

CMR Site Accreditation Process

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Every year there is an increase of our customers that are utilizing cardiac imaging on a regular basis. This market trend shows us that the potential for cardiac imaging is about to explode. The American College of Radiology has stepped forward to establish the criteria necessary to set the standard in cardiac imaging. The purpose of this article is to familiarize the customers of the United States to the process, guidelines, and quality that is necessary to meet the ACR requirements which will allow them to collect more revenue from third party reimbursements. The MRI Clinical Education team at the Uptime Service Center in Cary, North Carolina is available to answer imaging questions at (+1) 1-800-888-7436. Additional information on the ACR and their guidelines can be located on the American College of Radiology web site, www.acr.org.

Quality assurance

Effective April 1, 2007, all sites initially applying for ACR accreditation or renewal must have active participation in a peer review program.

Phantom testing

The ACR phantom testing will remain the same as ACR whole-body evaluation. The site will use the ACR protocols for T1 and T2 as well as its own routine T1 and T2 brain sequences. Most likely in the future there will be an ACR cardiac phantom for which pro-

ocols and criteria will be developed for evaluation. Phantom image testing will remain the same and assess the following:

- Image artifacts
- Image ghosting ratio
- Limiting high-contrast spatial resolution
- Signal uniformity
- Slice positioning accuracy
- Distance measurement and accuracy
- Slice thickness accuracy
- Signal uniformity

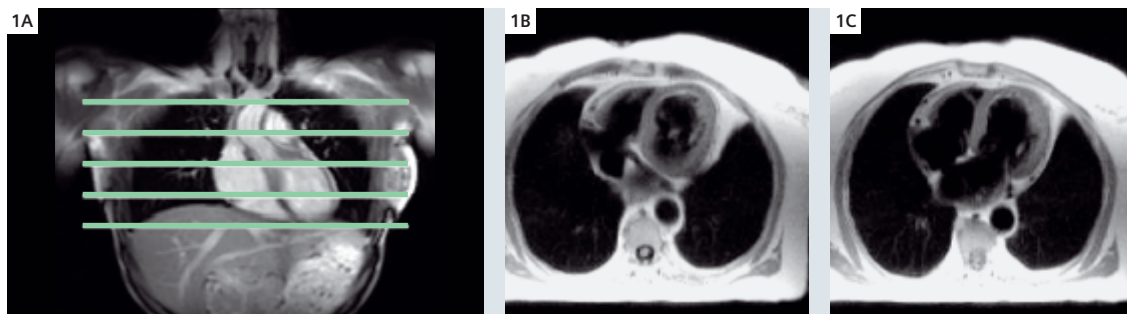
Quality control

The purpose of the QC program is to assess relative changes in system performance over time by the technologist, service engineer, medical physicist and physician.

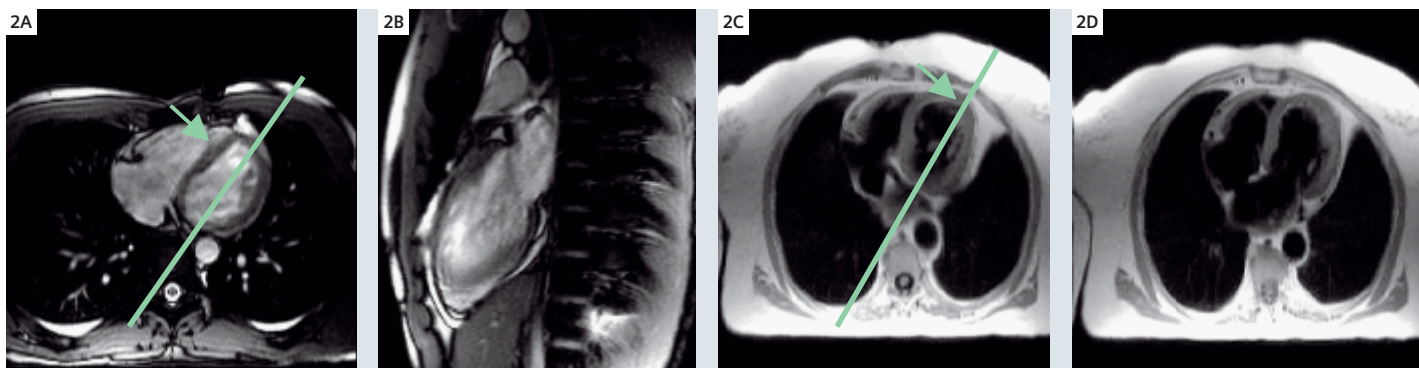
List of QC tests that must be performed:

Technologist's weekly QC tests

- Table positioning
- Setup and scanning
- Geometric accuracy
- Center frequency
- Visual checklist
- Low contrast resolution
- High contrast resolution
- Film quality control
- Artifact analysis



1 **Black Blood Exam** (e.g. SE or TSE): HASTE imaging technique is not allowed. Must be T1 (1 R-R/short TE) or PD (2 R-R/short TE). Axial plane or short axis plane and gated to the cardiac cycle. Anatomical coverage from aortic root to diaphragm or from base to apex.



