Quality Control and Maintenance Programs

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Task Group

Medical Imaging Equipment QA/QC

- Acceptance Testing
  - Agreement with Manufacturer's Specifications
- Commissioning
  - Data Acquisition for Clinical Use
    - Manual Technique Charts
    - Verification of Automatic Protocols
- Setting Base Line Values for QC Tests
  - Parameters to be Tested
  - Methodology
  - Frequency
  - Tolerance
  - Corrective Actions

Goal of Ultrasound QA/QC Program

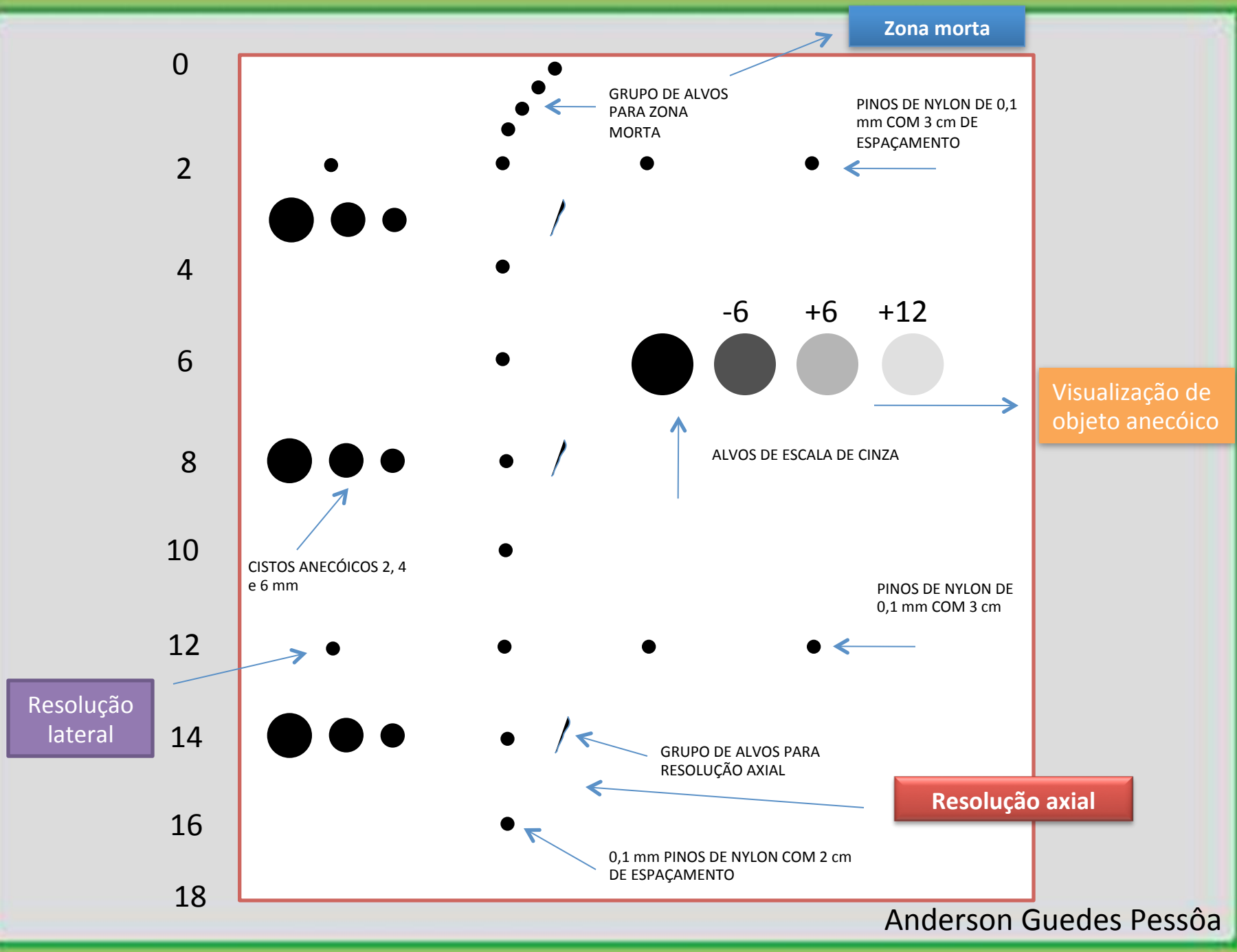
- To make sure a system is set up correctly and performs to specified standards.
- To maintain the consistency of the performance.
- To reveal problems at its earliest stage before it severely interferes with the clinical practices.

ACR Required Semi-Annual QC Tests for General Ultrasound Accreditation

- System sensitivity and/or penetration capability
- Image uniformity
- Photography and other hard copy recording
- Low contrast object detectability (optional)
- Assurance of electrical and mechanical safety
- Vertical and horizontal distance accuracy (recommended only when the program is initiated for a scanner)

PHANTOM


Gammex
2
4
6
1 2 3 4
8
10
12
14
16
Precision Multi-Purpose Grey Scale Phantom


Zona morta
GRUPO DE ALVOS PARA ZONA MORTA
PINOS DE NYLON DE 0,1 mm COM 3 cm DE ESPAÇAMENTO
0
2
4
6
8
10
12
14
16
18
-6
+6
+12
Visualização de objeto anecóico
ALVOS DE ESCALA DE CINZA
CISTOS ANECÓICOS 2, 4 e 6 mm
PINOS DE NYLON DE 0,1 mm COM 3 cm
Resolução lateral
GRUPO DE ALVOS PARA RESOLUÇÃO AXIAL
Resolução axial
0,1 mm PINOS DE NYLON COM 2 cm DE ESPAÇAMENTO
Anderson Guedes Pessôa

System Sensitivity/Penetration

The maximum depth of visualization is determined by comparing the gradually weakening echo texture to electronic noises near the bottom of the image.

Do this test with the same settings and monitor the changes over time.

Image Uniformity

Adjust the TGC controls and other sensitivity controls to obtain an image as uniform as possible

Inspect the image to detect any kinds of

- vertical or radially oriented streaks
- dropouts
- reduction of brightness near edges of the scan
- brightness transitions between focal zones

Soft and/or Hard Copy Recording II

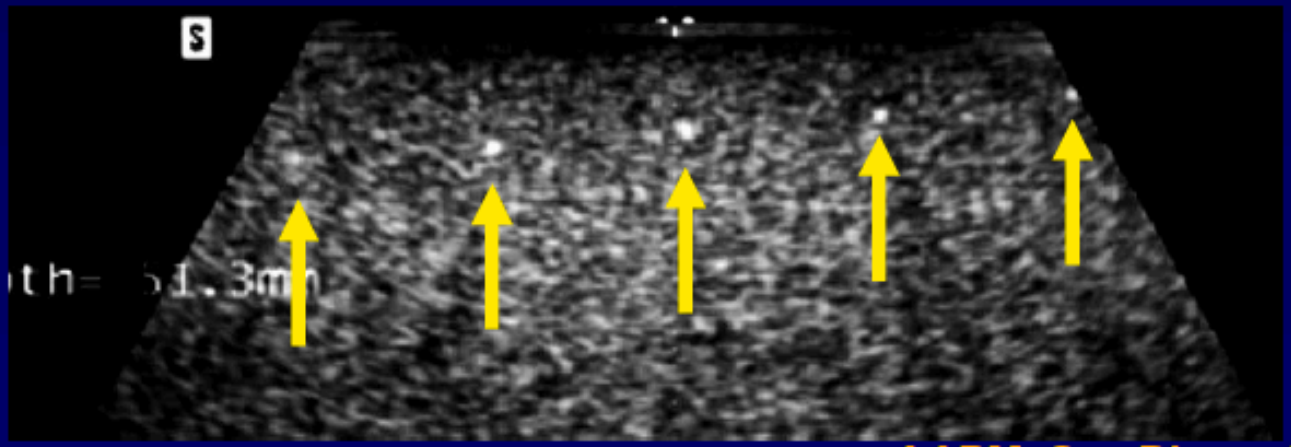
- Use the SMPTE test pattern and other patterns if they are available on the ultrasound scanner.
- Workstation monitor display should be included in QC tests.

