MRI Equipment Acceptance Test Summary

Site: Wake Forest Baptist Health MRI building MR04  
Report Date: 10/18/2017  
System MRAP#:  
Survey Date: 10/12/2017  
MRI System Manufacturer: Siemens  
Model: 3T Skyra  
Medical Physicist/MRI Scientist: Megan Johnston, PhD / Youngkyoo Jung, PhD  
Signature: [Signature]

<table>
<thead>
<tr>
<th>Equipment Evaluation Tests</th>
<th>Pass/Fail/NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Setup and Table Position Accuracy</td>
<td>Pass</td>
</tr>
<tr>
<td>2. Center Frequency</td>
<td>Pass</td>
</tr>
<tr>
<td>3. Transmitter Gain or Attenuation</td>
<td>Pass</td>
</tr>
<tr>
<td>4. Geometric Accuracy Measurements*</td>
<td>Pass</td>
</tr>
<tr>
<td>5. High-Contrast Spatial Resolution*</td>
<td>Pass</td>
</tr>
<tr>
<td>6. Low-Contrast Detectability*</td>
<td>Pass</td>
</tr>
<tr>
<td>7. Artifact Evaluation</td>
<td>Pass</td>
</tr>
<tr>
<td>8. Film Printer Quality Control (if applicable)</td>
<td>NA</td>
</tr>
<tr>
<td>9. Visual Checklist</td>
<td>Pass</td>
</tr>
<tr>
<td>10. Magnetic Field Homogeneity</td>
<td>Pass</td>
</tr>
<tr>
<td><strong>Method of Testing</strong></td>
<td>Phase Map</td>
</tr>
<tr>
<td>11. Slice-Position Accuracy*</td>
<td>Pass</td>
</tr>
<tr>
<td>12. Slice-Thickness Accuracy*</td>
<td>Pass</td>
</tr>
<tr>
<td>13. Radiofrequency Coil Checks</td>
<td>Pass</td>
</tr>
<tr>
<td><strong>Were all clinically used coils evaluated? (Yes/No)</strong></td>
<td>Yes</td>
</tr>
<tr>
<td>a. SNR</td>
<td>Pass</td>
</tr>
<tr>
<td>b. Volume Coil Percent Image Uniformity (PIU)</td>
<td>Pass</td>
</tr>
<tr>
<td>c. Percent Signal Ghosting (PSG)</td>
<td>Pass</td>
</tr>
<tr>
<td>14. Soft-Copy (Monitor) Quality Control</td>
<td>Pass</td>
</tr>
<tr>
<td>15. Long Term Stability</td>
<td>Pass</td>
</tr>
</tbody>
</table>

*tests that can be performed by scanning the ACR MRI Phantom

Medical Physicist's or MRI Scientist's Recommendations for Quality Improvement

The MR system meets ACR recommendations and local guidelines. The Mean drift measured with multiple EPI scans (see 15 in Data form) showed an excessively higher linear trend, which is commonly presented in dynamic EPI. The linear drift should be taken into account during DSC or fMRI processing.
MRI Equipment Acceptance Test Data Form

Site: WFBH MRI building MR01 Date: 10/12/2017
System MRAP #: Serial Number: 145332

Equipment:
MRI System Manufacturer: Siemens Model: 3T Skyra
ACR MRAP Phantom Number used: J1267

1. Setup and Table Position Accuracy
From ACR Sagittal Localizer
Location of the superior edge of the grid structure: 1 mm from the magnet isocenter
ACR Criteria: ≤ ±5 mm

