

Surveying and QC for FFDM

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for sharing many of these slides

OVERVIEW

- **Important pre-survey events**
- **Manufacturer's tests and equipment**
- **Performing the survey**
- **Summary of important points and what really matters**

Important Pre-Survey Events

- **Obtain proper training & CE credits (8 hours)**
 - **Hands-on training on actual unit:**
 - **Mechanics**
 - **Software**
 - **Artifacts**
 - **Learn vendor specific tests and tricks**

Important Pre-Survey Events

- **ACR Accreditation - www.acr.org**
 - **Download Specific Physicist's Evaluation Test Summary Forms for FFDM System being evaluated**
 - **Download Updated Equipment Evaluation Form that is current for both digital and film/screen systems**

Important Pre-Survey Events

- **ACR Accreditation**
 - **Before clinical use**
 - **Medical Physicist equipment evaluation and indicate it passes**
 - **New unit application**
 - **Not required to wait for ACR response**
 - **However, no reimbursement without FDA receiving ACR app.**
 - **Approximately 3 days for accreditation approval from ACR**

Important Pre-Survey Events

- **Contact the site – things to confirm:**
 - **Site is aware of ACR or FDA application process**
 - **FFDM unit is operable**
 - **Review workstation is operable**
 - **Images can be transmitted**
 - **Laser printer works, can print mammo images, and hooked up to all RWS's**
 - **Discuss QC issues**
 - **Many QC failures result in stopping clinical imaging**
 - **ACR Phantom – do they have one on-site?**

Important Pre-Survey Events

- **Contact Manufacturer's Service Engineers**
 - **Is installation complete?**
 - **Can they be present?**
 - **If not, how can they be contacted?**
 - **Is the system working properly?**
 - **Can the laser printer service engineer be present?**

Important Pre-Survey Events

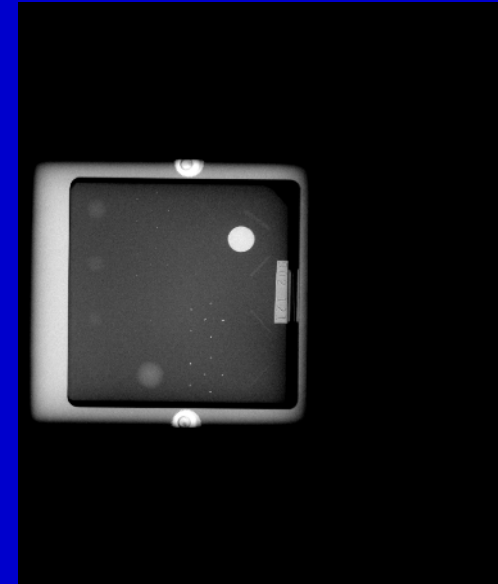
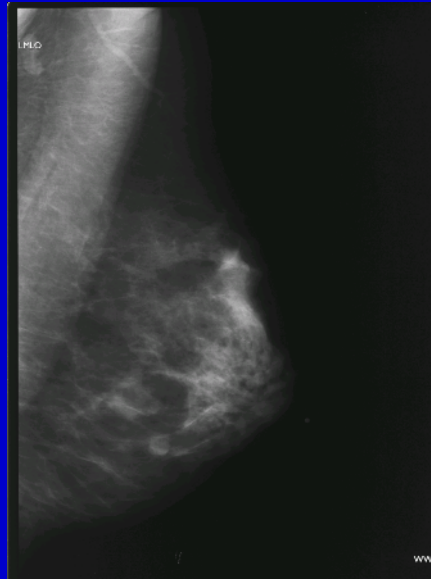
- **Gather Forms - ACR and Manufacturer's Physics test forms**
 - **Ensure you have tests that are required by manufacturer**
- **Gather test tools**
 - **Check required tests in manufacturer's manual**
 - **Artifact test tool – 2 inches of acrylic**
 - **Lead sheet**

Performing the Survey

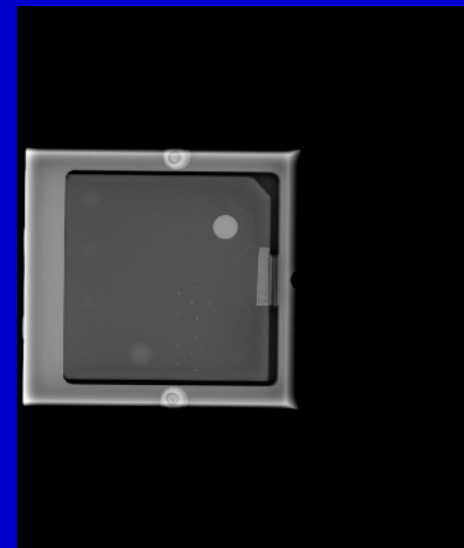
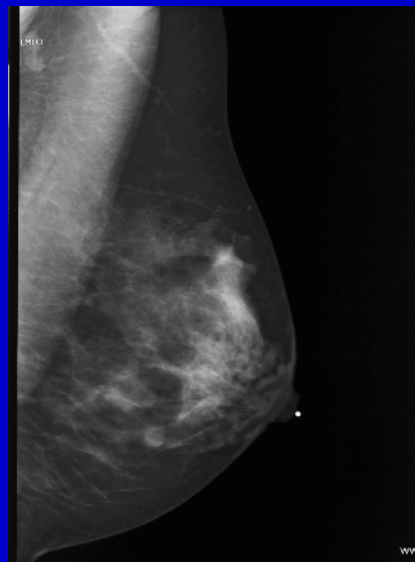
- **Must perform manufacturer's tests**
- **Turn off auto push and/or auto print**
 - Remember to turn them back on
- **Order of tests is important**
- **Use “Raw” or “Processed” images for testing per manufacturer's specifications**

