


ACR Updates - CT

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AAPM Annual Meeting
July 16, 2019



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Disclosures

- Chair, ACR CT Physics Subcommittee
- Senior Reviewer, ACR CT Accreditation Program
- Vice President, Medical Physicist, Alliance Medical Physics, LLC

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Outline

- Brief History
- Current ACR CT Accreditation Program Statistics and Status
- CT Accreditation Tips and Common Issues for the Medical Physicist
 - Clinical Involvement
 - Physics
- CT Accreditation Program Updates

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Brief History

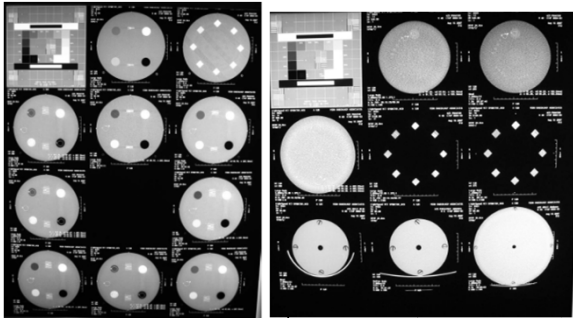
- 1987 Mammography Accreditation
- 1994 FDA adopts the ACR's MAP
- 1998 ACR CT Committee Formed
- 2002 CT Accreditation Program Began
- CT Quality Control Manuals



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Original Submission Format



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Current ACR CT Accreditation Program Statistics

- As of July 2019

Date	Sites					CT Units				
	Oct-05	May-08	Dec-16	Jul-18	Jul-19	Oct-05	May-08	Dec-16	Jul-18	Jul-19
Accredited	613	1783	7095	7139	7270	780	2140	9508	9849	10048
Active	765	3042	7211	7242	7364	1006	3720	9885	10132	10327


*Active – Accredited & In Process

- 2018 Pass/Fail Rate: 92% (8% Overall Repeat)
- 2019 Pass/Fail Rate: 94.5% (5.5% Overall Repeat)

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Current ACR CT Accreditation Program Statistics

- As of July 2018
 - Average turn around time from testing materials to final report
 - 30 Days
 - Lung Cancer Screening Designation
 - 2057 centers



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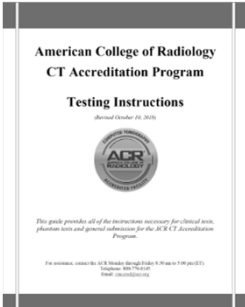
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Clinical Involvement

- Most common reason sites fail is they don't follow the clinical guide, not image quality.
- All images are examples of best work
- Still should submit scouts or localizers with cross reference locations
- Supervising physician is ultimately responsible
 - They must review the entire submission.
 - The medical physicist can play a role.

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ACR CT Testing Instructions



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Category D: Exam Identification

E. Category D: Exam Identification

Patient and technical data must be displayed on the images or be readily accessible in the DICOM header. All patient information annotated on clinical examinations will be kept confidential by the ACR, as stated in the Practice Site Accreditation Survey Agreement.

1. Patient name (first and last)
2. Patient age (or date of birth)
3. Gender of patient, date of exam
4. Institution name
5. Left/right labeling
6. Technical parameters:
 - kV
 - mA (or mAs or effective mAs or mAs/slice, as reported by scanner)
 - Rotation time
 - Pitch (if available)
 - Reconstructed image thickness (slice width)
 - Reconstructed filter/kernel
 - Display field of view (FOV)
7. Image number (numbered consecutively based on anatomic location)
8. Table position (scan location)
9. Presence or absence of IV contrast
10. Dose report



Category E: Examination Protocol

F. Category E: Examination Protocol

Facilities are required to submit a copy of their scanning protocols with the images. The facility should submit its protocols in the format that it normally uses on site, but they need to be readily understandable by a reviewer charged with correlating those protocols with the submitted images. The ACR does not provide forms for the site's protocols. These protocols must be submitted on paper (typed) with the provided label affixed to the protocol or uploaded if electronic submission is selected.

