

**Addendum to the National Accreditation Standards  
(to replace existing Appendix I on page 153 - 164 & K on page 169 -  
192)**

**APPENDIX I**

**STANDARDS FOR MAMMOGRAPHY IMAGING SYSTEM  
PERFORMANCE**

All mammography imaging system equipment shall meet the minimum performance standards specified in Table I.A to I.D and relevant radiation protection regulatory requirements. The equipment shall meet the minimum standards and shall be confirmed by testing performed at acceptance, annually and following major maintenance (for example, x-ray tube replacement) unless indicated otherwise. This testing shall be performed by, or under the close supervision of, suitably qualified and experienced persons as specified in Appendix J. Procedures used shall be consistent with the recommendations of the Australasian College of Physical Scientists and Engineers in Medicine mammography quality assurance position papers.<sup>4,164</sup> At acceptance, more extensive testing shall be performed as per the Australasian College of Physical Scientists and Engineers in Medicine recommendations.

**Table I.A: Screen/film mammography imaging system performance standards**

<b>Item</b>	<b>Minimum standards</b>
General mammographic unit condition	Mechanical stability, correct and safe function of system components and alarms.
Breast compression facility	<ul style="list-style-type: none"><li>• Maximum compression force <math>\leq 300</math> Newtons (N)</li><li>• Maximum power-driven compression force in range 150–200 N</li><li>• Force display accurate to within <math>\pm 20</math> N (when present)</li><li>• Compressed breast thickness display accuracy within <math>\pm 5</math></li></ul>

Item	Minimum standards
Collimation and alignment	<p data-bbox="711 134 927 161">mm (when present)</p> <p data-bbox="667 161 894 189">The X-ray field shall:</p> <ul style="list-style-type: none"> <li data-bbox="704 237 1187 264">(a) extend to the chest wall edge of the film</li> <li data-bbox="704 264 1349 323">(b) not extend beyond the edge of the primary beam stop for those edges not adjacent to the patient's chest wall</li> <li data-bbox="704 323 1317 382">(c) not extend by more than 2% of the source to image distance (SID) beyond any edge of the film and</li> <li data-bbox="704 382 1365 441">(d) for standard contact views, extend to the non-chest wall edges of the film<sup>A</sup></li> </ul> <p data-bbox="667 468 1365 611">The lack of alignment between any boundary of the light beam and the equivalent boundary of the X-ray beam in the plane of the image receptor shall not exceed 1% of the distance between the focus of the X-ray tube and the plane of the image receptor (ie. SID).</p> <p data-bbox="667 638 1256 665">The chest wall edge of the compression paddle shall:</p> <ul style="list-style-type: none"> <li data-bbox="667 665 1354 753">• be aligned just beyond the chest wall edge of the image receptor such that the chest-wall edge of the compression paddle does not appear in the mammogram</li> <li data-bbox="667 753 1365 842">• not extend beyond the chest-wall edge of the image receptor by more than 1% of the SID with the paddle at 4.5 cm above the breast support</li> </ul>
System resolution <sup>B</sup>	<p data-bbox="667 871 1276 930">For both contact and magnification geometries, system resolution shall be:</p> <ul style="list-style-type: none"> <li data-bbox="667 930 1305 989">• <math>\geq 11</math> line pairs per millimetre (lp/mm) for line-pair bars perpendicular to anode-cathode axis; and</li> <li data-bbox="667 989 1365 1016">• <math>\geq 13</math> lp/mm for line-pair bars parallel to anode-cathode axis</li> </ul>

<sup>A</sup> This requirement shall not apply to systems in the Program prior to July 2001

<sup>B</sup> For systems that meet manufacturer's focal spot size specifications and are operating in the Program as of the date of this document's publication this requirement shall only apply from the time of the next x-ray tube replacement.

Item	Minimum standards
Automatic exposure control (AEC) system performance	<p data-bbox="667 140 1380 168">An AEC shall be present and meet the following requirements:</p> <p data-bbox="667 197 841 224">Reproducibility:</p> <ul data-bbox="667 254 1380 342" style="list-style-type: none"> <li data-bbox="667 254 1380 342">• Coefficient of variation for both absorbed dose and milli-ampere seconds (mAs) for four phototimed exposures of a test object shall be better than or equal to 0.05</li> </ul> <p data-bbox="667 371 915 399">Mean Optical Density:</p> <ul data-bbox="667 428 1380 485" style="list-style-type: none"> <li data-bbox="667 428 1380 485">• Mean optical density shall be within <math>\pm 0.2</math> of the nominated optical density baseline for quality control phantom images.</li> </ul> <p data-bbox="711 514 1380 716">For a given imaging geometry, mean optical density is defined as the mean of optical density measurements made at 4 cm from the chest wall edge on the mid-line of the film for images of 2, 4 and 6 cm of perspex (or tissue mimicking material) obtained using clinically relevant AEC, kilovolts peak (kVp) and target/filter selections, the 18 by 24 cm film format and a single density setting.</p> <p data-bbox="667 745 841 772">Compensation:</p> <ul data-bbox="667 802 1380 978" style="list-style-type: none"> <li data-bbox="667 802 1380 978">• For photo-timed imaging of 2, 4 and 6 cm phantom thicknesses using a single density setting and clinically relevant kVp and target/filter selections the AEC shall be able to maintain optical density to within <math>\pm 0.15</math> of the mean optical density for contact geometry and <math>\pm 0.20</math> of the mean optical density for magnification geometry (if used)</li> </ul> <p data-bbox="667 1008 846 1035">Density Control:</p> <ul data-bbox="667 1064 1380 1205" style="list-style-type: none"> <li data-bbox="667 1064 1380 1205">• The difference in film optical density produced by adjacent density control settings should not be less than 0.10 and shall not exceed 0.20 except for units in the Program as of date of this document's publication, when it shall not exceed 0.25.</li> </ul> <p data-bbox="667 1234 1078 1262">Security Cut-Out and Back-up Timer:</p> <ul data-bbox="667 1291 1380 1467" style="list-style-type: none"> <li data-bbox="667 1291 1380 1467">• Security cut-out mechanisms should be present and terminate the exposure within 50 ms or within 5 mAs or with an entrance absorbed dose for the American College of Radiology (ACR) accreditation phantom of less than 0.44 mGy. In the absence of security cut-out a back-up timer shall terminate exposure at <math>\leq 600</math> mAs.</li> </ul>
Uniformity of cassette/screen response	<p data-bbox="667 1499 1380 1612">The optical density produced for a photo-timed exposure of a suitable phantom should be within <math>\pm 0.10</math> and shall be within <math>\pm 0.15</math> of the average optical density for all cassettes of the same size<sup>c</sup></p>
Image quality	<p data-bbox="667 1642 1380 1755">The ability to clearly visualise 4 fibres, 3 speck groups and 3 masses in an image of an American College of Radiology (ACR) accreditation phantom for a phototimed exposure using typical clinical settings at a MGD of <math>\leq 2</math> mGy.</p> <p data-bbox="667 1785 1243 1812">Images shall be free of clinically significant artefacts</p>

<sup>c</sup> Annual testing of uniformity of cassette/screen response may be performed by facility staff with results reviewed by the person performing annual system testing.

<b>Item</b>	<b>Minimum standards</b>
kVp accuracy	Measured kVp shall be within $\pm 5\%$ of the specified value over the clinically relevant range
kVp reproducibility	Coefficient of variation $\leq 0.02$ for a minimum of four exposures
Beam quality	The half value layer (HVL) shall satisfy relationship: $[(kVp/100) + 0.03] \leq HVL < [(kVp/100) + C]$ where C = 0.12 mm Al for Mo/Mo = 0.19 mm Al for Mo/Rh = 0.22 mm Al for Rh/Rh = 0.30 mm Al for W/Rh = 0.32 mm Al for W/Al
Mean glandular dose (MGD)	MGD for contact imaging (with grid) of a 4.2 cm 50% adipose, 50% glandular breast (ie. American College of Radiology accreditation phantom) shall be $\leq 2.0$ milligray (mGy) for exposures made using typical clinical settings.  The 2 mGy value shall be considered not as a dose limit but as a Diagnostic Reference Level (DRL) as defined by the International Commission on Radiological Protection in their Publication 73
Radiation output rate	For all clinically relevant SID settings the average rate of absorbed dose to air measured with the paddle in the beam shall be: <ul style="list-style-type: none"> <li><math>\geq 7.0</math> mGy/s at 4.5 cm above the breast support surface for a three-second, 28 kVp, Mo/Mo, large focus exposure; and</li> <li><math>\geq 1.5</math> mGy/s at 4.5 cm above the upper surface of the film cassette for a three second, 28 kVp, Mo/Mo, small focus exposure</li> </ul>
Accuracy of stereotactic localisation <sup>D</sup>	Localisation within $\pm 1$ mm
Film viewer luminance	Viewers used for interpreting mammograms shall be capable of producing a luminance of at least 3,000 candela per square meter ( $cd/m^2$ ).
Viewing area illuminance	$\leq 50$ lux
Film viewer masking	Shall be present and effectively restrict light to the exposed area of the film
X-ray tube leakage radiation <sup>E</sup>	The leakage radiation shall not exceed: <ul style="list-style-type: none"> <li>1 mGy in one hour at 1 metre from the focal spot with the x-ray tube operating at the maximum rated voltage and the maximum rated continuous tube current</li> <li>0.01 mGy/100 mAs at 30 cm from the focal spot at 30 kVp</li> </ul>

<sup>D</sup> As verification of stereotactic accuracy is performed regularly by facility staff this test may be omitted from annual testing.

