BICOE – Breast Imaging Center of Excellence

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IMAGING PHYSICS

Introduction

- Objectives
- Program Requirements
- Physicists Role
- Physicists Required Tests
  - Stereotactic Breast Biopsy
  - Ultrasound

Educational Objectives

- Understand the annual test requirements for stereotactic breast biopsy systems.
- Understand the testing requirements for breast ultrasound systems.
- Help facilities obtain the designation of Breast Imaging Center of Excellence.

What is it? - Requirements

- ACR Accreditation in:
  - Mammography – ACR or State Accreditation
  - Stereotactic Breast Biopsy
  - Ultrasound
    - Must include ultrasound guided breast biopsy

What do you get?

- Free participation in the National Mammography Database (NMD)
- Marketing tools
- National Recognition

National Mammography Database

- Receive routine medical audit reports that exceed FDA audit data collection requirements (Examples: Sample Facility Report | Sample Physician Report)
- Compare performance to peer facilities
- Target specific areas of improvement
- Implement successful quality improvement programs

Ref: http://www.acr.org/accreditation/bicoe/NMD-Participation.aspx

NMD™ NATIONAL MAMMOGRAPHY DATABASE

Physicists Role

- Mammography Accreditation
  - Annual testing (required)
  - QC Program Review (required)
  - Dose Measurement (required)
- Stereotactic Breast Biopsy Accreditation
  - Annual Testing (required)
  - QC Program Review (required)
  - Dose Measurement (required)

Physicists Role

- Ultrasound Accreditation
  - Semi-annual testing by service engineer or physicist

MQSA Physicist

- Initial Requirements
  - Mammography – MQSA
  - Stereotactic Breast Biopsy – ACR
  - Ultrasound - None
- Continuing requirements
  - Mammography – MQSA
  - Stereotactic Breast Biopsy – ACR
  - Ultrasound - None

Stereotactic Breast Biopsy Physicist

- Initial Qualifications
  - Qualified to perform Mammography surveys under MQSA
  - Perform one (1) hands on survey of a stereotactic breast biopsy unit under a QMP or at least 3 independent surveys prior to 6/1/97
- Continuing Experience
  - Upon renewal 2 SBB surveys over a 24 month period
- Continuing Education
  - Upon renewal 3 CEU's in SBB every three years

Ref: http://www.acr.org/accreditation/stereotactic/stereotactic_breast_reqs.aspx

What are the minimum continuing experience requirements for the physicist performing stereotactic breast biopsy system surveys for the ACR Accreditation program?

6% 1. 1 stereotactic breast biopsy survey over a 12 month period

81% 2. 2 stereotactic breast biopsy surveys over a 24 month period

0% 3. 3 stereotactic breast biopsy surveys over a 24 month period

13% 4. 3 stereotactic breast biopsy surveys over a 36 month period

0% 5. 4 stereotactic breast biopsy surveys over a 36 month period

Answer

2. 2 stereotactic breast biopsy surveys over a 24 month period

Ref: Stereotactic Breast Biopsy Program Requirements: American College of Radiology http://www.acr.org/accreditation/stereotactic.aspx

Ultrasound - Physicist

- No requirements yet!

Stereotactic Breast Biopsy Program Requirements

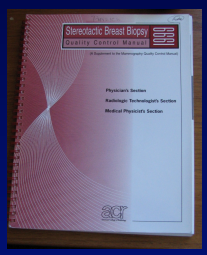
- Quality Assurance Questionnaire
- Test Image Data Sheet
- Dosimeter
- Clinical Images (on film)
- Phantom Images (on film)
- Medical Physicists Annual Survey Report
- Daily, Weekly Tech QC (one month)
- Monthly, Quarterly, Semi-annual Tech QC records (one year)

