ACR CT Accreditation Program
Image Quality Phantom and Dose Measurements

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Goal of accreditation

Increase quality

Timeline

- Program approved by ACR Council in 1997
- Robert Zeman, M.D. - Chairperson
- July 1998 first meeting
- Lots of work!!!
- Program Piloted summer 2001
- Program active March 2002, over 100 applications requested in 1st month
- Required for reimbursement by some insurers in 2004

Physics Subcommittee

- Cynthia McCollough, Ph.D., Chair
- Tom Payne, Ph.D.
- Mike McNitt-Gray, Ph.D.
- Tom Ruckdeschel, M.S.
- Jim Brink, M.D.
- ACR: Pam Wilcox, Penny Butler, Krista Bush, Chris Riha
ACR CT Accreditation Program

- Evaluation of the following primary determinants of clinical image quality
  - qualifications of personnel
  - clinical images and exam protocols
  - equipment performance
  - effectiveness of quality control measures
  - reference doses for three specific exams

Process Overview

- Entry application
  - Credentials of Physicians, Technologists, Physicists
  - Site and scanner demographics

- Full Application
  - Safety, QA, archive, reporting policies and procedures
  - Names, credentials and CME info for all Physicians, Technologists, Physicists
  - Clinical images
  - Phantom images

Physicist Qualifications

- Appropriate board certification or specific evidence of appropriate training
- ACR CME (CAMPEP, MEP) requirements
  - 150 hours every three years (not CT specific)
  - Minimum of 60 hours must be category 1
  - Category 2 can include teaching, literature review, manuscript preparation or review, computer instruction, etc.

**SECTION 1: PERSONNEL + MEDICAL PHYSICIST**

Please print or type. Complete one copy of Section 1 for each physician who provides technical services at the facility. If you have multiple physicians, photocopy the form and complete a separate copy for each individual.

<table>
<thead>
<tr>
<th>Name</th>
<th>Last Name</th>
<th>First Name</th>
<th>Id</th>
<th>Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

**CONTINUING EDUCATION**

5. What is the trend number of CT exams for which you perform or perform technical services within the past year?

<table>
<thead>
<tr>
<th></th>
<th>1-799</th>
<th>800-3,999</th>
<th>4,000-9,999</th>
<th>10,000 or more</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

6. Have you passed the CME exam in accordance with the ACR Standard on Continuing Medical Education?

| Yes | No |
Physicist Qualifications (cont.)

- Physicist may have assistance in data collection
  - Properly trained individuals approved by the CMP
  - CMP is responsible for all data
  - Must be present during initial and annual surveys
  - Must review, interpret and approve all data
  - Must provide a signed report of conclusions

Physicist Responsibilities

- Physicist should be available for dosimetry consultations in a reasonable time
- Must establish and supervise QC program
  - What tests, done by whom, how often
  - Designate an on-site RT responsible for conducting routine QC
- Initial acceptance testing and annual survey
  - Tests should be consistent with ACR Standard for CT Performance Evaluation

Annual Performance Evaluation

- Alignment light accuracy
- Alignment of table to gantry
- Table/gantry tilt
- Slice localization from localization image (SPR)
- Table incrementation accuracy
- Slice thickness
- Image quality
  - High contrast (spatial) resolution
  - Low contrast resolution
  - Image uniformity
  - Noise
  - Artifact evaluation
- CT number accuracy and constancy

Annual Performance Evaluation

- Display devices
  - Video display
  - Hard-copy display
- Dosimetry
  -Computed Tomography dosimetry index (CTDI)
  - Patient radiation dose for representative examinations
- Safety evaluation
  - Visual inspection
  - Audible/visual signals
  - Posting requirements
  - Scattered radiation measurements
- Other tests as required by state and/or local regulations
**Equipment and Exam Standards**

- Must meet all state and or federal requirements
- Must meet applicable ACR standards
  - Neuro CT for children and adults
  - Thoracic CT for children and adults
  - CT of the abdomen and pelvis
  - ...