Low Contrast Object Detectability

Scans of a low contrast resolution phantom can reveal the low contrast object detectability which is an optional test on the ACR semi-annual QC test list for general ultrasound accreditation.

Dead Zone (Ring Down)

A group of reflectors consisting of fibers are placed at different separations from the top of the phantom (~ 1-8 mm). As the transducer scans across the top, the distance from the transducer to the first reflector completely imaged is equal to the dead zone (ring down) distance.



Quality Control – X-Ray

- Radiation Safety
- Darkroom (if using film)
- Viewing Conditions
- Device Performance
- Patient Dose
- Image Quality

Image Receptors and Processors

- Films and Screens
  - Sensitometry, Densitometry, Film-Screen Contact
- Film Processors
  - Chemicals Temperature, Development Time, Artifacts
- Darkroom
  - Cleanliness, Safety Lights
- Illuminators
  - Luminance, Illuminance, Ambient Light

Film Processing

Manual
and
Automatic

QC Automatic Film Processor

Daily Log

- Temperature Solutions
  - Developer
  - Water
- Replenishment Rate
- Water Flow
- Transport Time
- Cleaning
- Maintenance
- Artifacts

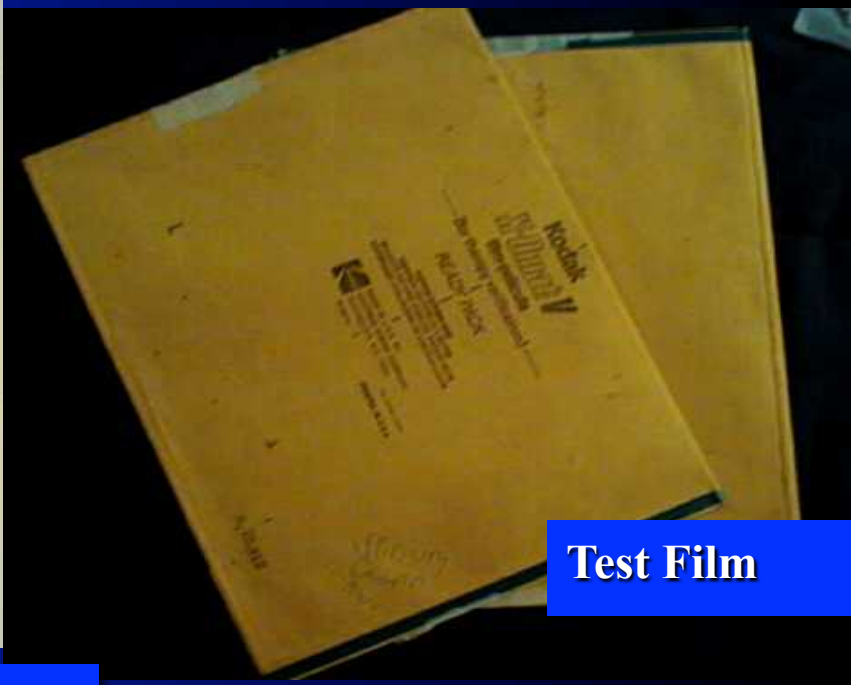
Digital Thermometer

DARKROOM AND FILM PROCESSOR EVALUATION

Light-Tightness ?