<sup>E</sup> At acceptance testing and following x-ray tube replacement

**Table I.B: Digital (DR) mammography imaging system performance standards**

Item	Minimum standards
General mammographic unit condition	<ul style="list-style-type: none"> <li>• Mechanical stability, correct and safe function of system components and alarms.</li> <li>• DICOM image header correctly displays parameters</li> </ul>
Breast compression facility	<ul style="list-style-type: none"> <li>• Maximum compression force <math>\leq 300</math> Newtons (N)</li> <li>• Maximum power-driven compression force in range 150–200 N</li> <li>• Force display accurate to within <math>\pm 20</math> N</li> <li>• Compressed breast thickness display accuracy within <math>\pm 5</math> mm</li> </ul>
Collimation and alignment	<p>The X-ray field shall:</p> <ul style="list-style-type: none"> <li>(a) extend to the chest wall edge of the image receptor, and</li> <li>(b) not extend beyond the edge of the primary beam stop for those edges not adjacent to the patient's chest wall by more than 2% of the source to image distance (SID).</li> </ul> <p>The lack of alignment between any boundary of the light beam and the equivalent boundary of the X-ray beam in the plane of the image receptor shall not exceed 1% of the distance between the focus of the X-ray tube and the plane of the image receptor (ie. SID).</p> <p>The chest wall edge of the compression paddle shall:</p> <ul style="list-style-type: none"> <li>• be aligned just beyond the chest wall edge of the image receptor such that the chest-wall edge of the compression paddle does not appear in the mammogram</li> <li>• not extend beyond the chest-wall edge of the image receptor by more than 1% of the SID with the paddle at 4.5 cm above the breast support</li> </ul>
Missed tissue at chest wall <sup>F</sup>	<p>Extent of missed tissue at chest wall <math>\leq 5</math> mm in contact mode  A slightly weaker limit of 7 mm is acceptable but not desirable for magnification mammography</p>

<sup>F</sup> At acceptance testing and following x-ray tube replacement.

Item	Minimum standards
System resolution	For both contact and magnification geometries, system resolution shall meet the manufacturer's specification. This may be established by measuring the Modulation Transfer Function (MTF) at acceptance.
Automatic exposure control (AEC) system performance	<p>An AEC shall be present and meet the following requirements:</p> <p>Reproducibility:</p> <ul style="list-style-type: none"> <li>• Coefficient of variation for both absorbed dose and milli-ampere seconds (mAs) for four phototimed exposures of a test object shall be better than or equal to 0.05</li> </ul> <p>Compensation &amp; Contrast to Noise Ratio (CNR):</p> <p>The equipment vendor must provide the manufacturer's recommended target pixel values and allowable tolerance for a range of PMMA absorber thicknesses. In some systems, the AEC is designed to maintain an essentially constant MPV over the thickness range, in which case a single target value is appropriate.</p> <ul style="list-style-type: none"> <li>• The MPV should be within <math>\pm 10\%</math> of the baseline value for the respective PMMA thickness.</li> </ul> <p>When a 0.2 mm Al foil is used as a contrast test tool the CNR for 2, 4 and 6 cm PMMA may be measured and the provisional requirement is that.</p> <ul style="list-style-type: none"> <li>• The measured CNR be at least 1.1, 1.0 and 0.9 of the minimum acceptable CNR with 4 cm PMMA (designated as <math>CNR_{\text{accept}}</math>) with 2 cm, 4 cm and 6 cm of PMMA as a test object, respectively<sup>G</sup>.</li> </ul> <p>For systems that use hardcopy for reporting the OD should comply with the standards for film screen mammography.</p> <p>Density Control (if applicable):</p> <ul style="list-style-type: none"> <li>• The density control should be capable of changing the mAs from the value used normally by -25% to +50%</li> </ul> <p>Security Cut-Out and Back-up Timer:</p> <ul style="list-style-type: none"> <li>• Security cut-out mechanisms should be present and terminate the exposure within 50 ms or within 5 mAs or with an entrance absorbed dose for the American College of Radiology (ACR) accreditation phantom of less than 0.44 mGy. In the absence of security cut-out a back-up timer shall terminate exposure at <math>\leq 600</math> mAs.</li> </ul>
Image uniformity and artefact	<ul style="list-style-type: none"> <li>• Maximum deviation of MPV in any ROI <math>\leq \pm 15\%</math> of MPV for central ROI</li> <li>• Maximum deviation in SNR <math>\leq \pm 25\%</math> of mean SNR for central ROI.</li> <li>• Maximum deviation in SNR as a function of time is <math>\leq \pm 10\%</math>.</li> <li>• There must be no evidence of blotches or regions of altered noise appearance, observable grid lines or table top structures, bright or dark pixels</li> </ul>

<sup>G</sup> For each model of mammography system, the value of  $CNR_{\text{accept}}$  is unique and has been established from recent experience in Europe (for list of values see page 13 ACPSEM Position Paper<sup>4</sup>)

<b>Item</b>	<b>Minimum standards</b>
Detector element failure	The manufacturers should provide a “bad pixel map” which indicates which del values are not based on their own reading. This should be inspected by the medical physicist at each visit and compared to earlier maps.
Image quality	The ability to clearly visualise 5 fibres, 3.5 speck groups <sup>H</sup> and 4 masses in an image of an American College of Radiology (ACR) accreditation phantom for a photo timed exposure using typical clinical settings at a MGD of $\leq 2$ mGy.  Images shall be free of clinically significant artefacts
Spatial linearity and geometric distortion <sup>I</sup>	Measured dimensions in image should be within 2% of true dimensions.
Ghost image evaluation	Assessed using 40 mm PMMA: <ul style="list-style-type: none"> <li>ghost image factor &lt; 2.0</li> </ul>
System linearity evaluation	<ul style="list-style-type: none"> <li>Plot of MPV versus the absorbed dose should have <math>R^2 &gt; 0.99</math></li> <li>Plot of noise or standard deviation squared (<math>SD^2</math>) versus the absorbed dose should have <math>R^2 &gt; 0.95</math></li> </ul>
kVp accuracy	Measured kVp shall be within $\pm 5\%$ of the specified value over the clinically relevant range
kVp reproducibility	Coefficient of variation $\leq 0.02$ for a minimum of four exposures
Beam quality	The half value layer (HVL) shall satisfy relationship: $[(kVp/100) + 0.03] \leq HVL < [(kVp/100) + C]$ where C = 0.12 mm Al for Mo/Mo = 0.19 mm Al for Mo/Rh = 0.22 mm Al for Rh/Rh = 0.30 mm Al for W/Rh = 0.32 mm Al for W/Al
Mean glandular dose (MGD)	MGD for contact imaging of a 4.2 cm 50% adipose, 50% glandular breast (ie. American College of Radiology accreditation phantom) shall be $\leq 2.0$ milligray (mGy) for exposures made using typical clinical settings.  The 2 mGy value shall be considered not as a dose limit but as a Diagnostic Reference Level (DRL) as defined by the International Commission on Radiological Protection in their Publication 73  Additionally the MGD shall be: <ul style="list-style-type: none"> <li><math>\leq 1</math> mGy for 2.0 cm PMMA (2.3 cm 50% adipose, 50% glandular breast)</li> <li><math>\leq 4.5</math> mGy for 6.0 cm PMMA, (6.5 cm 50% adipose, 50% glandular breast)</li> </ul>
Exposure time	For clinically relevant techniques and SID settings the maximum exposure time when irradiating 6 cm PMMA should be: <ul style="list-style-type: none"> <li><math>\leq 3.5</math> seconds for fine focus, and</li> <li><math>\leq 2</math> seconds for broad focus.</li> </ul>
Film viewer luminance	Viewers used for interpreting hardcopy images shall be capable of producing a luminance of at least 3,000 candela per square meter ( $cd/m^2$ ).