Technologist Quality Control

- Daily – Localization Accuracy Test
- Phantom Imaging (weekly)
- Printer QC (monthly)
- Visual Checklist (monthly)
- Compression (semi-annually)
- Repeat Analysis (quarterly)
- Zero Alignment Test (per manufacturer)
- Dark Room Testing (if using film screen)

Stereotactic Breast Biopsy

- Annual testing required by physicist
- ACR QC Manual available



Ref: Stereotactic Breast Biopsy Quality Control Manual
1999 American College of Radiology

Stereotactic Breast Biopsy Annual Test

- Unit Assembly Evaluation
- Collimation Assessment
- Focal Spot Performance and System Limiting Spatial Resolution
- kVp Accuracy
- Beam Quality Assessment (Half Value Layer)

Stereotactic Breast Biopsy Annual Test

- Automatic Exposure Control(AEC) or Manual Exposure Assessment
- Uniformity of Screen Speed (Screen Film Systems)
- Digital Receptor Uniformity (For Digital Image Receptors)
- Breast Entrance Exposure, Average Glandular Dose, and Exposure Reproducibility

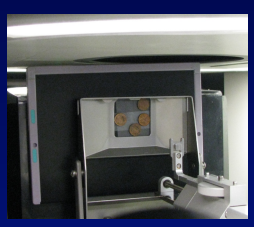
Stereotactic Breast Biopsy Annual Test

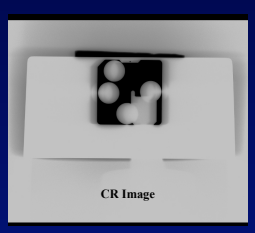
- Image Quality Evaluation
- Artifact Evaluation
- Localization Accuracy Test

Unit Assembly Evaluation

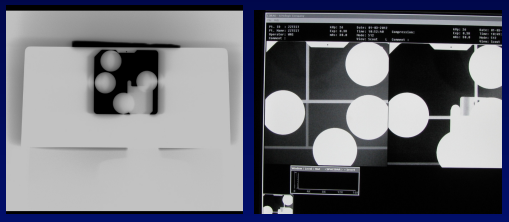
- Mechanically Stable
- Moving parts
- Locks/Detents
- Image receptor no vibes
- Compressed breast thickness indicator
- No rough edges
- Technique charts
  - 512/1024 modes
- Radiation shielding
- Needle guides support needle

Collimation





Collimation



If any edge of radiation field deviates more than 5 mm from the edge of the image receptor, or if any edge of the compression paddle projects into the X-ray field by more than 5 mm, then seek service adjustment.

What is the maximum allowable alignment deviation of the radiation field edge to the image receptor for a stereotactic breast biopsy system?

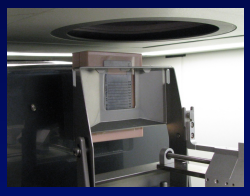
0%	1. 1 mm
13%	2. 2 mm
0%	3. 3 mm
0%	4. 4 mm
88%	5. 5 mm

Answer

- 5. 5 mm

Ref: Stereotactic Breast Biopsy Quality Control Manual 1999, Medical Physicist Section, Collimation Assessment, American College of Radiology

Focal Spot Performance and System Limiting Resolution



Action Limit: Note any significant degradation from previous measurement and seek service.

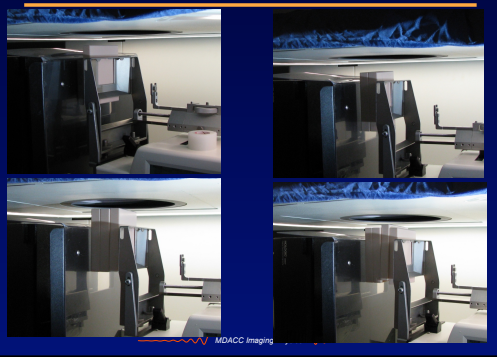
kVp

Action Limit: If the mean kVp differs from the nominal by more than +/- 5% of the nominal kVp, or if the coefficient of variation exceeds 0.02, then seek service correction