2. Center Frequency: 123.255089 MHz

3. Transmitter Gain or Attenuation: Ref RF Voltage 298.121 V

4. Geometric Accuracy Measurements:

<table>
<thead>
<tr>
<th>Series</th>
<th>Slice</th>
<th>Measurement Orientation</th>
<th>Measured (mm)</th>
<th>Actual (mm)</th>
<th>Difference (mm)</th>
<th>window level</th>
<th>window width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sag Loc</td>
<td>slice 1</td>
<td>Middle</td>
<td>148.02</td>
<td>148</td>
<td>0.02</td>
<td>800</td>
<td>1600</td>
</tr>
<tr>
<td>ACR T1</td>
<td>slice 1</td>
<td>top-bottom</td>
<td>190.86</td>
<td>190</td>
<td>0.86</td>
<td>950</td>
<td>1900</td>
</tr>
<tr>
<td>ACR T1</td>
<td>slice 1</td>
<td>left-right</td>
<td>191.02</td>
<td>190</td>
<td>1.02</td>
<td>950</td>
<td>1900</td>
</tr>
<tr>
<td>ACR T1</td>
<td>slice 5</td>
<td>top-bottom</td>
<td>191.31</td>
<td>190</td>
<td>1.31</td>
<td>950</td>
<td>1900</td>
</tr>
<tr>
<td>ACR T1</td>
<td>slice 5</td>
<td>left-right</td>
<td>191.37</td>
<td>190</td>
<td>1.37</td>
<td>950</td>
<td>1900</td>
</tr>
<tr>
<td>ACR T1</td>
<td>slice 5</td>
<td>diagonal (/)</td>
<td>190.04</td>
<td>190</td>
<td>0.04</td>
<td>950</td>
<td>1900</td>
</tr>
<tr>
<td>ACR T1</td>
<td>slice 5</td>
<td>diagonal ()</td>
<td>190.26</td>
<td>190</td>
<td>0.26</td>
<td>950</td>
<td>1900</td>
</tr>
</tbody>
</table>

ACR Criteria: ≤ ±2 mm

5. High Contrast Spatial Resolution
From ACR T1, slice 1

<table>
<thead>
<tr>
<th>Array</th>
<th>1.1 mm</th>
<th>1.0 mm</th>
<th>0.9 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL (horizontal)</td>
<td>v</td>
<td>v</td>
<td>v</td>
</tr>
<tr>
<td>LR (vertical)</td>
<td>v</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

From ACR T2, slice 1

<table>
<thead>
<tr>
<th>Array</th>
<th>1.1 mm</th>
<th>1.0 mm</th>
<th>0.9 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL (horizontal)</td>
<td>v</td>
<td>v</td>
<td>v</td>
</tr>
<tr>
<td>LR (vertical)</td>
<td>v</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

ACR Criteria: ≤ 1 mm

6. Low Contrast Detectability

<table>
<thead>
<tr>
<th>ACR T1</th>
<th>ACR T2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slice</td>
<td># of Spokes</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>10</td>
</tr>
</tbody>
</table>
7. Artifact Evaluation
No noticeable artifacts in T1 or T2 ACR images.

8. Film Printer Quality Control (if applicable)
Not applicable

9. Visual Checklist
All the items were working properly and were mechanically and electrically stable.

10. Magnetic field homogeneity
Method Used: Phase map
TE: 10 ms Phantom diameter: 24.5 cm FWHM: 81.2 Hz
Measured Homogeneity:

<table>
<thead>
<tr>
<th>Plane</th>
<th>Phase change (cycles)</th>
<th>Phase change (Hz)</th>
<th>Homogeneity (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axial</td>
<td>0.29</td>
<td>28.50</td>
<td>0.23</td>
</tr>
<tr>
<td>Sagittal</td>
<td>0.47</td>
<td>47.00</td>
<td>0.38</td>
</tr>
<tr>
<td>Coronal</td>
<td>0.31</td>
<td>31.00</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Criteria: < 1 ppm

11. Slice position accuracy
ACR T1
Slice location #1 -0.68 mm
Slice location #11 -2.8 mm

ACR T2
Slice location #1 -0.93 mm
Slice location #11 -3.32 mm

ACR Criteria: ≤ ±5 mm

12. Slice thickness accuracy
From Slice Position #1 of the ACR phantom
ACR T1
Ramp Signal Level: 209.85
Slice thickness Top: 54.68 mm Calculated slice thickness (mm): 5.23 mm
(allowed in mm) Bottom: 50.11 mm

