

## **PACS Monitor Quality Control Program**

**Purpose:** The PACS monitor quality control (QC) program objectives are to ensure consistent display performance, and identify problems before they become clinically significant.

**Introduction:** The majority of radiologic image interpretation is performed using a picture archiving and communication system (PACS). Our PACS system is composed of G.E. workstations with cathode ray tube (CRT) and liquid crystal display (LCD) monitors. These monitors must be maintained correctly in order to provide the clinician with an accurate image. The performance standards of these monitors are defined in part 14 of the DICOM standard and are termed the grey scale standard display function (GSDF). The GSDF ensures that pixel axis ascend linearly and that images on monitors with varying levels of brightness and varying response curves appear the same within the limits of the human eye (Huschorn, 2005).

In the clinical setting, it is important the PACs monitors are regularly checked. It is also important to ensure compliance with the QC program by developing a consistent evaluation process. This policy defines the PACS monitor QC program that will be used at LSUHSC Shreveport.

### **Program Outline – CRT Monitors**

CRT monitors will be evaluated based on four different standards:

- 1) Cleanliness – Monitor cleanliness is important to ensure that no aspect of the image is obscured. While cleanliness will be checked as part of the program, it is the responsibility of all users. Cleaning agents approved by the vendor will be kept in each physician's reading rooms.
- 2) Quantitative luminance – Luminance refers to the amount of light emitted, transmitted or reflected from a surface (Croth, Bernat, Fetterly, Hargandreasu, 2001). Each monitor has an established range of target values. CRT luminance is determined using a photometer and is further evaluated using the Society of Motion Picture and Television Engineers Test Pattern (SMPTE) ( 0%, 50%, and 100% luminance). The use of this pattern in luminance evaluation is to ensure visibility of the 5% and 95% SMPTE patches.

The measurement obtained by the photometer is compared to the lookup table (calibration data) for the graphics card/monitor being evaluated. If the monitor readings are outside of the defined ranges, adjustments are performed to correct the problems. The subjective analysis of the SMPTE pattern is performed after the monitor calibration has been checked and/or corrected.

*Note: Photometer procedures are maintained by the Biomedical Engineering Department.*

- 3) Image Quality Evaluation – The final evaluation step is to perform a qualitative assessment of the monitor using the SMPTE pattern and a set of clinical images. This assessment is used to assess the following image components; squareness of image geometry, spatial stability of the image, and the presence of visual artifacts.

These components are important since each can potentially affect clinical usefulness of the monitor. The following factors and the associated analysis techniques are used to perform the qualitative assessment:

- a) Image geometry – The SMPTE pattern should appear square which indicates that the aspect ratio is correct. In addition, the displayed pattern should be properly centered. Images with geometric distortion appear warped.
- b) Temporal artifacts – Artifacts are commonly caused by image instability which appears as a wavering boundary between areas of low or high brightness. Image flickering is most often visible in the spatial resolution targets with the highest frequency.
- c) Image blur – Blurring of images is assessed by examining the alphanumeric characters in the step wedge of the SMPTE pattern. The alphanumeric characters should be clear and easy to read.
- d) Image tearing – Tearing or what is sometimes termed “ghosting” of the image is assessed by examining the horizontally oriented spatial resolution patterns of the SMPTE image. Tearing creates a blurring or smearing of the resolution targets into neighboring structures.
- e) Phosphor burn in – Long term displaying of application dialog or tool boxes can result in a persistent faint image remaining on the screen.

If the qualitative assessment reveals any of these problems then clinical images are used to determine significance. The following CR image set will be used:

- Routine hand image
- Abdominal image
- PA chest

If artifacts or instability appear in these test images, then the monitor must be repaired.

These 3 steps for monitor quality control will be performed on each diagnostic workstation on the following schedule.

- 1) Upon installation of new or just repaired monitor
- 2) After any major repair such as tube replacement
- 3) Quarterly

### **Program Outline – LCD Monitor**

Procedure not completed at this time

### **Record Management/Reporting**

Evaluation of Monitors will be recorded on the PACS Monitor QC log form and maintained\_\_\_\_\_.

Monitors that do not pass evaluation will be reported to the Director of Biomedical Engineers and the Director of Radiology. At that time it will be determined if the monitor can be feasibly repaired or if it should be replaced. The monitor will be temporarily replaced by a standby unit. The standby unit must be calibrated to the workstation and evaluated before it is placed into clinical use.

References:

Groth, D.S, Bernatz, S.N, Fetterby, K.S, Hangiandreou, NJ. Calhode Ray tube Quality Control and Acceptance Testing Program: Initial Results for Clinical PACS Displays. Radiographics 2001, 21: 719-732.

Huschor, D. QC of Medical Image Displays. Decisions in Imaging Economics \_\_\_\_\_

Fetterly, L.A., Hangiandreau, N.J., Langer, S.G. Monitor QC. Decisions in Imaging Economics.

A Practical Approach to soft copy display consistency for PC based review workstation. The British Journal of Radiology 2003; 76: 648-652.

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<b>PACS Monitor Evaluation Form</b>	
Date/Time:	
Workstation ID:	
Reason for Evaluation: <input type="checkbox"/> new monitor <input type="checkbox"/> repair <input type="checkbox"/> quarterly evaluation <input type="checkbox"/> request	
Evaluation:	
Condition of Screen (cleanliness):	
<input type="checkbox"/> excellent <input type="checkbox"/> good <input type="checkbox"/> fair <input type="checkbox"/> poor	
Quantitative Luminance:	
<input type="checkbox"/> passed <input type="checkbox"/> failed	
<input type="checkbox"/> adjustment required	
Qualitative Assessment:	
Geometry	<input type="checkbox"/> passed <input type="checkbox"/> failed
Artifacts	<input type="checkbox"/> passed <input type="checkbox"/> failed
Blur	<input type="checkbox"/> passed <input type="checkbox"/> failed
Tearing	<input type="checkbox"/> passed <input type="checkbox"/> failed
Image Evaluation (Required only if an item in the qualitative assessment failed):	
<i>Review to be conducted in conjunction with a radiologist.</i>	
Hand image:	<input type="checkbox"/> acceptable <input type="checkbox"/> unacceptable
Abdominal image:	<input type="checkbox"/> acceptable <input type="checkbox"/> unacceptable
PA chest image:	<input type="checkbox"/> acceptable <input type="checkbox"/> unacceptable
Radiologist completing review: _____	
Evaluation completed by: _____	
Comments:	

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Proc 2.7