<sup>H</sup> Ideally, 4 speck groups should be visualised but field testing has established that significant variations in scoring of specks can arise when different ACR phantom units are utilised, This variation is attributable to manufacturing tolerances and ageing of the wax insert test object.

<sup>I</sup> At acceptance testing and following x-ray tube replacement

<b>Item</b>	<b>Minimum standards</b>
Viewing area illuminance	$\leq 50$ lux (hardcopy only)
Film viewer masking	Shall be present and effectively restrict light to the exposed area of the film (hardcopy only)
Monitor luminance and viewing conditions	<ul style="list-style-type: none"> <li>• Monitors used for interpretation must not be <math>&lt; 5</math> megapixels and that for acquisition must not be <math>&lt; 1.3</math> megapixels</li> <li>• Luminance dynamic range <math>&gt; 250:1</math></li> <li>• Ambient light <math>\leq 10</math> lux</li> </ul>
Monitor performance	Using TG18-QC pattern establish: <ul style="list-style-type: none"> <li>• No smearing artefact, ramps without terracing.</li> <li>• Lines straight, boxes square, active display centred, borders complete</li> <li>• Resolution patterns resolved</li> <li>• All shades of grey visible</li> <li>• Free from artefact</li> </ul>
X-ray tube leakage radiation <sup>J</sup>	The leakage radiation level shall not exceed: <ul style="list-style-type: none"> <li>• 1 mGy in one hour at 1 metre from the focal spot with the x-ray tube operating at the maximum rated voltage and the maximum rated continuous tube current</li> <li>• 0.01 mGy/100 mAs at 30 cm from the focal spot and 30 kVp</li> </ul>
Printer (hardcopy only)	$D_{\min} < 0.25$ OD and $D_{\max} > 3.4$ OD

<sup>J</sup> At acceptance testing and following x-ray tube replacement

**Table I.C: Computed Radiography (CR) mammography imaging system performance standards**

Item	Minimum standards
General mammographic unit condition	<ul style="list-style-type: none"> <li>• Mechanical stability, correct and safe function of system components and alarms.</li> <li>• DICOM image header correctly displays parameters</li> </ul>
Breast compression facility	<ul style="list-style-type: none"> <li>• Maximum compression force <math>\leq 300</math> Newtons (N)</li> <li>• Maximum power-driven compression force in range 150–200 N</li> <li>• Force display accurate to within <math>\pm 20</math> N</li> <li>• Compressed breast thickness display accuracy within <math>\pm 5</math> mm</li> </ul>
Collimation and alignment	<p>The X-ray field shall:</p> <ul style="list-style-type: none"> <li>(a) extend to the chest wall edge of the image receptor</li> <li>(b) not extend beyond the edge of the primary beam stop for those edges not adjacent to the patient's chest wall, and</li> <li>(c) not extend by more than 2% of the source to image distance (SID) beyond any edge of the image</li> </ul> <p>The lack of alignment between any boundary of the light beam and the equivalent boundary of the X-ray beam in the plane of the image receptor shall not exceed 1% of the distance between the focus of the X-ray tube and the plane of the image receptor (ie. SID).</p> <p>The chest wall edge of the compression paddle shall:</p> <ul style="list-style-type: none"> <li>• be aligned just beyond the chest wall edge of the image receptor such that the chest-wall edge of the compression paddle does not appear in the mammogram</li> <li>• not extend beyond the chest-wall edge of the image receptor by more than 1% of the SID with the paddle at 4.5 cm above the breast support</li> </ul>
Missed tissue at chest wall <sup>K</sup>	<p>Extent of missed tissue at chest wall <math>\leq 5</math> mm in contact mode  A slightly weaker limit of 7 mm is acceptable but not desirable for magnification mammography</p>

<sup>K</sup> At acceptance testing and following x-ray tube replacement

Item	Minimum standards
System resolution	For both contact and magnification geometries, system resolution shall meet the manufacturer's specification. This may be established by measuring the Modulation Transfer Function (MTF) at acceptance.
Automatic exposure control (AEC) system performance	<p>An AEC shall be present and meet the following requirements:</p> <p>Reproducibility:</p> <ul style="list-style-type: none"> <li>• Coefficient of variation for both absorbed dose and milli-ampere seconds (mAs) for four phototimed exposures of a test object shall be better than or equal to 0.05</li> </ul> <p>Compensation<sup>L</sup>:</p> <ul style="list-style-type: none"> <li>• The absorbed dose to the image plate should be within <math>\pm 10\%</math> of the baseline value for the respective PMMA thickness.</li> <li>• Variation of the absorbed dose to the image plate as a function of thickness (2 cm to 6 cm PMMA) should be less than <math>\pm 20\%</math> for both contact and magnification modes (if applicable).</li> </ul> <p>For systems that use hardcopy for reporting the OD should comply with the standards for film screen mammography.</p> <p>Density Control:</p> <ul style="list-style-type: none"> <li>• The density control should be capable of changing the mAs from the value used normally by <math>-25\%</math> to <math>+50\%</math></li> </ul> <p>Security Cut-Out and Back-up Timer:</p> <ul style="list-style-type: none"> <li>• Security cut-out mechanisms should be present and terminate the exposure within 50 ms or within 5 mAs or with an entrance absorbed dose for the American College of Radiology (ACR) accreditation phantom of less than 0.44 mGy. In the absence of security cut-out a back-up timer shall terminate exposure at <math>\leq 600</math> mAs.</li> </ul>
Image uniformity and artefact	<ul style="list-style-type: none"> <li>• Maximum deviation of MPV in any ROI <math>\leq \pm 10\%</math> of MPV for central ROI</li> <li>• Maximum deviation in SNR <math>\leq \pm 15\%</math> of mean SNR for central ROI.</li> <li>• Maximum deviation in SNR as a function of time is <math>\leq \pm 10\%</math>.</li> <li>• There must be no evidence of blotches or regions of altered noise appearance, observable grid lines or table top structures, bright or dark pixels</li> </ul>
Uniformity of cassette/image plate response	<ul style="list-style-type: none"> <li>• Maximum mAs variation <math>\leq \pm 10\%</math> between all plates</li> <li>• Coefficient of variation (COV) of absorbed dose to QC plate <math>&lt; 0.05</math></li> <li>• Absorbed dose to individual plate should differ from mean for that size by <math>&lt; \pm 5\%</math>.</li> <li>• Difference in mean absorbed dose to plates of different sizes <math>&lt; \pm 20\%</math>.<sup>M</sup></li> </ul>

<sup>L</sup> These specifications in terms of the exposure indicator depend on the CR manufacturer (see ACPSEM Position Paper<sup>4</sup>)

<sup>M</sup> These specifications in terms of the exposure indicator depend on the CR manufacturer (see ACPSEM Position Paper<sup>4</sup>)

<b>Item</b>	<b>Minimum standards</b>
Image quality	The ability to clearly visualise 5 fibres, 3.5 speck groups <sup>N</sup> and 4 masses in an image of an American College of Radiology (ACR) accreditation phantom for a phototimed exposure using typical clinical settings at a MGD of $\leq 2$ mGy.  Images shall be free of clinically significant artefacts
Spatial linearity and geometric distortion <sup>O</sup>	Measured dimensions in image should be within 2% of true dimensions.
Ghost image evaluation	Assessed using 40 mm PMMA: <ul style="list-style-type: none"> <li>ghost image factor <math>&lt; 2.0</math></li> </ul>
System linearity evaluation	<ul style="list-style-type: none"> <li>Appropriate plot of exposure indicator versus the absorbed dose should have <math>R^2 &gt; 0.99</math></li> </ul>
kVp accuracy	Measured kVp shall be within $\pm 5\%$ of the specified value over the clinically relevant range
kVp reproducibility	Coefficient of variation $\leq 0.02$ for a minimum of four exposures
Beam quality	The half value layer (HVL) shall satisfy relationship: $[(kVp/100) + 0.03] \leq HVL < [(kVp/100) + C]$ where C = 0.12 mm Al for Mo/Mo = 0.19 mm Al for Mo/Rh = 0.22 mm Al for Rh/Rh = 0.30 mm Al for W/Rh = 0.32 mm Al for W/Al
Mean glandular dose (MGD)	MGD for contact imaging of a 4.2 cm 50% adipose, 50% glandular breast (ie. American College of Radiology accreditation phantom) shall be $\leq 2.0$ milligray (mGy) for exposures made using typical clinical settings.  The 2 mGy value shall be considered not as a dose limit but as a Diagnostic Reference Level (DRL) as defined by the International Commission on Radiological Protection in their Publication 73  Additionally the MGD shall be: <ul style="list-style-type: none"> <li><math>\leq 1</math> mGy for 2.0 cm PMMA (2.3 cm 50% adipose, 50% glandular breast)</li> <li><math>\leq 4.5</math> mGy for 6.0 cm PMMA, (6.5 cm 50% adipose, 50% glandular breast)</li> </ul>
Exposure time	For clinically relevant techniques and SID settings the maximum exposure time when irradiating 6 cm PMMA should be: <ul style="list-style-type: none"> <li><math>\leq 3.5</math> seconds for fine focus, and</li> <li><math>\leq 2</math> seconds for broad focus.</li> </ul>
Film viewer luminance	Viewers used for interpreting hardcopy images shall be capable of producing a luminance of at least 3,000 candela per square meter ( $cd/m^2$ ).
Viewing area illuminance	$\leq 50$ lux (hardcopy only)
Film viewer masking	Shall be present and effectively restrict light to the exposed area of the film (hardcopy only)

<sup>N</sup> Ideally, 4 speck groups should be visualised but field testing has established that significant variations in scoring of specks can arise when different ACR phantom units are utilised, This variation is attributable to manufacturing tolerances and ageing of the wax insert test object.

