APPENDIX 2A: RADIOGRAPHER QUALITY CONTROL TESTS

(SF= Screen-film, CR=computed radiography, DR=digital radiography)

Do note that the tests are not limited to but should include those listed. Where applicable, the manufacturer's guidelines should be adhered to for getting the best out of your mammography unit.

No.	Tests	SF	CR	DR	Minimum Frequency	Performance Criteria	Corrective Action Time frame for Routine QC
1.	Daily Checklist		✓	✓	Daily	Must pass image receptor manufacturer's criteria	Immediately, before checked component is used for patients
2.	Laser Printer Density Consistency		✓	✓	Daily (wet); Monthly (dry)	• D_{max} may not fall below -0.15 operating level (OL) • DD and MD must be within $\pm$ 0.15 OL • D_{min} must be within $\pm$ 0.03 OL	Immediately, before patient images printed
3.	Processor Quality Control	✓			Daily	• If the MD and DD are within $\pm$ 0.10 of their respective OL and the B+F is within + 0.03 of its OL, the processor is in control and no further action is required. • If the MD or DD fall outside of the $\pm$ 0.10 control limit but within $\pm$ 0.15 limit, the test should be repeated immediately. • If the MD or DD exceeds the control limit of $\pm$ 0.15 and the B+F exceeds the OL by + 0.03, immediate corrective action must be taken before clinical mammograms are processed *(from 1999 ACR Mammography QC Manual)*	Immediately
4.	Darkroom Cleanliness	✓			Daily	May be evaluated best in terms of screen cleaniness, i.e, the number of dust artifacts appearing on the mammographic images *(from 1999 ACR Mammography QC Manual)*	Facility to establish and implement adequate protocols for cleaning procedures to be performed at frequencies specified.

No.	Tests	SF	CR	DR	Minimum Frequency	Performance Criteria	Corrective Action Time frame for Routine QC
5.	Phantom Image Quality	✓	✓	✓	Weekly	Must pass image receptor manufacturer's criteria For SF: • At a minimum, the 4 largest fibers, the 3 largest speck groups and the 3 largest masses must be visible and should not decrease by more than ½ from the OL. • The phantom image background OD should be at least 1.40 and should not vary by more than ± 0.20 from the OL. • The DD due to the 4.0 mm acrylic disc should be at least 0.40 and should not vary by more than ± 0.05 from the OL *(from 1999 ACR Mammography QC Manual).*	Immediately
6.	Display Monitor QC		✓	✓	Weekly	Must pass workstation manufacturer's criteria	Immediately: • Acquisition station – before patients imaged; • Final interpretation workstation - before patient images interpreted
7.	Screen / Imaging Plate Cleanliness	✓	✓		Weekly	Review clinical mammograms on a routine basis for white spots (minus density artifacts) *(from 1999 ACR Mammography QC Manual)*	Facility to establish and implement adequate protocols for cleaning procedures to be performed at frequencies specified.
8.	Viewboxes and Viewing Conditions	✓	✓	✓	Weekly (For CR & DR: If screen-film comparison films viewed or printed digital images interpreted)	• Any marks that are not easily removed with window cleaner should be removed with a safe and appropriate cleaner. • If viewboxes appear non-uniform, all of the fluorescent lamps should be replaced as soon as possible. • If viewbox masks are difficult to use, appropriate service or modifications should be requested *(from 1999 ACR Mammography QC Manual)*	Immediately, before patient images interpreted or comparison films reviewed