Beam Quality – Half Value Layer

- HVL ≥ kVp/100

Automatic Exposure Control (AEC)



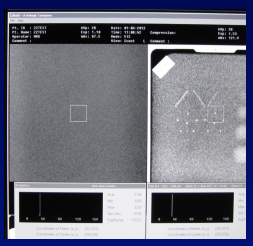
Technique Chart

Breast Thickness	Exposure Mode	kVp Setting	Density Control Setting	Phototimed (Yes or No)
< 3 cm	512	26	N/A	Yes
3 to 5 cm	512	28 - 30	N/A	Yes
5 to 7 cm	512	30 - 32	N/A	Yes
> 7 cm	512	34	N/A	Yes

Breast Thickness	Exposure Mode	kVp Setting	Density Control Setting	Phototimed (Yes or No)
< 3 cm	1024	28	N/A	Yes
3 to 5 cm	1024	30 - 32	N/A	Yes
5 to 7 cm	1024	32 - 34	N/A	Yes
> 7 cm	1024	34	N/A	No – 400 mAs

AEC Performance

- Select kVp
- Use AEC and make exposure
- Measure mean pixel value in center of field
- Meet manufacturers specificatiions



AEC

- Ideally, clinical techniques (whether AEC or manual) should keep exposure times under 2 seconds while meeting manufacturers signal requirements

Ref: Stereotactic Breast Biopsy Quality Control Manual 1999

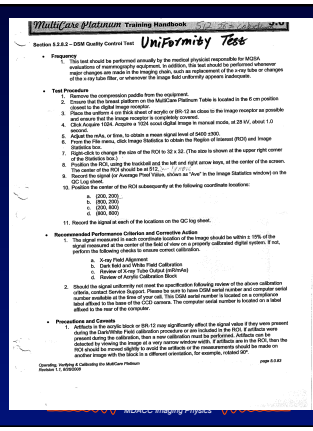
Digital Field Uniformity

Both 512 and 1024 modes

- Action Limit: If SNR(I) / SNR(Center) is > 1.15 or < 0.85, seek service correction.

Digital Field Uniformity

- May require manufacturers service manual for procedure.



MultiCare Platinum Training Handbook

Section 5.2.6.2 – DSM Quality Control Test Uniformity Test

- **Frequency**
  1. This test should be performed annually by the medical physicist responsible for MQSA evaluations of mammography equipment. In addition, this test should be performed whenever major changes are made in the imaging chain, such as replacement of the x-ray tube or changes of the x-ray tube filter, or whenever the image field uniformity appears inadequate.
- **Test Procedure**
  1. Remove the compression paddle from the equipment.
  2. Ensure that the breast platform on the MultiCare Platinum Table is located in the 6 cm position closest to the digital image receptor.
  3. Place the uniform 4 cm thick sheet of acrylic or BR-12 as close to the image receptor as possible and ensure that the image receptor is completely covered.
  4. Click Acquire 1024. Acquire a 1024 scout digital image in manual mode, at 28 kV, about 1.0 second.
  5. Adjust the mAs, or time, to obtain a mean signal level of 5400 ±300.
  6. Press the Fn menu, click Image Statistics to obtain the Region of Interest (ROI) and Image Statistics box.
  7. Right-click to change the size of the ROI to 32 x 32. (The size is shown at the upper right corner of the Statistics box.)
  8. Position the ROI, using the trackball and the left and right arrow keys, at the center of the screen. The center of the ROI should be at 512, 1 0 0 0.
  9. Record the signal (or Average Pixel Value, shown as "Ave" in the Image Statistics window) on the QC Log sheet.
  10. Position the center of the ROI subsequently at the following coordinate locations:
    a. (200, 200)
    b. (800, 200)
    c. (200, 800)
    d. (800, 800)
  11. Record the signal at each of the locations on the QC log sheet.
- **Recommended Performance Criterion and Corrective Action**
  1. The signal measured at each coordinate location of the image should be within ± 15% of the signal measured at the center of the field of view on a properly calibrated digital system. If not, perform the following checks to ensure correct calibration.
    a. X-ray Field Alignment
    b. Dark field and White Field Calibration
    c. Review of X-ray Tube Output (mR/mAs)
    d. Review of Acrylic Calibration Block
  2. Should the signal uniformity not meet the specification following review of the above calibration criteria, contact Service Support. Please be sure to have DSM serial number and computer serial number available at the time of your call. This DSM serial number is located on a compliance label affixed to the base of the CCD camera. The computer serial number is located on a label affixed to the rear of the computer.
- **Precautions and Caveats**
  1. Artifacts in the acrylic block or BR-12 may significantly affect the signal value if they were present during the Dark/White Field calibration procedure or are included in the ROI. If artifacts were present during the calibration, then a new calibration must be performed. Artifacts can be detected by viewing the image at a very narrow window width. If artifacts are in the ROI, then the ROI should be moved slightly to avoid the artifacts or the measurements should be made on another image with the block in a different orientation, for example, rotated 90°.

