The Revised ACR MRI Quality Control Manual: Status Report

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Overview: ACR MRI QC Manual 2014
- Relatively minor changes from the 2004 version. Changes primarily for clarification. Added alternative methods for SNR and field homogeneity with emphasis on MRI safety.
- Updated version to be released in 2014 (Electronic with FAQs and annual updates)
- Radiologist’s Section (Requirements and role in a QA program)
- Technologist’s Section (Recommended daily /weekly QC tests)
- Medical Physicist / MRI Scientist’s Section (QC program/Annual performance tests)

However, accreditation requirements have changed significantly since 2004.

Specifically, due to the changing requirements of both the Centers for Medicare and Medicaid Services (CMS) and the Joint Commission (JC)

CMS requires that all facilities providing Advanced Diagnostic Imaging services that are billed under Part B of the Medicare Physician Fee Schedule must be accredited by one of the CMS approved accreditation organizations by January 1, 2012:
- American College of Radiology (ACR)
- Intersocietal Accreditation Commission (IAC)
- Joint Commission (JC)

MRI, CT and Nuclear Medicine/PET

Joint Commission Guidelines

Restrict access to all MRI sites by implementing the four zone concept as defined in the ACR Guidance Document for Safe MR Practices: 2013.

Zone I: General public
Zone II: Unscrened MRI patients
Zone III: Screened MRI patients and personnel
Zone IV: Screened MRI patients under constant direct supervision of trained MR personnel

The Joint Commission
Proposed Standards Changes for Diagnostic Imaging Services
Hospital Accreditation Program 8/8/2013

For hospitals that provide magnetic resonance imaging (MRI) services: At least annually, a medical physicist or MRI scientist conducts a performance evaluation of all MRI imaging equipment. The evaluation results, along with recommendations for correcting any problems identified, are documented.

- Image uniformity
- Slice thickness accuracy
- Slice position accuracy
- High-contrast resolution
- Low-contrast resolution (or CNR)
- Geometric or distance accuracy
- Magnetic field homogeneity
- Artifact evaluation

MRI Safety:
- The hospital must manage safety risks in the MRI environment.
- MRI staff must participate in education and training on safe practices in the MRI environment

The Centers for Medicare and Medicaid Services (CMS) now require that all MRI facilities who bill under Part B Medicare to:

1. Meet all ACR performance guidelines
2. Operate at a field-strength ≥ 1T
3. Be accredited by ACR, JC or ICAMRL
4. Offer biopsy services
5. Provide both head and body scans

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Reference: Centers for Medicare and Medicaid Services website http://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/MedicareProviderSupEnroll/AdvancedDiagnosticImagingAccreditation.html

The Supervising Radiologist has overall responsibility for the site's accreditation program.

Responsibilities include:
• Assurance of staff training
• QC Program Review
• Medical Physicist assignment
• Annual Testing Review
• Safety Program Review
• Maintenance of Records and Documentation

MR Technologist's Section

Technologist is responsible for weekly/daily QC tests:

1. Center frequency
2. Table positioning
3. Setup and scanning
4. Geometric accuracy
5. High-contrast resolution
6. Low contrast resolution
7. Artifact analysis
8. Laser camera QC (if applicable)
9. Visual checklist
10. *Ensure Universal-Standard Precautions for infection control are followed

* New in 2014 manual

Weekly Visual Inspection

• Check patient table, patient communication, patient “panic button”, table movement and alignment and all light indicators
• Check RF room integrity (doors contacts and windows)
• Check emergency cart, safety lights, signage, equipment for MR compatibility and all patient monitors
• Check all RF coils for damage and cable integrity

Technologist’s Section

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Minimum Frequency</th>
<th>Approx. Time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center Frequency</td>
<td>Weekly</td>
<td>1</td>
</tr>
<tr>
<td>Table Positioning</td>
<td>Weekly</td>
<td>3</td>
</tr>
<tr>
<td>Setup &amp; Scanning</td>
<td>Weekly</td>
<td>7*</td>
</tr>
<tr>
<td>Geometric Accuracy</td>
<td>Weekly</td>
<td>2*</td>
</tr>
<tr>
<td>High Contrast Resolution</td>
<td>Weekly</td>
<td>1</td>
</tr>
<tr>
<td>Low Contrast Resolution</td>
<td>Weekly</td>
<td>2</td>
</tr>
<tr>
<td>Artifact Analysis</td>
<td>Weekly</td>
<td>1</td>
</tr>
<tr>
<td>Film Quality Control</td>
<td>Weekly</td>
<td>10</td>
</tr>
<tr>
<td>Visual Checklist</td>
<td>Weekly</td>
<td>5</td>
</tr>
</tbody>
</table>