Performing the Survey

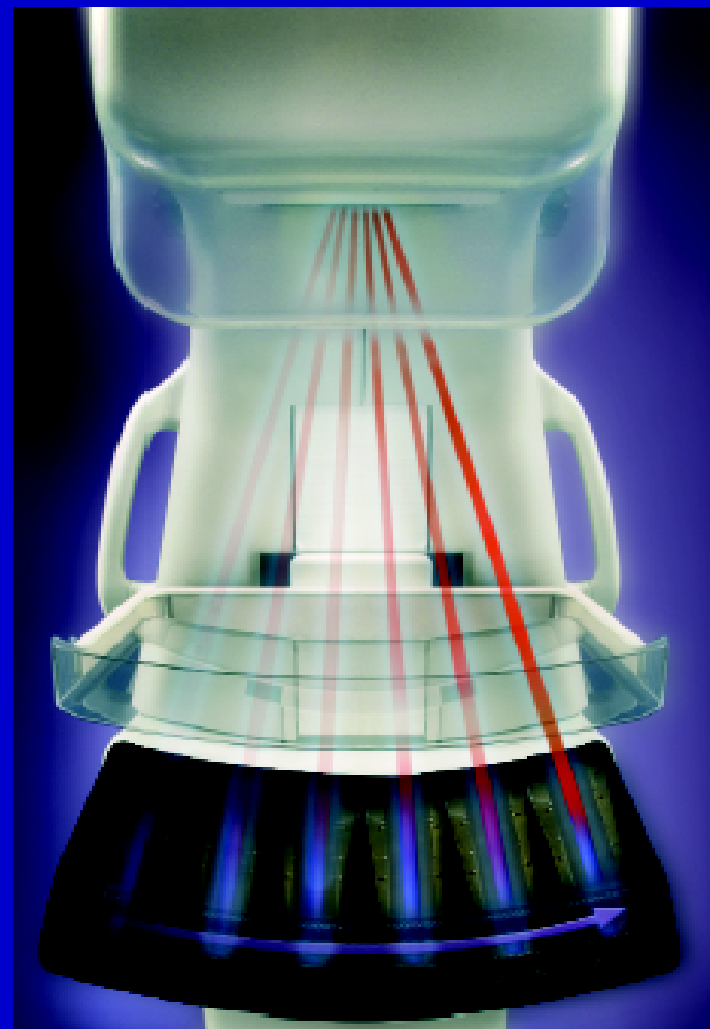
Raw Image



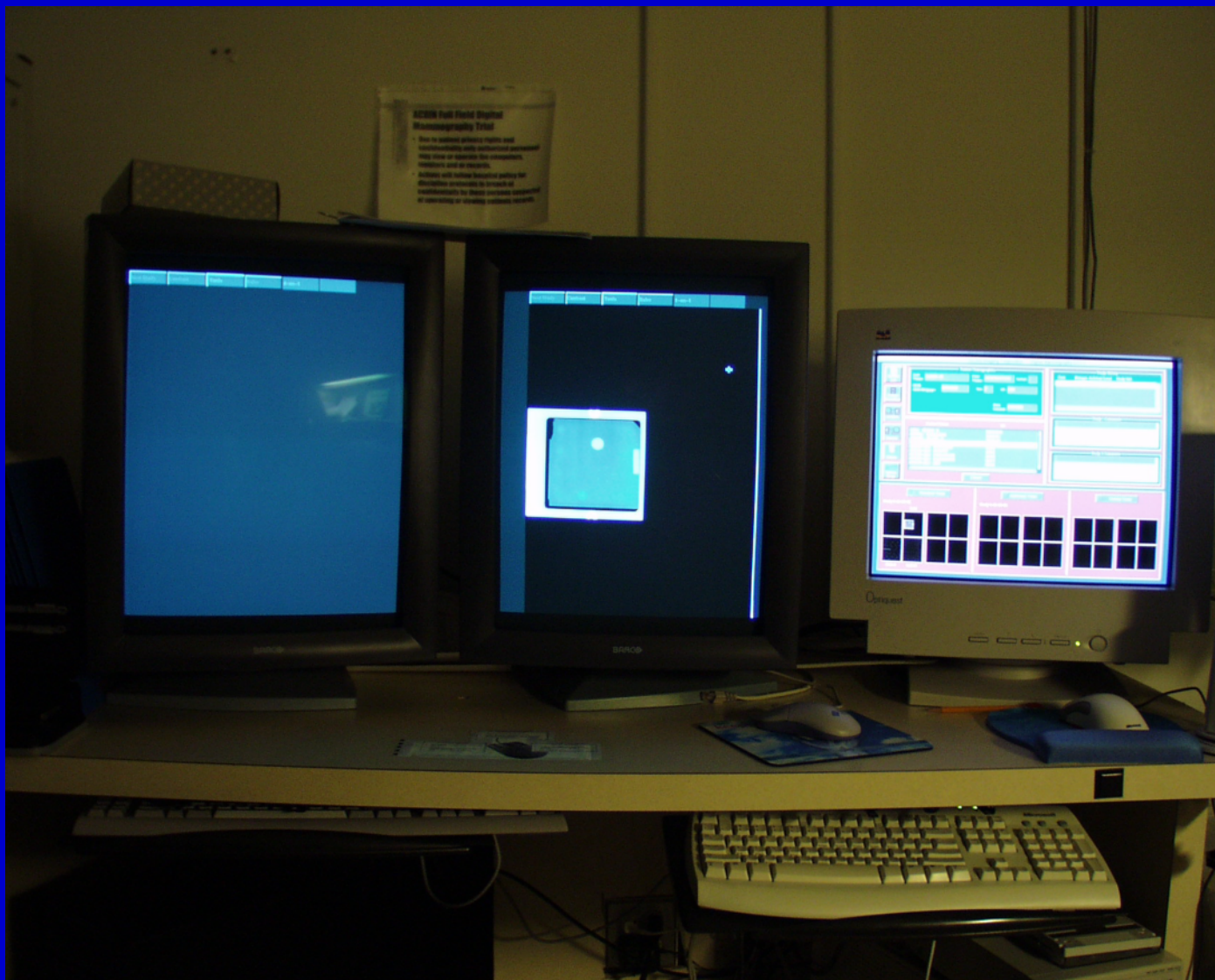
Processed Image



Fischer Senoscan



Fischer Senoscan



Fischer Senoscan - Performing the Survey

- Manufacturer's tests
 - X-ray field size and Chest wall missed tissue
 - Compression paddle alignment
 - kVp accuracy
 - Linearity, reproducibility, and accuracy
 - Beam Quality (HVL)
 - Dosimetry – average glandular dose
 - Phantom image acquisition

Fischer Senoscan - Performing the Survey

- Manufacturer's tests
 - Image quality
 - System resolution/scan speed uniformity
 - Flat field test
 - Geometric distortion and resolution uniformity
 - Automatic decompression control
 - System artifacts
 - Image display monitor(s) check – Tech Review
 - Image viewing room illuminance

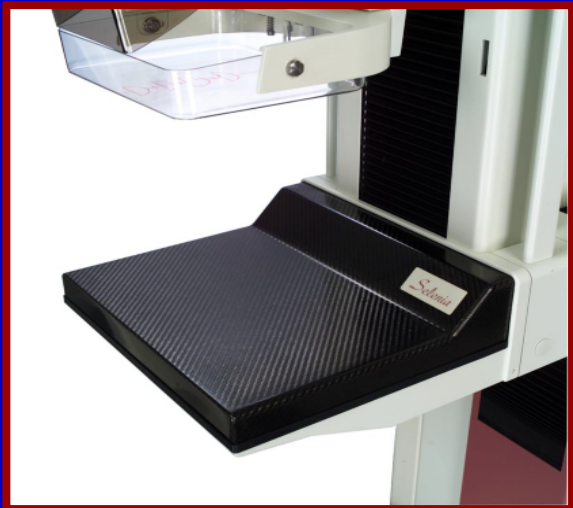
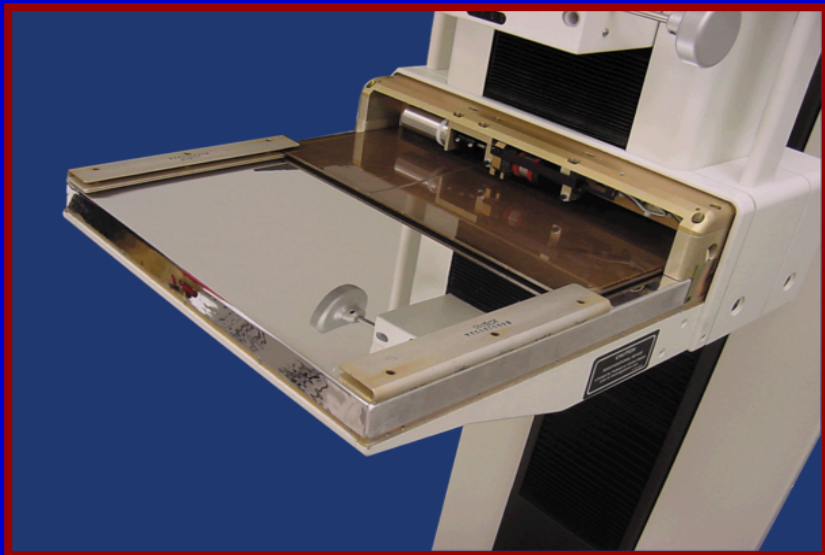
Fischer Senoscan - Performing the Survey

- Collimation

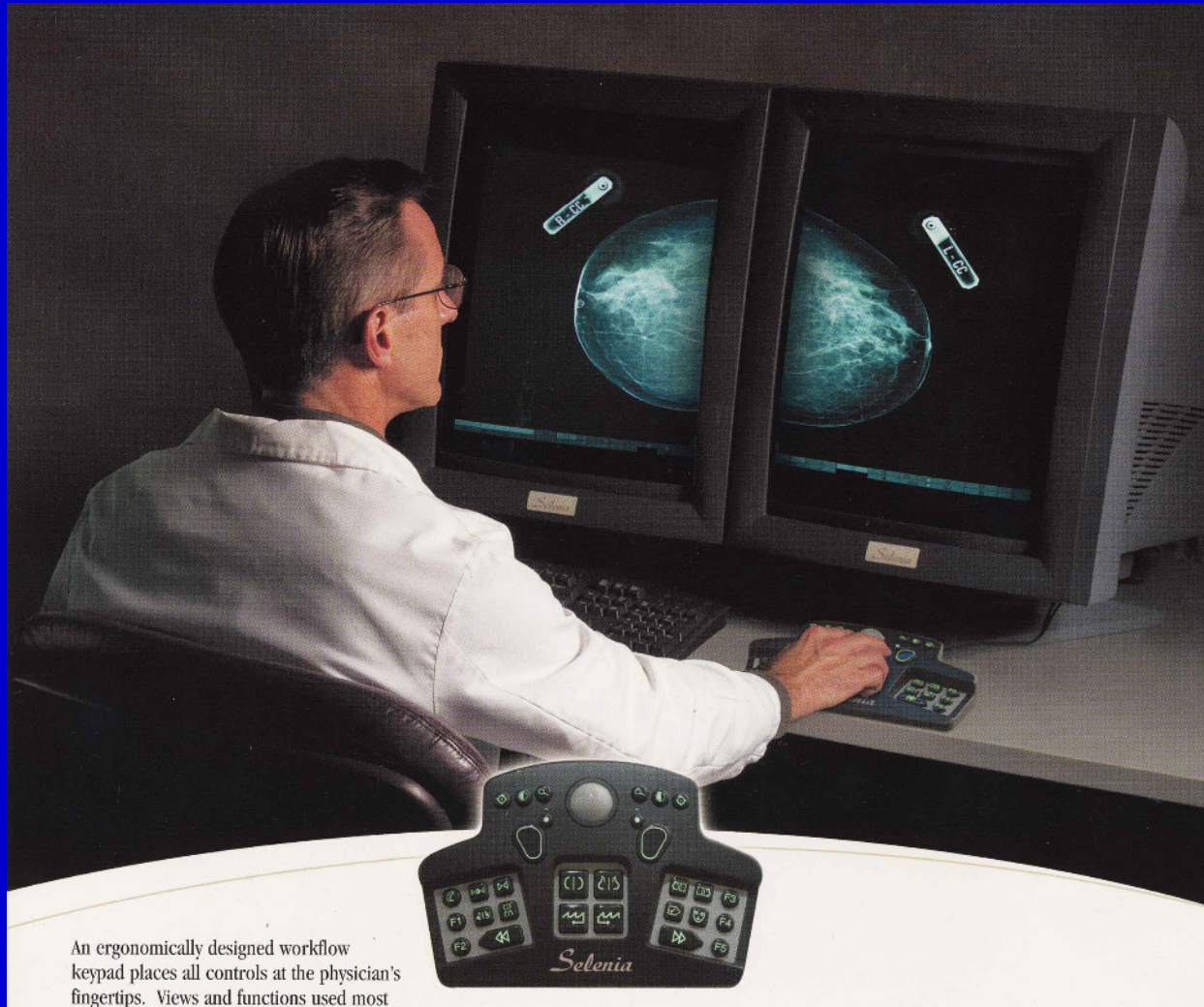
- Error between field-size markers and image receptor
must be less than 2% of SID
- Missed chest wall tissue less than 8.5 mm
- Compression paddle: distance between image receptor
at chest wall and inside of edge of paddle must
be ≤ 8.5 mm



Hologic/LORAD Selenia



LORAD Selenia Softcopy Workstation



An ergonomically designed workflow keypad places all controls at the physician's fingertips. Views and functions used most

LORAD Selenia - Performing the Survey

- Manufacturer's tests
 - Unit assembly evaluation *
 - Artifact evaluation *
 - Phantom image quality
 - Evaluation of system resolution
 - Signal-to-Noise and Contrast-to-Noise Measurements
 - Collimation assessment *

***30 Days to Repair**

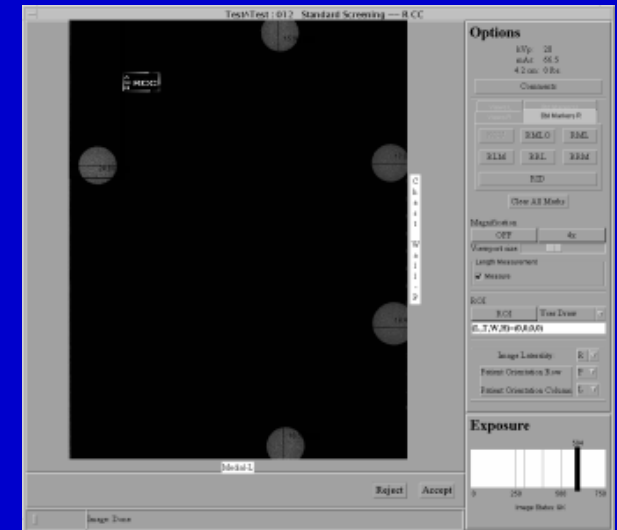
LORAD Selenia - Performing the Survey

- Manufacturer's tests
 - kVp accuracy and reproducibility *
 - Beam quality— HVL *
 - Breast Entrance exposure and average glandular dose
 - Radiation output rate *
 - Viewbox luminance and room illuminance *
 - **Softcopy Workstation QC**

