

Equipment Quality Control for Magnetic Resonance Imaging

September 30, 2019

Imaging Physics

CancerCare Manitoba

Purpose

An equipment quality control (QC) program for magnetic resonance establishes baseline performance levels, tracks system performance over time and reveals performance trends. This document outlines the tests that are typically part of a QC program in magnetic resonance imaging. Also provided, as an example, are detailed procedures for one model of scanner. Contact Imaging Physics for assistance in setting up a program.

What are the benefits of a QC program?

- Performance degradation can be identified leading to preventative action.
- Patients benefit when equipment performance is maintained at acceptable levels.
- A QC program is an important element in achieving accreditation.

What are the components of a QC program?

The QC program is set up by the facility under the guidance of a medical physicist certified by the Canadian College of Physicists in Medicine. The program consists of acceptance testing, on-going quality control, and periodic review of QC data and outcomes. Typically, the more routine QC activities are carried out by a technologist while in-depth checks are performed by, or under the guidance of, a medical physicist. A typical QC program includes the following:

Acceptance Testing

Acceptance testing must be performed by or under the oversight of a medical physicist when a system is installed, relocated (where relevant) or undergoes significant upgrades or maintenance. Acceptance testing verifies vendor specifications and establishes performance baselines. It is the facility's responsibility to arrange acceptance testing by a medical physicist.

Monthly

Using a head or extremity coil, scan the uniform phantom supplied with the system. Measure the signal level and the signal-to-noise ratio. For multi-element coils, multiple measurements may need to be recorded.

With the QC scan technique programmed into the scanner, the technologist test takes approximately 10 minutes. Note that vendor-supplied QA software that only provides a pass or fail result is not adequate. With the QC scan technique programmed into the scanner, the technologist test takes approximately 10 minutes. Note that vendor-supplied QA software that only provides a pass or fail result is not adequate.

Semi-annually

Review of equipment QC data at least semi-annually. The QC data should be recorded in a manner that allows monitoring of trends in performance levels.

Annually

Annual equipment QC review by a medical physicist. Ideally, all coils should be checked once per year (each coil can be checked any time during the year).

Beyond Annually

Testing by or under the oversight of a medical physicist to evaluate performance against vendor specifications and baseline levels established at acceptance.

Where to go for help?

Imaging Physics at CancerCare Manitoba provides physics testing for diagnostic imaging systems, and can assist diagnostic imaging departments in setting up QC programs, training staff to perform QC tests and identifying appropriate QC tools. You can contact Imaging Physics at Imaging.Physics@cancercare.mb.ca or by calling 204-787-4145. The MR specialist is Dr Daniel Rickey (204-787-1764).

Annual Medical Physics Review – MRI

This is a sample form of the annual QC review to be conducted by a medical physicist. This form is required by MANQAP to demonstrate ongoing compliance with the QC requirements.

Facility		Department	
System S/N		System Location	
System make & model		Contact Person	
Date of review		Time period of data reviewed	
Overall QC Program Assessment		<input type="checkbox"/> <i>ACCEPTABLE</i> <input type="checkbox"/> <i>ACCEPTABLE but requires remediation</i> <input type="checkbox"/> <i>NOT Acceptable. Immediate action required</i>	

QC Test	Status	Comments
Monthly Uniform Phantom Test (Signal Level and SNR)		
Regular Review of QC Data by site		
Monthly Modality Display Performance Test		
Physics testing or acceptance if equipment is new or relocated.		

Additional Comments:

Overall QC Program Assessment:

Required changes:

Additional Recommendation:

Review conducted by Signature Date
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Facility Quality Control for Siemens Magnetic Resonance Scanners

Overview

The MR scanners manufactured by Siemens provide software that will acquire images and calculate the quality control measurements. This document is a brief step-by-step guide showing how to use the software and save the measurements of signal level and the signal-to-noise ratio. Please note that the facility must record these data in a manner that allows monitoring of trends in performance levels, e.g., by using a spread sheet to plot the data.

Siemens Software

In order to use the software, the facility must have a license key and password. Note that these are scanner specific and must be renewed yearly.

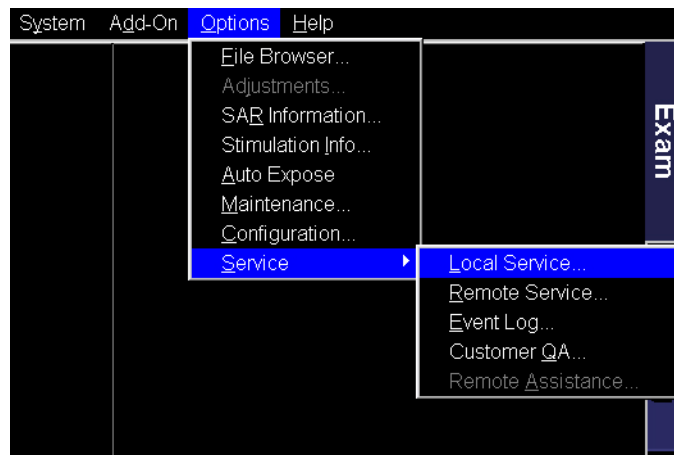


Figure 1. Select *local service* from the main window on the scanner.