ACR T2
Ramp Signal Level: 263.34
Slice thickness Top: 50.07 mm Calculated slice thickness (mm): 4.85 mm
(allowed in mm) Bottom: 46.99 mm

ACR Criteria: 5.0 ± 0.7 mm

13. RF Coil Performance Evaluation
A. Volume RF Coil
*Manufacturer's QC routine was performed on the following RF coils
1) RF coil description: Body (SN: 2311) Date: 10/17/2017
**B. RF Surface Coil (Phased array)**

*Manufacturer's QC routine was performed on the following RF coils*

1) RF coil description: **Body 18ch (SN: 30321) H Tra**  
   Date: **9/11/2017**  
   **SNR:**
   - B11: 71.3  
   - B12: 66.9  
   - B13: 68.3  
   - B14: 67.1  
   - B15: 67.3  
   - B16: 63.6  
   - B21: 60.9  
   - B22: 68.4  
   - B23: 73.8  
   - B24: 69.1  
   - B25: 65.3  
   - B26: 62.5  
   - B31: 68.8  
   - B32: 64.3  
   - B33: 70  
   - B34: 72.6  
   - B35: 67.3  
   - B36: 67.7  
   **Pass/Fail:** **Pass**

2) RF coil description: **Body 30ch (SN: 30164)**  
   Date: **9/11/2017**  
   **SNR:**
   - B11: 51.7  
   - B12: 43.5  
   - B13: 47.4  
   - B14: 46.9  
   - B15: 52  
   - B16: 54.3  
   - B21: 50.6  
   - B22: 42.6  
   - B23: 48.1  
   - B24: 40.4  
   - B25: 51  
   - B26: 48.7  
   - B31: 48.9  
   - B32: 50.4  
   - B33: 57  
   - B34: 55  
   - B35: 51.2  
   - B36: 45.4  
   - B41: 49.1  
   - B42: 44.3  
   - B43: 56.2  
   - B44: 43.7  
   - B45: 54.1  
   - B46: 50.4  
   - B51: 49.2  
   - B52: 44.4  
   - B53: 47  
   - B54: 51.5  
   - B55: 48.8  
   - B56: 55.7  
   **Pass/Fail:** **Pass**

3) RF coil description: **Head Neck 20ch (SN: 30397)**  
   Date: **9/11/2017**  
   **SNR:**
   - H11: 65.3  
   - H12: 57.4  
   - H13: 63.4  
   - H14: 60.9  
   - H21: 68.9  
   - H22: 63.3  
   - H23: 67.9  
   - H24: 68.6  
   - H31: 34.9  
   - H32: 25.6  
   - H33: 37.2  
   - H34: 32.8  
   - H41: 44  
   - H42: 29.7  
   - H43: 42.2  
   - H44: 41.5  
   - N11: 26.5  
   - N12: 25  
   - N21: 38  
   - N22: 31.7  
   **Pass/Fail:** **Pass**

4) RF coil description: **Spine 32ch (SN: 30365)**  
   Date: **9/11/2017**  
   **SNR:**
   - S11: 41.9  
   - S12: 46.3  
   - S13: 37.7  
   - S14: 57.7  
   - S21: 43.4  
   - S22: 38.3  
   - S23: 29  
   - S24: 38.5  
   - S31: 38.5  
   - S32: 40.8  
   - S33: 31.3  
   - S34: 49.9  
   - S41: 41.2  
   - S42: 34  
   - S43: 31.9  
   - S44: 43.2  
   - S51: 37.1  
   - S52: 41.6  
   - S53: 35  
   - S54: 54.3  
   **Pass/Fail:** **Pass**
5) RF coil description: Knee 15ch (SN: 1112)  
SNR:
- K1: 46.4  
- K2: 49.6  
- K3: 41.7  
- K4: 40.4  
- K5: 48.7  
- K6: 47.7  
- K7: 47.3  
- K8: 46.2  
- K9: 46.5  
- K10: 47.7  
- K11: 52.2  
- K12: 54  
- K13: 45.4  
- K14: 45.5  
- K15: 45  