***30 Days to Repair**

LORAD Selenia - Performing the Survey

- Collimation Assessment
 - Use coin techniques as described in ACR Manual
 - Test 24x29 cm detector mode
 - Test 18x24 cm detector mode
 - X-Ray field to light field coincidence
 - X-Ray field to image receptor alignment
 - Compression Paddle to Image Receptor Alignment



Lorad Selenia - Performing the Survey

- Artifact Evaluation
 - 4 cm acrylic block
 - Mo/Mo
 - Mo/Rh
 - Large & Small Spot
 - Evaluate for artifacts at WW ~ 250
 - Print films – check printer

LORAD Selenia - Performing the Survey

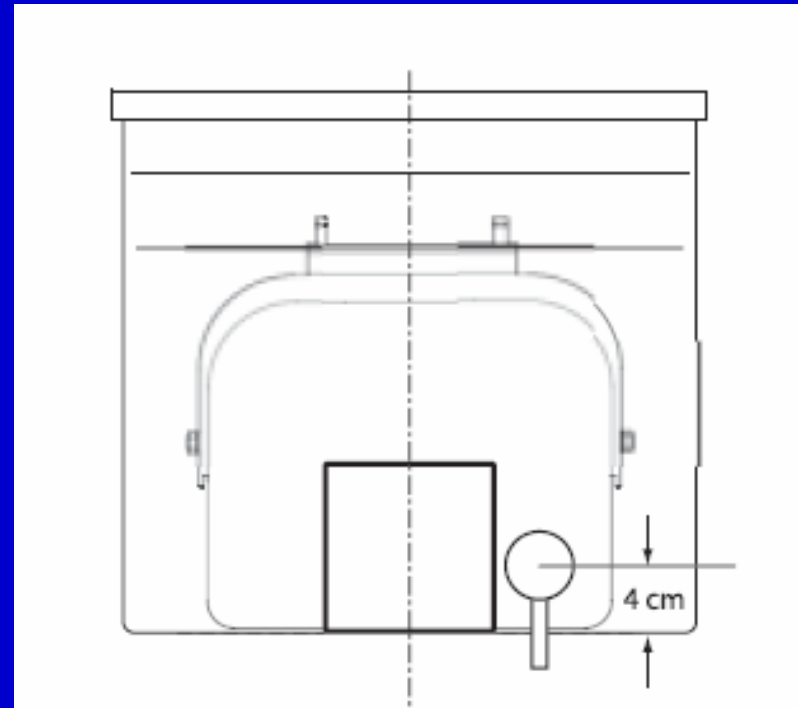
- kVp – Described in the 1999 ACR QC Manual
- HVL – Described in the 1999 ACR QC Manual
- Action Limits:
 - If measured HVL $< kVp/100 + 0.03$ (in mm Al) or
 - If measured HVL $> kVp/100 + C$ (in mm Al)
where $C = 0.12$ for Mo/Mo; $C = 0.19$ for Mo/Rh;
and $C = 0.22$ for Rh/Rh, then seek service correction.

LORAD Selenia - Performing the Survey

- Phantom Image Quality
 - 28 kVp, Auto Filter Mode, Photocell @ Position #2
 - Print film – measure OD and Contrast
 - Score on each SCW (Soft Copy Workstation)
 - 5 fibers
 - 4 speck groups
 - 4 masses
- Minimum Passing Score for
LORAD Selenia & Siemens
Mammomat Novation

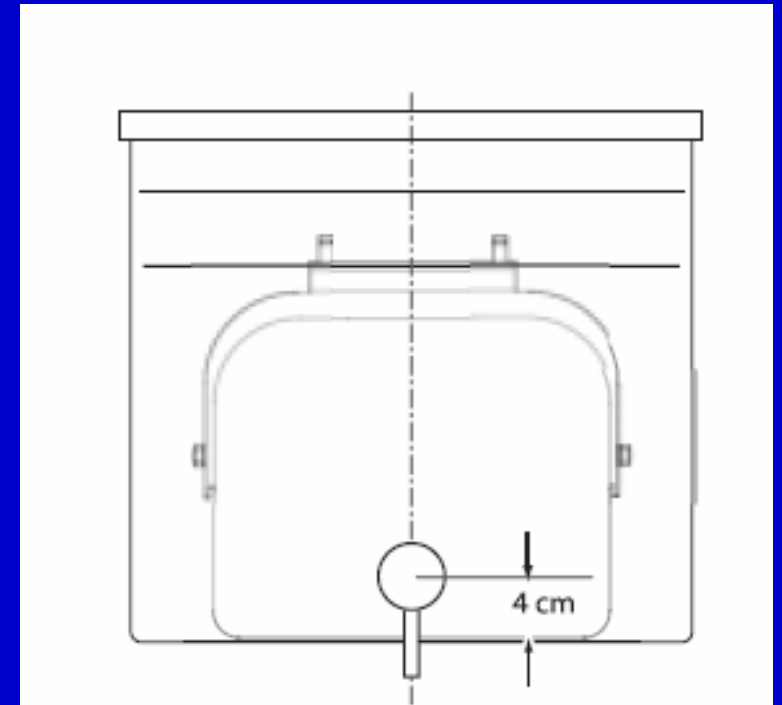
LORAD Selenia - Performing the Survey

- Breast Entrance Exposure and Average Glandular Dose
 - Technique set to clinically image average breast - 4.5 cm
 - 28 kVp, Auto Filter Mode
 - Photocell @ Position # 2
 - Calculated dose - < 3.0 mGy



Lorad Selenia - Performing the Survey

- Radiation Output Rate
 - Cover detector for protection – lead sheet
 - Manual Mode Exposure
 - 28 kVp, 300 mAs
 - Output Exposure - > 800 mR/sec

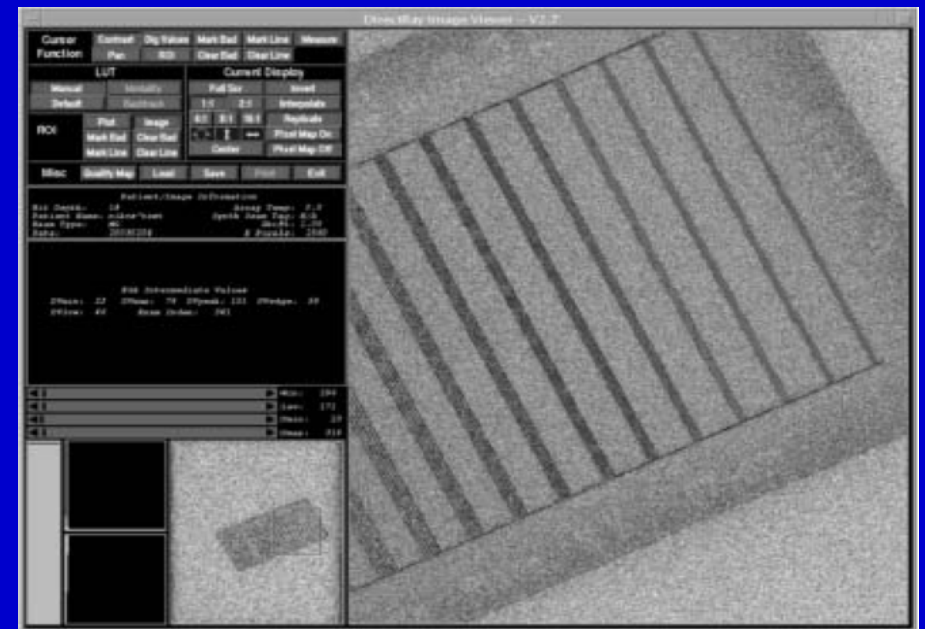


Lorad Selenia - Performing the Survey

- **Evaluation of System Resolution**

- **5-15 lp/mm Test Pattern**
- **4-cm Attenuation Block**
- **Pattern at 45-Degree Angle**
to the Detector

- The system limiting spatial resolution must be > 7 lp/mm



Lorad Selenia - Performing the Survey

- SNR and CNR Measurements

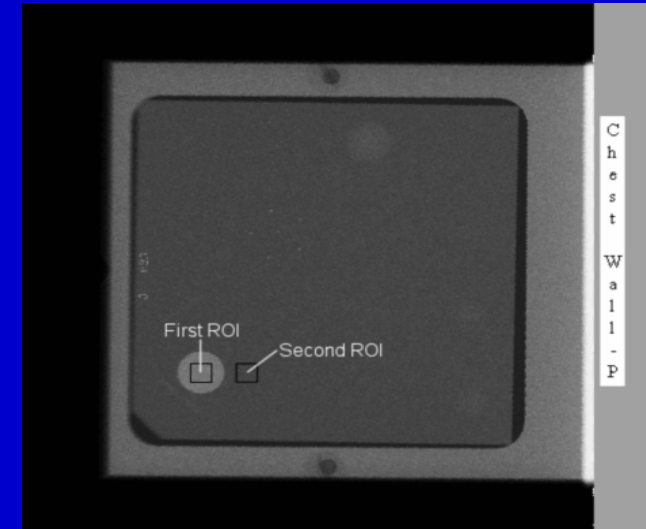
- SNR at least equal or greater than 40

- $SNR = (\text{Mean}_{\text{Bkgd}} - \text{DC}_{\text{offset}}) / \text{SD}_{\text{Bkgd}}$ $\text{DC}_{\text{offset}} = 50$

- Establish CNR during acceptance testing

- $CNR = (\text{Mean}_{\text{Bkgd}} - \text{Mean}_{\text{Disk}}) / \text{SD}_{\text{Bkgd}}$

- CNR should stay within $\pm 15\%$ of measurement obtained during acceptance testing