<sup>O</sup> At acceptance testing and following x-ray tube replacement

Item	Minimum standards
Monitor luminance and viewing conditions	<ul style="list-style-type: none"> <li>• Monitors used for interpretation must not be &lt; 5 megapixels and those for acquisition must not be &lt; 1.3 megapixels</li> <li>• Luminance dynamic range &gt; 250:1</li> <li>• Ambient light <math>\leq</math> 10 lux</li> </ul>
Monitor performance	Using TG18-QC pattern: <ul style="list-style-type: none"> <li>• No smearing artefact, ramps without terracing.</li> <li>• Lines straight, boxes square, active display centred, borders complete</li> <li>• Resolution patterns resolved</li> <li>• All shades of grey visible</li> <li>• Free from artefact</li> </ul>
X-ray tube leakage radiation <sup>P</sup>	The leakage radiation level shall not exceed: <ul style="list-style-type: none"> <li>• 1 mGy in one hour at 1 metre from the focal spot with the x-ray tube operating at the maximum rated voltage and the maximum rated continuous tube current</li> <li>• 0.01 mGy/100 mAs at 30 cm from the focal spot and 30 kVp</li> </ul>
Printer (hardcopy only)	$D_{\min} < 0.25$ OD and $D_{\max} > 3.4$ OD

<sup>P</sup> At acceptance testing and following x-ray tube replacement

**Table I.D: Digital stereotactic imaging system performance standards**

<b>Item</b>	<b>Minimum standards</b>
General mammographic unit condition	<ul style="list-style-type: none"> <li>• Mechanical stability, correct and safe function of system components and alarms.</li> <li>• DICOM image header (if present) correctly displays parameters</li> <li>• Technique charts are confirmed to be in place. This applies to units both with and without AEC.</li> <li>• The X-ray tube angular locations are positively locked and inadvertent movement from them cannot take place</li> <li>• The image receptor and compression plate biopsy window is free of wobble</li> <li>• The vernier table drive and needle guide is rigid and is free of wobble</li> <li>• The localisation system zeroes coordinates properly</li> <li>• The biopsy device is properly immobilised to prevent recoil.</li> </ul>
Breast compression facility	<ul style="list-style-type: none"> <li>• Maximum compression force <math>\leq 300</math> Newtons (N)</li> <li>• Maximum power-driven compression force in range 150–200 N</li> <li>• Force display accurate to within <math>\pm 20</math> N</li> <li>• Compressed breast thickness display accuracy within <math>\pm 5</math> mm</li> </ul>
Collimation and alignment	<p>The X-ray field defined by the biopsy window:</p> <ul style="list-style-type: none"> <li>(c) shall be aligned centrally with digital image receptor, and</li> <li>(d) may extend beyond the edge of the image receptor by no more than 5 mm on all four sides, where all distances are referred to the plane of the image receptor.</li> <li>(e)</li> </ul>

Item	Minimum standards
System resolution	The system resolution shall meet the manufacturer's specification. This may be established by measuring the Modulation Transfer Function (MTF) at acceptance.
Automatic exposure control (AEC) system performance	<p>The AEC shall meet the following requirements:</p> <p>Reproducibility:</p> <ul style="list-style-type: none"> <li>• Coefficient of variation for both absorbed dose and milli-ampere seconds (mAs) for four phototimed exposures of a test object shall be better than or equal to 0.05</li> </ul> <p>Compensation &amp; Contrast to Noise Ratio (CNR):</p> <p>The equipment vendor must provide the manufacturer's recommended target pixel values and allowable tolerance for a range of PMMA absorber thicknesses. In most old biopsy systems, the AEC is designed to maintain an essentially constant mean pixel value (MPV) over the thickness range, in which case a single target value is appropriate.</p> <ul style="list-style-type: none"> <li>• The MPV should be within <math>\pm 10\%</math> of the baseline value for the respective PMMA thickness.</li> </ul> <p>If the contrast to noise ratio (CNR) is measured using a 0.2 mm Al foil as a contrast test tool the CNR for 2, 4 and 6 cm PMMA the provisional requirement is that:</p> <ul style="list-style-type: none"> <li>• The measured CNR be at least 1.1, 1.0 and 0.9 of the minimum acceptable CNR with 4 cm PMMA (designated as <math>CNR_{\text{accept}}</math>) with 2 cm, 4 cm and 6 cm of PMMA as a test object, respectively<sup>Q</sup>.</li> </ul> <p>For systems that use hardcopy for reporting the OD should comply with the standards for film screen mammography.</p> <p>Density Control (if applicable):</p> <ul style="list-style-type: none"> <li>• The density control should be capable of changing the mAs from the value used normally by -25% to +50%</li> <li>•</li> </ul> <p>Security Cut-Out and Back-up Timer:</p> <ul style="list-style-type: none"> <li>• Security cut-out mechanisms should be present and terminate the exposure within 50 ms or within 5 mAs or with an entrance absorbed dose for the ACR mini-accreditation phantom of less than 0.44 mGy. In the absence of security cut-out a back-up timer shall terminate exposure at <math>\leq 600</math> mAs.</li> </ul>
Image uniformity and artefact	<ul style="list-style-type: none"> <li>• Maximum deviation of MPV in any ROI <math>\leq \pm 15\%</math> of MPV for central ROI</li> <li>• Maximum deviation in SNR <math>\leq \pm 15\%</math> of mean SNR for central ROI.</li> <li>• Maximum deviation in SNR as a function of time is <math>\leq \pm 10\%</math>.</li> <li>• There must be no evidence of blotches or regions of altered noise appearance, observable grid lines or table top structures, bright or dark pixels</li> </ul>

<sup>Q</sup> For each model of mammography system, the value of  $CNR_{\text{accept}}$  is unique and has been established from recent experience in Europe (see ACPSEM Position Paper<sup>4</sup>)

Item	Minimum standards
Image quality	<p>The ability to clearly visualise 3 fibres, 2 speck groups and 1.5 masses in an image of an ACR mini-accreditation phantom for a phototimed exposure using typical clinical settings at a MGD of <math>\leq 2</math> mGy.</p> <p>Images shall be free of clinically significant artefacts</p>
Spatial linearity and geometric distortion <sup>R</sup>	Measured dimensions in image should be within 2% of true dimensions.
Ghost image evaluation <sup>S</sup>	Assessed using 40 mm PMMA: <ul style="list-style-type: none"> <li>ghost image factor <math>&lt; 2.0</math></li> </ul>
System linearity evaluation <sup>T</sup>	<ul style="list-style-type: none"> <li>Plot of MPV versus the absorbed dose should have <math>R^2 &gt; 0.99</math></li> <li>Plot of noise or standard deviation squared (<math>SD^2</math>) versus the absorbed dose should have <math>R^2 &gt; 0.95</math></li> </ul>
kVp accuracy	Measured kVp shall be within $\pm 5\%$ of the specified value over the clinically relevant range
kVp reproducibility	Coefficient of variation $\leq 0.02$ for a minimum of four exposures
Beam quality	<p>The half value layer (HVL) shall satisfy relationship:  <math>[(kVp/100) + 0.03] \leq HVL &lt; [(kVp/100) + C]</math>  where C = 0.12 mm Al for Mo/Mo  = 0.19 mm Al for Mo/Rh  = 0.22 mm Al for Rh/Rh  = 0.30 mm Al for W/Rh  = 0.32 mm Al for W/Al</p>
Mean glandular dose (MGD)	<p>MGD for imaging of a 4.2 cm 50% adipose, 50% glandular breast (i.e. ACR mini accreditation phantom) shall be <math>\leq 2.0</math> milligray (mGy) for exposures made using typical clinical settings.</p> <p>The 2 mGy value shall be considered not as a dose limit but as a Diagnostic Reference Level (DRL) as defined by the International Commission on Radiological Protection in their Publication 73</p> <p>Additionally the MGD shall be:</p> <ul style="list-style-type: none"> <li><math>\leq 1</math> mGy for 2.0 cm PMMA (2.3 cm 50% adipose, 50% glandular breast)</li> <li><math>\leq 4.5</math> mGy for 6.0 cm PMMA, (6.5 cm 50% adipose, 50% glandular breast)</li> </ul>
Exposure time	<p>For clinically relevant techniques and SID settings the maximum exposure time when irradiating 6 cm PMMA should be:</p> <ul style="list-style-type: none"> <li><math>\leq 2</math> seconds</li> </ul>
Accuracy of stereotactic localisation <sup>U</sup>	Localisation within $\pm 1$ mm
Film viewer luminance	Viewers used for interpreting hardcopy images shall be capable of producing a luminance of at least 3,000 candela per square meter ( $cd/m^2$ )