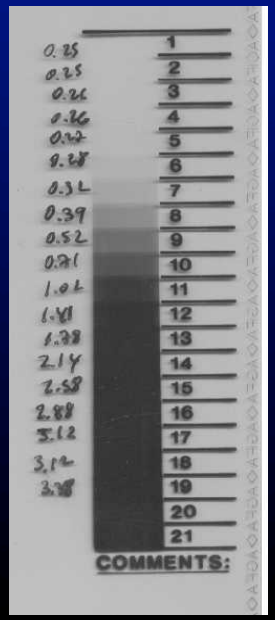
Clinical Film

Penetrameter



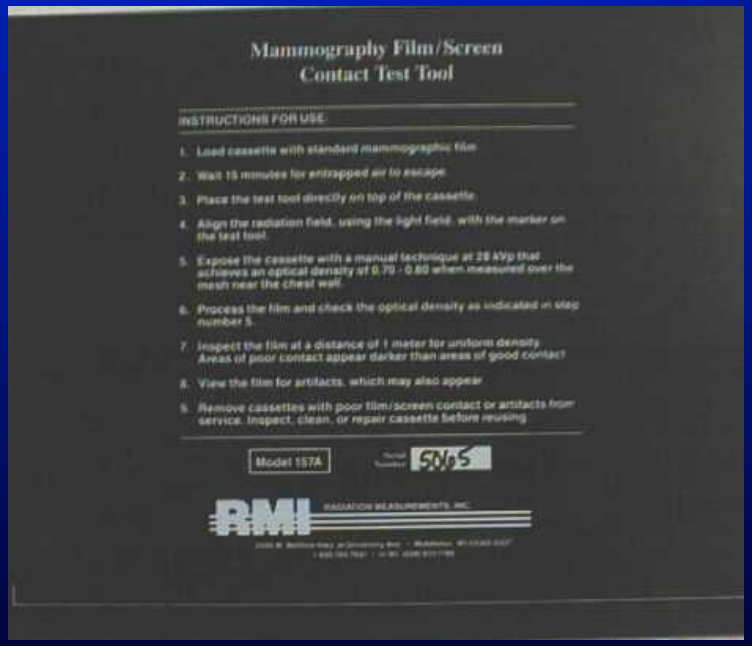
Test Film

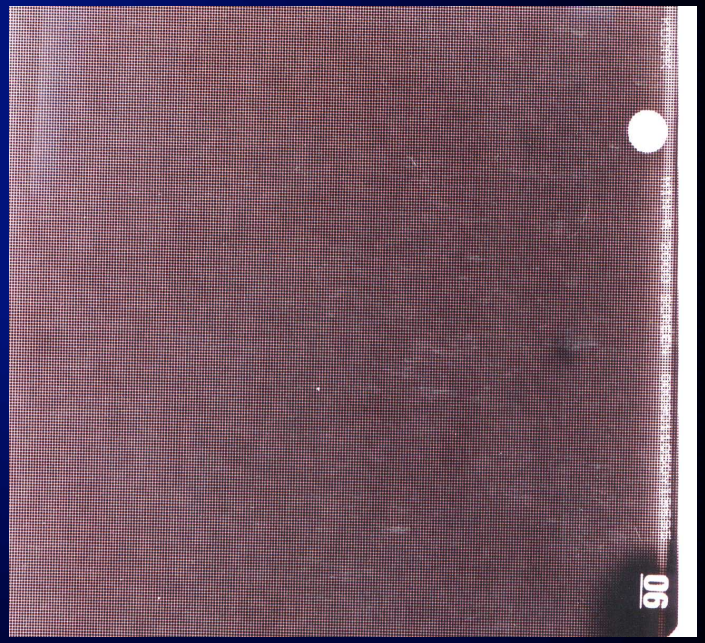
Sensitometer



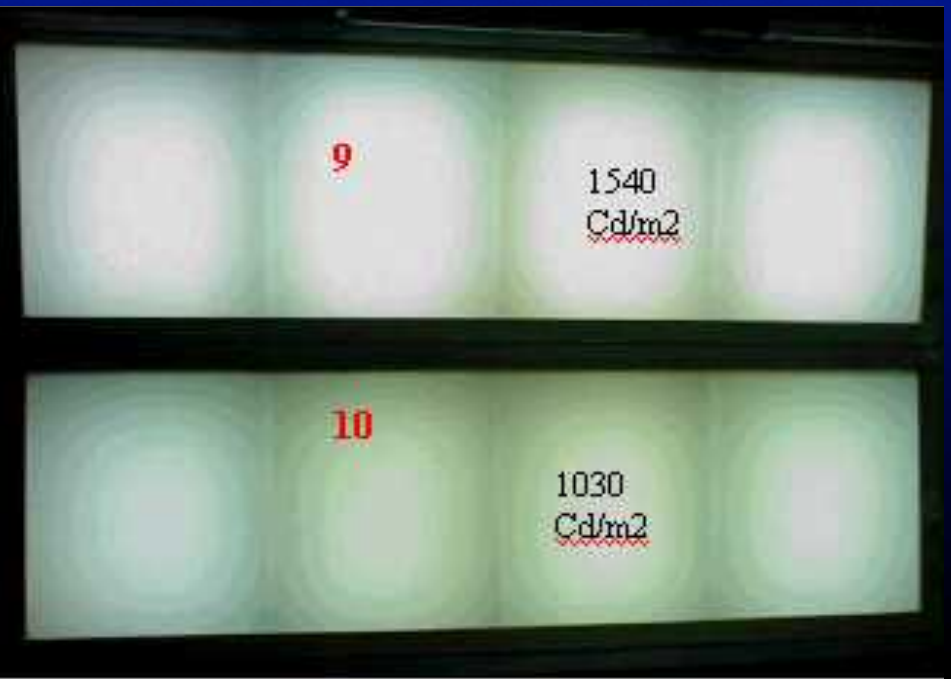
Densitometer

Film Screen Contact Test





Evaluation of View Boxes and Reading Rooms



Case Study

WHIS-RAD Units – Haiti

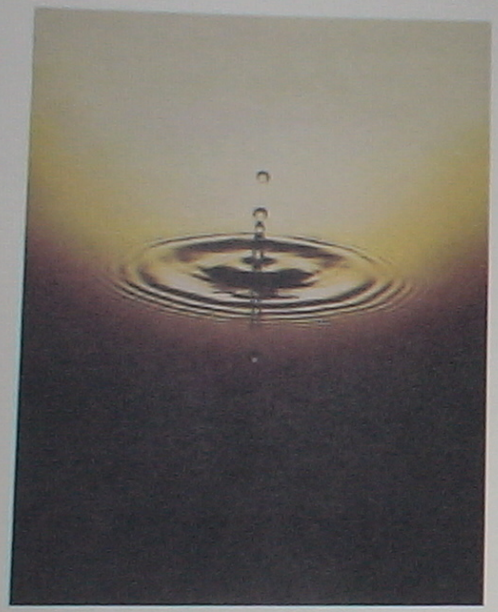
Upgrading Basic Radiology Services in Haiti

Equipment: WHIS-RAD (Philips and Bennett)

Training: Clinicians, Technicians

Regulations: Ministry of Health

Health Technology Assessment in Latin America and the Caribbean: Collection of Cases

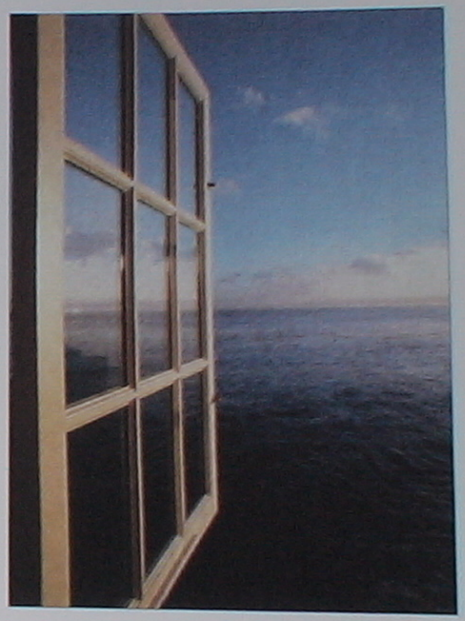


Division of Health Systems and Services Development

Pan American Health Organization

World Health Organization

Developing Health Technology Assessment in Latin America and the Caribbean



Organization and Management of Health Systems and Services Program

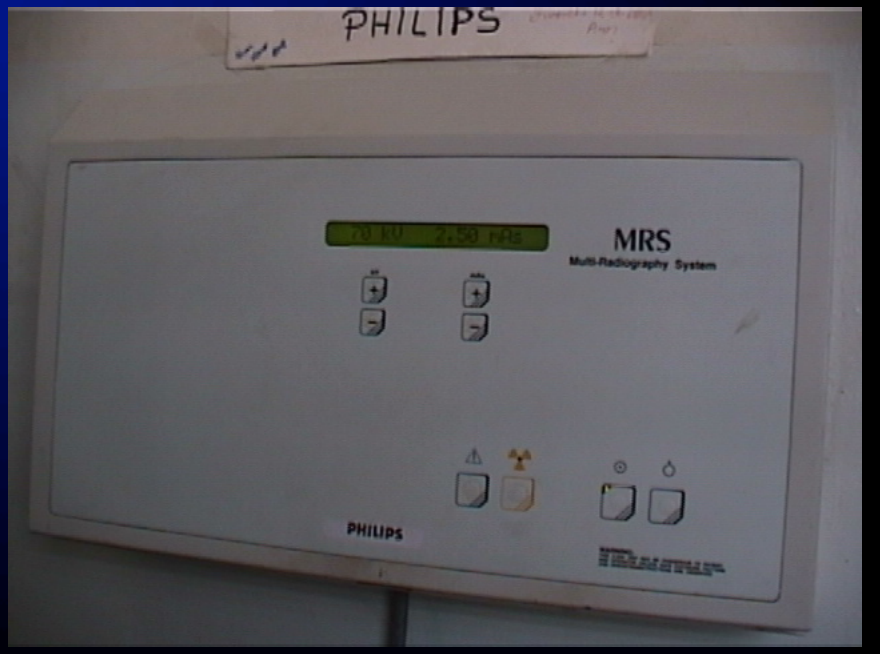
Division of Health Systems and Services Development