*Some measurements can be performed simultaneously

17 Minutes

Summary: Technologist’s QC

• Technologist must perform QC tests at least weekly and record the results in the QC logbook
• If any test result exceeds the appropriate action limit (established by Medical Physicist/MR Scientist), the test should be repeated. If the result still fails to meet the action limits, the service engineer and/or medical physicist should be notified.
• Action limits are generally based on multiple measurements over extended time periods
• 2014 Manual included details on the use of both the ACR Large Phantom as well as the ACR Small Phantom
The ACR MRI accreditation program requires the technologist’s weekly QA to include an assessment of:

1. Slice thickness accuracy
2. Magnetic field uniformity
3. Slice cross-talk interference
4. Geometric accuracy
5. Slice position accuracy

Reference: ACR website [www.acr.org](http://www.acr.org)
ACR MRI Quality Control Manual 2004
Technologist’s Section II. A. page 25

Medical Physicist’s/MRI Scientist’s Section

Medical Physicist is responsible for establishing the system QC Program and for Annual performance testing.

1. Establishing Action Limits for Technologist’s QC

Specific action limits are the responsibility of the medical physicist but must be at least as restrictive as the ACR recommended guidelines.

How to start?

1. Service engineer should run all vendor tests to assure system is performing to vendor specifications
2. Establish baseline during acceptance testing (AAPM Report 100)
3. Collect “weekly” QC data for at least 10 days
   - Central frequency
   - Transmitter gain / attenuation
   - Geometric accuracy
   - High contrast resolution
   - Low contrast resolution
4. Record as “Baseline” in Technologist’s QC notebook

QC Phantom Selection

The selection of the phantom used for routine QC is the responsibility of the medical physicist. The phantom should be capable of providing assessment of the JC/ACR/IAC required parameters and will typically depend upon the type of scanner:

- Whole body scanners – Large Phantom
- Extremity (Breast) scanners – Small Phantom

ACR Large Phantom: 190 mm
ACR Small Phantom: 100 mm

Acceptance Testing: Image Performance

(Similar accreditation annual performance tests.)

1. Static Magnetic Field: Uniformity and Drift
2. RF System
3. Gradient System
4. System measurements
   - Slice thickness and position accuracy
   - Signal-to-Noise Ratio (SNR)
   - Percent Image Uniformity (PIU)
   - Percent Signal Ghosting (PSG)
   - High-contrast spatial resolution
   - Low-contrast detectability
5. Advanced MR System Tests
   - Ultrafast (EPI) Tests (N/2 ghosting and spatial distortion)
   - Spectroscopy Tests (VOI position accuracy and spectral quality)
Establishing Action Limits

**General approach:** Determine mean and standard deviation (SD). May need to use ± 2SD depending upon the system.

1. Central frequency expressed in ppm (typically ± 1.5 ppm)
   
   (1.5 ppm @ 1.5T ~ 96 Hz or determined from statistical analysis)

2. Transmitter Gain or Attenuation (expressed in dB)

3. Geometric Accuracy (± 2 mm)

4. High-Contrast Resolution (at least 1 mm)

5. Low-Contrast Detectability (± 1 or 2 SD)

6. Artifacts (any artifacts should be noted and image saved)

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**Annual Performance Tests**

(Red indicate new 2014 requirements.)