<sup>R</sup> At acceptance testing and following x-ray tube replacement

<sup>S</sup> For *image receptor* systems, that do not allow positioning of ROIs on the image, a quantitative measure of ghosting cannot be undertaken.

<sup>T</sup> This test can be performed on units where the MPV for part or all of image can be extracted. However, the detector used to monitor the absorbed dose may influence the measurement so it may be necessary to employ mAs as a surrogate for absorbed dose.

<sup>U</sup> As verification of stereotactic accuracy is performed regularly by facility staff this test may be omitted from annual testing.

<b>Item</b>	<b>Minimum standards</b>
Viewing area illuminance	≤ 50 lux (hardcopy only)
Film viewer masking	Shall be present and effectively restrict light to the exposed area of the film (hardcopy only)
Monitor luminance and viewing conditions	<ul style="list-style-type: none"> <li>• Monitors used for interpretation must not be &lt; 2 megapixels and that for acquisition must not be &lt; 1.3 megapixels (note that where the acquisition and interpretation monitors may well be one and the same the higher specification applies unless the unit predates 2008, in which case the lower specification applies)</li> <li>• Luminance dynamic range &gt; 250:1</li> <li>• Ambient light ≤ 10 lux</li> </ul>
Monitor performance	<p>If possible using TG18-QC pattern establish:</p> <ul style="list-style-type: none"> <li>• No smearing artefact, ramps without terracing.</li> <li>• Lines straight, boxes square, active display centred, borders complete</li> <li>• Resolution patterns resolved</li> <li>• All shades of grey visible</li> <li>• Free from artefact</li> </ul>
X-ray tube leakage radiation <sup>v</sup>	<p>The leakage radiation level shall not exceed:</p> <ul style="list-style-type: none"> <li>• 1 mGy in one hour at 1 metre from the focal spot with the x-ray tube operating at the maximum rated voltage and the maximum rated continuous tube current</li> <li>• 0.01 mGy/100 mAs at 30 cm from the focal spot and 30 kVp</li> </ul>
Printer (hardcopy only)	$D_{\min} < 0.25$ OD and $D_{\max} > 3.4$ OD

<sup>v</sup> At acceptance testing and following x-ray tube replacement

### STANDARDS FOR MAMMOGRAPHY QUALITY CONTROL PROCEDURES

Much of the content of this Appendix is based on the recommendations of the Australasian College of Physical Scientists and Engineers in Medicine.<sup>4, 164</sup> It is recommended that these tables be read in conjunction with these Position Papers.

The designated radiographer is responsible for:

- Ensuring that all relevant staff are aware of their responsibilities with respect to mammography quality control.
- Allocating responsibility for quality control procedures to facility staff.

Radiographer quality control shall meet the minimum standards specified in tables K.A to K.D. Quality control test equipment meeting the minimum standards specified in Appendix L shall be readily available to facility staff.

The method of testing shall be documented in depth, and relevant staff should receive training in these procedures (see performance objective 4.6, standard 4.6.3).

Unless otherwise indicated:

- Baseline values shall be determined from an average of five results from tests performed on different days.
- All quality control records shall be retained for a minimum of 12 months (unless indicated otherwise in the tables).

**Table K.A: Quality control procedures and standards for screen/film mammography**

Procedure	Control-Limits/Requirements	Minimum Frequency	Required Procedure Elements	Minimum Record Requirements
Darkroom cleanliness	Clean and dust free environment	Daily (darkroom processing)  Weekly (daylight processing)	Cleaning of counter tops, darkroom floor and processor feed tray	Records that confirm the procedure has been performed for a given date
Film processor quality control				
<i>Establishing processor quality control operating levels</i>	Sensitometric performance including average gradient <sup>W</sup> and maximum density (D <sub>max</sub> ) as per manufacturer's specifications	At acceptance and to set new baselines as required. Thereafter for troubleshooting purposes	Confirmation that developer temperature, developer dwell time, developer and fixer replenishment rates, developer and fixer <sup>X</sup>  Confirmation that developer and fixer specific gravities are as per manufacturer's recommendations	Dated records of all measurements
<i>Daily processor quality control</i>	<i>Speed Index (SI) = baseline ± 0.15</i>  <i>Contrast Index (CI) = baseline ± 0.15</i>  <i>Base + fog = baseline ± 0.03</i>	When changing to a new box of control film	Monitoring of SI, CI and base + fog where: - SI is defined as the optical density of the step with an optical density closest to, but above, 1.2. - CI is defined as the difference in optical density between the step with an optical density closest to, but above, 2.2 and the step with an optical density closest to but not but not less than 0.45.  Use of a dedicated box of film of the type in current clinical use (control film) Averaging of 5 results from different days to determine baseline values Immediate processing of the sensitised quality control film Evaluation of results prior to processing of clinical films Consistency in orientation and placement of the film when feeding into the processor Use of a control chart to record results	Control chart showing: Plots against date of SI, CI and base plus fog A record of at least the last 25 results Clearly marked control limits Baseline values Step numbers used for calculation of CI and SI Dated remarks regarding corrective actions and baseline changes

<sup>W</sup> Average gradient is very dependent on the particular sensitometer used. This should be taken into account when comparing measured values of average gradient with manufacturer's specifications.

<sup>X</sup> If superior performance can be obtained using operating levels other than the manufacturer's specifications these operating levels may be used.

Procedure	Control-Limits/Requirements	Minimum Frequency	Required Procedure Elements	Minimum Record Requirements
<i>Cross-over procedure</i>		When changing to new box of control film	Ensuring that the processor is operating within control limits  Determination of the average CI, SI and base plus fog for film from the old and new boxes of control film using a minimum of three films  Adjustment of CI, SI and base plus fog baseline values by the differences in these average values	Dated records of cross-over results and calculations
Screen cleanliness	Clean and dust free cassettes and screens	Weekly and more frequently if required	Screen cleaning as per manufacturer's recommendations  In the case of wet cleaning: Removal of excess screen cleaner using a lint-free cloth  Air-drying of cassettes standing vertically, on edge and partially open	Records that confirm the procedure has been performed at least weekly
Phantom images	Optical density (OD) = baseline $\pm$ 0.20 <sup>Y</sup>  mAs = baseline $\pm$ 20%  Contrast = baseline $\pm$ 15%  Control limits for detail visibility are dependent on the phantom selected and the scoring method applied  The baseline optical density for phantom images shall be consistent with an OD range of 1.6 to 2.0 for measurements made centred laterally at 4cm in from the chest wall edge of the film.	Weekly	Obtaining the phantom image: Use of a suitable mammography image quality phantom Use of a designated test cassette that is in routine clinical use Use of a consistent automatic exposure control (AEC) detector position Light contact between the compression paddle and the phantom surface Consistent positioning of the phantom Use of the film in current clinical use Consistent selection of a clinically relevant kVp and target/filter combination Selection of the density setting in current clinical use  Evaluating the phantom image: Optical density measurements at consistent points on the film Use of constant viewing conditions that reflect those used to read clinical images Image quality scoring by the same person, if possible Use of a control chart to display results	Control chart showing: Plots against date of mAs, optical density, contrast and image quality score/s A record of at least the last 25 results Clearly marked control limits Baseline values Radiographic settings (kVp, target/filter combination, AEC detector position, density setting and focus to film distance). Dated remarks regarding corrective actions and baseline changes  Dated phantom images from at least the last six months showing x-ray system and radiographic settings

<sup>Y</sup> For phantom imaging a nominated baseline is used for optical density in preference to a baseline determined by averaging. The nominated optical density baseline shall be selected by the radiologist and be the same for all x-ray systems at a facility.