**Clinical Images**

- Three cases from each CT scanner
  - head / neck, chest and abdomen
  - attestation allowed for head- or body-only scanners
- One case must be a “specialty” exam
- One case must be pediatric for sites that scan kids
- Exam choices detailed in application instructions
- Images submitted on film with 1 page summary sheet of exam parameters and patient info

**Phantom Images and Dose**

- One set of phantom images (2 films) per CT
- Completed data sheets, including dosimetry
- Calculations of CTDIvol, DLP and E using the site’s measured CTDIw and the reported scan acquisition parameters (pitch)
  - Routine head (cerebrum)
  - Adult abdomen
  - Pediatric abdomen (5 y.o)

**Accreditation Cycle**

- Peer review report sent to each facility to aid in “raising the bar” for CT imaging
- Accreditation is for a 3 year period
- Random site visits and film checks can occur
- For scanners added between accreditation cycles, site must submit clinical and phantom images, and dose info
**The Scan-a-thon**

**Consensus**

- Single phantom design must be used
- No existing phantom had all desirable test objects
- Solid one-piece construction, 20-cm diameter
- Test objects must be simple to evaluate
- Objects and tests must be extendable to spiral
- Dosimetry will be CTDI100-based in PMMA
- Assessment of phantom images will be film-based

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**The ACR CT phantom was designed to examine a broad range of scanner parameters**

- Positioning Accuracy
- CT # Accuracy
- Slice Width Accuracy
- Low Contrast Resolution
- High Contrast (Spatial) Resolution
- Image Uniformity and Noise
- Image Artifacts
- Distance Measurement Accuracy
- Section Sensitivity Profiles

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<table>
<thead>
<tr>
<th>Head</th>
<th>Foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

- 20 cm
- 4 cm
Instruction Manual

- Detailed step by step scan and analysis instructions
- Tells which set of scan parameters to use to acquire which phantom images
- Data sheet provides cells for measured and calculated data
- W/L and location on film grid given for all images to be filmed
- Dose measurement and calculation methods

Calibrations and water phantom

- Scanner should already meet all site QC criteria
- Perform scanner warm-up and daily calibrations
- Check water phantom for
  - Artifacts
  - CT number of water
  - Uniformity and noise
- Check SMPTE pattern on laser imager

Site Scanning Data Form

- Site or manufacturer-recommended protocols
  - Adult Head: Routine head (brain) CT for evaluation of patient with headaches to exclude neoplasms
  - High Resolution Chest: CT exam of the chest for evaluation of diffuse lung disease
  - Adult Abdomen: Routine oncologic CT survey of the abdomen for detection of possible liver metastases
  - Pediatric Abdomen: CT examination of pediatric (approx. 5 years old) abdomen for the evaluation of blunt trauma injuries
<table>
<thead>
<tr>
<th></th>
<th>Low Resolution</th>
<th>High Resolution</th>
<th>Adult Abdomen</th>
<th>Pediatric Abdomen (5 y.o.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>kVp</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time per rotation (s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scan FOV (cm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Display FOV (cm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reconstruction Algorithm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axial or Helical Scan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z-axis collimation (T, in mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># data channels</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A: Table Increment (mm) or H: Table Speed (mm/rot)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pitch 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reconstructed Scan Width (mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reconstructed Scan Interval (mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dose Reduction Technique(s):
- z-axis collimation (T) = the width of the tomographic section along the z-axis imaged by one data channel. In multi-detector row (multi-slice) CT scanners, several detector elements may be grouped together to form one data channel.
- number of data channels (N) = the number of tomographic sections imaged in a single axial scan
- maximum number of data channels (Nm) = the maximum number of tomographic sections for a single axial scan
- increment (I) = the table increment per axial scan or the table increment per rotation of the x-ray tube in a helical scan
- mA = the actual tube current used (averaged over one rotation)
- exposure time = the time required for one complete rotation of the x-ray source.

- Some scanners do not display
  - collimation width T
  - number of rows used N
  - IEC pitch
- Table feed per rotation (I) usually given
- Conversion table for GE on ACR website
- Other FAQ info also on ACR site

ACR CT Accreditation Tests performed using site’s clinical protocol (Table 1):
- Alignment light accuracy
- Table incrementation accuracy
- Slice thickness accuracy
- CT number accuracy
- Image Quality
  - low contrast resolution
  - image uniformity
  - image noise
  - artifact evaluation
  - high contrast resolution
- CTDI measurements
- Patient exam dose estimates
Phantom and Scanner Alignment

- Align Module 1 to lasers
- Scan with Hi Res Chest protocol
- Prescribe a scan at center of Module 4 (120 mm superior)
- Scan with Hi Res Chest protocol
High-resolution chest technique

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

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

If FAIL, do not pass “go”, do not collect accreditation
CT Number Accuracy and Slice Thickness