2 Two-chamber vertical long axis (VLA): Position slice parallel to ventricular septum through the middle of left ventricle. Use axial image to verify slice passing through mitral valve and another axial view to ensure that slice goes through apex.

Medical physicist's annual QC tests

- Slice position accuracy
- Slice thickness accuracy
- Magnetic field homogeneity
- Soft copy displays (monitors)
- Inter-slice radiofrequency interference
- Radiofrequency coil checks

General recommendations for clinical imaging

- Images submitted to the ACR must be from clinical examinations. Exams performed on models or volunteers are not permitted.
- Clinical images must be obtained within one week (before or after) the acquisition of the phantom images.
- Clinical images for each region of anatomy to be submitted to the ACR must be from one patient only.
- Only images that are requested in the Full MRI Accreditation Application document should be submitted to the ACR. Include slice displays for each series. Submit on film only.
- Phantom clinical protocols done in the head coil must be used for the clinical patient head studies; if not, a letter of explanation must be included.

Required images for clinical Cardiac MRI accreditation:

Each scanner applying for Cardiac ACR MRI accreditation has to submit four complete patient exams.

- Black Blood SE or TSE (one exam) T1 or PD/axial or short axis/ cardiac gated (Figure 1).
- Delayed Enhanced Exams (two exams)
 - Short axis cines covers left ventricle base to apex (Figure 3).
 - Long axis cines 2-chamber VLA and 4-chamber HLA including LVOT (Figures 2, 4, 5).
 - Delayed enhanced IR prepared short axis with T1 optimized to suppress normal myocardium (Figure 6).
- Basic Cardiac Exam (one exam)
 - Short axis cines covers left ventricle base to apex (Figure 3).
 - Long axis cines 2-chamber VLA and 4-chamber HLA including LVOT (Figures 2, 4, 5).

Each set of clinical images will be evaluated for

- Cine display
- Anatomical coverage and imaging planes
- Artifacts
- Pulse sequence and image contrast
- Temporal resolution
- Spatial resolution
- Exam ID including all patient information annotated on clinical exams

Recommended clinical parameters Black Blood examination:

T1 (1R-R/short TE) or proton density (2 R-R/short TE) (Figure 1)				
Slice Thickness	Gap	Pixel Phase	Pixel Freq.	Temporal Res.
≤ 8.0	≤ 4.0	≤ 2.5	≤ 1.6	NA

in mm

Anatomical coverage / tips

- Must cover from aortic root to diaphragm (axial)
- Or from the base to the apex (short axis)
- Position slices perpendicular to the long axis of left ventricle (short axis)
- Must cover the entire cardiac cycle
- Used to display the morphology of the heart
- Most effective for blood flow in the through-plane (perpendicular)

Potential artifacts

- Poor contrast between dark blood and myocardium
- Poor resolution, images are too grainy and/or blurry
- Ghosting, patient motion and/or aliasing
- Excessive inhomogeneities, susceptibility, and/or chemical shift

Delayed Enhanced examination: a) Short axis cine

Steady State Free Precession (TrueFISP) or Spoiled GRE (fl2d) techniques (Figure 3)				
Slice Thickness	Gap	Pixel Phase	Pixel Freq.	Temporal Res.
≤ 8.0	≤ 2.0	≤ 3.1	≤ 2.1	≤ 45 ms