A typical protocol should at least include the following elements:

- Indication
- Scanner acquisition settings (routine kV, mA/mAs/effective mAs, collimation (N x T), pitch, rotation time, usage of radiation dose reduction methods (automatic exposure control such as tube current modulation, settings for dose reduction methods, etc.)
- Phase of respiration
- Reconstruction settings (reconstructed image width (slice thickness), reconstruction interval, reconstruction kernel/filter, reconstructed field of view (FOV))
- Anatomical coverage (i.e. lung apices to lung bases, top of diaphragm to iliac crest, etc.)
- IV contrast (with injection rate and scan delay), if applicable
- EKG gating (cardiac studies) policy

Other Common Issues

Pediatric Head	
A. Technique Parameters	
Required series	Non-enhanced
Reconstructed slice width	≤ 5 mm
Reconstruction algorithm	Standard or equivalent
Scan FOV	"Head" or equivalent
CTDIvol	Reference value: 35 mGy* Pass/fail criteria: 40 mGy*
B. Anatomic Coverage	
Coverage	Base of the skull through the vertex
Lens exposure	Lens exposure should be avoided

*CTDIvol values are based on a 1 year old age.

Other Common Issues

Pediatric Abdomen	
A. Technique Parameters	
Required series	IV contrast enhanced
Reconstructed slice width	≤ 5 mm
Reconstructed algorithm	Standard or soft tissue (or appropriate body kernel)
Oral contrast	Oral contrast material must be present with barium or neutral contrast agents
CTDIvol	Reference value: 15 mGy* Pass/fail criteria: 20 mGy*
B. Anatomic Coverage	
Coverage	Diaphragm through the iliac crest
A. Technique Parameters	
Required series	IV contrast enhanced
Reconstructed slice width	≤ 3 mm
Reconstruction algorithm	Standard or soft tissue (or appropriate body kernel)
Oral contrast	Not required
CTDIvol	There are no reference values for this examination
B. Anatomic Coverage	
Coverage	Extend just above the diaphragm to the iliac crest or inferior extent of the kidneys

*As reported by the scanner using a 16 cm phantom. If scanner reports values using a 32 cm phantom, then approximate limits would be 7.5 mGy and 10 mGy. The CTDIvol is based on a 40-50 lb. patient size.

What About Subjectivity of CTDI?

Adult Chest	
A. Technique Parameters	
Required series	IV contrast may be used but is not required
Reconstructed slice width	≤ 5 mm
Reconstructed algorithm	Standard or equivalent
CTDIvol	Reference Value: 21 mGy* Radiation dose reduction methods such as Automatic Exposure Control methods (e.g. Tube Current Modulation) are encouraged.
B. Anatomic Coverage	
Coverage	Lung apex to below the lung bases

*National Council on Radiation Protection and Measurement Diagnostic. Reference levels and achievable doses in medical and dental imaging: recommendations for the United States. Bethesda, MD. NCRP Report #172; 2012.
The 21 mGy reference value for the adult chest study is based on an average size patient and may be higher for larger sized patients.

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Physics Scoring Changes

1. Dosimetry Images Not Submitted

Previous:

- Major deficiency
- Results in an appeal with CTDI image submission

New:

- Reviewer rejects submission without scoring
- ACR staff follows up with the site to have CTDI images submitted.

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Physics Scoring Changes

2. CT Beam Collimation - N x T on phantom data form does not match CTDI images exclusive of scanner limitations

Previous:

- Major deficiency

New (exclusive of scanner limitations):

- Minor deficiency – Detector configuration smaller than indicated (overestimates dose)
- Major deficiency – Detector configuration larger than indicated (underestimates dose)

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Physics Scoring Changes

3. Artifacts

Previous:

- Scored on module 3 image only

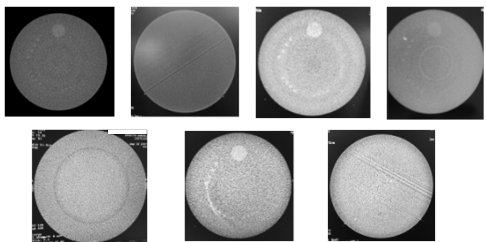
New:

- Artifacts to be scored on modules 1 through 3. Major or minor deficiency at reviewer’s discretion.
- Not Deficient
 - Artifacts due to phantom construction
 - Artifacts between modules
 - Artifacts due to phantom, i.e. BBs streak on Module 1

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Artifact Examples

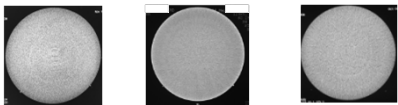
Major Deficiency:



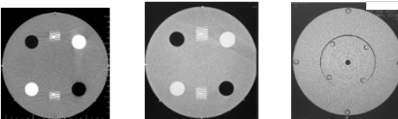
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Artifact Examples