Procedure	Control-Limits/Requirements	Minimum Frequency	Required Procedure Elements	Minimum Record Requirements
Darkroom fog	Increase in optical density $\leq 0.05$ for 2 minutes exposure to safelight	Six monthly	Use of a mammography film exposed to between 1.4 and 2.0 optical density Partial exposure of the film to safelight conditions for two minutes	Records of test date, measured fog level and any corrective actions
Screen-film contact	Areas of poor contact shall not be greater than 10 mm in diameter	Six monthly	Use of a 40 mesh film/screen contact test tool. Allowing 15 minutes or the cassette manufacturer's recommended time following loading of film before exposure Use of mesh images with an average optical density of approximately 0.7 - 0.8 (or test-tool manufacturer's recommendations) Viewing of mesh images from approximately 1 metre	Records of test date, the identity of each cassette tested and the corresponding result (pass or fail)
Compression	Maximum motorised compression force in range 150 - 200 newtons	Six monthly	Protection of the compression paddle to prevent damage Measurement of the maximum motorised compression force using a suitable measuring device (eg. Analogue bathroom scales)	Records of test date, maximum motorised compression force and any corrective actions
Repeat analysis	Overall repeat rate $<3\%$	Quarterly	Analysis of the proportion of repeats attributable to positioning, a range of equipment faults and other reasons for the quarter or from at least 250 consecutive client examinations	Records of date analysis was performed, analysis results and any corrective actions
Viewboxes and viewing conditions	Appropriate viewing conditions	Quarterly	Cleaning of viewers Visual inspection of uniformity of viewer brightness and colour Confirmation of presence and operation of masking devices Visual inspection of ambient lighting conditions	Records of the date the procedure was performed and any corrective actions taken
Analysis of fixer retention in film	$\leq 0.05 \text{ g/m}^2$	Quarterly	Procedure as per recommendations of the test kit manufacturer	Records of the date the test was performed and test results
Maintenance & fault logging	Records for each imaging system and film processor	As required	Recording of equipment faults, incidents and occasions of maintenance (preventative and corrective) as they occur	Dated records that identify the person reporting the event

Procedure	Control-Limits/Requirements	Minimum Frequency	Required Procedure Elements	Minimum Record Requirements
X-ray system constancy check	mAs = baseline $\pm 10\%$	Daily, prior to system use	<p>Completion of x-ray system manufacturer's recommended warm-up procedure prior to testing</p> <p>Use of a suitable phantom equivalent to 4 - 5 cm perspex</p> <p>Use of a designated test cassette that is in routine clinical use</p> <p>Use of a consistent AEC detector position</p> <p>Light contact between the compression paddle and the phantom surface</p> <p>Consistent positioning of the phantom</p> <p>Consistent selection of kVp, target/filter combination and density setting</p> <p>Use of a control chart to display results</p>	<p>A control chart showing:</p> <p>A plot against date of mAs results</p> <p>A record of at least the last 25 results</p> <p>Clearly marked control limits</p> <p>Baseline values</p> <p>Radiographic settings (kVp, target/filter combination, AEC detector position, density setting and focus to film distance)</p> <p>X-ray system identification</p> <p>Dated remarks regarding corrective actions and baseline changes</p>
Stereotactic accuracy confirmation	Localisation accuracy within $\pm 1$ mm	Prior to first use on day of procedures	Procedure as per manufacturer's recommendations	Records that confirm the procedure has been performed for a given date and describe any corrective actions
AEC calibration test	The AEC shall be able to maintain optical density to within: $\pm 0.15$ of the mean optical density for contact geometry $\pm 0.20$ of the mean optical density for magnification geometry	Quarterly	<p>Use of a designated test cassette that is in routine clinical use</p> <p>Use of a consistent AEC detector position</p> <p>Light contact between the compression paddle and the phantom surface</p> <p>Use of the film in current clinical use</p> <p>Imaging of 2, 4 and 6 cm phantom thicknesses</p> <p>Selection of clinically relevant kVp, target/filter combination and density setting</p> <p>Measurement of optical density at 4 cm in from the chest wall edge on the mid-line of the film</p>	<p>Records showing:</p> <p>Date test was performed</p> <p>X-ray system identification and focus to film distance</p> <p>kVp, target/filter, density setting, mAs and optical density for each phantom thickness</p> <p>Mean optical density (ie. average for 2, 4 and 6 cm images) for each geometry</p> <p>Maximum difference in optical density above and below the mean value for each geometry</p>
Infection control of breast imaging equipment	Clean equipment	As required	<p>All cleaning as per manufacturer's recommendations and/or suitable infection control advice.</p> <p>Cleaning of breast support and compression paddle between each examination.</p>	Documented procedures
Test equipment quality control <i>Densitometer calibration check</i>	Accurate to within: $\pm 0.03$ for the OD range 0 to 3.0; and $\pm 3\%$ for the optical density range 3.0 to 4.0	Annually	Verification of accuracy using an OD calibration strip traceable to an accepted standard	Records of test date and result (pass or fail)

Procedure	Control-Limits/Requirements	Minimum Frequency	Required Procedure Elements	Minimum Record Requirements
<i>Thermometer calibration check</i>	Measurement accurate to within $\pm$ 0.1°C for the applicable temperature range	Annually	Single point validation against a thermometer with a current calibration traceable to an accepted standard <u>OR</u> Calibration of thermometer to an accepted standard	Records of test date and result (pass or fail)

**Table K.B: Quality control procedures and standards for DR mammography**

Procedure	Control-Limits/Requirements	Minimum Frequency	Required Procedure Elements	Minimum Record Requirements
Monitor cleanliness	Monitor screens must be free of dust, fingerprints and other marks that might interfere with image interpretation.	Weekly	Clean all monitor screens gently with lint-free cloth as per manufacturer's instructions	Records that confirm the procedure has been performed for a given date
Viewing conditions	Appropriate viewing conditions	Weekly	Visual inspection of ambient lighting conditions to ensure conformance with acceptable viewing condition configuration.	Records that confirm the procedure has been performed for a given date
Printer QC (if applicable)	<p>Borders in TG18-QC pattern must be visible, lines must be straight, all corner patches must be visible, squares of different shades from black to white must be distinct, all high contrast resolution patterns and the two pixel low contrast patterns must be visible in all four corners, the 5% and 95% pixel value squares must be clearly visible, and no disturbing artefacts should be visible.</p> <ul style="list-style-type: none"> <li>The speed index (SI) = baseline <math>\pm</math> 0.15</li> <li>contrast index (CI) = baseline <math>\pm</math> 0.15</li> <li>Base + fog (B+F) = baseline <math>\pm</math> 0.03</li> <li><math>D_{max}</math> = baseline <math>\pm</math> 0.10</li> </ul>	Weekly	<ul style="list-style-type: none"> <li>Print the TG18-QC test pattern.</li> <li>Check visibility and distortion of several items used for evaluating the quality of the image.</li> <li>Check for disturbing artefacts.</li> <li>Monitoring of SI, CI, base + fog and <math>D_{max}</math> where: <ul style="list-style-type: none"> <li>SI is defined as the optical density of the step with an optical density closest to, but above, 1.2.</li> <li>CI is defined as the difference in optical density between the step with an optical density closest to, but above, 2.2 and the step with an optical density closest to but not but not less than 0.45.</li> </ul> </li> </ul>	<p><b>Control chart showing:</b></p> <ul style="list-style-type: none"> <li>Plots against date of SI, CI, base plus fog and <math>D_{max}</math></li> <li>A record of at least the last 25 results</li> <li>Clearly marked control limits</li> <li>Baseline values</li> <li>Step numbers used for calculation of CI and SI</li> <li>Dated remarks regarding corrective actions and baseline changes</li> </ul>

