Implementation of the 2016 ACR Digital Mammography Quality Control Manual: Technologist’s Section
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QC Test Drivers
- Based on a variety of sources
  - MQSA
  - SFM
  - ACRIN DMIST
  - Manufacturer’s QC programs
  - MITA
  - Subcommittee clinical experience
- Apply to all manufacturers
- Be clinically relevant
- Be user friendly

Phantom Design Goals
- More challenging targets
- More sensitive to changes
- Fewer digital processing artifacts
- Full field
- Same attenuation as current phantom
- Same Pass/Fail targets as current phantom
New Phantom

Cousins

New Phantom in Clinical Environment
Phantom Design Specifications

- Cover = Nominal 0.3 cm
- Screws: 19.0 ± 0.1 cm
- CNR Cavity (0.1 ± 0.005 cm Deep)
  - Depth of CNR Cavity = 0.1 ± 0.005 cm
- Milled out wax insert area: 7.0 cm (+0.04, -0.00 cm)
- Compensator = 0.023 cm
- Wax = 0.70 cm ± 0.02 cm
- Milled out wax insert area: 13.0 cm (+0.04, -0.00 cm)
- ID Tag
  - Air Gap = 0.027 cm Nominal
  - Total Insert Depth = 0.75 cm
  - Total Thickness Under Insert = 3.05 cm
  - Test object distance from base of wax = 0.35 ± 0.10 cm

Tolerances:
- Wax insert well depth: ± 0.005 cm (± 2 mils)
- Wax insert well width and length: +0.04 / -0.00 cm
- CNR cavity depth: ± 0.005 cm (± 2 mils)
- CNR diameter: ± 0.05 cm

Attenuation Correction

- Lorad/Hologic Digital Auto-Filter
- 52 mm Mo/Mo
- 29 kVp
- 66 mAs
- 1.64 mGy

Clinical Unit Image

- Lorad/Hologic Digital
- Auto Filter
- 52 mm Mo/Mo
- 29 kVp
- 66 mAs
- 1.64 mGy
### Attenuation Equalization

The New Insert

Specks are lime glass spheres

### Test Object Comparison

<table>
<thead>
<tr>
<th>Fibers (mm)</th>
<th>Spacks (mm)</th>
<th>Masses (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACR 156</td>
<td>FFDM</td>
<td>ACR 156</td>
</tr>
<tr>
<td>1.56</td>
<td>1.12</td>
<td>0.89</td>
</tr>
<tr>
<td>0.89</td>
<td>0.61</td>
<td>0.33</td>
</tr>
<tr>
<td>0.54</td>
<td>0.25</td>
<td>0.16</td>
</tr>
<tr>
<td>0.40</td>
<td>0.20</td>
<td>0.17</td>
</tr>
<tr>
<td>0.30</td>
<td>0.14</td>
<td>0.20</td>
</tr>
</tbody>
</table>
### AEC Technique Comparison

<table>
<thead>
<tr>
<th>Mode</th>
<th>Phantom</th>
<th>Compression Thickness (cm)</th>
<th>Target/Filter</th>
<th>kVp</th>
<th>mAs</th>
<th>Machine Reported Dose (mGy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lorad – Mo</td>
<td>FFDM</td>
<td>5.2</td>
<td>Mo/Mo</td>
<td>29</td>
<td>66.4</td>
<td>1.64</td>
</tr>
<tr>
<td>Lorad – W</td>
<td>FFDM</td>
<td>5.2</td>
<td>Mo/Mo</td>
<td>29</td>
<td>65</td>
<td>1.61</td>
</tr>
<tr>
<td>Fuji CR 18 x 24 cm</td>
<td>FFDM</td>
<td>4.0</td>
<td>W/Rh</td>
<td>27</td>
<td>90</td>
<td>**</td>
</tr>
</tbody>
</table>

### Manual Technique Signal Comparison

<table>
<thead>
<tr>
<th>Mode</th>
<th>Phantom</th>
<th>Target/Filter</th>
<th>kVp</th>
<th>mAs</th>
<th>Signal in Wax</th>
<th>St. Dev. In Wax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lorad/Hologic – Mo/Mo</td>
<td>FFDM</td>
<td>Mo/Mo</td>
<td>29</td>
<td>65</td>
<td>542.0</td>
<td>9.7</td>
</tr>
<tr>
<td></td>
<td>SFM</td>
<td>Mo/Mo</td>
<td>29</td>
<td>65</td>
<td>546.5</td>
<td>9.7</td>
</tr>
</tbody>
</table>
Versatility!