Pan American Health Organization

Pan American Sanitary Bureau, Regional Office of the

World Health Organization

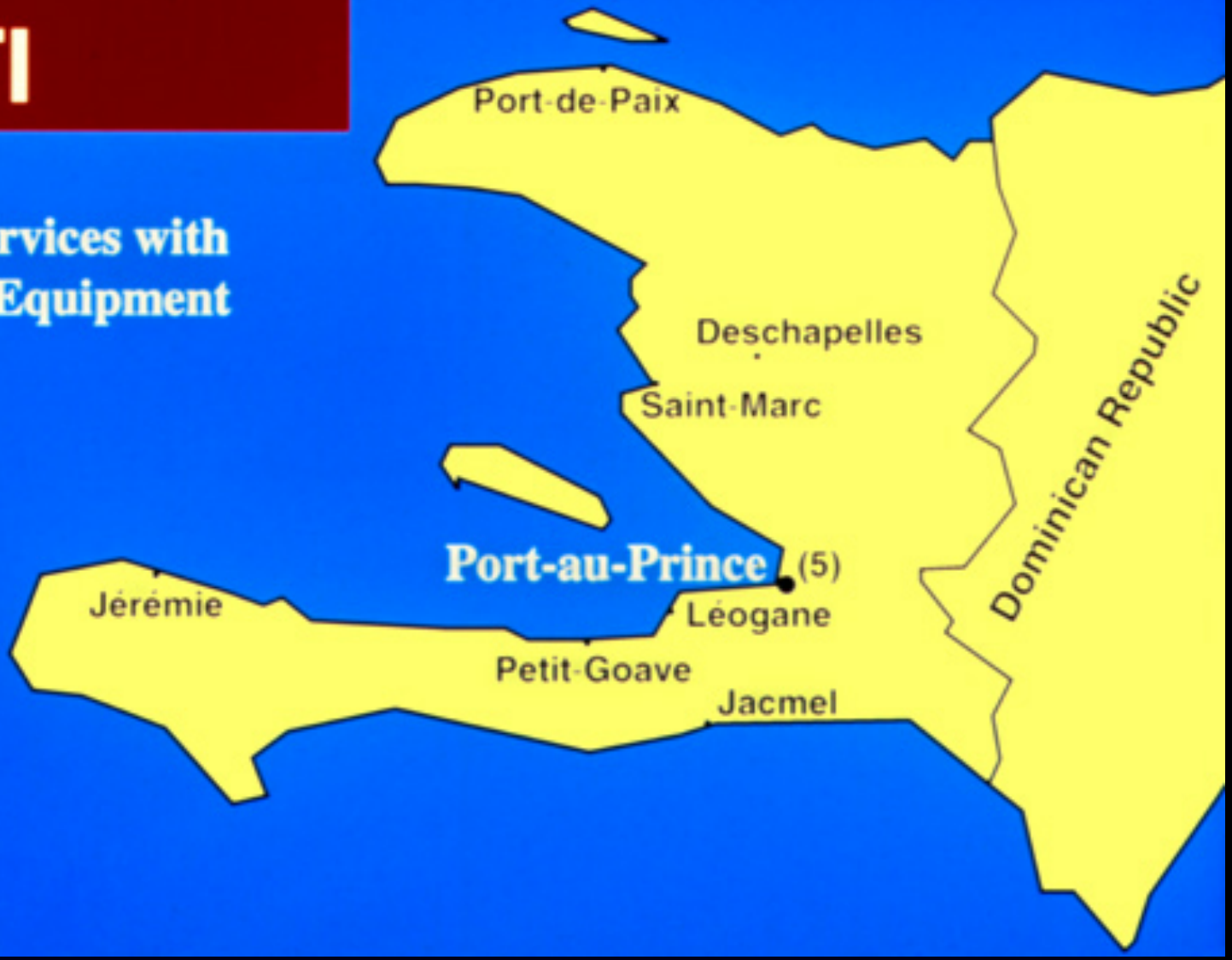
Bennnett



Philips

HAITI

Radiology Services with WHIS-RAD Equipment

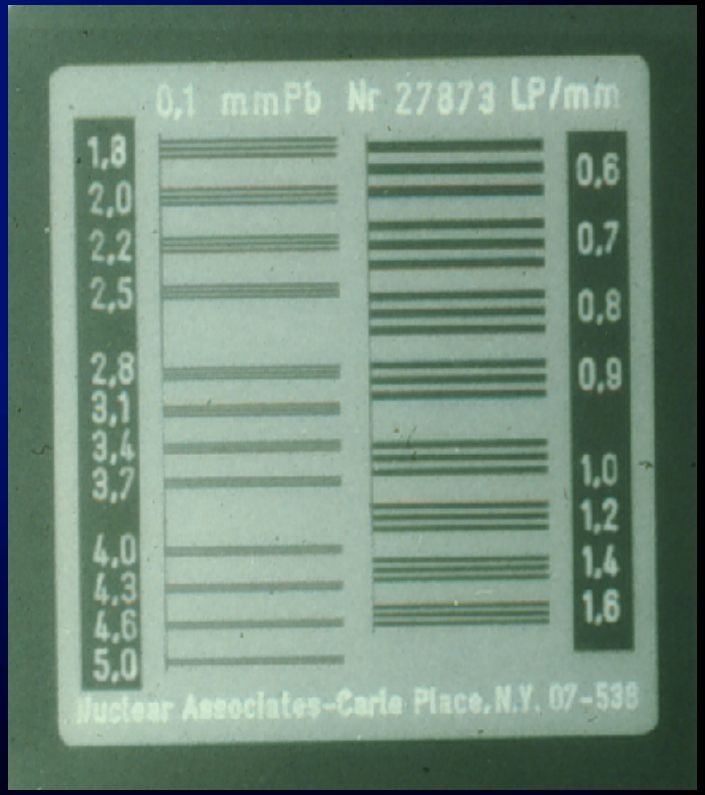


Radiology Service

Petit Goave, Haiti

WHIS-RAD Units
Measurements

- Field Size and Alignment
- Tube Potential
- Half Value Layer
- Reproducibility
- Linearity
- Exposure (mR/mAs)
  vs Tube Potential
- Focal Spot
- Image Quality



WHIS-RAD Units
Image Quality Assessment

[0.1 mm Pb (HC) and 0.001 mm Pb (LC) Bar Patterns on Image Receptor 70 kV, 3.2 mAs]

Hospital	Contrast[1]	Resolution (lp/mm)		Processing[2]
		HC	LC	
UR	1.27	3.1	2.0	OK
LS	0.37	3.1	2.2	A
DE	1.04	3.4	2.2	A
SM	0.47	3.7	2.5	A
PP	0.41	3.1	2.8	A
LE	0.75	4.0	2.5	A
PG	0.71	4.0	2.2	OK
JA	1.12	4.0	2.5	A
JE	0.72	2.5	1.2	A

[1]Contrast: Difference in Optical Densities between Transparent and Opaque Areas in Pb Bar Patterns
[2]A: Artifacts

The worse problem is film processing

- Will digital (computed) radiography be the solution?