<table>
<thead>
<tr>
<th>Measuremen</th>
<th>Technologist QC (Weekly)</th>
<th>Medical Physicist MRI Checks (Annually)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Table Positioning, Setup and Scanning</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2. Central frequency</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>3. Transmitter Gain or Attenuation</td>
<td>X</td>
<td>X</td>
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<tr>
<td>4. Geometric Accuracy</td>
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<td>X</td>
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<tr>
<td>5. High-Contrast Spatial Resolution</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>6. Low-Contrast Detectability</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>7. Artifact Evaluation</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>8. Hardcopy (Film) QC (if applicable)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>9. Visual Checklist</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>10. Percent Signal Ghosting (PSG)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>11. Image Intensity Uniformity (PIU)</td>
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<td></td>
</tr>
<tr>
<td>12. Magnet Field Uniformity</td>
<td>X</td>
<td></td>
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<tr>
<td>13. Slice Position Accuracy</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>14. Slice Thickness Accuracy</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>15. Radiofrequency Coil Checks (SNR and PIU for volume coil)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>16. Soft Copy (Monitor) QC</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>17. DOT Radiation Protection Assessment</td>
<td>X</td>
<td></td>
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</tbody>
</table>

As part of annual testing, physicist must repeat and evaluation weekly Tech QC measurements as well as the sequences required for accreditation submission.

Note: Interslice RF cross-talk test has been eliminated.

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**Annual System Performance Evaluation**

1. Repeat and verify weekly QC measurements:

   - Setup and positioning accuracy (mechanical inspection)
   - Central frequency
   - Transmitter gain or attenuation (head coil RF calibration)
   - Geometric accuracy (gradient calibration)
   - High contrast spatial resolution
   - Low contrast detectability
   - Image artifact assessment
   - Hardcopy (film) QC
   - Softcopy (Monitor) QC
   - Visual checklist

2. Perform the scans required for accreditation submission and evaluate per the criteria in the MRI Accreditation Phantom Guidance Document

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**ACR Annual Performance Report Measurements, ct’d**

1. Magnetic field uniformity
2. Slice Position Accuracy
3. Slice Thickness Accuracy
4. RF Coil Checks
   a. Volume Coils
      - Signal-to-Noise Ratio (SNR)
      - Percent Image Uniformity (PIU)
      - Percent Signal Ghosting (PSG)
   b. Surface Coils (Coil arrays)
      - Maximum SNR
5. Soft Copy (Monitor) Display
   - Max and Min Luminance
   - Luminance Uniformity
   - SMTE pattern evaluation
6. Safety Assessment

Note: Annual Performance Report

1. Must include some form of field uniformity assessment
2. Must have monitor assessment
Prior to annual coils checks physicist should:
• Inventory and inspect all cables, coils and connector boxes
• Record coil serial number and manufacture date
• Report any findings to site vendor service engineer
• Repeat all weekly/daily technologist’s tests
• Perform all scans required for accreditation application

For RF coils tests, choose most appropriate phantom for the coil geometry.
• Positioning and scan technique should be documented and reproducible
• Each individual array element should be tested

Annual Magnetic Field Homogeneity Testing
(2014 Manual provides alternative methods):

• Spectral FWHM with large sphere (Only global sensitivity)
• Phase-Difference Method (Provides planar map image)
• Phase-Map Method (Provides planar map image)
• Bandwidth-Difference Method
  (Chen, et al Med. Phys. 33 (11), 2006. Note: only sensitive along frequency axis)

Alternative: For systems that do not allow any of these methods. One may use the service engineer’s most recent shim report (< 6 month).

Spectral FWHM Method

With the sphere in the coil, use manual prescan to obtain and display the spectrum of the resonance frequencies.

Determine the “full width at half maximum” (FWHM) of the spectrum and express in units of ppm.

Note: Spectral method provides a global assessment of field homogeneity over the size of the signal producing phantom.

\[
\text{FWHM} = \frac{\Delta \nu}{63.87 B_0(1)}
\]

Magnetic Field Homogeneity

Spheres are provided by some vendors and can be used for the homogeneity tests. The spherical volume diameter should be similar to that cited by the manufacturer’s homogeneity specifications.

The sphere should be placed at the field isocenter.

Phase-Difference Method

Acquire two gradient-echo images with different echo times. Display and store as phase images. Subtract the second phase image from the first to obtain a phase difference image in which each pixel’s intensity represents the difference between the phases of the two acquisitions, since the TE of the solution is constant.

