

ACR MRI Accreditation Program Medium Phantom

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Disclosures

No disclosures

No conflicts of interest



Learning Objectives

1. Learn requirements for using the new medium phantom in the ACR MRI Accreditation Program.
2. Understand key changes to the program that affect both the large and medium phantoms.



Medium MRAP Phantom

1. Motivation, advantages, challenges
2. Incorporation into MRAP for whole body scanners
3. Phantom design
4. Medium phantom pass/fail criteria
5. Large/Medium phantom 1.5T to <3T LCD limit
6. Other changes
7. Tips for successful phantom image submissions



Motivation

- Most commonly used modern head coils are multi-channel phased array coils, which tend to be smaller than quadrature transmit-receive coils.
- The addition of a medium-sized phantom allows sites to perform QC and to submit accreditation phantom images using a brain coil routinely used in clinical imaging.
- In ~Fall 2021 a medium size ACR MRI phantom will be incorporated into MRAP* for use with whole body MRI scanners. This phantom will accommodate clinical head coils that are too small for the large ACR phantom.

**CMS has approved*



Incorporation into MRAP

- For whole body scanners, facilities will indicate whether they are submitting the large or medium phantom for accreditation/reaccreditation.
- Only scanners where the large phantom doesn't fit in the clinical head coil will be affected.
- Sites must submit phantom images using a head coil that is routinely used for clinical brain imaging on the scanner, and must use the largest phantom that fits inside that coil.
- Rollout is expected when *ACRedit Plus* is launched (~Fall 2021)
- Grace period: approximately one year from rollout (date TBA)



Grace Period

- Scanners currently using the large phantom in a routine clinical head coil – no change.
- Scanners where the routine brain coil is too small for large phantom, will need to switch to medium phantom in a routine clinical brain coil for accreditation submissions.
 - If accrediting/reaccrediting prior to the end of the grace period, submit either large or medium phantom images.
 - After the grace period, all sites must submit phantom images using a routine head coil used on that scanner, using largest phantom that fits inside that coil.
- Scanners without a head coil, that do not perform brain imaging – contact ACR.



Weekly Technologist QC

- Ultimately the choice of the phantom/coil combination to use for weekly tech QC has always been determined by the qualified MRI physicist/scientist. *(2015 ACR MRI Quality Control Manual, p. 23)*
- However, for weekly Technologist QC, the ACR strongly recommends using the ACR phantom that fits in a head coil routinely used for clinical brain imaging. This will typically be the same phantom/coil combination used to acquire phantom images for accreditation.



Advantages

Advantages of using a clinical phased array head coil for Technologist QC, rather than a quad T/R coil that is large enough for the large phantom, but rarely used for clinical imaging:

1. No coil swap after morning QC before patient scanning.
2. Perform QC with a coil that is used clinically, providing more relevant scanner performance information.
3. Test more relevant RF transmit/receive chain (body transmit, phased array receive vs quadrature head coil transmit-receive)



Challenges

The grace period will allow time for facilities to:

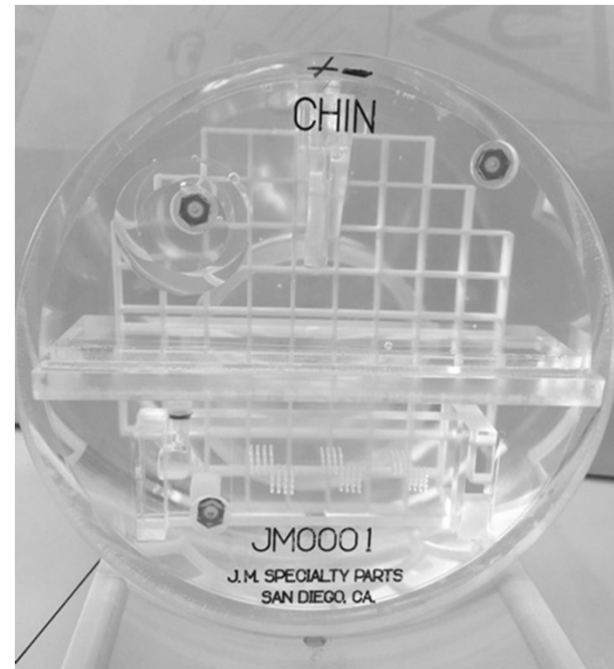
1. Purchase the new phantom.
2. Transition workflows and record keeping to incorporate the new phantom for accreditation, technologist QC and annual testing.
3. Modify automated phantom analysis software, if applicable.