Pass/Fail: Pass

6) RF coil description: FlexLarge 4ch (SN: 8625761)  
SNR:
- FL1: 29.7  
- FL2: 39.7  
- FL3: 30.2  
- FL4: 39.7  

Pass/Fail: Pass

7) RF coil description: FlexSmall 4ch (SN: 8625761)  
SNR:
- FS1: 35.1  
- FS2: 36.6  
- FS3: 31.7  
- FS4: 29.9  

Pass/Fail: Pass

14. Soft Copy Quality Control

Luminance Meter Make/Model: Nuclear Associates Model No. 07-621  
Cal expires: N/A  
with a fiber-optic probe (Model 07-634)

Monitor Description: DCS1913-D (S/N: 16BD25)

Luminance measured: Cd/m²

<table>
<thead>
<tr>
<th>Monitor Center of</th>
<th>Top Left</th>
<th>Top Right</th>
<th>Bottom Right</th>
<th>Bottom Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consol of MR01</td>
<td>127</td>
<td>116</td>
<td>110</td>
<td>114</td>
</tr>
</tbody>
</table>

Maximum & minimum luminance

Maximum in the center: 127  
ACR Criteria: >90 Cd/m²

Minimum in the center: 0.9  
ACR Criteria: <1.2 Cd/m²

Luminance uniformity

Average of values obtained in four corners of screen: 112.5 Cd/m²

Percent difference: 4.3478%  
ACR Criteria: ≤ 30%

Resolution

Acceptance Test
The SMPTE pattern was displayed and the high-contrast line-pair images in each of the corners and center were distinguishable and sharp.

**Spatial accuracy**

The grid pattern of SMPTE was inspected and all the vertical and horizontal lines depicted on the monitor were straight to within +/- 1mm.

### 15. Long Term Stability Test

<table>
<thead>
<tr>
<th>RF coil description:</th>
<th>20ch Head/Neck (SN: 30397)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phantom description:</td>
<td>spherical agar phantom (fBIRN)</td>
</tr>
<tr>
<td>Pulse sequence:</td>
<td>Type: EPI TR: 2000ms TE: 30 ms flip angle: 77 degrees</td>
</tr>
<tr>
<td>FOV:</td>
<td>22x22 cm²</td>
</tr>
<tr>
<td>Matrix:</td>
<td>64x64</td>
</tr>
<tr>
<td>BW:</td>
<td>2298 Hz/Px</td>
</tr>
<tr>
<td>Reps:</td>
<td>200</td>
</tr>
<tr>
<td>No. of slices:</td>
<td>33</td>
</tr>
<tr>
<td>Slice thickness:</td>
<td>4 mm</td>
</tr>
<tr>
<td>spacing:</td>
<td>1 mm</td>
</tr>
<tr>
<td>SNR:</td>
<td>381</td>
</tr>
<tr>
<td>SFNR:</td>
<td>348</td>
</tr>
<tr>
<td>Mean % fluctuation:</td>
<td>0.03</td>
</tr>
<tr>
<td>Mean Drift:</td>
<td>1.13</td>
</tr>
<tr>
<td>Criteria:</td>
<td>&gt;200</td>
</tr>
<tr>
<td></td>
<td>&gt;200</td>
</tr>
<tr>
<td></td>
<td>&lt;0.15</td>
</tr>
<tr>
<td></td>
<td>&lt;0.7</td>
</tr>
</tbody>
</table>

**Specific Comments:**

1. The initial measurement of field homogeneity failed to meet the ACR and manufacturer's specifications but this issue has been resolved after shim coil tune-up. Field inhomogeneity was measured again and it passed the test.
2. The Mean drift measured with multiple EPI scans showed a higher linear trend, which is commonly presented in EPI. The linear drift should be taken into account during DSC or fMRI post-processing.