The difference \(\Delta B_0\) between the \(B_0\) field at a given voxel and the reference value at the center of the field of view (FOV) is:

\[
\Delta B_0 = \frac{\Delta \phi}{g}(TE_1 - TE_2),
\]

where the \(\Delta \phi\) is in rad, \(g\) is the gyromagnetic ratio \((42,576 \text{ Hz mT}^{-1}) = 267,513 \text{ radians per second per mT}\) for protons and the TE values are in units of seconds.

Repeat this procedure to obtain data from other planes.

Determine the greatest difference in any plane between the values of \(\Delta B_0\) within circular regions of interest having specific d.s.v. This value divided by the \(B_0\) field strength of the magnet will yield the homogeneity (in ppm) for the specified d.s.v.
**Phase-Difference Method**

The phase-difference method provides a spatial map of the field homogeneity within the chosen plane. Additional plane orientations should be used to provide a measure of volumetric homogeneity.

Note: Consult system manufacturer to determine the units used for the value of the phase pixels (e.g. radians x 1000).

**Phase-Map Method**

Gradient Echo Sequence: TE = 1/resonance frequency (ppm) (e.g. 1 ppm @ 1.5T = 1.63 Hz = 15.6 ms)

The assessment of magnetic field uniformity is required:

1. At the time of equipment installation only
2. Only for systems of field strength ≥ 1T
3. To be performed by the service engineer
4. As part of each annual testing
5. To be ≤ 1.5 ppm


**Bandwidth-Difference Method**

The BW difference method is sensitive to homogeneity in the frequency-encode direction only and thus should be repeated at different orientations.

The assessment of magnetic field uniformity is required:

1. At the time of equipment installation only
2. Only for systems of field strength ≥ 1T
3. To be performed by the service engineer
4. As part of each annual testing
5. To be ≤ 1.5 ppm

**ACR Large Phantom Analysis**

Five sequences: ACR T1, Dual-Echo T2, and Site T1 and T2
(SE 50/500 and SE 20-80/2000 ms, 25 cm, 256X256, multi-slices (11 at 5mm), 1 NEX)

Localizer: Geometric Accuracy (z)

#1) Slice thickness and position, geometric accuracy, high contrast resolution
#3) Geometric accuracy (x,y)
#7) Percent image uniformity (PIU), Percent signal ghosting (PSG)
#8-11) Low contrast object detectability (LCD), and slice position (in #11)

Images courtesy of E.F. Jackson, PhD
**ACR Small Phantom**

*(Extremity Systems)*

- Sag localizer: Geometric accuracy
- #1) Slice thickness and position, geometric accuracy, high contrast resolution
- #2) Geometric accuracy
- #5) PIU, ghosting (PSG)
- #6-7) LCD

**Five Sequences**
1) ACR Sagittal (20/200)
2) ACR T1 SE (20/500)
3) ACR T2 SE (80/2000)
4) SI (knee)
5) Site T2 (knee)

- **1 sag 20mm slice**
- **7 axial 5mm slices w/ 3mm gap**
- **FOV 12 cm**
- **192 x 152 matrix**

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**ACR Guidelines for Phantom Scans**

**Large Phantom**
(FOV = 25 cm, 256 X 256)

- Dimensional accuracy (Sagittal) ± 2 mm
- Dimensional accuracy (Axial) ± 2 mm
- Slice Thickness ± 0.7 mm
- Slice Position ≤ 5 mm
- Image Uniformity (PIU) ≥ 87.5% (< 3T)
- Percent Signal Ghosting ≤ 2.5%
- High-contrast Resolution 1 mm
- Low-contrast Detectability Score ≥ 9 (<3T)

**Small Phantom**
(FOV = 12 cm, 152 X 192)

- Dimensional accuracy (Sagittal) ± 2 mm
- Dimensional accuracy (Axial) ± 2 mm
- Slice Thickness ± 0.7 mm
- Slice Position ≤ 5 mm
- Image Uniformity (PIU) ≥ 87.5% (< 3T)
- Percent Signal Ghosting ≤ 2.5%
- High-contrast Resolution 0.8 mm
- Low-contrast Detectability Score ≥ 37 (<3T)

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**ACR T1 and T2**

**Slice Position Accuracy**

- Magnify image by 2-4x
- WW: min (crisp ends)
- WL: not critical ~ ½ mean
- Measure bar length difference
- Record ½ bar length difference

