Gammex RMI CT Phantom, 438
(ACR CT Accreditation phantom, 464)

S. Edyvean, Jim Weston

Imaging Performance Assessment of CT Scanners
St. Georges Hospital, London
www.im pactscan.org

Some images courtesy of Cynthia McCullough
Mayo Clinic, Rochester, USA
Gammex RMI CT Phantom, 438

• David Aikman
  – Gammex RMI Ltd., Nottingham
Gammex RMI CT Phantom
Manual, also ACR (American College of Radiology) website
Testing and QC Forms

Facilities that have applied for the Computed Tomography (CT) Accreditation Program will submit the following documents with their image submission for review. These forms are provided to the facility in hard-copy form once their initial application has been processed at the ACR. For your convenience, additional copies may be printed by clicking on the links below. Please note that these forms should not be submitted with an initial application for accreditation.

Computed Tomography Testing and QC Forms

- Quality Assurance Questionnaire
- Electronic Submission Memorandum to Facilities
- Clinical Image Quality Guide
- Clinical Testing Instructions
- Clinical Test Image Data Form
- Phantom Order Form
- Phantom Testing Instructions
- Phantom Testing Criteria
- Phantom Site Scanning Data Form
- Phantom Dose Calculator Spreadsheet (Air Kerma)
- Phantom Dose Calculator Spreadsheet (Exposure)
- Detector Configuration Frequently Asked Questions Part I
- Detector Configuration Frequently Asked Questions Part II
- Checklist
### Table 1: Typical Image Acquisition Technical Parameters

<table>
<thead>
<tr>
<th></th>
<th>Adult Head (cerebellum portion)</th>
<th>High Resolution Chest</th>
<th>Adult Abdomen</th>
<th>Pediatric Abdomen (5 y.o.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>kVp</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>mA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Time per rotation (s)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Scan FOV (cm or name)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Display FOV (cm)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Reconstruction Algorithm</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Axial (A) or Helical (H)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Z-axis collimation (T, in mm)^1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong># data channels used^1 (N)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>A: Table Increment (mm) or H: Table Speed (mm/rot) (/)^1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pitch^2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Reconstructed Scan Width (mm)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Reconstructed Scan Interval (mm)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dose Reduction Technique(s)^3</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

^1 Standard collimation 2.4 x Pitch. ^2 Standard pitch: 0.5. ^3 Standard dose reduction techniques include: Bucky, Automatic Exposure Control (AEC), Prospective Target Dose (PTD), and Image Quality Optimizer (IQO).
Setting up
Module 1: alignment, image thickness, CT number

- **Polyethylene:** $\approx -97$ HU
- **Water:** $\approx 0$ HU
- **Acrylic:** $\approx +120$ HU
- **“Bone”:** $\approx +910$ HU
- **Air:** $\approx -1000$ HU
Module 1: alignment, image thickness, CT number

Must see all four BBs (in Modules 1 & 4)

Longer wire must have same number of lines above and below (±1)

WW = 1000
WL = 0
Module 1: alignment, image thickness, CT number

Wires are 0.5 mm apart in z-direction

\[
\frac{11}{2} = 5.5 \text{ mm}
\]

\[
\frac{10}{2} = 5 \text{ mm}
\]

\[
\text{WW} = 400
\]

\[
\text{WL} = 0
\]
Module 1: alignment, image thickness, CT number

Polyethylene ≈ -97 HU
Water ≈ 0 HU
Acrylic ≈ +120 HU

“Bone” ≈ +910 HU
Air ≈ -1000 HU

WW = 400
WL = 0
### Section 5 – Module 1: CT Number Calibration and Slice Thickness

#### Adult Abdomen technique

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Measured</th>
<th>Film Page: Box</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location of center of Module 1</td>
<td>_______mm</td>
<td></td>
</tr>
</tbody>
</table>

#### CT number calibration and scan width accuracy for adult abdomen slice width

<table>
<thead>
<tr>
<th>Material</th>
<th>Mean CT # = _______ HU</th>
<th>Top</th>
<th>Bottom</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>Mean CT # = _______ HU</td>
<td></td>
<td></td>
<td>1:4</td>
</tr>
<tr>
<td></td>
<td>_______mm</td>
<td></td>
<td>_______mm</td>
<td></td>
</tr>
<tr>
<td>Acrylic</td>
<td>Mean CT # = _______ HU</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bone</td>
<td>Mean CT # = _______ HU</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air</td>
<td>Mean CT # = _______ HU</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Dependency of CT Number of water on scan width and kVp, and scan width accuracy

<table>
<thead>
<tr>
<th>Hi Res Chest = _______mm</th>
<th>CT number of water</th>
<th>Top</th>
<th>Bottom</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean CT # = _______ HU</td>
<td>_______mm</td>
<td></td>
<td>_______mm</td>
<td>1:5</td>
</tr>
<tr>
<td>~ 3 mm = _______mm</td>
<td>Mean CT # = _______ HU</td>
<td></td>
<td>_______mm</td>
<td>1:6</td>
</tr>
</tbody>
</table>
Module 2: Low contrast detectability

- Low contrast = 6 HU ± 0.5 HU
  - (cf Catphan 10, 5, 3 HU single object of each size)
Phantoms for low contrast detectability (LCD)

• Catphan 500
  - 2-15 mm diameter
  - 10 HU contrast
  - 5 HU contrast
  - 3 HU contrast

• Catphan is closest to a ‘standard’ phantom
Module 2: Low contrast detectability

- Low contrast = 6 HU ± 0.5 HU
  - (cf Catphan 10, 5, 3 HU single object of each size)
Module 3: uniformity, noise, distance, mtf & ssp

0.3 mm tungsten carbide beads

WW = 100
WL = 0
Module 4: high contrast spatial resolution

Bar patterns: lp/cm
Aluminium in solid water

WW = 100
WL ≈ 1100
Gammex RMI CT Phantom

- Nicely designed phantom
- Excellent phantom stand
- Good additional documentation from ACR
- Slightly limited for axial MSCT? (40 mm modules)
- Bar pattern doesn’t go to maximum resolution
- LCD of 6HU different from manufacturers spec. (use 3HU from Catphan)
Gammex RMI CT Phantom

• David Aikman
  – Gammex RMI Ltd., Nottingham
  – 01159850808, daa@gammex.com

• Cost
  – List price £5589 (not including stand),
  – Discount for early sales ~10%
Incidental Findings
Incidental Findings
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