Device Performance (if CR/DR)

- X-Ray Units
- CR Plates (if CR)
- Workstations
- Computer
- Communications

Follow manufacturer's recommendations for specific tests

Quality Control CR/DR

- ACR practice guides recently published:
  - Determinants of image quality for digital mammography
  - Digital radiography – *includes technique guides*
- AAPM Task Group 10 published => AAPM Report 93 CR acceptance testing and quality control
- AAPM Task Group 116 recommendations for exposure index evaluation and reporting
- AAPM Task Group 150 effort on an overall quality control guideline for digital radiography

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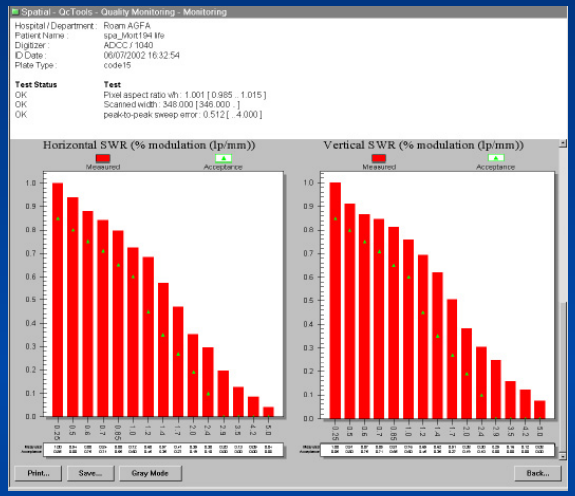
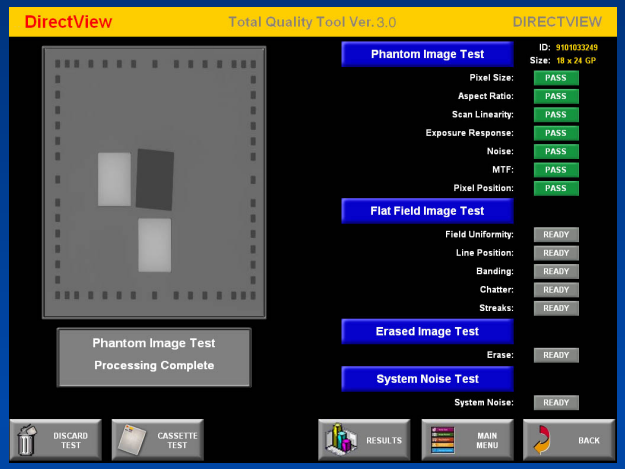
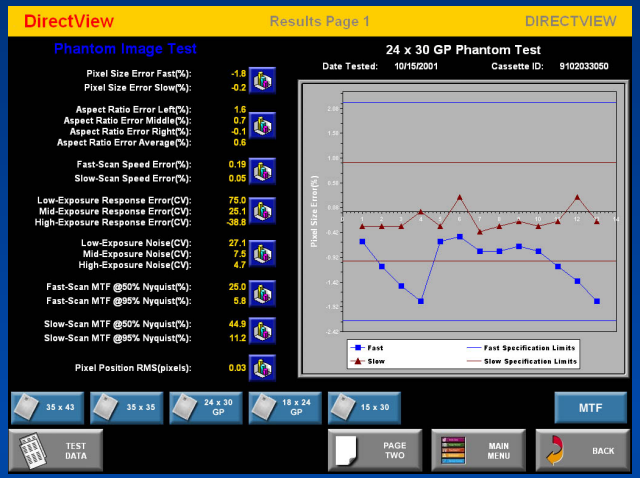
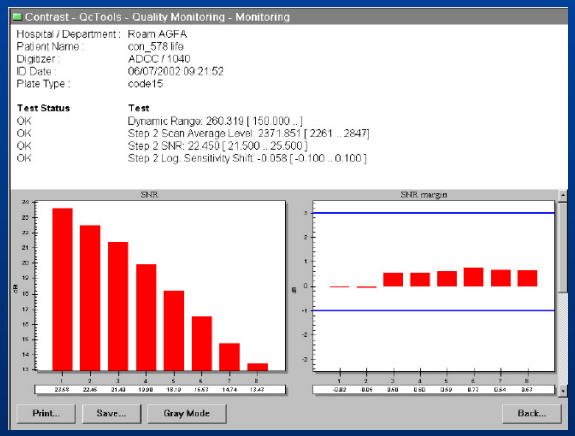
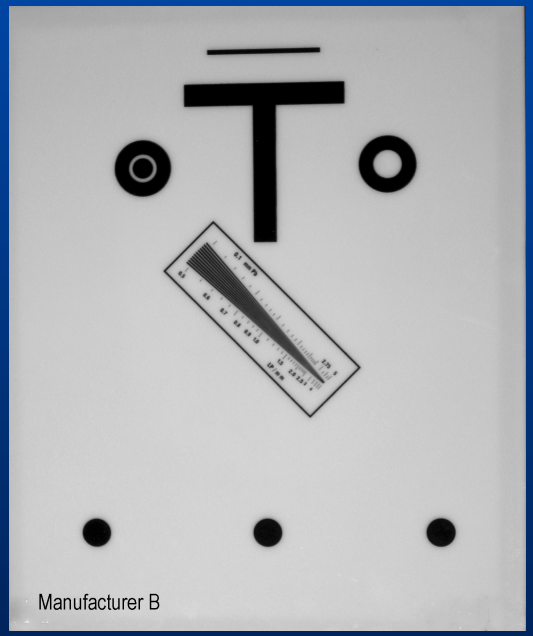
Manufacturers are improving accommodations for QC in CR and DR











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What is needed?

- Computer friendly phantoms
- Objective quantitative analysis methods
- System performance tracking and database logs
- Reject analysis software (JCAHO issues)
- Exposure monitoring tools and database tracking

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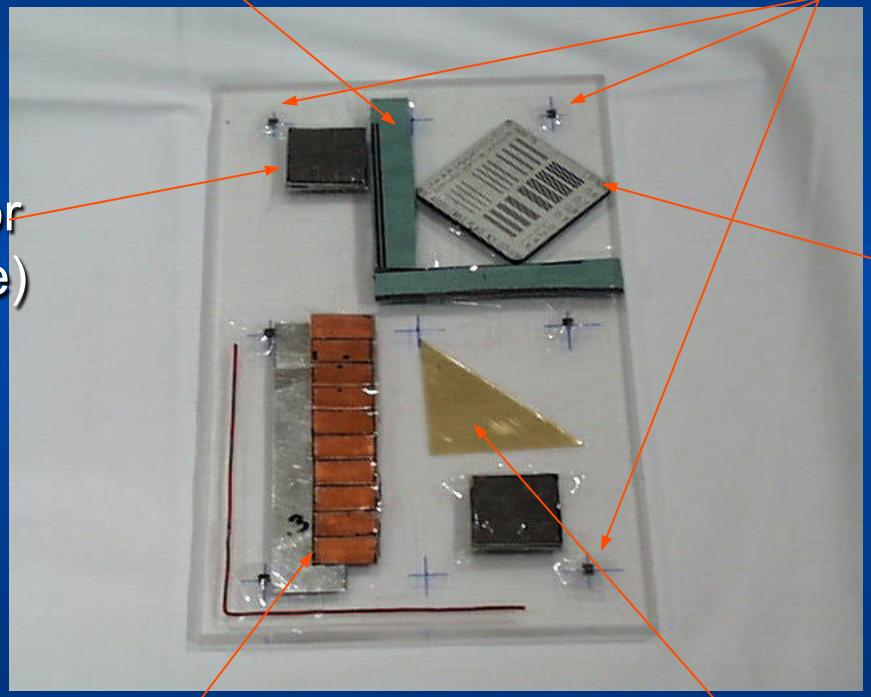
Example QC test phantom (UC Davis)