- Align Module 1 to lasers
- Scan with Adult Abdomen protocol
- Record slice thickness and all CT numbers
  - Water, air, polyethylene, bone and acrylic
- Scan varying slice thickness (≥ 3, 5, 7 mm & Hi Res)
  - Measure water CT number and slice thickness
- Scan varying kVp (scan with all available)
  - Measure water CT number and slice thickness
**Low Contrast Resolution**

- Scan Module 2
  - Adult Abdomen protocol
  - Adult Head protocol
- Record the diameter (mm) of the smallest set of LCR rods seen

**Record diameter**

- 25 mm
- 6 mm
- 5 mm
- 4 mm
- 3 mm
- 2 mm

Low contrast = 6 HU ± 0.5 HU
**Image Uniformity and Noise**

- Scan Module 3
  - Adult Abdomen protocol
- Record mean CT number & SD at center
- Record mean CT number at 3, 6, 9, 12 o’clock
- Examine for artifacts

### Module 3

**100 mm**

**WW = 100**

**WL = 0**

**Table: Section 3: Module 3 Uniformity and Noise**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Measured</th>
<th>Calculated</th>
<th>Flex Page Not</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center Hounsfield</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard deviation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Center mean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 o’clock mean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 o’clock mean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 o’clock mean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 o’clock mean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artifacts</td>
<td>Y/N</td>
<td>Y/N</td>
<td>Other</td>
</tr>
</tbody>
</table>

**Adult abdomen and head techniques**

**Measure uniformity and noise**

**Assess for artifacts**

**Measure distance accuracy (optional)**
High Contrast Resolution

- Scan Module 4
  - Adult abdomen protocol
  - Hi Resolution Chest protocol
- Record limiting resolution (lp/cm)

Adult abdomen, adult head and high-resolution chest techniques

Record the first highest frequency bar pattern for which the bars and spaces merge

Wrong window and level

WW = 100
WL ≈ 1100

WW = 400
WL = 0
“What’s the dose?” is not a simple question

Computed Tomography Dose Index (CTDI) is the integral under the radiation dose profile from a single axial scan.

What dose do you want to know?
- Skin dose
- Midline dose
- Fetal dose
- Average dose
- Total dose
- Dose equivalent
- Effective dose equivalent
- Equivalent dose
- Effective dose
- CTDI
- CTDI_FDA
- CTDI_{100}
- CTDI_w
- CTDI_{vol}
- MSAD
- BERT

Radiation dose profile
- N-T
- Nominal beam width
CTDI ion chamber (100 mm long)  CTDI_{100}

Acrylic CTDI phantoms
32 cm diameter (body)
16 cm diameter (head)
Holes for measurements throughout FOV

Typical FOV dose distributions (%)

<table>
<thead>
<tr>
<th>Body</th>
<th>Head</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

CTDlw = \frac{2}{3} \text{CTDI}_{100} (edge) + \frac{1}{3} \text{CTDI}_{100} (center)

Axial Position (mm)

Position in scan plane = 0.88

Multiple-scan profile:
3 mm x 3 mm, 40 scans

Volume CTDI (MSAD)

Single-scan profile

PITCH = \text{table index per rotation (I)}

\text{total nominal scan width (NT)}

\text{CTDIm}_{\text{total}} = \frac{1}{\text{pitch}} \cdot \text{CTDI}_{\text{w}}

estimate of average dose in the scan volume \((x, y, z)\)

measurements from one axial scan
DLP = CTDIvol (mGy) \times \text{scan length (cm)}

DLP = 200 \text{ mGy/cm}

CTDIvol = 20 \text{ mGy}
		\text{ten 1-cm slices}

DLP = 400 \text{ mGy/cm}

CTDIvol \text{ STILL} = 20 \text{ mGy}
		\text{twenty 1-cm slices}

DLP = CTDIvol (mGy) \times \text{scan length (cm)}

Dose indicators are now displayed prospectively on the CT Console

Typical Dose Values
(shown on operator console)