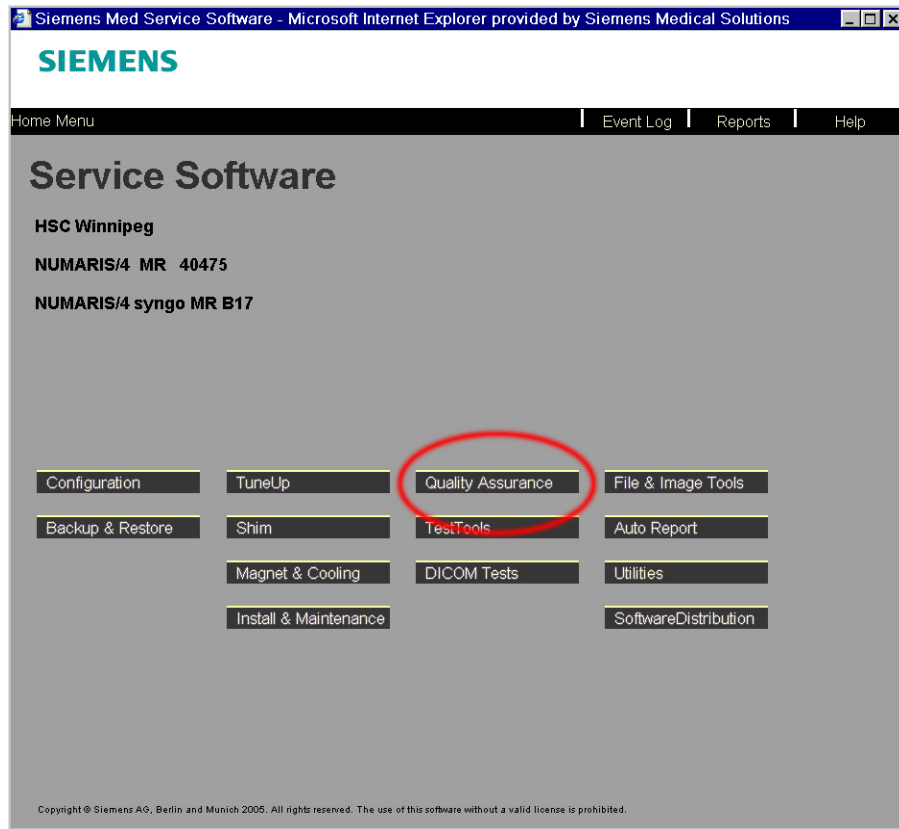


Figure 2. Select *quality assurance* from the service software menu.

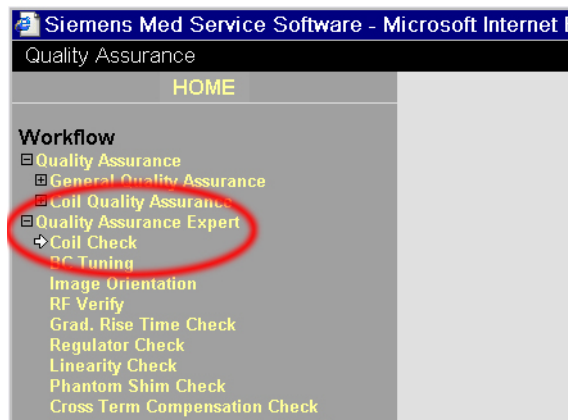


Figure 3. Select *quality assurance expert* and then *coil check* from the service software menu.

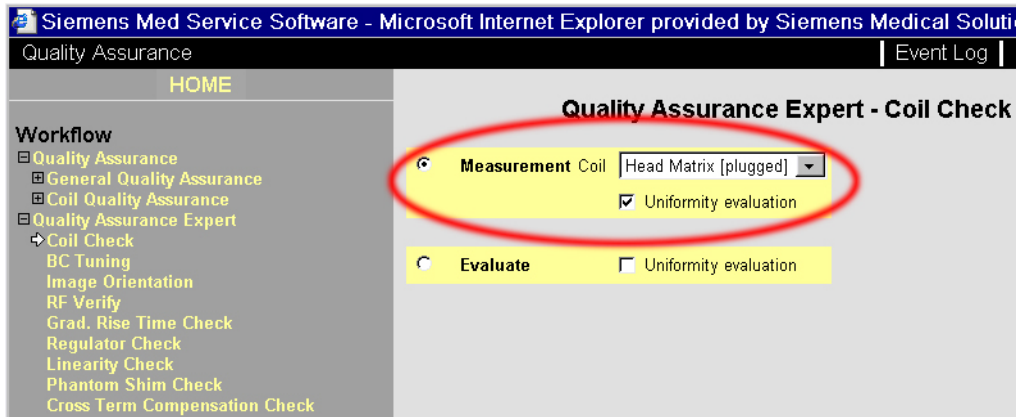


Figure 4. Select the *head matrix* coil. Select the *uniformity evaluation* if it is present.

