: ACR accreditation of nuclear medicine imaging departments. J Nucl Med Technol 2006; 34:18-24