No.	Tests	SF	CR	DR	Minimum Frequency	Performance Criteria	Corrective Action Time frame for Routine QC
9.	Full-field artifacts			✓	Monthly	Shall not be present at a level that obstructs or mimics clinical information.	Immediately
10.	Visual / Monthly checklist	✓	✓	✓	Monthly	Must pass image receptor manufacturer's criteria.	As specified by the manufacturer for each check
11.	Laser Printer Artifacts		✓	✓	Monthly	Must pass laser printer manufacturer's criteria	Immediately, before patient images printed
12.	Resolution/ Modulation Transfer Function (MTF)		✓	✓	Quarterly (For CR & DR - all with scanning x-ray beams / laser readouts	Must pass image receptor manufacturer's criteria	Immediately
13.	Reject and repeat analysis	✓	✓	✓	Quarterly	• If the total repeat or reject rate changes from the previously determined rate by more than 2.0 percent of the total films included in the analysis, the reason(s) for the change shall be determined. • Any corrective actions shall be recorded and the results of these corrective actions shall be assessed. *[900.10(e)(3)(ii)]*	Within 30 days of the test date
14.	Printed Image Quality		✓	✓	Quarterly	Must pass laser printer manufacturer's criteria	Immediately, before patient images printed
15.	Analysis of Fixer Retention	✓	✓	✓	Quarterly (For CR & DR - all laser printers with wet processors)	The residual fixer shall be no more than 5 micrograms per square cm. *[900.10(e)(3)(i)]*	Within 30 days of the test date
16.	Compression force	✓	✓	✓	Semi-annually	• A compression force of at least 111 newtons (25 pounds) shall be provided. • The maximum compression force for the initial power drive shall be between 111 newtons (25 pounds) and 200 newtons (45 pounds) *[900.10(e)(4)(iii)]*	Immediately

No.	Tests	SF	CR	DR	Minimum Frequency	Performance Criteria	Corrective Action Time frame for Routine QC
17.	Darkroom fog	✓			Semi-annually	• The fog (the optical DD measured between the fogged and unfogged areas of the film) should be < 0.05. • If the fog is > 0.05, the source of fog must be determined *(from 1999 ACR Mammography QC Manual)*	Immediately, before any further examinations performed or any films processed using the component of the mammography system that failed the test.
18.	Screen-Film Contact	✓			Semi-annually	• Large areas (> 1 cm in diameter) of poor contacts not eliminated by screen cleaning and remain in the same location – cassette to be replaced. • Multiple small areas (< 1 cm in diameter) are acceptable – cassette may be returned to clinical use *(from 1999 ACR Mammography QC Manual)*	Immediately, before any further examinations performed or any films processed using the component of the mammography system that failed the test

APPENDIX 2B: MEDICAL PHYSICIST QUALITY CONTROL TESTS

(SF= Screen-film, CR=computed radiography, DR=digital radiography)

Do note that the tests are not limited to but should include those listed. Where applicable, the manufacturer's guidelines should be adhered to for getting the best out of your mammography unit.

No.	Tests	SF	CR	DR	Minimum Frequency	Performance Criteria	Corrective Action Time frame for Routine QC
1.	Mammography Unit Assembly Evaluation	✓	✓	✓	Annually	Must pass image receptor manufacturer's criteria.	Immediately or within 30 days of the test date, depending on the problem.
2.	Phantom Image Quality	✓	✓	✓	Annually	Must pass image receptor manufacturer's criteria.	Immediately
3.	Chest Wall Missed Tissue	✓	✓	✓	Annually	Must not exceed 7 mm. *(note: criteria based on ACRIN experience)*	Immediately
4.	Automatic Exposure Control (AEC) System Performance / Evaluation	✓	✓	✓	Annually	Must pass image receptor manufacturer's criteria	Within 30 days of the test date
5.	Artifact Evaluation	✓	✓	✓	Annually	Shall not be present at a level that obstructs or mimics clinical information.	Within 30 days of the test date
6.	Beam Quality Assessment (HVL)	✓	✓	✓	Annually	Must meet upper and lower criteria in the 1999 ACR Mammography QC Manual. *(note: both upper and lower criteria are important to maintain a check on beam quality in the recommended absence of routine kVp tests;if necessary, the MP may conduct kVp testing to investigate outliers).*	Within 30 days of the test date
7.	Breast Entrance Exposure & Average Glandular Dose	✓	✓	✓	Annually	Average glandular dose delivered during a single cranio-caudal view of an *attenuator* simulating the *attenuation* of a standard breast (e.g., 4 cm of PMMA) shall not exceed 3.0 milligray (mGy) (0.3 rad) per exposure. *[based on 900.10(e)(5)(vi)]*	Immediately