Operating, Verifying & Calibrating the MultiCare Platinum
Revision 1.1, 6/30/2009

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Breast Entrance Exposure Average Glandular Dose, and Exposure Reproducibility

- Use AEC to expose Phantom
- Find closest manual technique
- Replace phantom with ion chamber
- Make 4 exposures

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Dose

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Dose

- We check both 512 and 1024 modes
- Made change to technique chart to get 1024 mode to be less than 300 mrad
- "The average glandular dose to an average (4.2 cm compressed) breast should not exceed 3 mGy (300 mrad) per view for film-screen or digital image receptors"

Technique Chart

Breast Thickness	Exposure Mode	kVp Setting	Density Control Setting	Phototimed (Yes or No)
< 3 cm	512	26	N/A	Yes
3 to 5 cm	512	28 - 30	N/A	Yes
5 to 7 cm	512	30 - 32	N/A	Yes
> 7 cm	512	34	N/A	Yes

Breast Thickness	Exposure Mode	kVp Setting	Density Control Setting	Phototimed (Yes or No)
< 3 cm	1024	28	N/A	Yes
3 to 5 cm	1024	30 - 32	N/A	Yes
5 to 7 cm	1024	32 - 34	N/A	Yes
> 7 cm	1024	34	N/A	No – 400 mAs

What is the maximum allowable dose per view to a 4.2 cm compressed breast as recommended by the ACR?

0%	1. 1.5 mGy
0%	2. 2.0 mGy
0%	3. 2.5 mGy
100%	4. 3.0 mGy
0%	5. 3.5 mGy

Answer

4. 3.0 mGy

Ref: Stereotactic Breast Biopsy Quality Control Manual, Medical Physicist Section Breast Entrance Exposure, Average Glandular Dose, and Exposure Reproducibility

Image Quality Evaluation

Required Minimum Scores-Film Screen

- Mammography Accreditation Phantom
  - 4.0 Fibers
  - 3.0 Specs
  - 3.0 Masses
  - Total: 10.0
- Mini-phantom
  - 2.0 Fibers
  - 2.0 Specs
  - 2.0 Masses
  - Total: 6.0

Required Minimum Scores - Digital Receptor

- Mammography Accreditation Phantom
  - 5.0 Fibers
  - 4.0 Specs
  - 3.5 Masses
  - Total: 12.5
- Mini-phantom
  - 3.0 Fibers
  - 3.0 Specs
  - 2.5 Masses
  - Total: 8.5

What are the minimum scores for a digital receptor when using the mini-phantom?