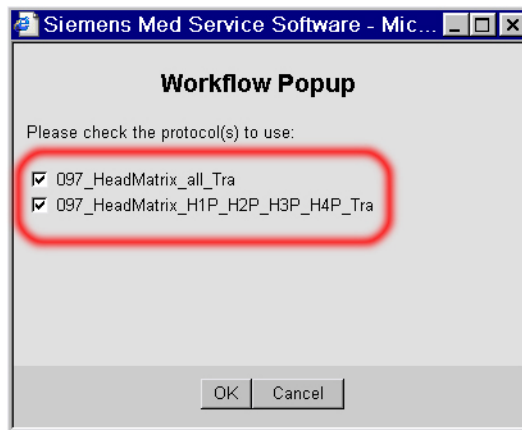


Figure 5. A *workflow popup* will ask you to confirm the protocols used. In this case, the protocol *097_HeadMatrix_H1P_H2P_H3P_H4P_Tra* is not absolutely necessary for routine QC. However, it is useful for isolating problems with the coil and is therefore recommended.

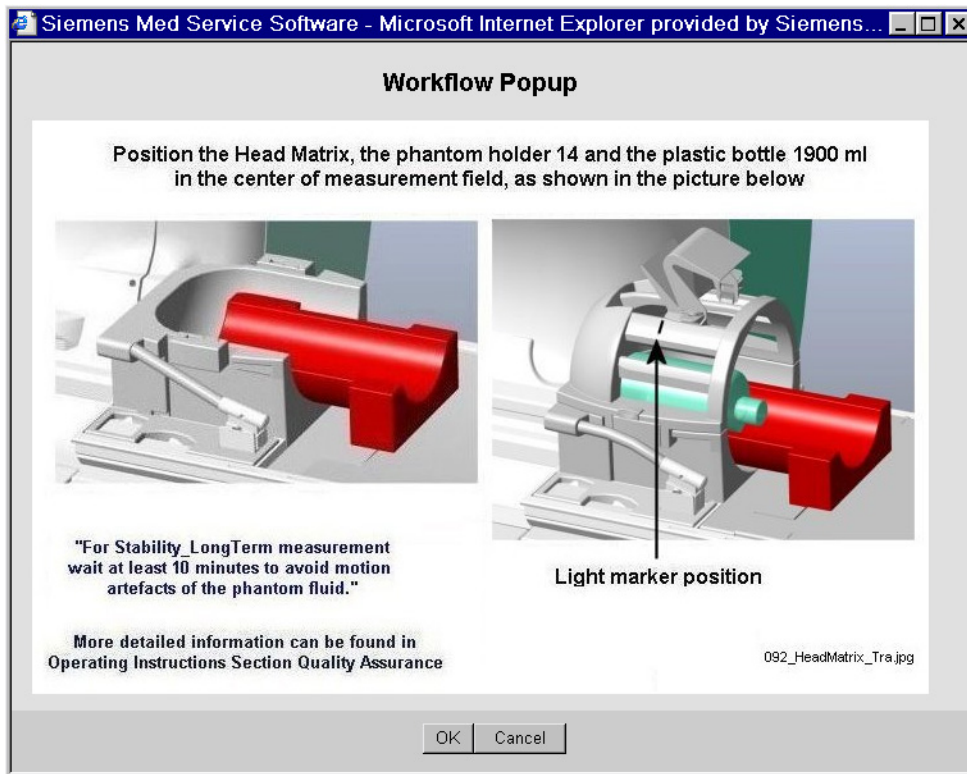


Figure 6. A *workflow popup* will then provide detailed instructions on how to position the phantom. These instructions will vary depending on the coil and scanner.

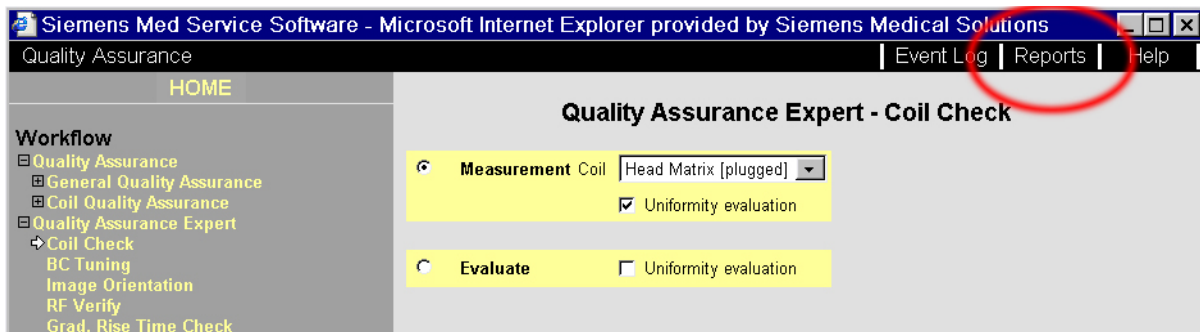


Figure 7. Once the QC protocol has finished running (about five minutes) select the *reports* menu.