40 line/cm grid
(visual aliasing)

Fiducial Markers
(locators and distance accuracy)



Lead attenuator
(dynamic range)

Resolution
Bar Pattern
(qualitative)

Copper step wedge
(dynamic range, linearity, SNR)

Brass stock with
sharp edge-on exit side
(presampled MTF)

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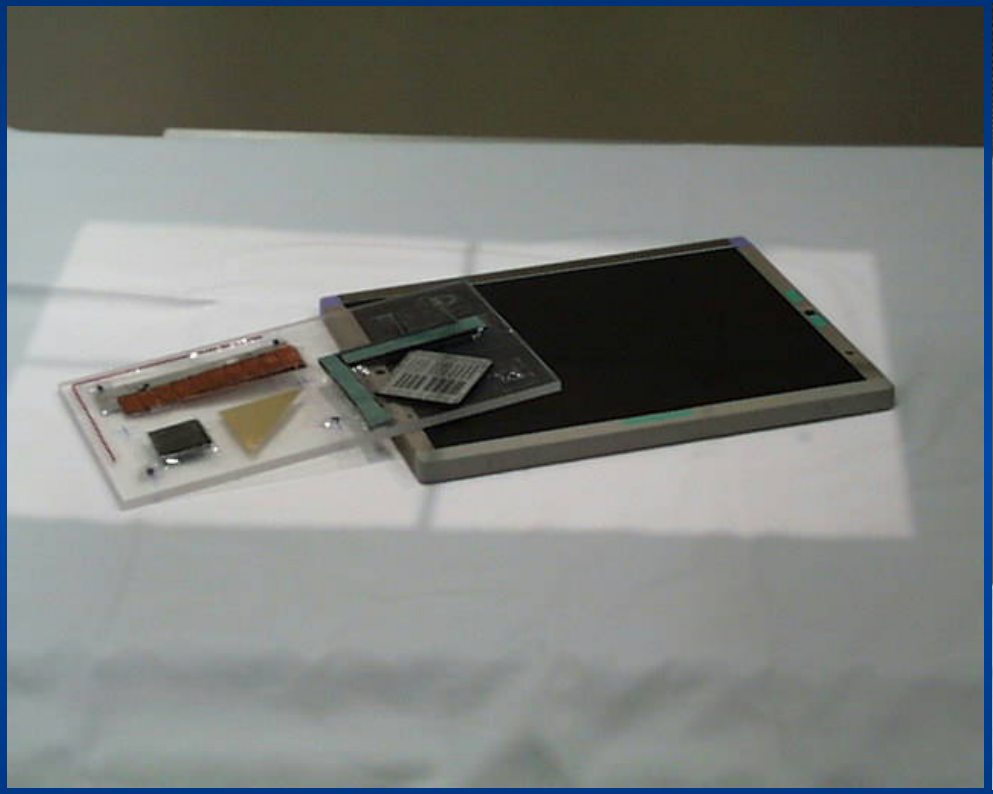

QC phantom with CR imaging plate

Acquisition geometry

Images were acquired on an 18x24 cm detector at 80 kVp and 2 mAs at 180 cm (approx 2 mR incident)

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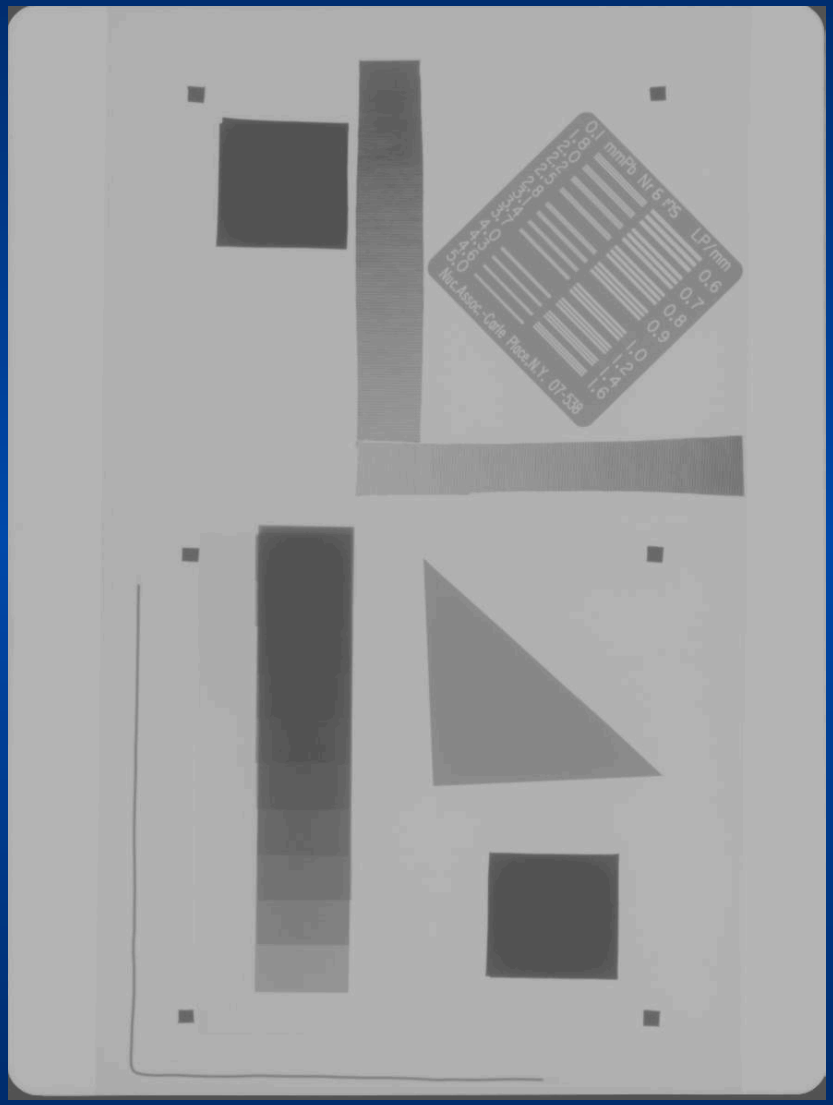
Raw Image