<table>
<thead>
<tr>
<th>Exam</th>
<th>Detector Config</th>
<th>Pitch</th>
<th>mAs</th>
<th>Z-Extent (cm)</th>
<th>CTDIvol (mGy)</th>
<th>DLP (mGy/cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>head</td>
<td>4 x 2.5 axial</td>
<td></td>
<td>230</td>
<td>15</td>
<td>33.5</td>
<td>503</td>
</tr>
<tr>
<td>chest</td>
<td>4 x 5 0.75</td>
<td>100</td>
<td>40</td>
<td>12.0</td>
<td>480</td>
<td></td>
</tr>
<tr>
<td>abdomen</td>
<td>4 x 5 0.75</td>
<td>150</td>
<td>20</td>
<td>19.1</td>
<td>382</td>
<td></td>
</tr>
<tr>
<td>abd &amp; pelvis</td>
<td>4 x 5 0.75</td>
<td>150</td>
<td>40</td>
<td>19.1</td>
<td>764</td>
<td></td>
</tr>
</tbody>
</table>

Newer software will display CTDIvol

Dose Information

Projected series DLP: \text{377.35 mGy cm}

Accumulated exam DLP: \text{0.00 mGy cm}
**Reference doses**

- Concept has been shown to lower average dose in other modalities and/or other countries
- Represent the upper third or quartile of doses sampled from actual clinical practice data
- *Do not represent ideal or suggested doses*
- Identify when dose is unusually high

**European Guidelines**

<table>
<thead>
<tr>
<th>Exam</th>
<th>CTDIw</th>
<th>DLP</th>
<th>Effective Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>60</td>
<td>1050</td>
<td>2.4</td>
</tr>
<tr>
<td>Chest</td>
<td>30</td>
<td>650</td>
<td>11.1</td>
</tr>
<tr>
<td>Abd</td>
<td>35</td>
<td>800</td>
<td>12.0</td>
</tr>
<tr>
<td>Pelvis</td>
<td>35</td>
<td>600</td>
<td>11.4</td>
</tr>
<tr>
<td>Chest/Abd/Pel</td>
<td>2050</td>
<td>34.5</td>
<td></td>
</tr>
</tbody>
</table>

From European Commission EUR 16262
European Guidelines on Quality Criteria for Computed Tomography

**ACR CT Dose Reference Values**
- Adult Head 60 mGy
- Adult Abdomen 35 mGy
- Pediatric (5yr old) Abdomen 25 mGy

**Currently no pass/fail criteria**
- ACR will require documentation detailing either site’s justification or corrective action
- At renewal (3 yrs), reference doses will become pass/fail

**Analysis of ACR data will determine future reference dose values (will use CTDIvol)**

**Phantom size affects CTDI values**

Same kVp, mAs, collimation, pitch

**Body**

- **Head**
  - 32 cm
  - CTDIw = 16.6
  - CTDIv = 40

- **Body**
  - 40 cm
  - CTDIw = 20
  - CTDIv = 40
Phantom size affects CTDI values

Same kVp, collimation, pitch

Body
200 mAs

20 mAs

20 mAs

20 mAs

CTDIw = 16.6

Head
116 mAs

16.6

16.6

16.6

CTDIw = 16.6

ACR CT Dose Reference Values

- Adult Abdomen 35 mGy
- Pediatric (5yr old) Abdomen 25 mGy

Use of smaller phantom requires factor of 2.4 reduction in dose to get same CTDIw

Decrease in reference value (25/35) suggests another factor of 1.4 reduction in dose with respect to site’s adult protocol

Total dose reduction for 5 y.o. abdomen should be about a factor of to 3 - 4

Preliminary dose statistics

- Adult head
  - 76 mGy ± 30 (35 - 180 +) 60% sites > reference
  - U.S. average 1990 and 2000 approx. 50 mGy
- 5 y.o. abdomen
  - 21 mGy ± 10 (5 to 52) 24% sites > reference
- Adult abdomen
  - 21 mGy ± 7 (9 to 40) 10% sites > reference
  - Same CTDIw implies average mAs reduction of 2.4 occurring for pediatric exams submitted for accreditation

When someone asks …
“What is the dose”
they typically mean
“What is the risk of biologic injury”
• Biological injury includes
  – deterministic effects (skin burns, cataract formation)
  – stochastic effects (cancer induction, genetic effects)
• Risk estimates are derived from
  – atomic bomb survivor data, other exposed groups
• Risk estimates are dependent on
  – organ dose and type, age, gender, reproductive status
  – organ doses depend on patient size

What’s my dose (risk)?
Radiation detriment better expressed by

**Effective Dose**

a *single dose parameter* which *reflects the risk of a non-uniform exposure* in terms of a whole-body exposure

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**ICRP 60 Weighting Values**