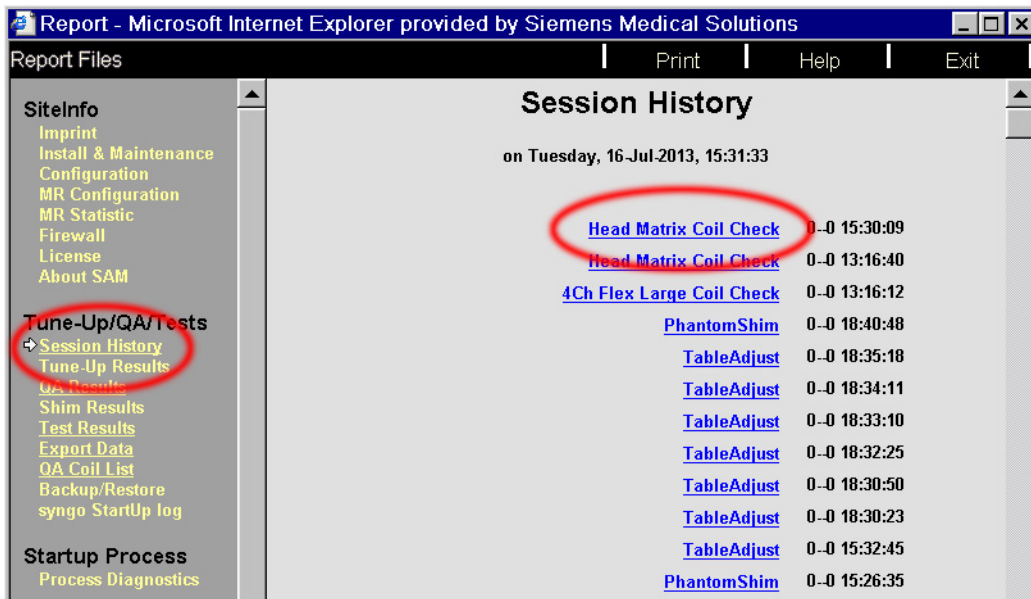


Figure 8. Select the *session history* on the left to display a list of all measurements performed on the scanner. The list on the right is the QC displayed chronologically. Select the head coil check, which should be at the top of the list.

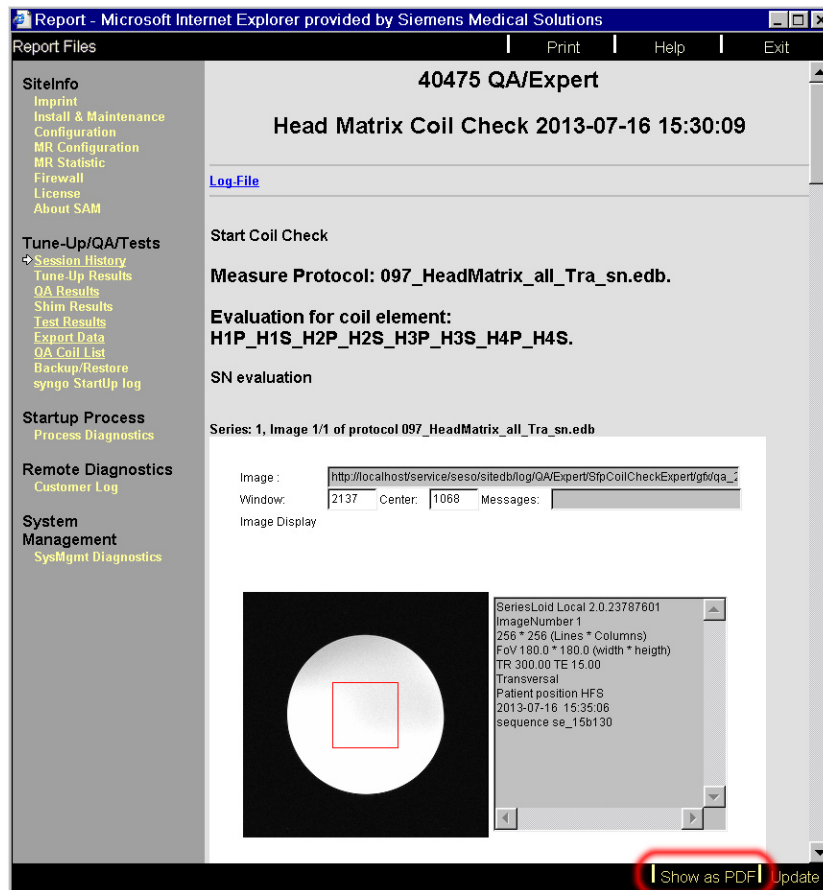


Figure 9. The system will display a detailed report containing all of the QC measurements. Confirm that all of the measurements are within specifications. The

most convenient way to store these is to select *show as pdf* located on the bottom right.