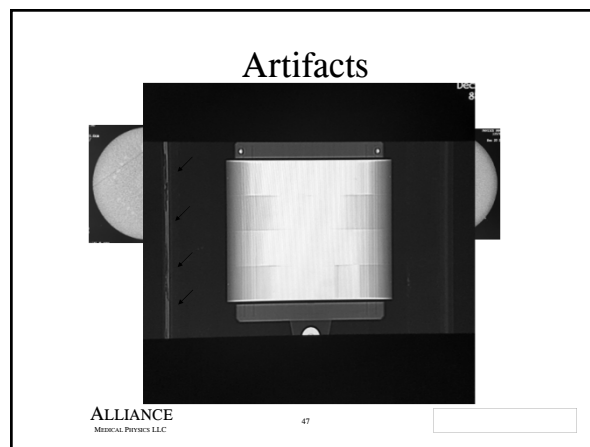
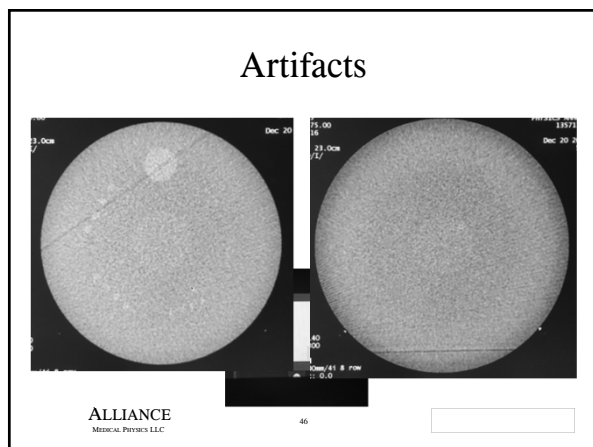
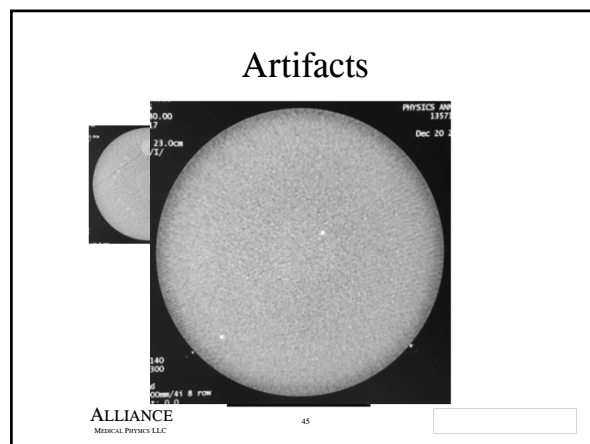
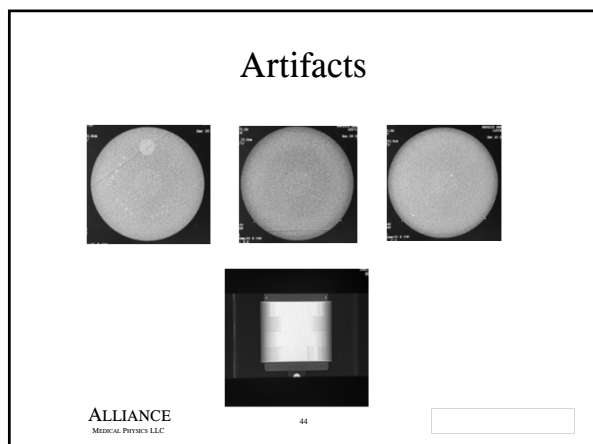
Minor Deficiency:



No Deficiency:



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Physics Scoring Changes

4. CTDI Minimum Images

Previous: Not specified

New:

- Submit all images in one axial rotation. Can be either:
 - 12 o'clock
 - Center
- Only one series per protocol is needed
- Minor deficiency if all images for one rotation are not submitted (future).
- Rationale: DICOM header does not always show N x T

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Physics Scoring Changes

5. Pitch

Previous:

- Minor deficiency - Pitch used on ACR phantom scan is more than 10% different from what is recorded in the phantom data form

New:

- Major deficiency - Pitch is more than 10% less from what is recorded in the phantom data form
- Minor deficiency - Pitch is more than 10% greater from what is recorded in the phantom data form

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Physics Scoring Changes

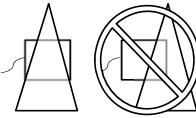
6. Pediatric Abdomen CTDI Phantom Size
Current:

- Major Deficiency – Phantom size scanned does not match phantom size on the CTDI form.