For L=4, S=200
Exposure (mR) =
exp(0.009 x PV - 4.6)

where PV is the pixel value

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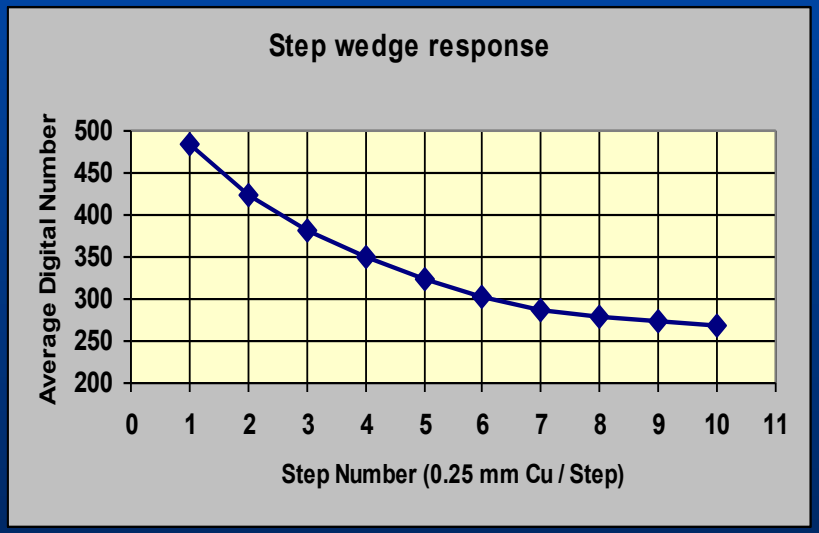
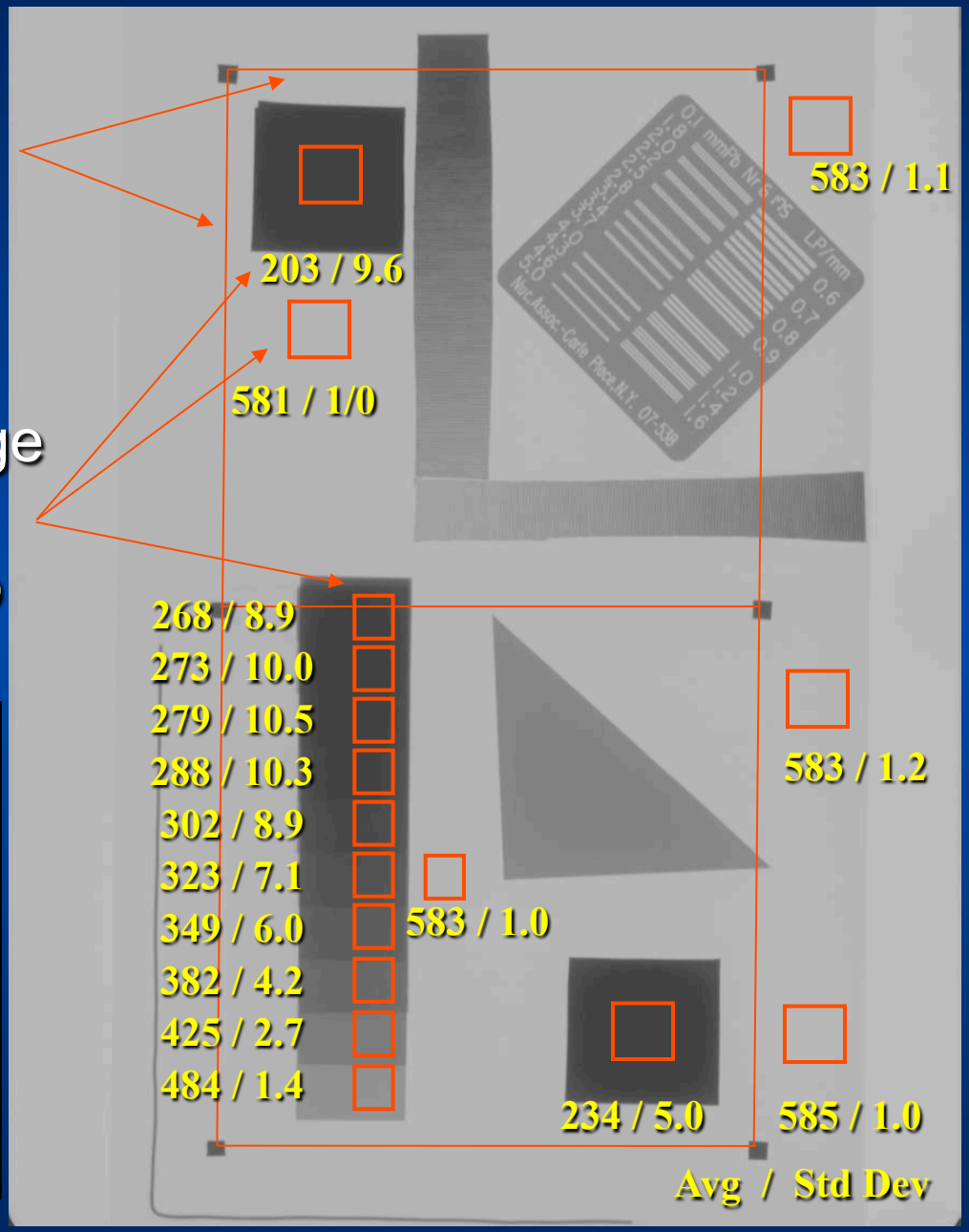
Distance accuracy and aspect ratio measurements

ROIs - Step wedge
Open field
Beam stop





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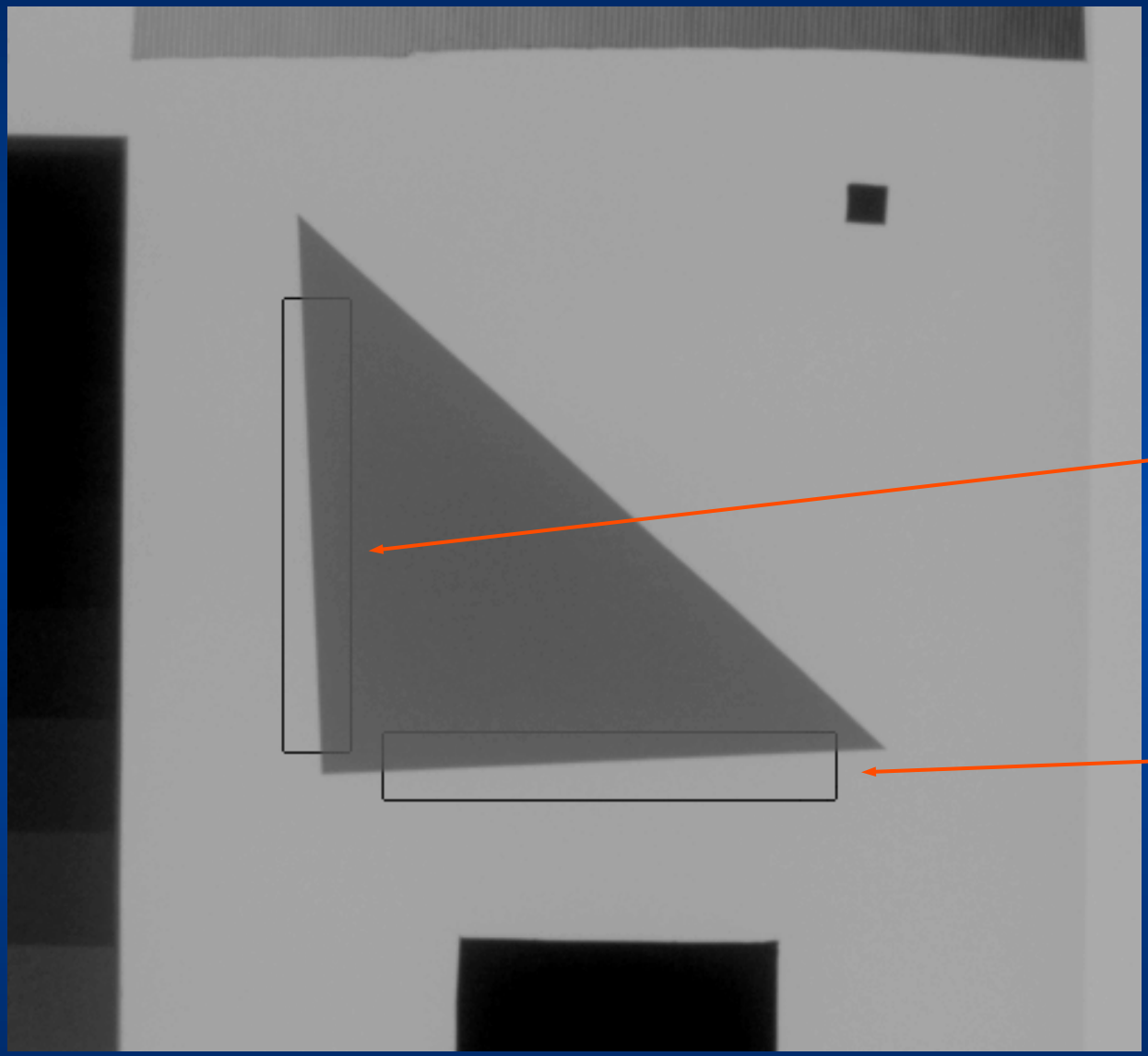