Procedure	Control-Limits/Requirements	Minimum Frequency	Required Procedure Elements	Minimum Record Requirements
Monitor QC (monitors used for interpretation and attached to the acquisition workstation)	Borders in TG18-QC pattern must be visible, lines must be straight, all corner patches must be visible, squares of different shades from black to white must be distinct, all high contrast resolution patterns and the two pixel low contrast patterns must be visible in all four corners, the 5% and 95% pixel value squares must be clearly visible, and no disturbing artefacts should be visible. The number of letters visible in the phrase "Quality Control" for the dark, mid-grey and light renditions should = baseline values.	Weekly	<ul style="list-style-type: none"> <li>• Display the TG18-QC test pattern.</li> <li>• Ensure viewing conditions are acceptable</li> <li>• Use window width set to maximum and window level set to half of maximum</li> <li>• Check visibility and distortion of several items used for evaluating the quality of the image.</li> <li>• Check for disturbing artefacts.</li> </ul>	Control chart showing: <ul style="list-style-type: none"> <li>• Monitor identification</li> <li>• Monitor settings (window and level)</li> <li>• A record of at least the last 25 results</li> <li>• Baseline values</li> <li>• Dated remarks regarding corrective actions and baseline changes</li> </ul>
Phantom images	<ul style="list-style-type: none"> <li>• Mean pixel value (MPV) in image = baseline <math>\pm</math> 10%</li> <li>• mAs = baseline <math>\pm</math> 10%</li> <li>• Signal to noise ratio (SNR) = baseline <math>\pm</math> 10%</li> </ul> <p>Clearly visualize in ACR phantom:</p> <ul style="list-style-type: none"> <li>• 5 fibres</li> <li>• 3.5 speck groups</li> <li>• 4 masses</li> </ul>	Weekly	<p>Obtaining the phantom image:</p> <ul style="list-style-type: none"> <li>• Use of an ACR accreditation mammography image quality phantom</li> <li>• Use of a consistent automatic exposure control (AEC) detector position where manually selected</li> <li>• Light contact between the compression paddle and the phantom surface</li> <li>• Consistent positioning of the phantom</li> <li>• Consistent selection of a clinically relevant kVp and target/filter combination</li> <li>• Selection of the density setting in current clinical use (if applicable)</li> </ul> <p>Evaluating the phantom image:</p> <ul style="list-style-type: none"> <li>• Use of consistent viewing conditions that reflect those used to read clinical images</li> <li>• Image quality scoring by the same person, if possible</li> <li>• Measure MPV and noise (SD) in reproducible ROI</li> <li>• Calculate the SNR by dividing MPV by the SD</li> <li>• Use of a control chart to display results</li> </ul>	Control chart showing: <ul style="list-style-type: none"> <li>• Plots against date of mAs, MPV, SNR, and image quality scores</li> <li>• A record of at least the last 25 results</li> <li>• Clearly marked control limits</li> <li>• Baseline values</li> <li>• Radiographic settings (kVp, target/filter combination, AEC detector position, density setting and source to image distance (SID)).</li> <li>• Dated remarks regarding corrective actions and baseline changes</li> </ul> <p>Dated phantom images from at least the last six months showing x-ray system and radiographic settings</p>

Procedure	Control-Limits/Requirements	Minimum Frequency	Required Procedure Elements	Minimum Record Requirements
Full field artefact evaluation	<p>There must be no evidence of:</p> <ul style="list-style-type: none"> <li>Structures that are more conspicuous than the objects in the phantom used for weekly testing.</li> <li>Blotches or regions of altered noise appearance.</li> <li>Observable grid lines or table top structures.</li> <li>Bright or dark pixels.</li> <li>Significant stitching or registration artefacts</li> </ul>	Monthly	<ul style="list-style-type: none"> <li>Expose a uniform thickness of PMMA so that MPV is within 10% of weekly phantom value.</li> <li>View image on a monitor used for interpretation of digital mammography images</li> <li>Print image if interpretation performed using hard copy.</li> </ul>	<p>Records showing:</p> <ul style="list-style-type: none"> <li>Date test was performed.</li> <li>Listing of significant artefacts</li> <li>Person performing test</li> </ul>
Mechanical inspection	<ul style="list-style-type: none"> <li>No hazardous, inoperative, out of alignment or improperly operating items on the system.</li> <li>All items listed on the visual check list have received a pass.</li> </ul>	Monthly	<ul style="list-style-type: none"> <li>Visual inspection of the system to ensure safe and optimum operation.</li> </ul>	<p>Records showing:</p> <ul style="list-style-type: none"> <li>Date inspection performed</li> <li>Inspection results</li> <li>Person performing test</li> </ul>
Repeat analysis	Overall repeat rate <3%	Quarterly	Analysis of the proportion of repeats attributable to positioning, a range of equipment faults and other reasons for the quarter or from at least 250 consecutive client examinations	Records of date analysis was performed, analysis results and any corrective actions
Image receptor homogeneity	<ul style="list-style-type: none"> <li>Maximum deviation in MPV in ROI &lt; <math>\pm 15\%</math> of MPV in central ROI.</li> <li>Maximum variation of the MPV in central ROI between successive images &lt; <math>\pm 10\%</math>.</li> </ul>	Quarterly or more frequently if recommended by the manufacturer	<p>Use manufacturer's protocol if available or otherwise:</p> <ul style="list-style-type: none"> <li>Image a standard test block at clinical settings.</li> <li>Run the flat field programme (if applicable) on the unprocessed (raw) image using 100 mm<sup>2</sup> square or circular ROI</li> </ul> <p>Note 1: If the MPV of a ROI deviates by more than 15% from the MPV in the central ROI, the detector gain map may require re-calibration</p> <p>Note 2: If required, to exclude failure due to non uniformities in the standard test block, rotate latter by 180° and repeat measurement.</p>	<p>Records showing:</p> <ul style="list-style-type: none"> <li>Date test was performed.</li> <li>X-ray system identification.</li> <li>kVp, target/filter, density setting and mAs.</li> <li>Test results</li> <li>Person performing test.</li> </ul>

Procedure	Control-Limits/Requirements	Minimum Frequency	Required Procedure Elements	Minimum Record Requirements
AEC calibration test	The AEC shall be able to maintain mean pixel value (MPV) to within $\pm 10\%$ of the baseline MPV for each thickness.	Quarterly	<ul style="list-style-type: none"> <li>Use of a consistent AEC detector position (if applicable)</li> <li>Light contact between the compression paddle and the phantom surface</li> <li>Imaging of 2, 4 and 6 cm phantom thicknesses</li> <li>Selection of clinically relevant kVp, target/filter combination and mode</li> <li>Measurement of MPV in a ROI of area 4 cm<sup>2</sup> at 6 cm in from the chest wall edge on the mid-line of the image</li> </ul>	Records showing: <ul style="list-style-type: none"> <li>Date test was performed</li> <li>X-ray system identification and source to image distance (SID)</li> <li>kVp, target/filter, mode, mAs and MPV for each phantom thickness</li> <li>Note departure from tolerance in MPV for each thickness of PMMA</li> </ul>
Compression	Maximum motorised compression force in range 150 - 200 newtons	Six monthly	<ul style="list-style-type: none"> <li>Protection of the compression paddle to prevent damage</li> <li>Measurement of the maximum motorised compression force using a suitable measuring device (eg. Analogue bathroom scales)</li> </ul>	Records of test date, maximum motorised compression force and any corrective actions
Test equipment quality control	Optical density measurement accurate to within: <ul style="list-style-type: none"> <li><math>\pm 0.03</math> for the OD range 0 to 3.0; and</li> <li><math>\pm 3\%</math> for the optical density range 3.0 to 4.0</li> </ul>	Six monthly	Verification of accuracy using an OD calibration strip traceable to an accepted standard	Records of test date and result (pass or fail)
• Densitometer calibration check				
Maintenance & fault logging	Records for each imaging system, including diagnostic monitors and film printer if relevant	As required	Recording of equipment faults, incidents and occasions of maintenance (preventative and corrective) as they occur	Dated records that identify the person reporting the event
Infection control of breast imaging equipment	Clean equipment	As required	<ul style="list-style-type: none"> <li>All cleaning as per manufacturer's recommendations and/or suitable infection control advice.</li> <li>Cleaning of breast support and compression paddle between each examination.</li> </ul>	Documented procedures

**Table K.C: Quality control procedures and standards for CR mammography**

<b>Procedure</b>	<b>Control-Limits/Requirements</b>	<b>Minimum Frequency</b>	<b>Required Procedure Elements</b>	<b>Minimum Record Requirements</b>
Monitor cleanliness	Monitor screens must be free of dust, fingerprints and other marks that might interfere with image interpretation	Weekly	Clean all monitor screens gently with lint-free cloth as per manufacturer's instructions	Records that confirm the procedure has been performed for a given date
Viewing conditions	<ul style="list-style-type: none"> <li>• Appropriate viewing conditions</li> <li>• All viewbox lamps must be operational and appropriate masking available<sup>z</sup></li> </ul>	Weekly	<ul style="list-style-type: none"> <li>• Visual inspection of ambient lighting conditions to ensure conformance with acceptable viewing condition configuration.</li> <li>• Visual inspection of viewboxes for uniformity of brightness.</li> <li>• Confirmation of presence and operation of masking for viewboxes.</li> </ul>	Records that confirm the procedure has been performed for a given date