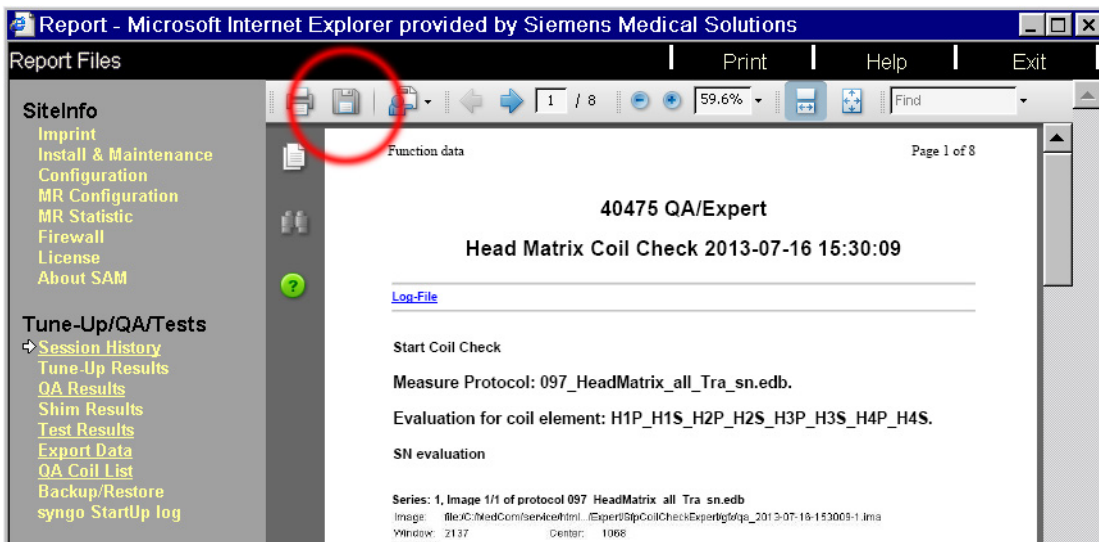


Figure 10. Selecting the disc icon will enable saving to a memory stick. It is necessary to store these files where they will not be deleted.

Measure Protocol: 097_HeadMatrix_all_Tra_sn.edb.

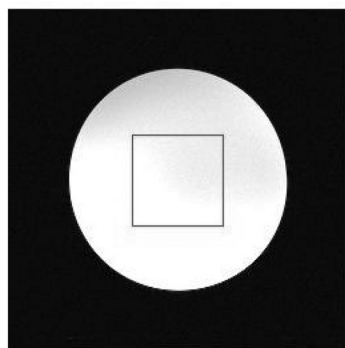
Evaluation for coil element: H1P_H1S_H2P_H2S_H3P_H3S_H4P_H4S.

SN evaluation

Series: 1, Image 1/1 of protocol 097_HeadMatrix_all_Tra_sn.edb

Image: file://C:/MedCom/service/html/Expert/SfpCoilCheckExpert/gfx/qa_2013-07-16-153009-1.ima
 Window: 2137 Center: 1068
 Message:

Image Display:



SeriesLoid Local 2.0.23787601
 ImageNumber 1
 256 * 256 (Lines * Columns)
 FoV 180.0 * 180.0 (width * height)
 TR 300.00 TE 15.00
 Transversal
 Patient position HFS
 2013-07-16 15:35:06
 sequence se_15b130

S/N and Brightness Results

	Value	Low Spec	High Spec
Protocol	097_HeadMatrix_Tra_sn		
S/N	77.00	50.00	
Brightness	2137.00	1000.00	4000.00

Figure 11. Although the report will contain many measurements, the most important two are the *S/N* and *brightness* values for the entire coil. Some coils will have more than one set of these.

Recording Results

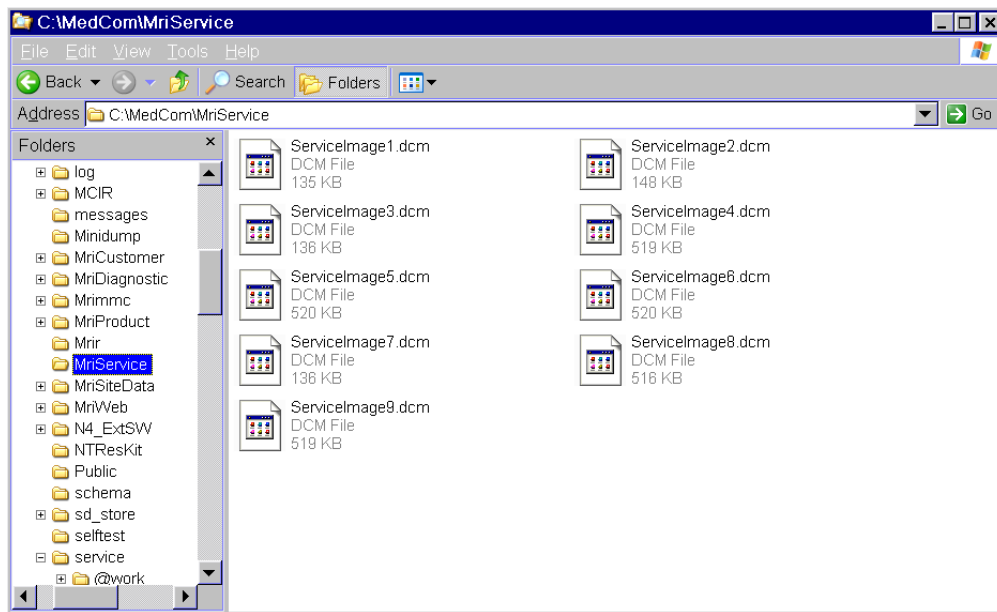
The report on the scanner should be saved as a PDF file. Ideally the S/N and brightness values for the entire coil would be copied to a spread sheet and plotted for trend analysis. The S/N and *brightness* values for the individual coil elements are not normally tracked in the spreadsheet. Note that these measurements will vary depending on the model of coil and scanner. The site should also note when they review their data. It is a very good idea to keep good records of maintenance as these will be reviewed at some point.

