**NARRATIVE GUIDELINES**
**FOR PERFORMING PBTC NIC MR QA PROGRAM**

The following is a written narration of the process for positioning the ACR phantom, running the required scan sequences, and then obtaining the correct measurements and calculations from the scanned images.

First, the MRI Technologist places the ACR phantom in the head holder to correctly align it with the assistance of the laser lights on the cross hairs of the phantom. Once placed in the holder, the technologist then attempts to adjust the phantom so that it is horizontally and vertically in a 90 degree angle with the cross hairs and the laser lights. For the positioning to be accurate, the technologist will have to adjust the phantom using the carpenter's level to determine the correctness of the position. Placed along the front Plexiglas rim of the phantom, the technologist can adjust the side to side horizontal straightness. Then the level is placed along the long axis of the phantom to determine the superior to inferior horizontal accuracy. If needed, one can place alcohol swab pads under the front end of the bottom of the phantom to raise the level by small increments. Verification of a perfectly straight horizontal or a 0 degree angle is seen by referring to the carpenter's level placed on the long axis.

Once the above procedure has been done, the technologist will then do a preliminary set of fast localizers.
The "quick and dirty" 3 plane localizer takes about 34 seconds. This is a time saver sequence, which produces the sagittal and axial planes with enough horizontal and vertical detail to see where any slight adjustment is needed. From this fast GRE, one can easily see if the phantom is even a fraction out of alignment. The resulting quick images will indicate where repositioning is necessary, and the subtle adjustments can be made by either adding or subtracting the amount of alcohol swab pads placed under the anterior or posterior end of the phantom

After this readjustment, one needs to do another quick set of localizers. Then, with the new set of images, re- check to see if the alignment is perfect. You can make sure by using the drawing tools: draw a straight line, equal to 0 degrees, across the top edge of the sagittal image. Then, take an axial image and draw 2 lines, one horizontal and one vertical, across the axial image. If the lines drawn are 90 degrees (vertical), and 0 degrees (horizontal), then one can be sure of the exactitude of the phantom's position.

Now we are ready to begin scanning the phantom with the ACR required scan sequences: Sagittal T1, Axial T1, Axial T2.

After the first sagittal sequence is run, you can now set up the axial selections. As you can see, we do eleven axial slices, inferior to superior, starting at the vertex of that bottom triangle. The importance of placing the first slice exactly in the center of the vertex of the bottom triangle cannot be overemphasized, as this placement does align the subsequent slices and hence the quality of the scan.

Let's look now at the resulting axial images. There are eleven images total. These will be the images used by the technologist to perform the measurements and calculations.

Now we can begin the actual measurements:

## GEOMETRIC ACCURACY

The first measurement is for Geometric Accuracy. For this measurement we use the sagittal image. Using the measurement box from the left side of the screen, choose the line tool. On the sagittal image once places the end of the line tool and drags the other end to the bottom. The measurement is roughly 143 cm to 147 mm. All measurements are seen at the bottom of the screen, and can be screen saved if so desired.

Next, examine axial image number 1.
On this image you will make two measurements: one, from top to bottom, and the second from left to right. The measurements will equal about 188 to 190 for each.

For the last measurement for Geometric Accuracy, we go to Axial image number 5. On this image, which looks like a grid, the tech will do four measurements: top to bottom, left to right, and the 2 diagonals. Each measurement will be approximately 188 to 192 mm.

## HIGH CONTRAST SPATIAL RESOLUTION

Following this, we move on to the High Contrast Spatial Resolution measurements. These images require the technologist to use zooming of the screen plus correct adjustment of windows and levels to be able to see the rows and columns.
Zoom in drastically, in order to see the small dotted squares enlarged several times. Here you will determine in the first square the visualization of the 4 dots seen in at least one row across. In the second square, we try to visualize the 4 dots in at least one column down. Usually, these dots, 4 in a row, and 4 in a column down can only be seen in the first 2 sets of dotted squares. The third set of squares usually cannot be determined.

## SLICE THICKNESS ACCURACY

Moving forward to the next measurement: Slice Thickness Accuracy. We use the Axial image number 1 once again, this time we focus the zoom in on the middle stripe area of the circle. For this image to appear correctly, one has to window to about 1 and level correctly, in order to see the 2 white horizontal bars in the center. Using the measurement tool again, draw a line, 0 degrees, across the top bar, from end to end. Note that the measurement is indicated at the bottom of the screen. Do this same procedure with the bottom bar, noting the measurement given at the bottom of the screen.

## SLICE POSITION ACCURACY

Remaining on the same Axial image number 1, enlarge the image by zooming to the top of the screen. This is the evaluation of the Slice Position Accuracy. We perform this measurement by using two lines exactly perpendicular to each other. Check this by drawing a 0 degree horizontal line matching the lowest horizontal area on the Bar length. Then, draw a perpendicular line, 90 degrees, to the first line drawn. This line will be the measurement of the Bar Length difference. The amount will be somewhere between 0 and 4.

The second part of this Slice Position Accuracy is to go to Axial image number 11. The same thing will be done with this image.
Record the results on your calculation sheet.

## IMAGE INTENSITY UNIFORMITY

For this measurement we use Axial image number 7. Correct windows and levels are essential to do this one. Set the window level to 0, and keep it there. Now go to the measurement tool- box and this time choose the circle device. Enlarge the circle so that its area is about 20,500 $mm^2$ or a bit less, encompassing most of the interior of the phantom. Note the amount of the Image Intensity that is recorded at the bottom of the screen. Write this number on your calculation sheet.
Using this same image, grab another circle device, decrease the circle's area to about 100 $mm^2$.
Now, with window at 0, bring level down very gradually, to darken a portion of the edge of the circle. Stop when one small side area of the circle is dark and you can fit the small circle device in it close to the edge of the large circle.

Next, we get another circle, the same size as the previous one, and , leaving the window at 0, bring the level down much more, to darken almost the entire image. The image on screen is that of a dark circle with a small portion that contains just small pixel areas of white. Place the small circle on the white dotted area that has the most/brightest pixels. This number is also recorded on the calculation sheets.

## PERCENT SIGNAL GHOSTING

For the next measurements, use the same Axial image number 7. Once again go to the circle device, choose the circle again, but this time elongate the circle into a cigar shaped oval, about 1000 $mm^2$, more or less. Place this oval at the top of the screen, the bottom, the right, and the left of the screen. Record the numbers on your calculation sheet

LOW CONTRAST DETECTABILITY

Go to Axial image 11. For this evaluation, the windows and levels have to be changed drastically. As you can see in this first image 11, the contrast has to be increased to see as many spokes as possible. We repeat this process with Axial images 10, 9, 8., increasing the contrast for each image in order to visualize the spokes. The best rule of thumb for determining this set is to remember that one must be able to see three disks in a spoke in order to count the spoke as being seen. If you only can see 2 disks in a spoke, then you stop at the last one in which you could see three disks. Generally, one can easily count 10 spokes in image 11, and as one goes to image 10, then 9, and finally 8, the spokes become increasingly difficult to see.

We hope that this written instructive narration, along with the video itself will be helpful when performing the ACR QC. The problems that we have had during the past year, we have presented here with the hope that this will be a timesaver for the person performing the monthly QC. Most of the descriptions we have provided are based on the use of a quadrature head coil. As the multiple element phased array type of coils become available and are more widely used, some changes as to how some of the signal intensity measurements are made may be needed and we will update this document as necessary. Please feel free to write to us directly with any comments, questions, or criticisms. This video and our commitment is an ongoing process.

Sincerely,

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