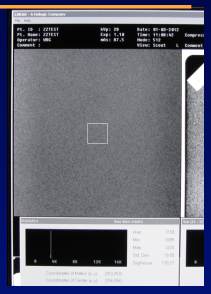
0% 1. 1.0 Fibers, 1.0 Spec groups, 1.0 Masses
12% 2. 2.0 Fibers, 2.0 Spec groups, 2.5 Masses
82% 3. 3.0 Fibers, 3.0 Spec groups, 2.5 Masses
6% 4. 3.5 Fibers, 3.5 Spec groups, 3.0 Masses
0% 5. 4.0 Fibers, 4.0 Spec groups, 4.0 Masses

Answer

- 3. 3.0 Fibers, 3.0 Spec groups, 2.5 Masses
- Ref: Stereotactic Breast Biopsy Quality Control Manual, Medical Physicist Section Image Quality Evaluation

Artifact Evaluation

- Note any artifacts or non-uniformities in the field.
- Both 512 and 1024 modes

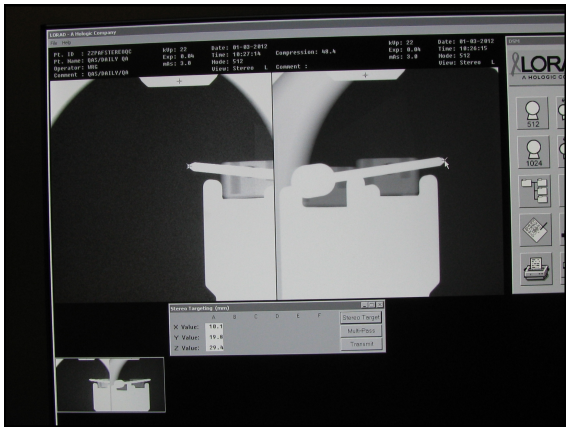


Localization Accuracy Test

Localization

Localization

Daily Localization Accuracy Test



Breast Ultrasound Accreditation

Program Requirements - QC

Recommended Quality Control for Breast Ultrasound		
Test	**Frequency**	**Performed By**
Maximum depth of visualization and hardcopy recording with a tissue-mimicking phantom	Semiannually	Service engineer/medical physicist
Vertical and horizontal distance accuracy	Semiannually	Service engineer/medical physicist
Uniformity	Semiannually	Service engineer/medical physicist
Electrical-mechanical cleanliness condition	Semiannually	Service engineer/medical physicist
Anechoic void perception	Semiannually	Service engineer/medical physicist
Ring down	Semiannually	Service engineer/medical physicist
Lateral resolution	Semiannually	Service engineer/medical physicist
Quality control checklist	Semiannually	Service engineer/medical physicist
Adherence to universal infection control procedures	After each biopsy	Technologist
Clean transducers	After each patient	Technologist
Vertical and horizontal distance accuracy	Quarterly	Technologist
Grey-scale photography	Quarterly	Technologist

Physicist Report or Service Engineer Report

As part of accreditation, facilities must submit a copy of the service engineer's most recent preventative maintenance report or the medical physicist's most recent equipment survey. Although the ACR will not initially use this information to determine whether a facility passes or fails accreditation, it may be used in the future to set criteria

What is the recommended frequency for equipment surveys of ultrasound equipment for the ACR's breast ultrasound accreditation program?

1. Quarterly
2. Semiannually
3. Annually
4. Every other year
5. None

Answer

- 2. Semi-annually

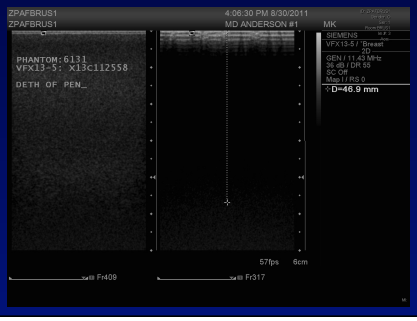
Ref: Stereotactic Breast Biopsy Accreditation Program Requirements