50% of the required RT and MP tests incorporate the new phantom

What Is New? Technologist Section

- Monitor QC for the interpretation workstations
- Management forms
- ACR Technique and Procedure Summaries
- Corrective Action Log
- Facility Offsite Display Locations
- QC Summary Checklists
- Digital Mammography Unit QC Summary Checklist
- Facility Display Device QC Summary Checklist
- Facility Equipment Inventory
- Improved QC Forms
- Instructions for Mobile Units
- Reduced calculations

RT Tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Minimum Frequency</th>
<th>Corrective Action Timeframe</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACR Phantom Quality</td>
<td>Weekly</td>
<td>Before clinical use</td>
</tr>
<tr>
<td>Computer Radiography (CR) Cassette Ensure (Applicable)</td>
<td>Weekly</td>
<td>Before clinical use</td>
</tr>
<tr>
<td>Compression Thickness Indicator</td>
<td>Monthly</td>
<td>Within 30 days</td>
</tr>
<tr>
<td>Vocal Checklist</td>
<td>Monthly</td>
<td>Critical items, before clinical use; less critical items, within 30 days within 30 days, before clinical use for severe defects</td>
</tr>
<tr>
<td>Acquisition Workstation (AW) Monitor QC</td>
<td>Monthly</td>
<td>Before clinical use</td>
</tr>
<tr>
<td>Radiological Workstation (RM) Monitor QC</td>
<td>Monthly</td>
<td>Before clinical use</td>
</tr>
<tr>
<td>Film Printer QC (applicable)</td>
<td>Monthly</td>
<td>Before clinical use</td>
</tr>
<tr>
<td>Viewbox Cleanliness (applicable)</td>
<td>Monthly</td>
<td>Before clinical use</td>
</tr>
<tr>
<td>Facility QR Review</td>
<td>Quarterly</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Compression Force</td>
<td>Semimonthly</td>
<td>Before clinical use</td>
</tr>
<tr>
<td>Manufacturer Detector Calibration (if applicable)</td>
<td>MR Recommendation</td>
<td>Before clinical use</td>
</tr>
<tr>
<td>Optional - Repeat Analysis</td>
<td>As Needed</td>
<td>Within 30 days after analysis</td>
</tr>
<tr>
<td>Optional - System QC for Workstations</td>
<td>As Needed</td>
<td>Within 30 days, before clinical use for severe artifacts</td>
</tr>
<tr>
<td>Optional - Radiological Image Quality Feedback</td>
<td>As Needed</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>
1. Phantom Image Quality
- For CR, erase plate first
- Create patient
  - use whatever ID system you want
- Align phantom
  - insert on top toward chest wall
- Compress to 5 daN (12 lb)
- Use CLINICAL technique
  - AEC activated insert, if applicable
  - Acquire image
- Record resulting technical factors

Evaluate image
- Count test objects
  - Artifacts
  - Use full resolution (1/1 pixel ratio)
- Note no artifact deduction
- Must see 2 fibers, 3 speck groups, 2 masses
- Corrective actions required prior to clinical use

Phantom Scoring

<table>
<thead>
<tr>
<th>Test Object</th>
<th>Full Point</th>
<th>Half Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fibers (6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full length visible (≥8 mm long)</td>
<td>At least half of length visible (35 and &lt;8 mm long)</td>
<td></td>
</tr>
<tr>
<td>Correct location</td>
<td>Correct location</td>
<td></td>
</tr>
<tr>
<td>Correct orientation</td>
<td>Correct orientation</td>
<td></td>
</tr>
<tr>
<td>1 break allowed (must be ≤ width of fiber)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speck Groups (6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 - 6 specks visible</td>
<td>2 - 3 specks visible</td>
<td></td>
</tr>
<tr>
<td>Correct locations</td>
<td>Correct locations</td>
<td></td>
</tr>
<tr>
<td>Masses (6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Density difference visible</td>
<td>Density difference visible</td>
<td></td>
</tr>
<tr>
<td>Border is continuous and generally circular (≥ 3/4 border visible)</td>
<td>Border is not continuous or generally circular (≥ 1/2 and &lt; 3/4 border visible)</td>
<td></td>
</tr>
<tr>
<td>Correct location</td>
<td>Correct location</td>
<td></td>
</tr>
</tbody>
</table>