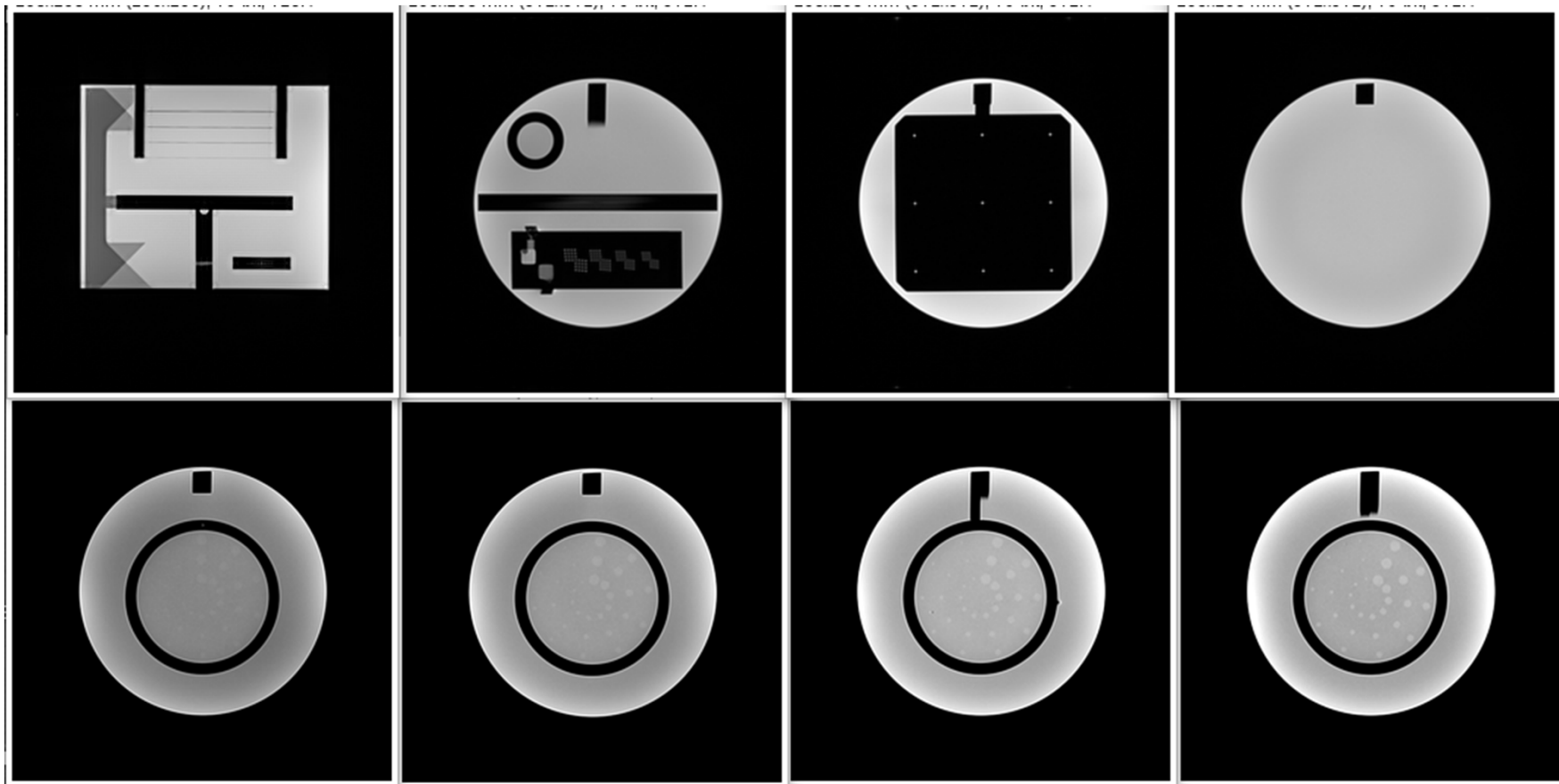
Medium Phantom design

Medium phantom internal signal-producing length is 134 mm, internal diameter is 165 mm. Phantom includes the re-designed geometric accuracy and resolution inserts.

Medium Phantom
Prototype



Medium Phantom design



Limits for Accreditation

Scan parameters and measurement methods are the same for both the large and medium phantoms, although the phantom dimensions, some ROI sizes, and certain limits differ.

See *Large and Medium Phantom Test Guidance for the MRI Accreditation Program* for detailed information.



Limits for Accreditation

1. Geometric accuracy

- Passing criteria for the medium phantom are tighter ($\pm 2\text{mm}$) than for the large phantom ($\pm 3\text{mm}$) - measured over a smaller distance closer to isocenter, where geometric accuracy is typically better.