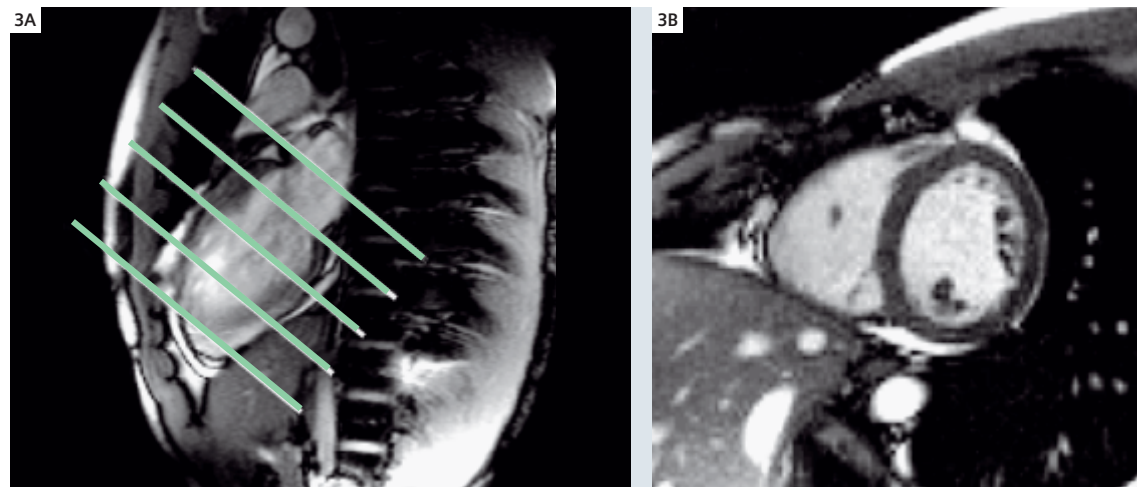
in mm

Anatomical coverage / tips

- Must cover the entire left ventricle from base to apex
- Optimal sequence cine_trufi_retro
- Must cover of the entire cardiac cycle
- Number of calculated phases are user defined
- Position slices perpendicular to the long axis of left ventricle

Potential artifacts

- Poor contrast between bright blood and dark myocardium
- Poor resolution, images are too grainy and/or blurry
- Ghosting, patient motion and/or aliasing
- Excessive inhomogeneities, susceptibility, and/or chemical shift



3 **3A** Short axis view apex to base (SA): Position slices perpendicular to the long axis of left ventricle. Slices need to cover entire left ventricle from the base to the apex.

b) Long axis cine

Steady State Free Precession (trufi) or Spoiled GRE (fl2d) techniques (Figure 2)

Slice Thickness	Gap	Pixel Phase	Pixel Freq.	Temporal Res.
≤ 8.0	NA	≤ 3.1	≤ 2.1	≤ 45 ms

in mm

c) Delayed Enhancement

Inversion Recovery Prepared GRE (tfl psir or tfl psir) (Figure 6)

Slice Thickness	Gap	Pixel Phase	Pixel Freq.	Temporal Res.
≤ 8.0	≤ 2.0	≤ 1.8	≤ 1.4	< 200 ms

in mm

Anatomical coverage / tips

- Two-chamber must be submitted (vertical)
- Four-chamber must be submitted (horizontal) (Figure 4)
- Left ventricle aortic outflow tract must be demonstrated (Figure 5)
- Optimal sequence cine_trufi_retro
- Must cover of the entire cardiac cycle
- Number of calculated phases are user defined

Potential artifacts

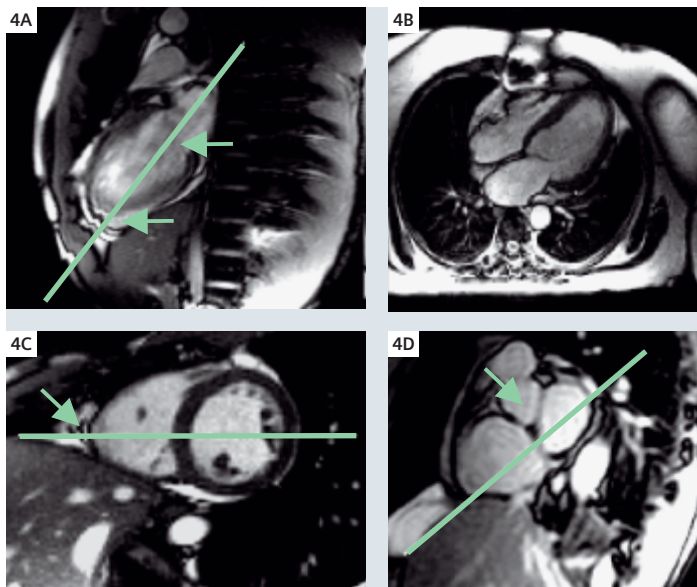
- Poor contrast between bright blood and dark myocardium
- Poor resolution, images are too grainy and/or blurry
- Ghosting, patient motion and/or aliasing
- Excessive inhomogeneities, susceptibility, and/or chemical shift