Display Quality Control

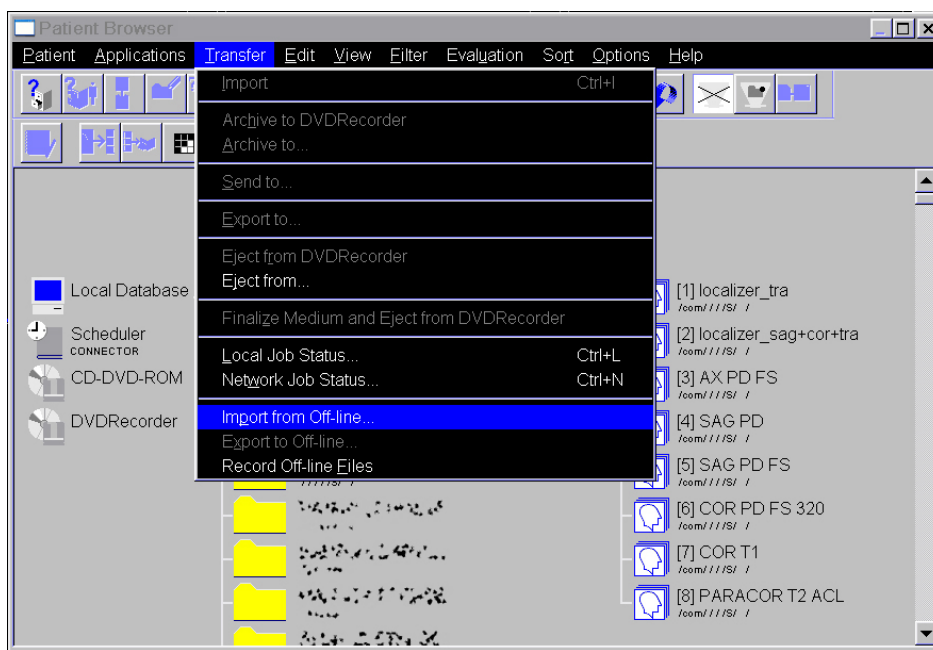
Ideally there should also be routine quality control tests performed on the MR scanner's display. For Siemens scanners, there are test patterns located in the folder C:\MedCom\MriService on the host computer. These can be copied to a removable USB drive and then imported to the image viewer.

installing the test patterns

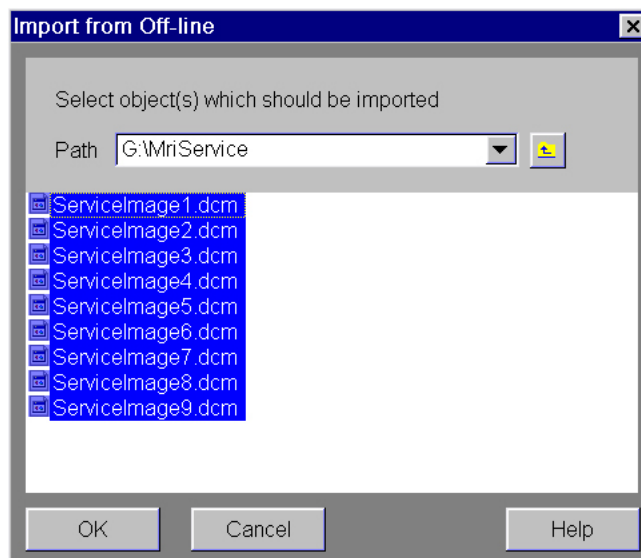
To obtain the images, login as an advanced user. Navigate to the folder C:\MedCom\MriService and copy the entire folder with images to a removable USB drive.



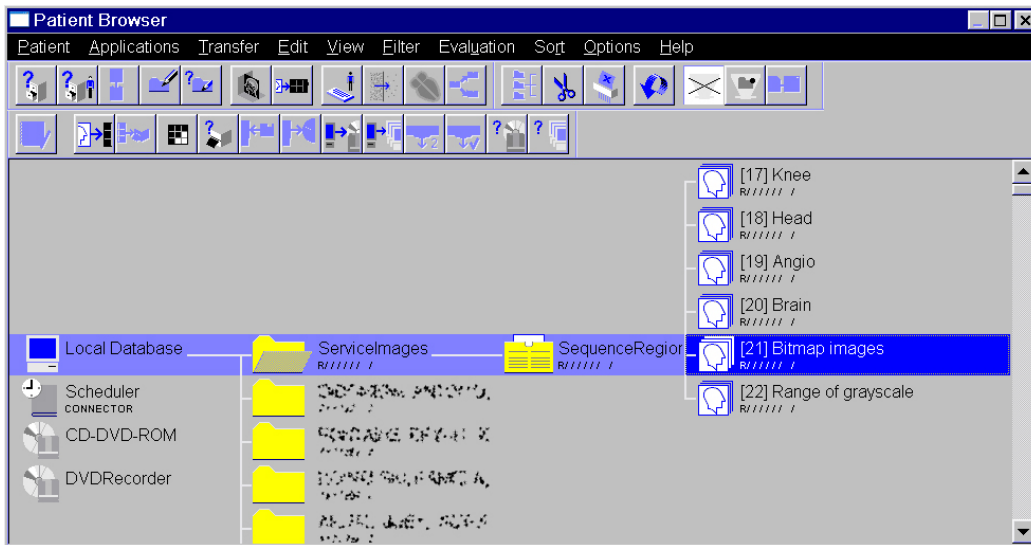
From the patient browser, select "transfer" and then "Import from off-line...". Make sure that a patient is not selected in the browser, otherwise the images won't import.