**Example:**

\[
\text{Slice position error} = \frac{(33.2 \text{ mm} - 28.0 \text{ mm})}{2} = 2.6 \text{ mm}
\]

**Criterion:** ≤ 5 mm

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**QC Measurement of Geometric Accuracy**

*(Sagittal localizer: true dimension 148 mm)*

- WW = 0
- WL = 13130
- WW = 13130
- WL = 6551

**Measurement = 147.5 mm**

1) Set WW to (minimum) then raise WL until ½ of water is dark (This value of WL is an estimate of the mean water intensity.)
2) Now set WW to the value of WL determined above and set WL to ½ that value.
3) Make measurements using length/distance tool provided by vendor

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**Slice Thickness**

*ACR T1 and T2*

**Slice 1**

- Two 10:1 ramps
- Magnify image by 2-4x
- Define two ROIs, one over center of each ramp (entirely within ramp)
- Obtain average intensity from the two ROIs

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**Measure and Record for Geometric Accuracy**

- Slice 5

1) Set WW to (minimum) then raise WL until ½ of water is dark (This value of WL is an estimate of the mean water intensity.)
2) Now set WW to the value of WL determined above and set WL to ½ that value.
3) Make measurements using length/distance tool provided by vendor
**Slice Thickness**

Measurements:
- Set WL to ½ average intensity (~mean)
- Set WW to minimum
- Measure lengths of top and bottom ramps
- Calculate slice thickness

\[
\text{Slice thickness} = 0.2 \times \frac{\text{top} \times \text{bottom}}{\text{top} + \text{bottom}}
\]

Criterion: 5.0 ± 0.7 mm

**High Contrast Spatial Resolution**

- Turn off gradient distortion correction algorithm (if possible)
- Magnify by 2-4 X
- Use UL for horizontal resolution and LR for vertical resolution
- Must be able to resolve 1.0 mm holes vertically and horizontally
- Set WW and WL for visualization

**Percent Image Uniformity**

ACR T1 and T2

- Without Correction
- With Correction

\[
\text{Percent integral uniformity (PIU)} = 100 \times \frac{\text{WW}}{\text{WL}} \times \frac{1}{\frac{\text{high}}{\text{low}} + \frac{\text{low}}{\text{high}}}
\]

- ≤1.5 T
  - Criterion: PIU ≥ 87.5%
- 3.0 T
  - Criterion: PIU ≥ 82.5%

**Low Contrast Detectability**

ACR T1 and T2

- Slices 8-11: 1.4%
- Slice 8: 2.5%
- Slice 9: 3.6%
- Slice 11: 5.1%

Set WW and WL for visualization

- 1.5 T or less
  - Criterion: ≥ 9 spokes
- 3.0 T
  - Criterion: ≥ 37 spokes

**Gradient Distortion Correction Effect on Spatial Resolution**

**Ghosting**

Window and level to make sure ROIs are in the background noise.
(Warping of image space due to gradient nonlinearity corrections.)
**Volume Coil Measurements**

Note: If possible intensity correction algorithms should be off.

Must assess for all coils that are used clinically:

1. SNR (signal-to-noise ratio)
2. Uniformity (percent image uniformity: PIU)
3. Ghosting ratio

*Note: For multi-element coils using multiple receive channels it may be necessary to use a different method for estimating noise than described in the ACR QC manual. (2014 ACR Manual)*

Image compliments of Geoff Clarke, Ph.D.

**Image Intensity Correction**

Algorithm used for coil arrays will affect background and the calculated SNR, e.g. SCIC, CLEAR and PURE. Recommend turning off image intensity correction when assessing coil SNR.