Anatomical coverage / tips

- Must be short axis plane in patients with prior myocardial infarction
- Must cover the entire cardiac cycle
- Good contrast between blood pool, enhancing infarction and normal myocardium
- Position slices perpendicular to the long axis of left ventricle

Potential artifacts

- Insufficient delay may not distinguish between blood pool and myocardial infarction
- Suboptimal TI may result in poor contrast between dark myocardium and bright infarction
- Poor resolution, images are too grainy and/or blurry
- Ghosting, patient motion and/or aliasing
- Excessive inhomogeneities, susceptibility, and/or chemical shift



4 Four-chamber horizontal long axis (HLA): Position slice off short axis view through right ventricle apex and midline to left ventricle. Use another short axis image to verify slice misses aortic root. Position slice on vertical long axis through mitral valve and apex of left ventricle.

Basic cardiac examination: a) Short axis cine

Steady State Free Precession (trufi) or Spoiled GRE (fl2d) techniques (Figure 3)				
Slice Thickness	Gap	Pixel Phase	Pixel Freq.	Temporal Res.
≤ 8.0	≤ 2.0	≤ 3.1	≤ 2.1	≤ 45 ms

in mm

Anatomical coverage / tips

- Must cover the entire left ventricle from base to apex
- Optimal sequence cine_trufi_retro
- Must cover of the entire cardiac cycle
- Number of calculated phases are user defined
- Position slices perpendicular to the long axis of left ventricle

Potential artifacts

- Poor contrast between bright blood and dark myocardium
- Poor resolution, images are too grainy and/or blurry
- Ghosting, patient motion and/or aliasing
- Excessive inhomogeneities, susceptibility, and/or chemical shift

b) Long axis cine

Steady State Free Precession (trufi) or Spoiled GRE (fl2d) technique (Figure 2)				
Slice Thickness	Gap	Pixel Phase	Pixel Freq.	Temporal Res.
≤ 8.0	NA	≤ 3.1	≤ 2.1	≤ 45 ms

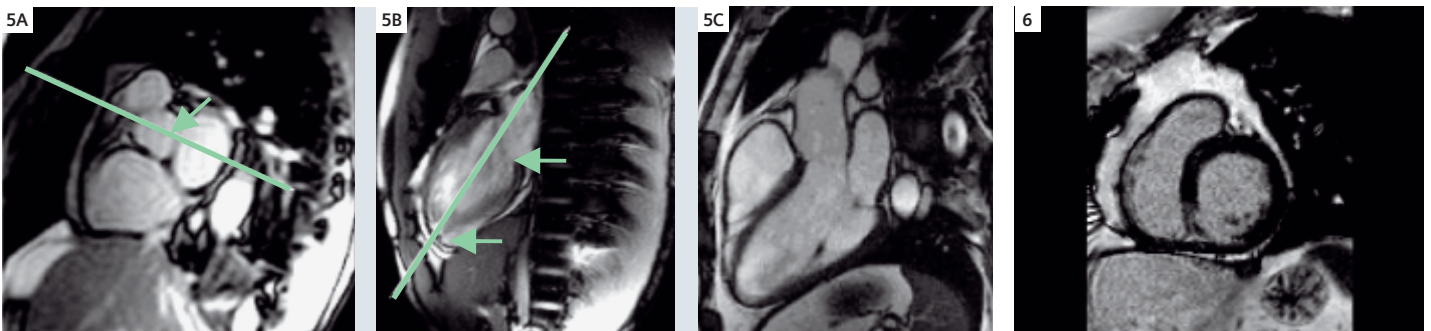
in mm

Anatomical coverage / tips

- Two-chamber must be submitted (vertical)
- Four-chamber must be submitted (horizontal) (Figure 4)
- Left ventricle aortic outflow tract must be demonstrated (Figure 5)
- Optimal sequence cine_trufi_retro
- Must cover of the entire cardiac cycle
- Number of calculated phases are user defined

Potential artifacts

- Poor contrast between bright blood and dark myocardium
- Poor resolution, images are too grainy and/or blurry
- Ghosting, patient motion and/or aliasing
- Excessive inhomogeneities, susceptibility, and/or chemical shift



5 **Left Ventricle Outflow Tract (LVOT):** Position slice on vertical long axis through mitral valve and apex of left ventricle. Use short axis image to position slice through aortic root and left ventricular outflow tract.

6 **Delayed Enhanced tfl_psr:** Short axis plane with patients having prior myocardial infarction. Inversion prepared GRE sequence with inversion time (TI) optimized to suppress myocardium. Good contrast between blood pool, enhancing infarction, and normal myocardium.