MTF analysis windows

MTF horizontal

MTF vertical

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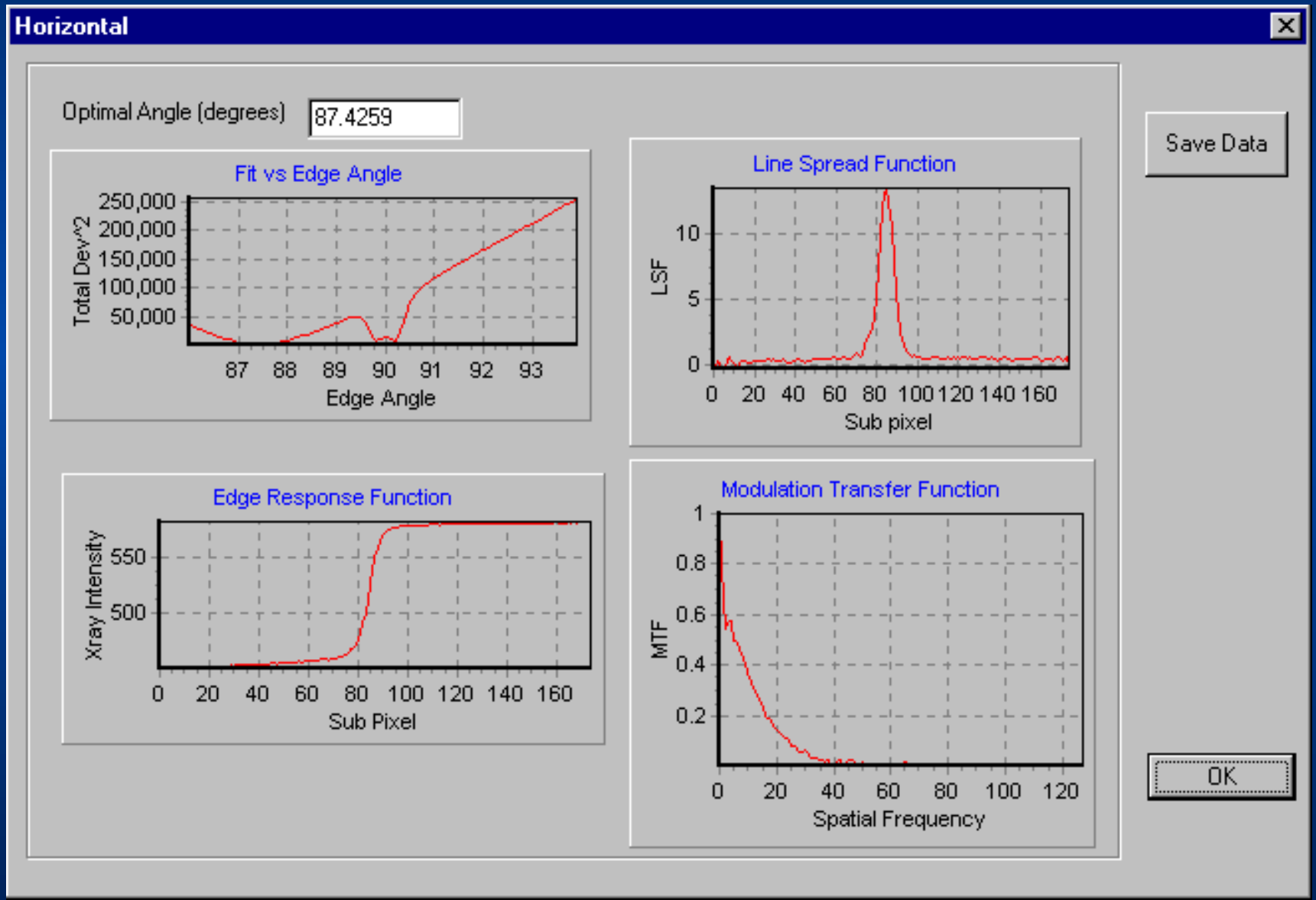
Horizontal MTF results



Periodic Quality Control

- Daily (Technologist)
  - Inspect CR/DR system and status and interfaces
  - Erase image receptors
  - Log image artifacts as they appear
- Weekly / Biweekly (Technologist)
  - Review calibration monitor test image (TG-18)
  - Acquire QC phantom test images. Verify performance
  - Check and clean IP's (if necessary) with recommended agents
- Quarterly (Technologist)
  - Inspect cassettes. Clean with recommended agents
  - Review image retake rate and exposure trends
  - Update QC log. Review out-of-tolerance issues

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QC Management Aspects

- Financial
- Administrative
- Technical

- Physical Infrastructure
- Equipment & Accessories
- Human Resources

Administrative Decisions

- Assignment of Functions and Responsibilities
  - Radiation Safety Officer
  - QC Technologist
- Clinical Consultations - Teleradiology Issues
- Preventive Maintenance Schedule
- Medical Physicist
  - Telephone Consultations
  - Visits

Health Station Manager

Medical Physicist Functions

- Develop/Review Purchase Specifications
- Perform Acceptance Tests
- Evaluate Diagnostic Imaging Equipment
- Assess Radiation Safety Levels
- Train Staff in Radiation Protection
- Develop & Supervise QC Program
- Supervise Maintenance Program
- Participate in QA Program, if one exists

QC – Health Station (HS)

- **Maintenance Program**
  - Mechanical / electrical checks done locally
  - Follow up periodic preventive maintenance visits
- **Medical Physics Program**
  - Tests done locally
  - Follow up medical physicist recommendations
- **Radiation Safety**
  - Periodic local safety checks
  - Reports to the Regulatory Authority prepared by medical physicist and sent by HS Manager?