No.	Tests	SF	CR	DR	Minimum Frequency	Performance Criteria	Corrective Action Time frame for Routine QC
8.	kVp Accuracy and Reproducibility	✓	✓	✓	Annually *(note: ACRIN data shows that annual **accuracy** testing is **not** necessary due to the stability of modern generators used with digital systems; for the same reason, **reproducibility** testing is **not** needed for either Mammography Equipment Evaluations or Annual Surveys)*	Shall be accurate within ±5 % of the indicated or selected kVp at: 1) The lowest clinical kVp that can be measured by a kVp test device; 2) The most commonly used clinical kVp; and 3) The highest available clinical kVp. *[900.10(e)(5)(ii)(A)]*	Immediately (for CR & DR) Within 30 days of the test date (for SF)
9.	Ghost Image Evaluation		✓	✓	Annually	Must pass image receptor manufacturer's criteria if applicable.	Within 30 days of the test date
10.	Evaluation of System Resolution/ Modulation Transfer Function (MTF)	✓	✓	✓	Annually	Must pass image receptor manufacturer's criteria.	Immediately
11.	Noise		✓	✓	Annually	To be developed.	Within 30 days of the test date
12.	Spatial Linearity & Geometric Distortion of the Detector		✓	✓	Annually (All w/moving parts [slot-scan & CR])	Must pass image receptor manufacturer's criteria.	Immediately
13.	Monitor Display Quality & Baseline Values		✓	✓	Annually (All softcopy)	Must pass workstation manufacturer's criteria.	Immediately

No.	Tests	SF	CR	DR	Minimum Frequency	Performance Criteria	Corrective Action Time frame for Routine QC
14.	Collimation Assessment	✓	✓	✓	Annually	• All systems shall have beam-limiting devices that allow the entire chest wall edge of the x-ray field to extend to the chest wall edge of the image receptor and provide means to assure that the x-ray field does not extend beyond any edge of the image receptor by more than 2 percent of the SID. • If a light field that passes through the X-ray beam limitation device is provided, it shall be aligned with the X-ray field so that the total of any misalignment of the edges of the light field and the X-ray field along either the length or the width of the visually defined field at the plane of the breast support surface shall not exceed 2 percent of the SID. • The chest wall edge of the compression paddle shall not extend beyond the chest wall edge of the image receptor by more than one percent of the SID when tested with the compression paddle placed above the breast support surface at a distance equivalent to standard breast thickness. • The shadow of the vertical edge of the compression paddle shall not be visible on the image. *[900.10(e)(5)(vii)]*	Within 30 days of the test date
15.	Monitor Luminance Response & Viewing Conditions		✓	✓	Annually (All softcopy)	Must pass workstation manufacturer's criteria.	Immediately

No.	Tests	SF	CR	DR	Minimum Frequency	Performance Criteria	Corrective Action Time frame for Routine QC
16.	Measurement of Viewbox Luminance & Room Illuminance	✓	✓	✓	Annually (For CR & DR: If screen-film comparison films viewed or printed digital images interpreted)	Must pass workstation manufacturer's criteria.	Immediately
17.	Laser Printer Evaluation & Baseline Values		✓	✓	Annually	Must pass laser printer manufacturer's criteria.	Immediately
18.	Uniformity of Screen Speed	✓			Annually	• All cassettes in the facility shall be tested and the difference between the maximum and minimum optical densities shall not exceed 0.30. • Screen artifacts shall also be evaluated during this test.	Within 30 days of the test date

* Any failures found during a Mammography Equipment Evaluation must be corrected ***immediately***.
* The stipulation of passing manufacturer's performance criteria is applicable only if the test is part of that manufacturer's QC protocol and specific passing criteria are given.
* The medical physicist's survey report must be sent to the facility within 30 days of the date of the survey. *[900.10(e)(8)(iv)]*
* The medical physicist should perform additional, more selective diagnostic tests to further characterize sources of problems if any of the above tests fail. For example, if the HVL test fails, the medical physicist may want to perform a kVp test.
* Revised regulations should require that routine preventative maintenance be performed on all mammography units following the procedures outlined by the original equipment manufacturer.