**SNR Image-Difference Method**

SNR = \[
\frac{\text{Mean Signal}}{\sqrt{2} \cdot \pi} = 0.655 \cdot \text{Mean Signal}
\]

Percent Image Uniformity (same):

\[\text{PIU} = 100 \cdot \left(1 - \frac{\text{Max ROI} - \text{Min ROI}}{\text{Max ROI} + \text{Min ROI}}\right)\]

Percent Signal Ghosting (same):

\[\text{PSG} = 100 \cdot \left(\frac{\text{Left} - \text{Right}}{\text{Top} - \text{Bottom}} - 2 \cdot \text{Mean Signal}\right)\]

**When evaluating high-contrast spatial resolution, it is recommended that:**

1. The smallest FOV be used
2. Gradient distortion correction be turned off
3. The largest available acquisition matrix be used
4. Receive-only coils should not be used

Surface Coil Report

Surface Coil Measurements
1. Use a phantom that most closely matches the coil geometry
2. Carefully record the geometry (best recorded with a photograph) so that it can be reproduced in subsequent measurements.
3. Measure and record the maximum SNR
4. ROI area ~ 0.15% of FOV (e.g. 256x256 ~ 100 pixels)

Surface Coil Report

Volume Coil Report

Note: Reports should include assessment relative to previous performance or assessment relative to similar systems.

Surface Coil Measurements

1. Use a phantom that most closely matches the coil geometry
2. Carefully record the geometry (best recorded with a photograph) so that it can be reproduced in subsequent measurements.
3. Measure and record the maximum SNR
4. ROI area ~ 0.15% of FOV (e.g. 256x256 ~ 100 pixels)

Testing Coil Arrays

The 2014 ACR MRI Manual recommends that the images from each coil element be reconstructed and displayed individually to check for malfunctioning array elements. This is increasingly important with high-density arrays. A single SNR and/or uniformity measurement often will not detect a single bad element (or even a few bad elements). Some scanners provide an easy option, selectable by the technologist or other operator, to allow for the reconstruction and display of the image from each element. On other systems, service or research mode access is required.

Multi-element coils:

New guidelines recommend that each element be checked.

Parallel Imaging with acceleration (8-channel head coil): Not currently addressed
Soft Copy Display

Requires the use of a precision luminance meter to make measurements from the monitor screen.

Four Tests:
1. Max and Min luminance ($L_{\text{max}}$ and $L_{\text{min}}$)
2. Luminance uniformity
3. Resolution using SMPTE pattern
4. Spatial accuracy (SMPTE)

Specifications:
1. Max luminance ($W_{\text{LWW}} = \text{min}$): > 90 Cd/m²
2. Min luminance: < 1.2 Cd/m²
3. Uniformity: % difference = $200 \times (L_{\text{max}} - L_{\text{min}})/(L_{\text{max}} + L_{\text{min}})$
4. Resolution: display bar pattern of 100% contrast
5. Spatial accuracy: lines straight within +/- 0.5mm

Annual Medical Physicist’s Site Safety Assessment (Checklist)

- Site Access Restrictions (MR Zones)
- Documented MR Safety Education/Training for all personnel
- Patient and non-MR Personnel Screening
- Pediatric Patient Policy
- Designated MR Safety Officer
- Evacuation Policy
- Fire Safety Policy
- Control of Agent Safety Policy
- Sedation Policy
- Thermal Burn Policy
- Emergency Code Procedures
- Device and Object Screening and designation of MR Safe/Conditional status
- Procedures for Reporting MR Safety Incidents or Adverse Incidents
- Written Regular MR safety training for each facility staff member

Criteria for Compliance

1. Written policies are present and are being reviewed and updated on a regular basis.
2. Facility has appropriate signage and methods of controlled access.
3. Documentation of regular MR safety training for each facility staff member

Complete Medical Physicist/MR Scientist Equipment Performance testing should be performed:

1. At least quarterly
2. Whenever a new coil is installed
3. After the report of an RF burn
4. Upon installation
5. Whenever SNR falls below the action level

Reference: ACR website [www.acr.org](http://www.acr.org)


It is very important that the consulting medical physicist provide recommendations for Quality Improvement and maintain frequent contact with the site QC Technologist to monitor the QC program and to assist in corrective actions.
Conclusion and Comments

- The 2014 ACR MRI Quality Control Manual has relatively modest changes from the 2004 version.

- There is an emphasis on MRI safety and infection control to minimize patient risk.

- An attempt was made to embrace NEMA standards and to identify several alternate methods for image parameter assessment.

- Currently the revised manual does not identify a specific method for testing parallel imaging. However, when a generally accepted method is identified, it will be incorporated into the electronic manual by means of an annual update.