Artifacts are handled as Pass/Fail
2. CR Cassette Erasure (if applicable)
   - Perform erasure procedure for all cassettes
   - Document completion of the task

3. Compression Thickness Indicator
   - Use any easily available object that’s about 4-6 cm thick
     - Two tape rolls work well
     - Note actual dimension
   - Use smallest, non-flex paddle available
   - Compress to about 5 daN (12 lb)
     - Record value and be consistent
     - Record indicated thickness
     - Must be accurate to ±5 mm
   - Corrective actions within 30 days

4. Visual Checklist
   - Pretty much the same as it always is
   - Make sure all bells and whistles are acting properly
   - Be sure to rotate the C-arm the way you would for patient imaging
   - When checking for cracks in paddles, face shields, and breast supports, only indicate issues that impact patient safety and image quality
   - It may be necessary to add additional items to the checklist that are specific to your particular equipment or procedures
   - Corrections required:
     - Prior to clinical use for critical tests
     - Within 30 days for non-critical tests
5. Acquisition Workstation
Monitor QC
► Need TG18-QC test pattern or equivalent
  ◦ If this is not possible, this part of the test cannot be performed
► Inspect monitor for fingerprints, etc.
  ◦ Clean as needed
► View test pattern
  ◦ 5%, 95% boxes visible
  ◦ Line-pairs distinguishable center and corners
► Corrective actions prior to clinical use
► Perform manufacturer automated QC if prescribed
  ◦ Corrective actions within 30 days

6. Radiologist Workstation
Monitor QC
► Need TG18-QC test pattern or equivalent
  ◦ If this is not possible, this part of the test cannot be performed
► Inspect monitor for fingerprints, etc.
  ◦ Clean as needed
► View ACR DM Phantom image
  ◦ Score and inspect for artifacts as in Test 1
► View test pattern
  ◦ 5%, 95% boxes visible
  ◦ Line-pairs distinguishable center and corners
► Corrective actions prior to clinical use
► Perform manufacturer automated QC if prescribed
  ◦ Corrective actions within 30 days

7. Film Printer QC (if applicable)
► Required if images are printed for referring physicians and patients
  ◦ If printer used less than monthly, do before clinical films are printed
► Print ACR DM Phantom image
  ◦ Do not adjust WW/WL
  ◦ Print true size
  ◦ Film size use for majority of clinical printing
► Score and inspect for artifacts as in Test 1
► Measure OD inside and outside of the cavity
► Calculate contrast = OD_cavity - OD_background
► Measure D_max
► Same phantom score requirements
  ◦ Background OD must be 21.6, should be 1.7-2.2 (2.0 optimal)
  ◦ D_max must be 3.1, should be ≥ 3.5
► Corrective actions prior to clinical use
8. Viewbox Cleanliness (if applicable)
- Required if prior or outside images are viewed on viewboxes
- Viewboxes must be clean and free of marks
- If viewboxes appear non-uniform, all lamps must be replaced
- Masks must be functioning
- Corrective actions prior to clinical use

9. Facility QC Review
- Review of RT and MP QC efforts
- Must be done by:
  - Lead interpreting physician
  - Facility manager
  - In person or by remote means
- Record MP test results on form
- Enter prior week of RT QC data
- Review most recent quarter of data with LIP and manager
- Review each QC test and results
- Note corrective action documentation present as needed
- Discuss reasons for failures
- Review MP results
- Document the review

10. Compression Force
- Few changes from the 1999 ACR Mammography QC Manual
- Must check that adequate force (≥25 lb) for length of average exposure
- Corrective actions prior to clinical use
11. Manufacturer Detector Calibration (if applicable)

- Required if a manufacturer specifies that a calibration must be performed
- Must follow manufacturer's procedure
- Must follow manufacturer's schedule
- Corrective actions prior to clinical use

Optional Tests

- Repeat analysis
- System QC for Radiologist
- Radiologist Image Quality Feedback

Up Next:

- Eric Berns, PhD
  - Medical Physicist Section