<table>
<thead>
<tr>
<th>Organ</th>
<th>Weighting Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gonads</td>
<td>0.20</td>
</tr>
<tr>
<td>RBM, colon, lung, stomach</td>
<td>0.12</td>
</tr>
<tr>
<td>Bladder, breast, liver</td>
<td>0.05</td>
</tr>
<tr>
<td>Esophagus, thyroid</td>
<td>0.05</td>
</tr>
<tr>
<td>Skin, bone surface,</td>
<td>0.01</td>
</tr>
<tr>
<td>Remainder</td>
<td>0.05</td>
</tr>
<tr>
<td><strong>Σ</strong></td>
<td><strong>1.00</strong></td>
</tr>
</tbody>
</table>

Equipment exposure measurements and exam technique factors → CTDI(air, isocenter)

Multiply by

Conversion coefficients (exposure to dose)

NRPB, GSF

Data In

Organ Doses

Data Out

ICRP 60: Effective Dose (E)

Several implementations
Typical effective dose values

- **Head CT**: 1 - 2 mSv
- **Chest CT**: 5 - 7 mSv
- **Abdomen CT**: 5 - 7 mSv
- **Pelvis CT**: 3 - 4 mSv
- **Abd & pelvis CT**: 8 - 11 mSv

Average U.S. background radiation
≈ 3.6 mSv

Caveats

- Effective dose estimates
  - facilitate exam optimization
  - allow risk comparisons between different exams
  - provide risk information for IRB protocol review
  - are based on healthy worker adult populations
  - should be used as a broad measure of risk
    (i.e. one or two significant digits are sufficient)
  - DO NOT APPLY TO ANY INDIVIDUAL PATIENT

Effective Dose:
Variability in estimation methods

- GSF and NRPB conversion coefficient data sets
- Several SW packages available to perform computations
  - WinDose (IMP), CT-Expo (Nagel), CTdosimetry (ImPACT), P-Dose (CyberQual), CT-Dose (LeHeron), DoseMacro (Mayo)
- For thorax $E \approx 0.017 \cdot DLP$
  - European Guidelines on Quality Criteria for CT
  - DLP takes into account much of scanner influence
  - Appears to give reasonable estimate of $E$ (± 30%)

Dose Information for Accreditation

- Submit calculations of CTDIvol, DLP and Effective Dose using the site’s measured CTDIw and the reported scan acquisition parameters (pitch)
  - Routine head (cerebrum)
  - Adult abdomen
  - Pediatric abdomen (5 y.o)
- CTDI phantom acquisition must be filmed
CTDI Measurements

- Adult Head
  - 16 cm CTDI phantom
  - Phantom in head holder
- Pediatric abdomen (5 y.o.)
  - 16 cm CTDI phantom
  - Phantom on table
- Adult Body
  - 32 cm CTDI phantom
  - Phantom on table
- Measure at center and 12:00
- MUST use Axial scan mode

CTDI Body Phantom (32-cm diameter PMMA Phantom) Measured Calculated Film

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Value</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>kVp</td>
<td>120</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mA</td>
<td>240</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exposure time per rotation (s)</td>
<td>0.8</td>
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<td></td>
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<tr>
<td>Active Chamber length (mm)</td>
<td>100</td>
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<td></td>
</tr>
<tr>
<td>Chamber correction factor</td>
<td>0.97</td>
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</tr>
<tr>
<td>CTDIw (mGy)</td>
<td>19.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CTDI Body Phantom at 12 o'clock position in phantom (mGy)

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>23.0</td>
</tr>
<tr>
<td>2</td>
<td>23.0</td>
</tr>
<tr>
<td>3</td>
<td>23.0</td>
</tr>
</tbody>
</table>

Average of above 3 measurements (mGy) 23.0

CTDI Body Phantom at center in phantom (mGy)

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11.2</td>
</tr>
<tr>
<td>2</td>
<td>11.2</td>
</tr>
<tr>
<td>3</td>
<td>11.2</td>
</tr>
</tbody>
</table>

Average of above 3 measurements (mGy) 11.2
Clinical exam dose estimates using measured CTDIw and site's Adult Abdomen Protocol from Table 1:

- Volume CTDI = CTDIw / pitch
  \[ \frac{19.0 \times (4 \times 3.75)}{11.25} = 25.4 \]

- DLP = CTDIvol \times \text{total length of scan (given)}

- ESTIMATED Effective Dose = DLP \times \text{body part coefficient}

Goal of accreditation:

Increase quality
From head ... "Holy great mother of God, I've been cloned!"

to toe ...

We need to keep our eyes on quality!

For further information contact the ACR