LORAD Selenia - Performing the Survey

- SoftCopy Workstation QC

- Use supplied photometer and run monitor QC software
 - **White level** = CRT and LCD Monitors (levels depend on model)
 - **Black level** = 0 cd/m² - CRT Monitors Only
 - **Quality Level Performance** – checks full monitor calibration automatically
 - Warning level = 5% Tolerance level = 10% → Recalibrate
 - CRT and LCD Monitors
 - **Uniformity Performance** – minimize non-uniformities away from center of display
 - CRT Monitors Only

LORAD Selenia - Performing the Survey

- Viewbox Luminance and Room Illuminance

Mammographic viewbox is capable of a luminance of at least 3000 cd/sq m (nit)

Room illuminance (viewbox surface as seen by observer) is ≤ 50 lux

Room illuminance (monitor surface) is ≤ 20 lux for softcopy reading

GE Seno DS



GE Senographe DS

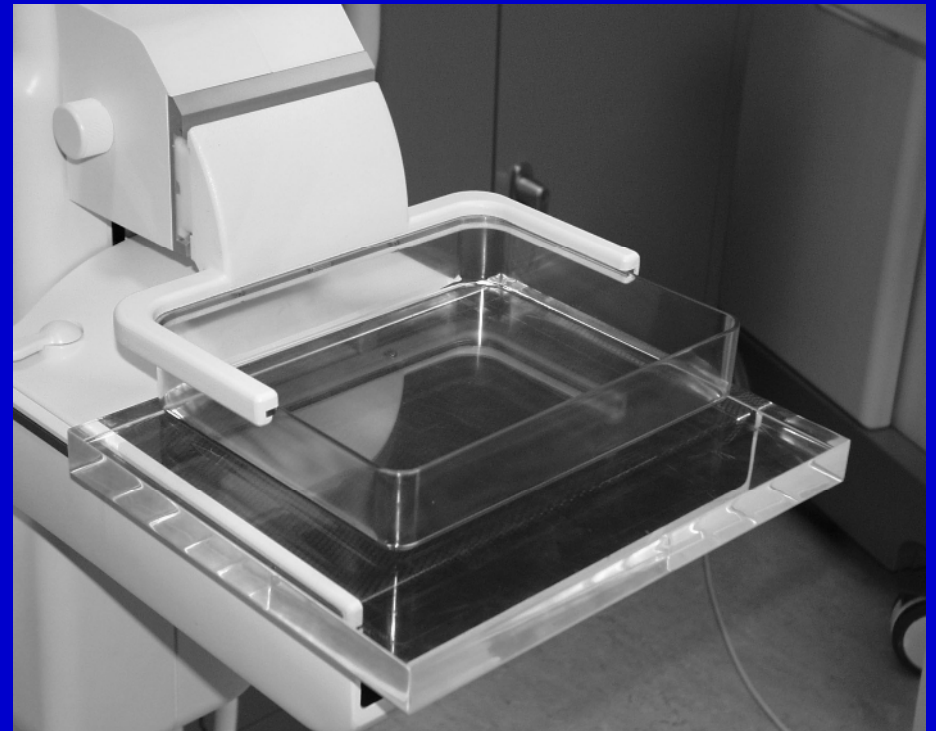
Seno Advantage RWS



Artifacts



Physicist must test all Target/Filter combinations and both sizes of focal spots for artifacts



GE Senographe Essential

Large and Small Fields
Require Collimation
Assessment of all three
positions of small field
plus large field for both
target materials