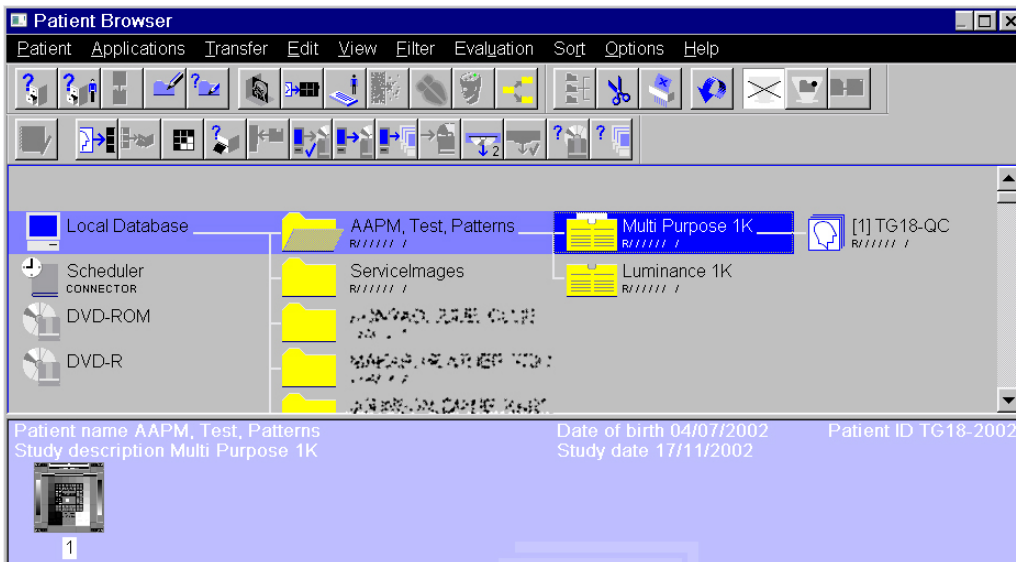
Next, select the services images to be imported. Select all of the images even though only a few will be used.



Once imported the service images can be viewed in the patient browser. There is some variation in the available images depending on the model of the scanner. Older scanners may only show the "ServiceImages" patient as shown below.

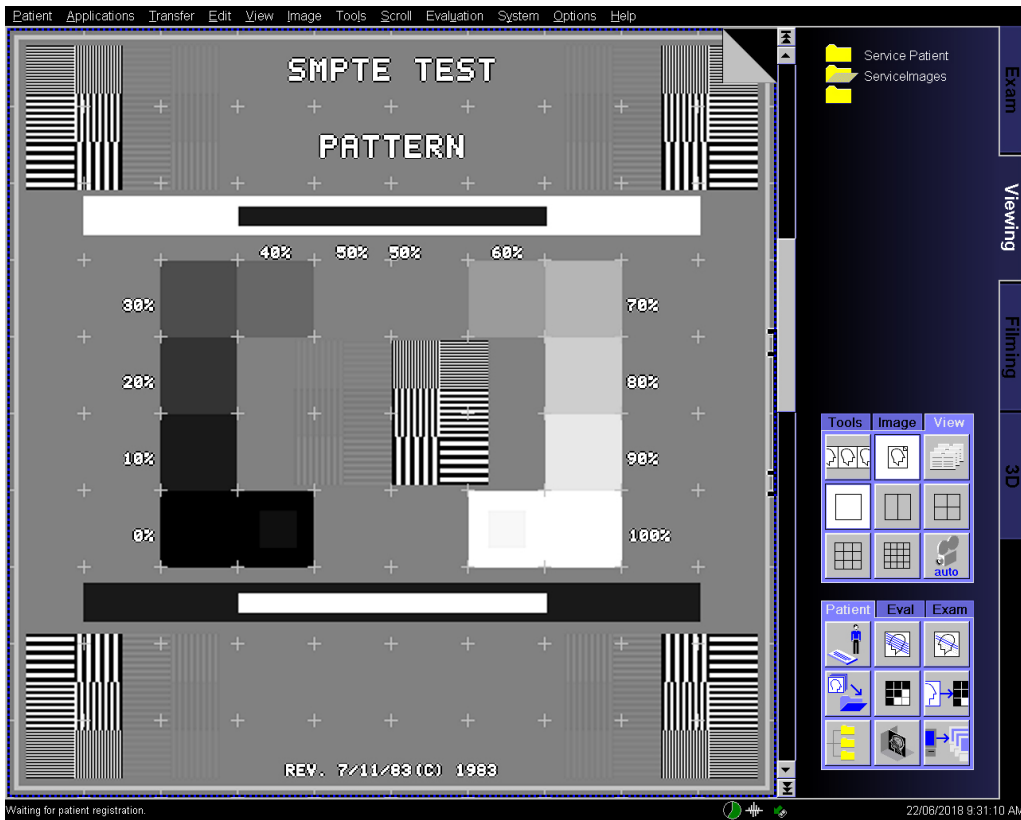


If the scanner also shows a “AAPM, Test, Pattern” patient as shown below, this is preferred over the “ServicelImages” patient.