7. CTDI Beam Centering (Rare)


Previous:

- No deficiency




New:

- Major Deficiency- If the beam is shifted off the end of the CTDI phantom by 50% or more.

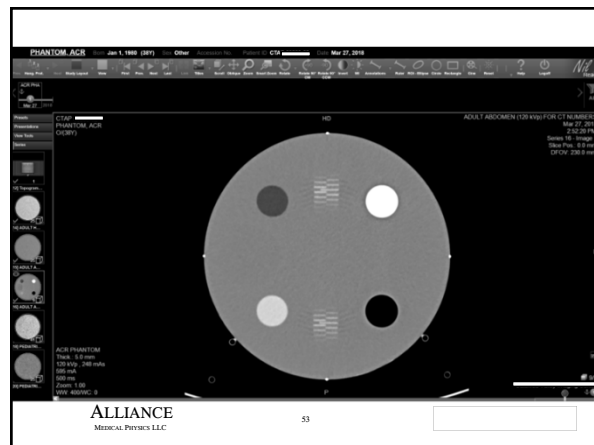

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Electronic Submission Required

- Can still use TRIAD software
- Advantages:
 - No additional software needed
 - Can view images in browser
 - Could view site’s clinical images prior to submission in web browser
 - Can view images after submission for a period of time
- CD submission will require special approval



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Phantom				
Total Files: 220				
DICOM File	Study Description	Study Date	View Images	
<input type="checkbox"/>	ADULT HEAD DOSE	3272016	View	
Series Description				
	ADULT HEAD DOSE	CT	3	3272016 2
	ADULT HEAD DOSE	CT	4	3272016 2
<input type="checkbox"/>	ACR PHANTOM	3272016	View	
Series Description				
	ADULT ABDOMEN	CT	15	3272016 25
	PEDIATRIC ABDOMEN	CT	20	3272016 25
	TRIUMPH 8.8 T201	CT	12	3272016 1
	ADULT ABDOMEN (120 kVp) FOR CT NUMBERS	CT	16	3272016 9
	ADULT HEAD	CT	11	3272016 25
	PEDIATRIC HEAD	CT	18	3272016 41
<input type="checkbox"/>	PEDIATRIC HEAD DOSE	3272016	View	
Series Description				
	PEDIATRIC HEAD DOSE	CT	3	3272016 3
	PEDIATRIC HEAD DOSE	CT	4	3272016 3
<input type="checkbox"/>	Customer CTDI	6162017	View	
Series Description				
	PCD ABD DOSE	CT	1	3272016 40
	PRD ABD DOSE	CT	0	3272016 40
<input type="checkbox"/>	ADULT ABDOMEN DOSE	3272016	View	
Series Description				
	ADULT ABD DOSE	CT	4	3272016 2
	ADULT ABD DOSE	CT	5	3272016 2




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Quality Control Manual

- Future Considerations
 - TG 233 - Performance Evaluation of Computed Tomography Systems
 - Gantry Tilt
 - Radiation Output Measurements
 - TG 299 - Quality Control in - Multi-Energy Computed Tomography (MECT)
 - Image Quality
 - CTDI Measurement




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Future Considerations

- Special Submissions:
 - Ultra High Resolution Scanners (1024, 2048)
 - 512 to 1024
 - Noise Variance increases by 4x (1/4 photons per pixel)
 - » σ increases by 2x
 - Signal power increases by 4x (4x as many pixels)
 - » No effect on CNR (CNR relies on mean)
 - Results in CNR decrease by 1/2
- Contact the ACR for guidance.

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Further Tips

- Don't submit excess images, i.e. all annual survey images
- Fill out the Phantom Data Forms and CTDI Calculation forms, and upload images yourself
- Double check that your Phantom Data Forms and CTDI forms match
- Check to make sure images open with ClearCanvas and that they are actually on the CD.

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Acknowledgements

- Cynthia Davidson, RDMS; RVT; RT(R)
Program Manager, CT/MR Accreditation
- Thomas Ruckdeschel, MS, DABR

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Resources

1. ACR CT Program Requirements
<https://www.acraccreditation.org/-/media/ACRAccreditation/Documents/CT/Requirements.pdf?la=en>
2. ACR CT Program Testing Instructions
ACR CT Program Requirements
<https://www.acraccreditation.org/-/media/ACRAccreditation/Documents/CT/Requirements.pdf?la=en>

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