GE Senographe Essential Control Panel

**Laterality
must be
selected prior
to each
exposure**



GE Senographe DS

Quality Assurance Plan

Automated Evaluative Procedure

Patented Technology

Tracks IQ Over Time

Spatial Resolution

Small Signal Contrast

Dynamic Range

Resolution Uniformity

Distortion

Other

Run by Technologist

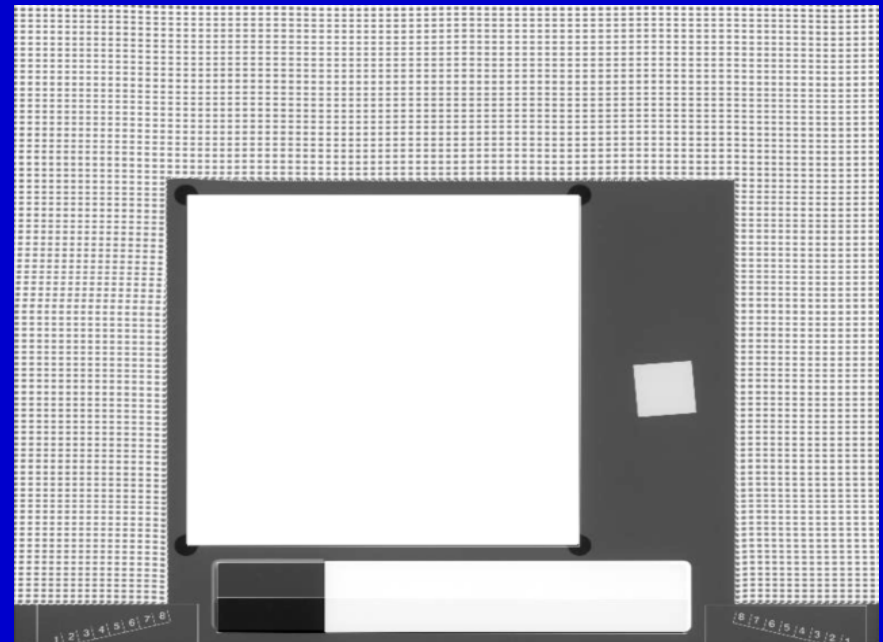
Pass/Fail Result

In-Site Interactive

Remote Corrections

Automatic Service Dispatch

GE Image Quality Signature
Test (IQST) Phantom



**QAP *Not* a calibration but a process that maximizes
Senographe digital image quality consistency**

GE Senographe DS

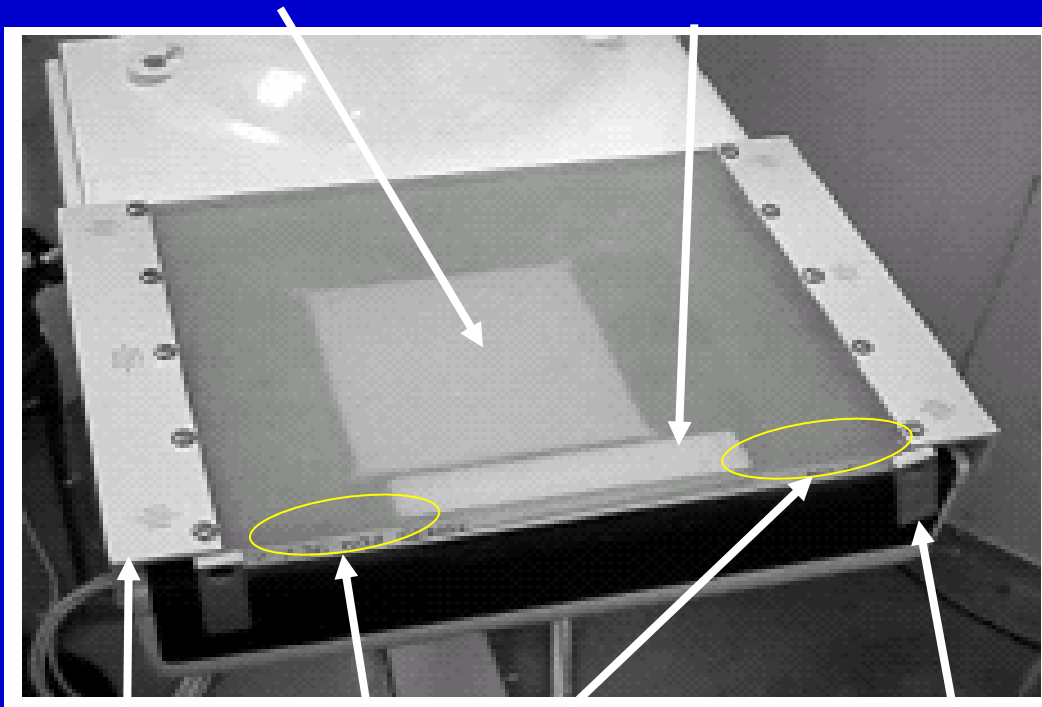
QA Phantom Overview

Uniform area for noise power spectrum measurement

Step wedge for contrast measurement

Mesh for resolution uniformity measurement

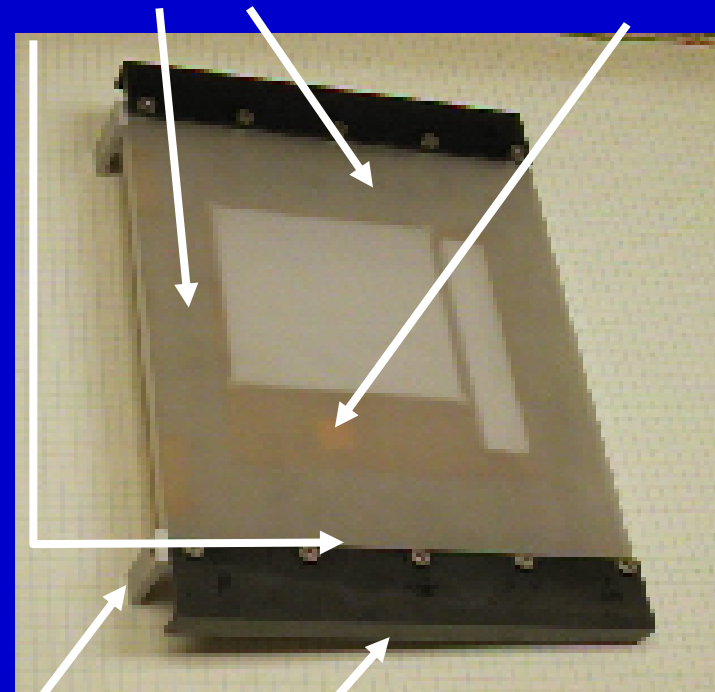
Edge object for MTF measurement



Rulers for measuring distance of detector from chest wall edge of Bucky

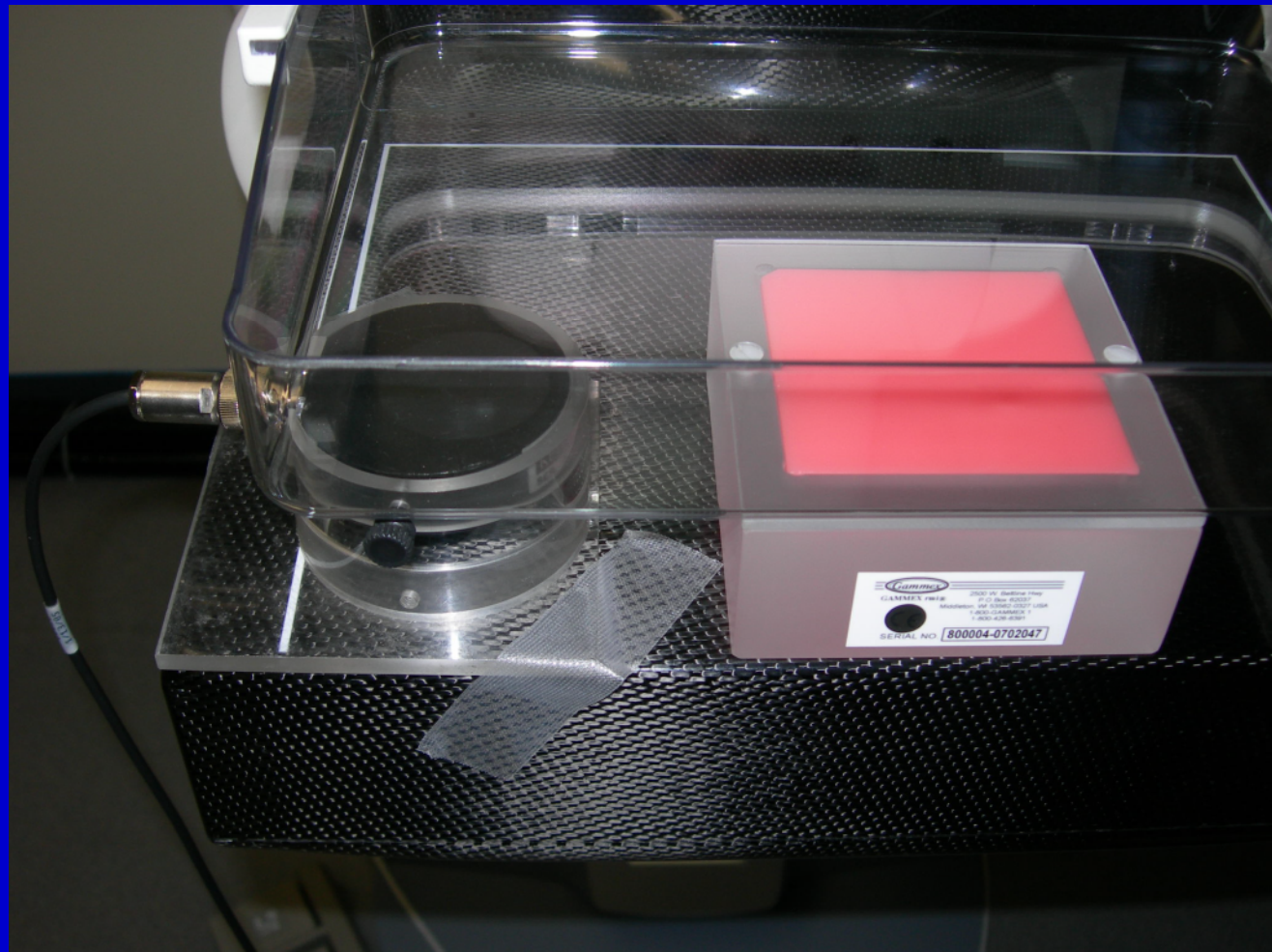
Tabs to position IQST with respect to chest wall edge of image receptor.

Rails to position the IQST left-to-right



GE Senographe Essential

**Measure Entrance
Skin Exposure
with Ion Chamber
at 5 cm from
outside edge of
detector area.**



CR Plates

Fuji CRm System

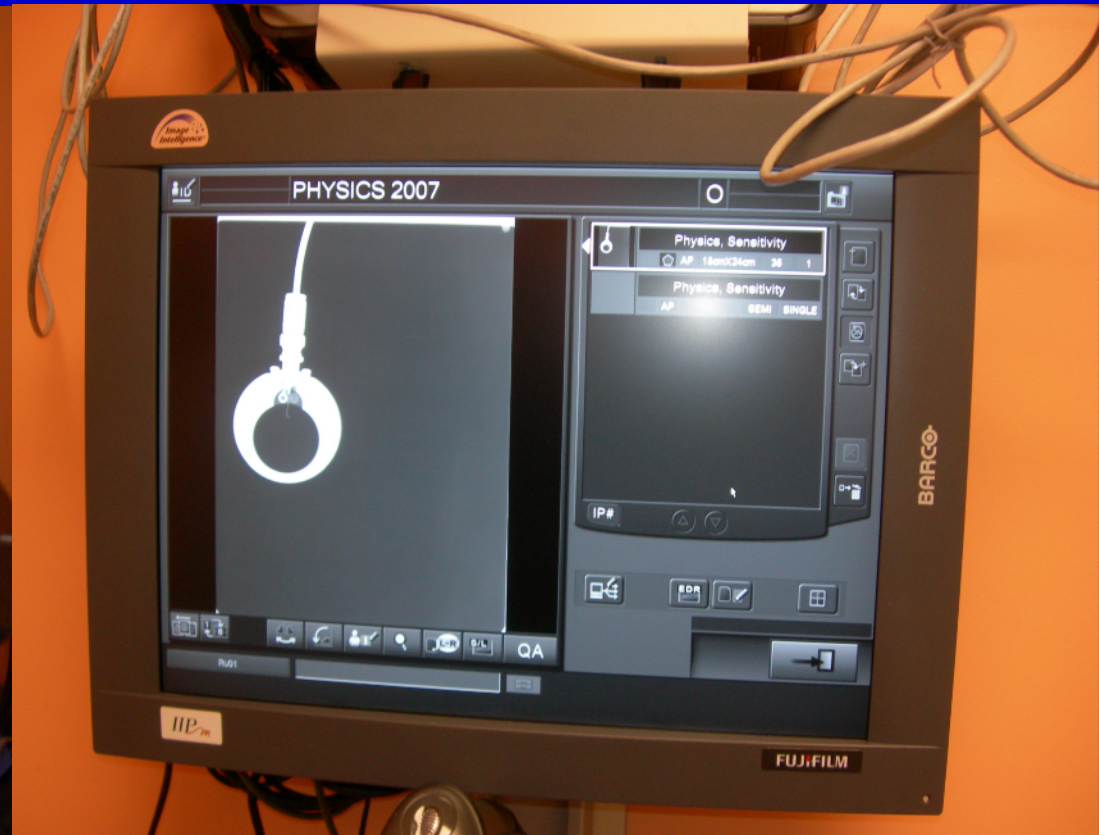
CR Plate Reader



Fuji CRm System

S-Value Confirmation

Measure Exposure Rate at Surface of Breast Support



Fuji CRm System

Dynamic Range Test



Fuji CRm System - CNR Test

CNR PER OBJECT THICKNESS

| Image Mode: | Auto Time | | | | | | | |
|-------------------|-----------|--------|------|------------|--------------|--------|----------------------------|------------------|
| Focal Spot: | 3 | | | | | | | |
| Density Control: | 0 | | | | | | | |
| AEC Mode: | Auto Time | | | | | | | |
| Phantom Thickness | Target | Filter | kVp | mAs (Auto) | mAs (Manual) | CNR | CNR (relative to 4cm PMMA) | Acceptable level |
| 2 cm | Mo | Mo | 25.0 | 27.2 | 28.0 | 17.197 | 114.4% | >110% |
| 4 cm | Mo | Mo | 25.0 | 135.0 | 130.0 | 15.030 | 100.0% | 100% |
| 6 cm | Mo | Rh | 30.0 | 282.0 | 280.0 | 13.765 | 91.6% | >90% |
| | | | | | | | PASS | |

Inter Plate Consistency

mAs limit is plus or minus 10 % from mean.
SNR limit is plus or minus 15 % from mean.

Exposure Unite ID:

Lorad M-III

| | AEC-mode | Target | Filter | kVp |
|---------------------|-----------|--------|--------|-----|
| Exposure conditions | Auto Time | Mo | Mo | 25 |

Group: Small Cassettes

| Cassette ID | mAs | Acceptable | SNR | Acceptable |
|-------------|-----|------------|------------|------------|
| A456, #3 | 132 | Yes | 70.9 46 | Yes |
| A234, #2 | 132 | Yes | 70.9 52 | Yes |
| A123, #1 | 132 | Yes | 70.1 52 | Yes |
| A222, #4 | 132 | Yes | 70.1 66 | Yes |
| A111, #5 | 132 | Yes | 69.5 21 | Yes |
| A777, #6 | 133 | Yes | 69.6 62 | Yes |

Fuji CRm - Monitor Tests

Site: Med. Img Ctr of So Cal
 Room #: Reading Room

Date of Survey: 4/19/2007
 Date of Installation: Apr-07

| DOME©E5 | Left Monitor | Right Monitor |
|-----------------------------------|--------------|---------------|
| Serial Numbers | 703PNKN00011 | 703PNKN00028 |
| | | |
| Luminance Value Setting (cd/sq-m) | 499.2 | 500.88 |

Target Value = 500 cd/sq-m

| | | |
|---|---|-----------------------------|
| Is the CXtra icon present in the taskbar and shown as a green check mark? | <input checked="" type="checkbox"/> Yes | <input type="checkbox"/> No |
| Manual Conformance report for both displays attached? | <input checked="" type="checkbox"/> Yes | <input type="checkbox"/> No |
| Is DICOM calibration Graph for both displays attached? | <input checked="" type="checkbox"/> Yes | <input type="checkbox"/> No |