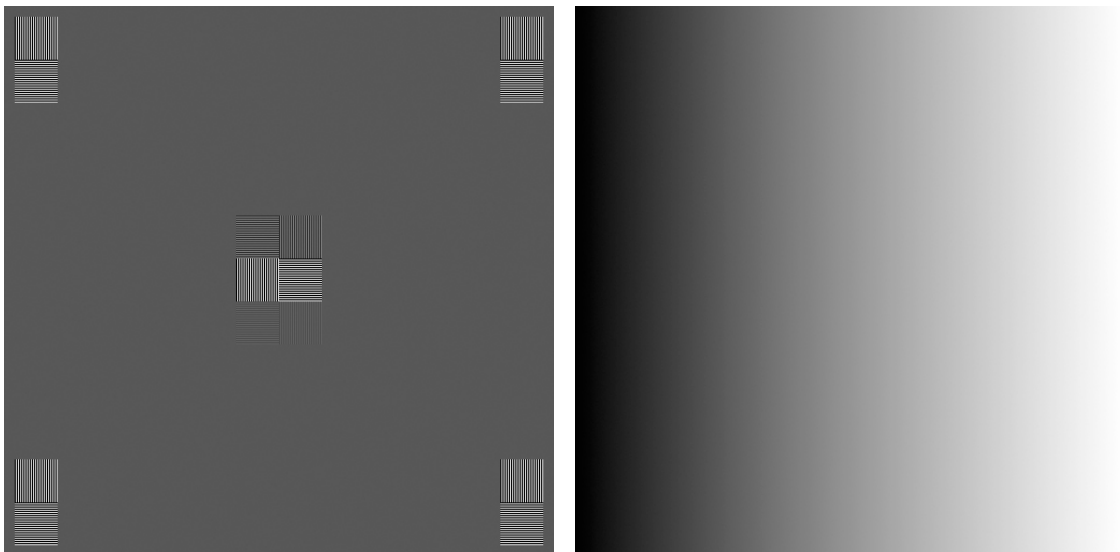


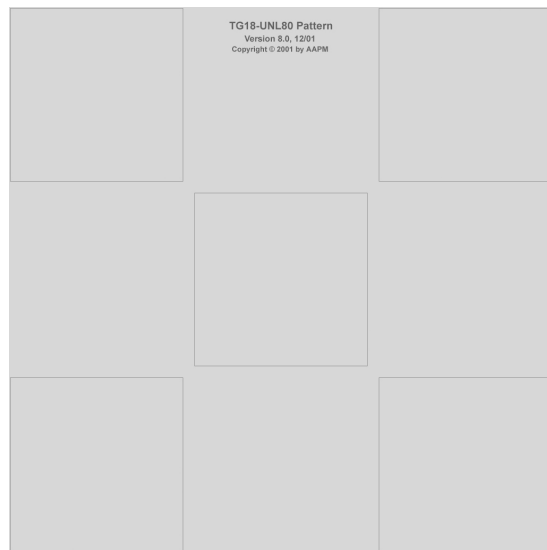
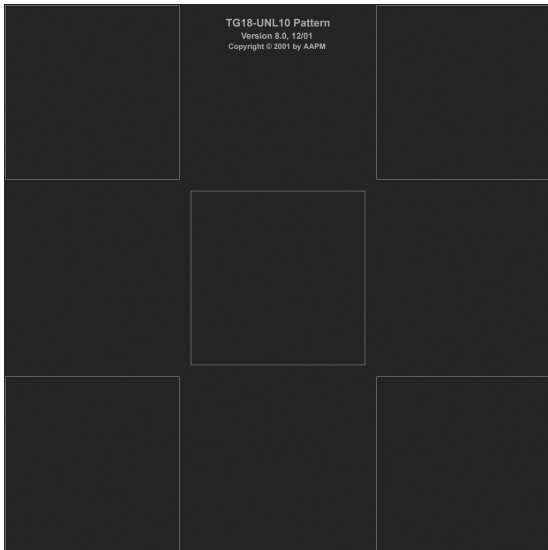
interpreting the patterns

The most important test is the SMPTE pattern as shown below. See the complementary guidance document, “Modality Display QC Instructions” for more information on how to interpret the SMPTE pattern. The window and level settings should automatically go to 100 and 1024 respectively. Note that the TG18-QC version will look a bit different and window and level settings should automatically go to 2048 and 4096 respectively. It is important not to adjust the window and level settings.



There are two other service images that are of interest. These are shown below with the top pair from the “ServiceImages” patient and the lower pair from the “AAPM, Test, Pattern” patient. These should also default to their own window and level settings. With either pair check the display for any pixels that appear too bright or too dark. Also look for any artefacts including nonuniformities.





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