http://www.acr.org/accreditation/breast.aspx

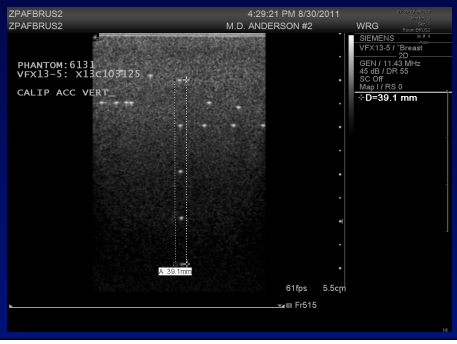
Electrical – Mechanical Condition

- Power cord
- Wheel Locks, Brakes
- Housing
- Scan Head Cable, Plugs
- Scan Head Housing, Window
- Monitor
- Air Filters
- VCR
- Printer Function

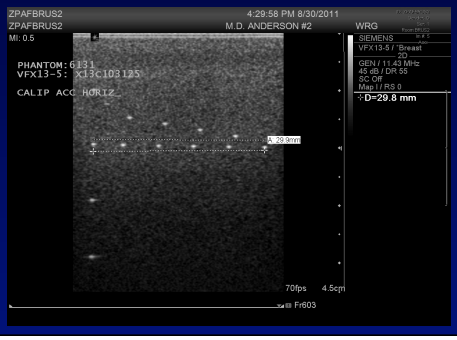
Maximum Depth of Visualization



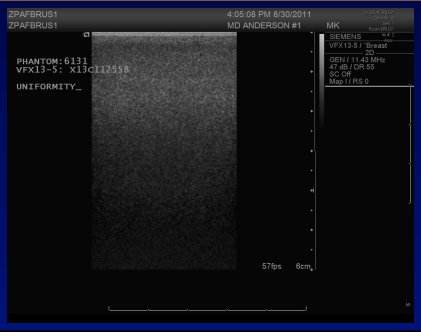
Vertical Distance Accuracy



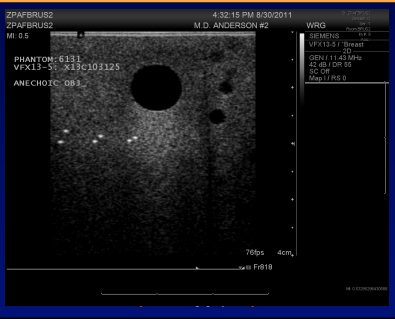
Horizontal Distance Accuracy



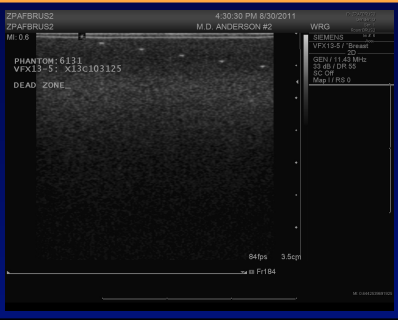
Uniformity



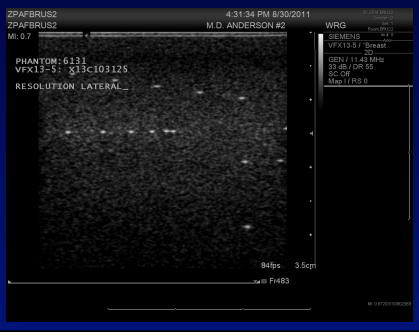
Anechoic Void Perception



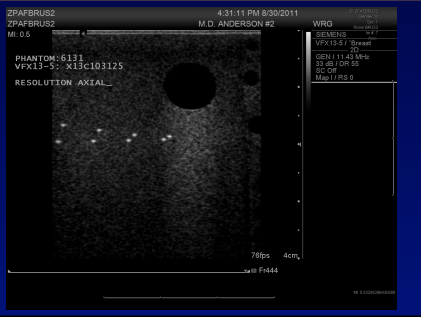
Ring Down – Dead Zone



Lateral Resolution



Axial Resolution



Questions?

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