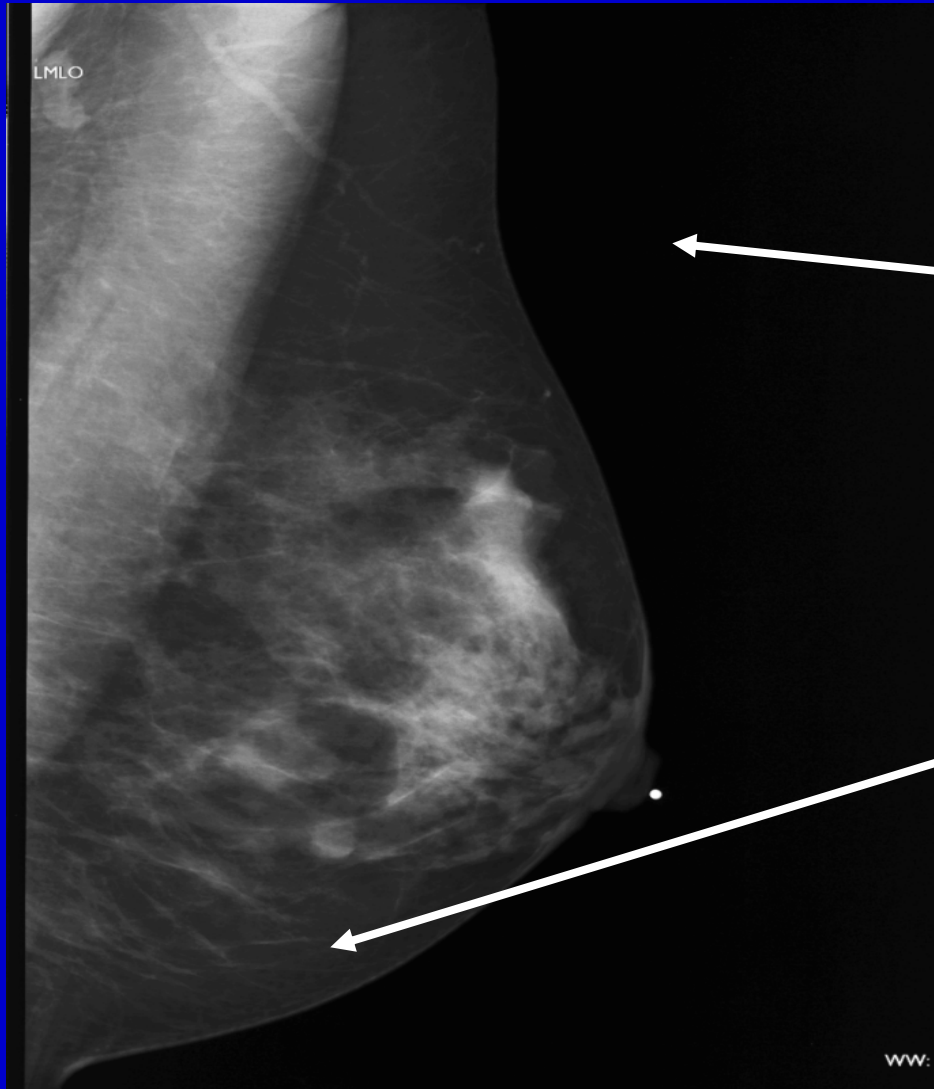
Laser Printer -
must be able to
print images on
mammography
laser film



FDA-Approved Laser Imagers for Digital Mammography

- **Agfa LR5200 Laser Imager (Wet Chemistry)**
- **Agfa DS4500M**
- **Kodak 8600 & 8610 Laser Imagers**
- **Konica DryPro 793 Laser Imager**
- **Kodak 8900M**
- **Fuji Drypix 5000 & 7000 Laser Imagers**
- **Fuji Drypix FM-DP L**

OD Requirements for Hi-Resolution Laser Imagers



$D_{\max} > 3.5 \text{ OD}$

Mid-density $> 1.5 \text{ OD}$

Laser Processor QC

Kodak daily sensitometry



Base + Fog

Density Difference – OD closest to 2.20 minus OD closest but not less than 0.45

Mid-density – step closest to but not less than 1.20

D_{\max}

Action Limits:

$MD \ \& \ DD \pm 0.15 \ OD$

$B+Fog = 0.03$

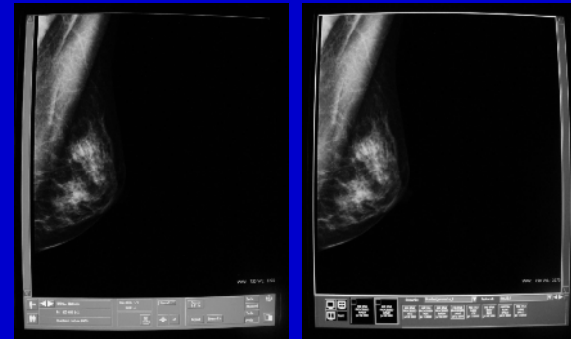
$D_{\max} \pm 0.25$

FDA Required Laser Printer QC

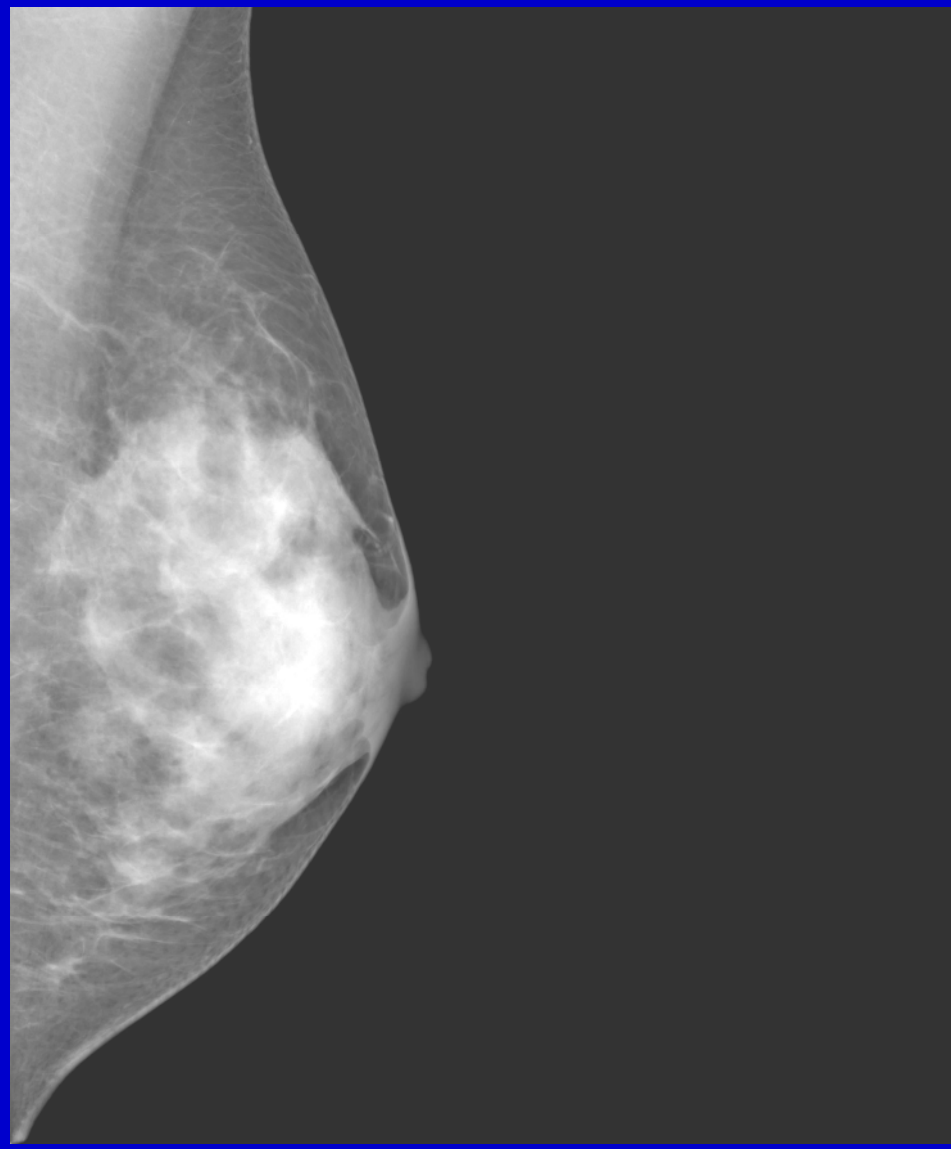
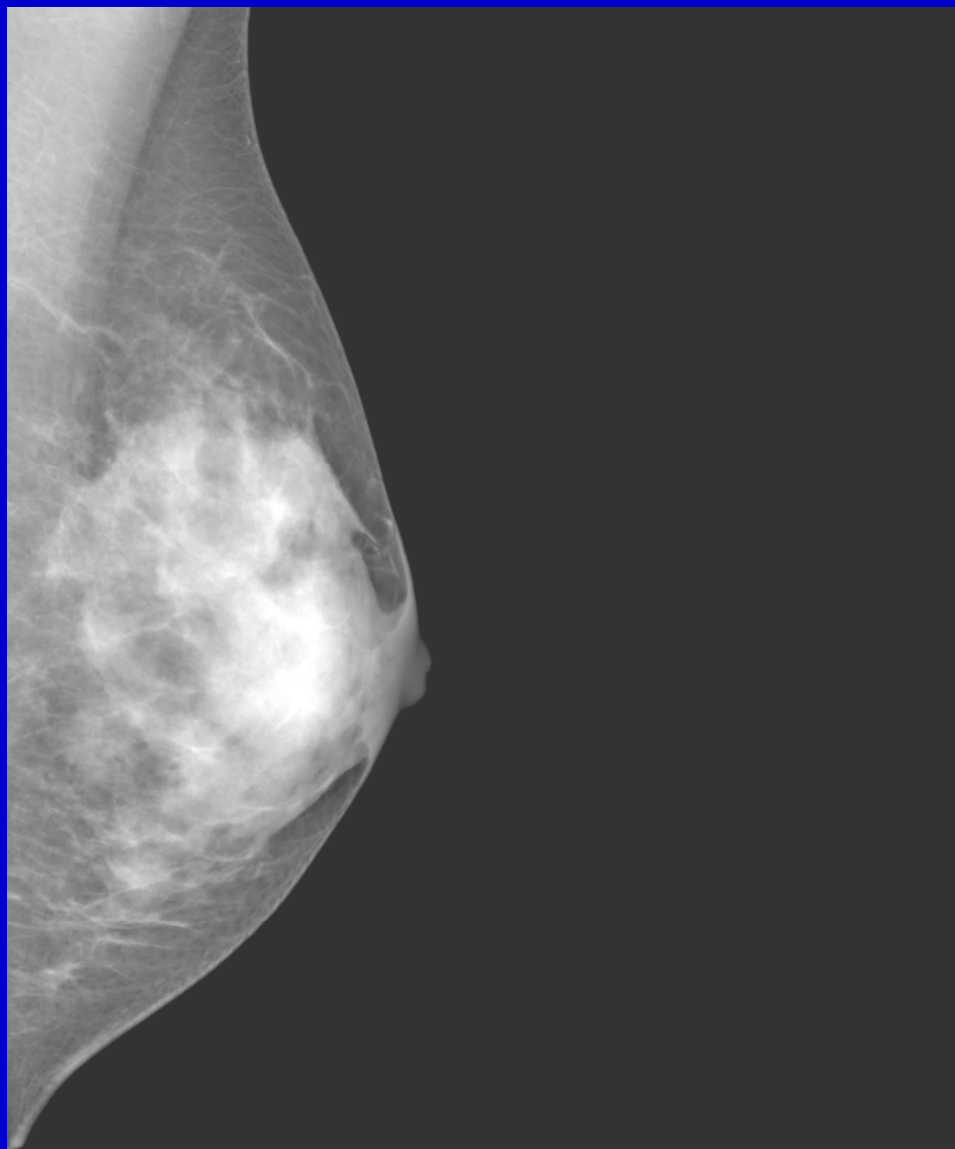
- GE 2000D & Senographe DS: Follow the laser printer manufacturer's QC manual
- Fischer Senoscan: Follow the laser printer manufacturer's QC manual
- Lorad Selenia: Follow the Lorad Selenia QC Manual
- Siemens Mammomat Novation DR: Follow the laser printer manufacturer's QC manual but conduct QC every day that images are printed.