Table 3: Large and Medium phantom internal dimensions and geometric accuracy limits

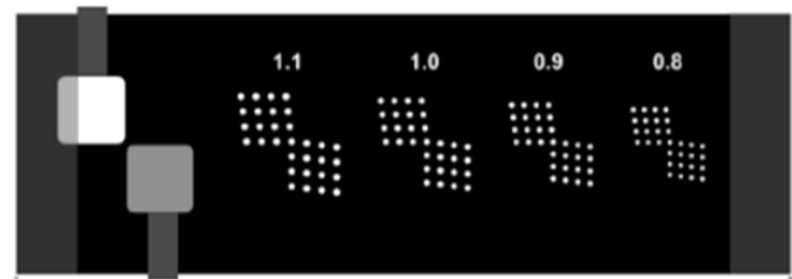
Phantom	Sagittal length (mm)	Pass/Fail Limit (mm)	Axial diameter (mm)	Pass/Fail Limit (mm)
Large	148	148 +/- 3.0	190	190 +/- 3.0
Medium	134	134 +/- 2.0	165	165 +/- 2.0



Limits for Accreditation

2. High contrast spatial resolution:

- Must resolve 1.0mm or smaller on ACR T1 and T2 series for both large/medium phantoms. Same limit regardless of the whether the resolution insert has 3 or 4 arrays.
- If either ACR series fails, can pass if both Site series pass.



Limits for Accreditation

3. Slice thickness accuracy

- Same limit for large and medium phantoms ($\pm 1\text{mm}$)
- If either ACR series fails, can pass if both Site series pass.

4. Slice position accuracy

- $\leq 7\text{mm}$ is passing for both phantoms. However, $<4\text{mm}$ is recommended for optimum LCD scores.

5. Ghosting ratio limits

- $\leq 3\%$ for both phantoms



Limits for Accreditation

6. Percent Image Uniformity (PIU)

- PIU limits for the medium phantom are tighter than the large phantom - measured over a smaller region. Same for T1 and T2.
- 3T uniformity limit is lower due to dielectric effects.
- For images acquired using phased array coils or at 3T, be sure to apply vendor's intensity/uniformity correction.



Phantom	Large ROI (cm ²)	Small ROI (cm ²)	PIU Limit (%) <3T	PIU Limit (%) 3T
Large	195-205 (200)	1.0	≥85	≥80
Medium	155-165 (160)	1.0	≥90	≥85



Limits for Accreditation

7. Low Contrast Detectability (LCD)

- Limits apply to both the large and medium phantoms.
- Beginning ~Fall-2021 LCD limits for 1.5T to <3T will be raised.
- For 1.5T to <3T , T1 and T2 limits differ
- No change for 3T or for $B_0 < 1.5T$.
- If either ACR series fails, can pass if both Site series pass.

Nominal Field Strength	ACR T1 LCD Limit (total spokes)	ACR T2 LCD Limit (total spokes)
<1.5T	≥ 7	≥ 7
1.5T - <3T	 ≥ 30	 ≥ 25
3T	≥ 37	≥ 37



New 1.5T-2T LCD Limits

- Motivation for new limits: 1.5T and 2T scanners are capable of much higher LCD scores than the historical limit.
- The new limits were established based on review of 15,550 ACR large phantom LCD reviewer scores in ACRedit submitted 2015-2020, in addition to large and medium phantom data acquired by committee members.
- The data support a lower LCD limit for the T2 series than for the T1 series.



Other changes

Changes in scan parameters for phantom images submitted for accreditation: Applies to both Large & Medium Phantoms

- ACR Sagittal Localizer 10mm slice thickness is preferred, although 20mm is acceptable.
- ACR T2 series – At the time the program started, the double-echo spin echo pulse sequence was common. Now it is rarely used. A single echo T2-weighted spin echo (TR/TE: 2000/80) is preferred, although double echo is acceptable. FSE is not acceptable.



Other changes

Online forms and documents updated

- *Large/Medium Phantom Test Data Form:*
 - Added selection of medium or large phantom, updated scan parameters. Accreditation is an online process, but sites can use the form for reference.
- *Medium Phantom Weekly MR Equipment QC Form*
- *Large and Medium Phantom Test Guidance* document
 - Document is available under Gather Data Section of acraccreditation.org/modalities/MRI
- Updates to ACR website TBA



Phantom Test Guidance

Large and Medium Phantom Test Guidance for the



MRI Accreditation Program

Detailed guidance for large and medium phantom image acquisition specifically for accreditation.

Includes image analysis methods, pass/fail criteria, and common causes of failure and corrective actions.

ACR Quality Control Manual to be updated.



Tips for Successful Phantom Submissions

1. Phantom positioning and slice positioning are extremely important, especially for achieving the highest LCD score possible.
2. Prior to uploading to ACRedit, review and score the phantom images to ensure that they will pass.
3. Once uploaded, verify that all 5 required series are present and complete (ACR: Sag, T1, T2, Site: T1, T2)
4. Images must be in lossless compressed or uncompressed DICOM image format. Verify that images are NOT lossy compressed.
5. Contact the ACR if you have any questions.



Thank You!