RWS Clinical Image Check

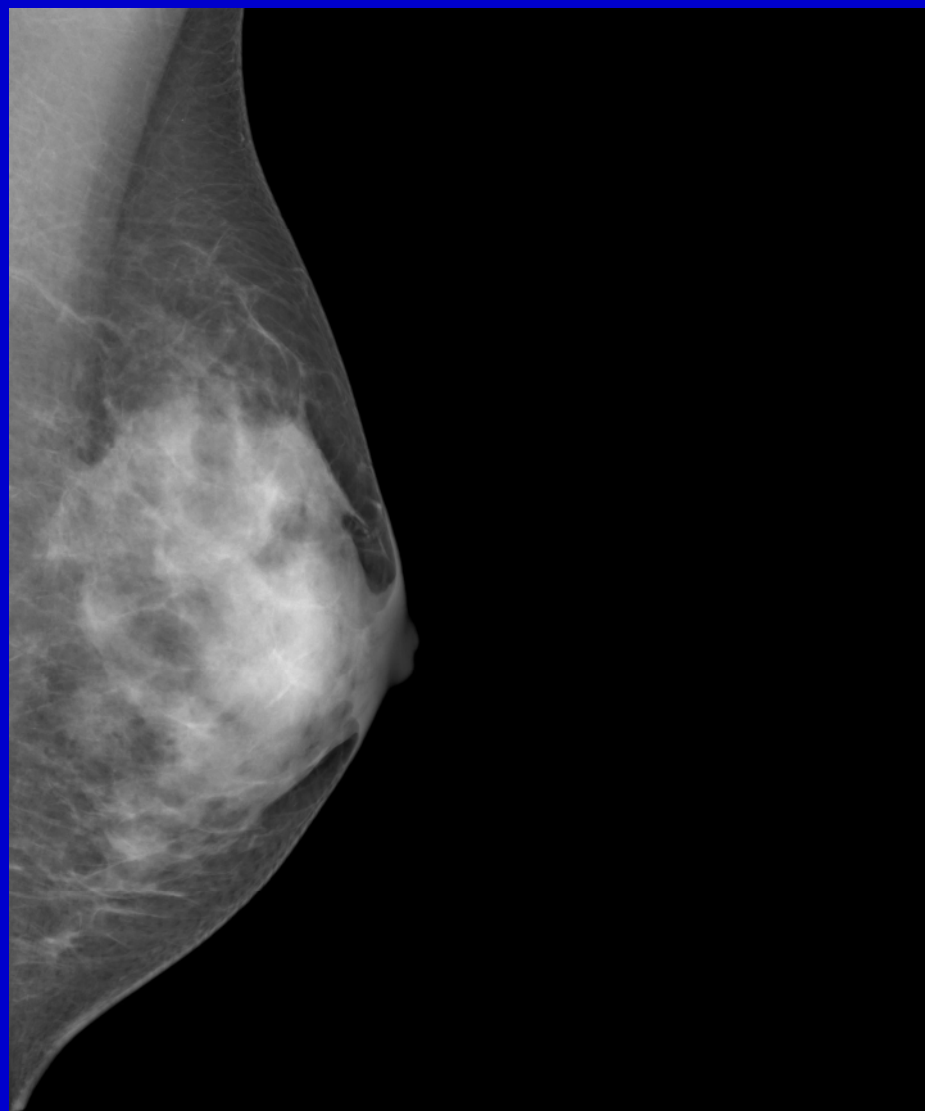
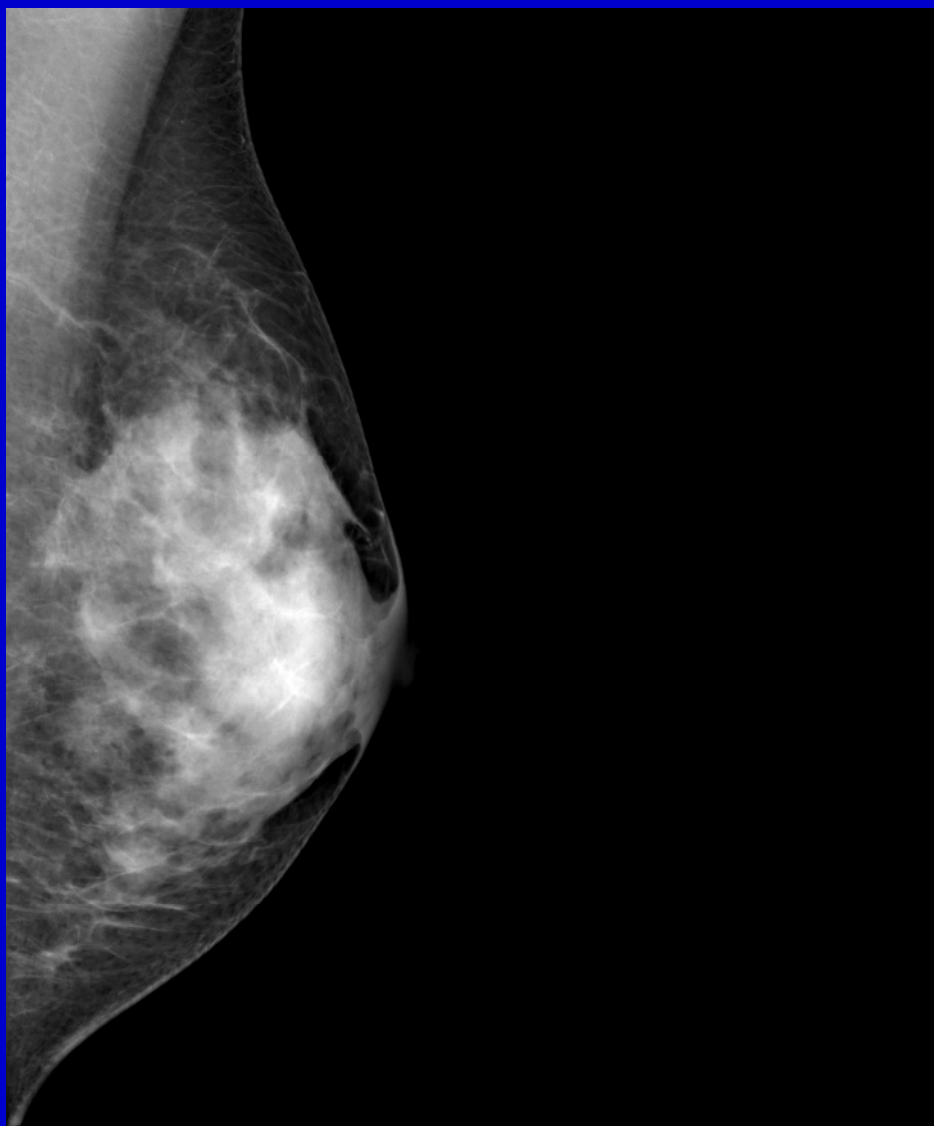
- Does the background match?
- Is the background dark enough?
- Does the dense tissue area match?
- Is the dense tissue light enough?
- Is the contrast adequate?



RWS Clinical Image Check



RWS Clinical Image Check



Summary Points

- Obtain proper hands-on training
- ACR & FDA applications and forms
- Turn off and on auto print and/or auto push
- Artifacts – most problems can be seen on this test
- Lead sheet protecting detector for Focal Spot, HVL & kVp
- Laser Printer
 - D_{\max} at least 3.5 OD
 - Mid-density about 1.5 OD

Summary Points

- Review workstation monitors – look at the clinical images!
 - Do they match?
 - Appropriate dark and light levels
- Do all work on correct images – raw vs. processed
- Take your time and use your professional judgement

| | # Units | Average Scores | | | Ave Dose* (mrads) |
|--------------------|---------------|----------------|---------------|---------------|----------------------|
| | | Fibers | Specks | Masses | |
| Screen-Film | 14,574 | 4.70 | 3.60 | 3.74 | 168.7 |
| (SD) | | (0.48) | (0.4) | (0.41) | (31.4) |
| FFDM | 1711 | 4.84 | 3.85 | 4.00 | 128.6 |
| (SD) | | (0.54) | (0.33) | (0.39) | (38.6) |

**as measured by TLD*

Average Glandular Dose in FFDM Systems

The average dose recorded in these FFDM units (GE 2000D, Fischer SenoScan, Siemens Novation and LORAD Selenia) is about 20% less than the dose of screen-film units measured by MQSA inspectors during the same time period of testing.

Mfr QC Manuals Are All Very Different

Example: Medical Physicist Tests

Test Names

| Test | Flat Field |
|---------|------------------------|
| GE | "Flat Field" |
| Fischer | "Flat Field" |
| Lorad | "Artifact Evaluation" |
| Siemens | "Detector Calibration" |

Equipment Evaluations on FFDM Components

| Item/Repair | MP Involvement |
|--|---|
| Bucky & detector replacement | MP must evaluate in person |
| Bucky (but not detector) replacement | MP must oversee |
| Any detector replacement or repair | MP must evaluate in person |
| Software modifications | MP must evaluate in person (some alternative standards otherwise) |
| Monitor (display) or printer replacement | Must follow FFDM mfr's QC manual |

- Same as FDA's
- ACR suggests using mfr's data forms
- Medical physicist **must** complete ACR's summary forms
 - MQSA Requirements for Mammography Equipment (checklist)
 - Medical Physicist's Mammography QC Test Summary form
 - Available on ACR website in Excel
- Forms provides ACR with essential pass/fail information
 - If medical physicist passes test, ACR accepts it
 - If he/she fails test, ACR requests corrective action
 - If he/she writes "N/A," "see comments" (or anything other than pass or fail), ACR will follow-up; accreditation will be delayed
- Different formats (even if they contain all the necessary information) will delay review

Download Summary Forms from ACR Website (www.acr.org)

- Required for Equipment Evaluation report
- Addresses 900.12(b) of the FDA regulations
- Same for S-F and FFDM
- In Excel format

MEDICAL PHYSICIST'S CHECKLIST MQSA REQUIREMENTS FOR MAMMOGRAPHY EQUIPMENT

Facility Name: _____
 Unit Manufacturer: _____ Model: _____
 Medical Physicist: _____ Room #: _____
 Signature: _____ Date: _____

| Feature | FDA Rule Section | Requirement | Applies to | Meets FDA Requirements? (if NA, please explain) |
|--|------------------|--|------------|--|
| Motion of tube-image receptor assembly | 3(i) | The assembly shall be capable of being fixed in any position where it is designed to operate. Once fixed in any such position, it shall not undergo unintended motion. | S-F & FFDM | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA |
| | 3(ii) | This mechanism shall not fail in the event of power interruption. | S-F & FFDM | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA |
| Image receptor sizes | 4(i) | Systems using screen-film image receptors shall provide, at a minimum, for operation with image receptors of 18 x 24 cm and 24 x 30 cm. | S-F | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA |
| | 4(ii) | Systems using screen-film image receptors shall be equipped with moving grids matched to all image receptor sizes provided. | S-F | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA |
| | 4(iii) | Systems used for magnification procedures shall be capable of operation with the grid removed from between the source and image receptor. | S-F & FFDM | <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA |

- Use for both Equipment Evaluations and Annual Surveys
- Addresses 900.12(e) of the FDA regulations
- All have been revised in July 2006 to further streamline
- Excel format
 - Built-in P/F drop-down boxes
- Use the one for your digital unit manufacturer
 - General Electric Fischer
 - Lorad Siemens
 - Fuji
- Check version of manufacturer's QC manual used
- Single overall review workstation assessment

MEDICAL PHYSICIST'S MAMMOGRAPHY QC TEST SUMMARY

Full-Field Digital – General Electric

Site Name

Address

Medical Physicist's Name

X-Ray Unit Manufacturer

Date of Installation

General Electric

Report Date

Survey Date

Signature

Model

Room ID

QC Manual Version: (check one; must use version applicable to unit tested; contact mfr if questions) ☐ 2000D 2371472-100 Rev 0, 2003

☐ DS 5133453-2-100 Rev 1, 2006

☐ ESSENTIAL 5141465-2-100 Rev 1, 2006

☐ OTHER (write in):

Accessory Equipment:

Review Workstation*

Laser Film Printer*

Manufacturer

Model

Location

QC Manual Version

☐ On-site ☐ Off-site

☐ On-site ☐ Off-site

*FDA recommends that only monitors and printers specifically cleared for FFDM use by FDA's Office of Device Evaluation (ODE) be used, but the use of others is also legal. See FDA's Policy Guidance Help System Modification Document #9 (page 27).

Survey Type:

☐ Mammo Eqpt Evaluation of new unit (include MQSA Rqmts for Mammo Eqpt checklist) ☐ Annual Survey

Medical Physicist's QC Tests

1. Flat Field

2. Phantom Image Quality

Phantom IQ Test on AWS

Phantom IQ Test on Printer

15. Review Workstation (RWS) Tests* (for all RWS, even if located offsite)

Overall Results ("Pass" means all tests pass; indicate "Fail" if any test fails)

| Fibers | Specks | Masses |
|--------|--------|--------|
| | | |
| | | |

Click in boxes to use drop-down lists

PASS/FAIL

*FDA requires that all RWS comply with a QC program that is substantially the same as that recommended by the image receptor manufacturer. If the RWS has been approved by the FDA's ODE for FFDM, the FDA considers the RWS's QC manual to be "substantially the same" and you may follow it for QC. (Check with the RWS manufacturer for their system's FDA clearance status and their QC manual.) If the RWS has not been approved by the FDA's ODE for FFDM, you must follow the QC manual provided by the image receptor manufacturer. (In this case, check with the image receptor manufacturer for their required tests.)

*** YOUR MEDICAL PHYSICIST MUST SUMMARIZE HIS/HER RESULTS ON THIS FORM ***

- FDA **recommends** only using printers cleared by FDA's Office of Device Evaluation for FFDM (but may legally use others)
- Facility must have access to a laser printer (either on-site or someplace else)
- Printer **must exist and be tested** by MP before the facility performs mammography
- Laser film printer QC

| FFDM Mfr | Model | FFDM Mfr's Printer QC Instructions |
|----------|-------------------------|---|
| GE | 2000D, DS, Essential | Follow the laser printer mfr's QC |
| Fischer | SenoScan | Follow the laser printer mfr's QC |
| Lorad | Selenia | Follow the Lorad Selenia QC Manual |
| Siemens | Mammomat Novation DR | Follow the laser printer mfr's QC (but conduct QC every day you print) |

- FDA MQSA regs state facilities must comply with a QA program ***substantially the same as recommended by the FFDM manufacturer*** (i.e., GE, Fischer, Lorad, Siemens, Fuji)
 - Impractical; sometimes impossible since some is software-based
- FDA has informed the ACR that
 - If the monitor/workstation has been approved by FDA's ODE for FFDM, the monitor's QC manual is "substantially the same" and facilities may follow
 - If monitor was not approved by FDA ODE for FFDM facilities must follow one by FFDM mfr
- FDA ODE approved monitors/workstations
 - Over 500 approved total
 - ??? have been approved for FFDM

- **Clinical image review (fatty and dense breast)**
- **Phantom image review**
- **Dose (<300 mrad)**
- **Processor QC or**
- **Laser QC for FFDM**
 - Follow your mfr QC manual
- **Criteria the same for digital as with screen-film**

- **Tech QC**
 - Laser printer density consistency (dry lasers) – monthly –
 - ACRIN data shows it rarely fails
 - Darkroom fog test – eliminate
 - MTF/System Resolution – only for systems with moving parts (e.g., slot-scan, CR) – quarterly
- **Medical Physicist QC**
 - Eliminate annual kVp testing
 - ACRIN data shows it rarely fails with modern generators

SAM'S Questions

The data collected by MQSA and the ACR Mammography Accreditation Program indicate that the average patient mid-glandular dose for an exam on a FFDM unit relative to the same exam on a Film/Screen unit is as follows:

- | | | |
|-----|----|---|
| 0% | 1. | MGD on the FFDM unit is 50% greater than the average MGD on the FS unit |
| 0% | 2. | MGD on the FFDM unit is 20% greater than the MGD on the FS unit. |
| 8% | 3. | MGD on the FFDM unit is the same as the MGD on the FS unit |
| 75% | 4. | MGD on the FFDM unit is 20% less than the MGD on the FS unit. |
| 17% | 5. | MGD on the FFDM unit is 50% less than the MGD on the FS unit |

Answer: d - approximately 20% less than the MGD on the Film-Screen units

- Reference:

ACR Accreditation Data presented at RSNA 2007 by Pam Wilcox.
FDA/MQSA Information page on CDRH/MQSA website - data by
Wally Murad, Ph.D., FDA.

Using the Mammography Accreditation Phantom specified by the FDA and Accrediting bodies with the Hologic and Siemens FFDM units that use the amorphous selenium detector, the minimum acceptable phantom image quality scores are:

- | | | |
|-----|----|------------------------------------|
| 17% | 1. | 4 fibers, 3 speck groups, 3 masses |
| 0% | 2. | 5 fibers, 3 speck groups, 4 masses |
| 83% | 3. | 5 fibers, 4 speck groups, 4 masses |
| 0% | 4. | 4 fibers, 4 speck groups, 4 masses |
| 0% | 5. | 3 fibers, 4 speck groups, 4 masses |

Answer: C - 5 fibers, 4 speck groups,
4 masses

- Ref: Hologic and Siemens Quality Assurance
Manuals, 2007 Versions

The minimum acceptable Half Value Layer measurement on a FFDM unit at 28 kVp for Mo/Mo is:

27% 1. 0.28 mm Al

55% 2. 0.31 mm Al

9% 3. 0.34 mm Al

0% 4. 0.37 mm Al

9% 5. 0.40 mm Al

Answer: B - 0.31 mm Al

- Minimum HVL (Mo/Mo) =
 $(\text{kVp}/100) + 0.03 \text{ mm Al}$
- Therefore, @ 28 kVp, minimum HVL =
 $(28/100) + 0.03 = 0.31 \text{ mm Al}$
- Ref: Mammography Quality Control Manual -
American College of Radiology (1999)

The minimal acceptable resolution for a digital detector is:

0% 1. 3 lp/mm

0% 2. 4 lp/mm

33% 3. 5 lp/mm

67% 4. 7 lp/mm

0% 5. 10 lp/mm

Answer: D - 7 lp/mm

- Ref: GE, Hologic and Siemens Quality Assurance Manuals, 2007 Version

The maximum acceptable illuminance in a reading room for digital mammograms is:

17% 1. 50 lux

0% 2. 40 lux

83% 3. 20 lux

0% 4. 10 lux

0% 5. 5 lux

Answer: C - 20 lux

- Ref: “Medical Physicist’s Evaluation Forms,”
American College of Radiology Website,
February 2006 Version