<sup>z</sup> If applicable

Procedure	Control-Limits/Requirements	Minimum Frequency	Required Procedure Elements	Minimum Record Requirements
Printer area cleanliness (if applicable)	Clean and dust free environment	Weekly	<ul style="list-style-type: none"> <li>Wet cleaning of printer area floor and open shelves.</li> <li>Inspect and clean air intake filters on the film printer.</li> </ul>	Records that confirm the procedure has been performed for a given date
Phantom images	<ul style="list-style-type: none"> <li>mAs = baseline <math>\pm</math> 10%</li> <li>Absorbed dose to image plate = baseline <math>\pm</math> 10%<sup>AA</sup></li> <li>Mean pixel value (MPV) = baseline <math>\pm</math> 10%</li> <li>OD = baseline <math>\pm</math> 20% (hardcopy only)</li> </ul> <p>Clearly visualize in ACR phantom:</p> <ul style="list-style-type: none"> <li>5 fibres</li> <li>3.5 speck groups</li> <li>4 masses</li> </ul>	Weekly	<p><b>Obtaining the phantom image:</b></p> <ul style="list-style-type: none"> <li>Use of an ACR accreditation mammography image quality phantom</li> <li>Use a designated QC test cassette and imaging plate that is in routine clinical use.</li> <li>Use of a consistent automatic exposure control (AEC) detector position where manually selected</li> <li>Light contact between the compression paddle and the phantom surface</li> <li>Consistent positioning of the phantom</li> <li>Consistent selection of a clinically relevant kVp and target/filter combination</li> <li>Selection of the density setting in current clinical use</li> <li>Consistent time delay between plate irradiation and readout</li> </ul> <p>Evaluating the phantom image:</p> <ul style="list-style-type: none"> <li>Use of consistent viewing conditions that reflect those used to read clinical images. This applies to both soft and hardcopy</li> <li>Image quality scoring by the same person, if possible</li> <li>Measure MPV in reproducible ROI or measure OD in reproducible part of phantom image (hardcopy only)</li> <li>Use of a control chart to display results</li> </ul>	<p>Control chart showing:</p> <ul style="list-style-type: none"> <li>Plots against date of mAs, MPV, and image quality scores</li> <li>A record of at least the last 25 results</li> <li>Clearly marked control limits</li> <li>Baseline values</li> <li>Radiographic settings (kVp, target/filter combination, AEC detector position, density setting and source to image distance (SID)).</li> <li>Dated remarks regarding corrective actions and baseline changes</li> </ul> <p>Dated phantom images from at least the last six months showing x-ray system and radiographic settings</p>

<sup>AA</sup> See ACPSEM Position Paper<sup>4</sup> for interpretation of absorbed dose to image plate in terms of exposure indicator.

Procedure	Control-Limits/Requirements	Minimum Frequency	Required Procedure Elements	Minimum Record Requirements
Printer QC (if applicable)	<p>Borders in TG18-QC pattern must be visible, lines must be straight, all corner patches must be visible, squares of different shades from black to white must be distinct, all high contrast resolution patterns and the two pixel low contrast patterns must be visible in all four corners, the 5% and 95% pixel value squares must be clearly visible, and no disturbing artefacts should be visible.</p> <ul style="list-style-type: none"> <li>The speed index (SI) = baseline <math>\pm</math> 0.15</li> <li>contrast index (CI) = baseline <math>\pm</math> 0.15</li> <li>Base + fog (B+F) = baseline <math>\pm</math> 0.03</li> <li><math>D_{max}</math> = baseline <math>\pm</math> 0.10</li> </ul>	Weekly	<ul style="list-style-type: none"> <li>Print the TG18-QC test pattern.</li> <li>Check visibility and distortion of several items used for evaluating the quality of the image.</li> <li>Check for disturbing artefacts.</li> <li>Monitoring of SI, CI, base + fog and <math>D_{max}</math> where: <ul style="list-style-type: none"> <li>SI is defined as the optical density of the step with an optical density closest to, but above, 1.2.</li> <li>CI is defined as the difference in optical density between the step with an optical density closest to, but above, 2.2 and the step with an optical density closest to but not but not less than 0.45.</li> </ul> </li> </ul>	<p>Control chart showing:</p> <ul style="list-style-type: none"> <li>Plots against date of SI, CI, base plus fog and <math>D_{max}</math></li> <li>A record of at least the last 25 results</li> <li>Clearly marked control limits</li> <li>Baseline values</li> <li>Step numbers used for calculation of CI and SI</li> <li>Dated remarks regarding corrective actions and baseline changes</li> </ul>
Monitor QC (monitors used for interpretation and attached to the acquisition workstation)	<p>Borders in TG18-QC pattern must be visible, lines must be straight, all corner patches must be visible, squares of different shades from black to white must be distinct, all high contrast resolution patterns and the two pixel low contrast patterns must be visible in all four corners, the 5% and 95% pixel value squares must be clearly visible, and no disturbing artefacts should be visible.</p> <p>The number of letters visible in the phrase "Quality Control" for the dark, mid-grey and light renditions should = baseline values</p>	Weekly	<ul style="list-style-type: none"> <li>Display the TG18-QC test pattern.</li> <li>Ensure viewing conditions are acceptable</li> <li>Use window width set to maximum and window level set to half of maximum</li> <li>Check visibility and distortion of several items used for evaluating the quality of the image.</li> <li>Check for disturbing artefacts.</li> </ul>	<p>Control chart showing:</p> <ul style="list-style-type: none"> <li>Monitor identification</li> <li>Monitor settings (window and level)</li> <li>A record of at least the last 25 results</li> <li>Baseline values</li> <li>Dated remarks regarding corrective actions and baseline changes</li> </ul>
Mechanical inspection	<ul style="list-style-type: none"> <li>No hazardous, inoperative, out of alignment or improperly operating items on the system.</li> <li>All items listed on the visual check list have received a pass.</li> </ul>	Monthly	<ul style="list-style-type: none"> <li>Visual inspection of the system to ensure safe and optimum operation.</li> </ul>	<p>Records showing:</p> <ul style="list-style-type: none"> <li>Date inspection performed</li> <li>Inspection results</li> <li>Person performing test</li> </ul>

Procedure	Control-Limits/Requirements	Minimum Frequency	Required Procedure Elements	Minimum Record Requirements
Repeat analysis	Overall repeat rate <3%	Quarterly	Analysis of the proportion of repeats attributable to positioning, a range of equipment faults and other reasons for the quarter or from at least 250 consecutive client examinations	Records of date analysis was performed, analysis results and any corrective actions
Image receptor homogeneity	<ul style="list-style-type: none"> <li>Maximum deviation in MPV in any two ROIs &lt; <math>\pm 10\%</math></li> <li>Maximum variation of the MPV in central ROI between successive images &lt; <math>\pm 10\%</math>.</li> </ul>	Quarterly or more frequently if recommended by the manufacturer	<ul style="list-style-type: none"> <li>Image a standard test block at clinical settings.</li> <li>Perform measurements on the unprocessed (raw) image using 100 mm<sup>2</sup> square or circular ROI if possible</li> </ul> <p>Note 1: If the MPV of any two ROIs deviates by more than 10% from each other the CR unit's shading correction may require re-calibration</p>	Records showing: <ul style="list-style-type: none"> <li>Date test was performed.</li> <li>X-ray system identification.</li> <li>kVp, target/filter, density setting and mAs.</li> <li>Test results</li> <li>Person performing test.</li> </ul>
AEC calibration test	The AEC shall be able to maintain: <ul style="list-style-type: none"> <li>the absorbed dose to the plate for each of the three thicknesses of PMMA to within <math>\pm 10\%</math> of the baseline value <sup>BB</sup></li> <li>The variation as a function of thickness to less than <math>\pm 20\%</math></li> </ul>	Quarterly	<ul style="list-style-type: none"> <li>Use of a consistent AEC detector position</li> <li>Light contact between the compression paddle and the phantom surface</li> <li>Use designated QC imaging plate</li> <li>Imaging of 2, 4 and 6 cm phantom thicknesses</li> <li>Selection of clinically relevant kVp, target/filter combination and density control</li> <li>Consistent time delay between plate irradiation and readout</li> </ul>	Records showing: <ul style="list-style-type: none"> <li>Date test was performed</li> <li>X-ray system identification and source to image distance (SID)</li> <li>kVp, target/filter, density control, mAs and exposure indicator for each phantom thickness</li> <li>Note departure from tolerance in MPV for each thickness of PMMA</li> </ul>
Compression	Maximum motorised compression force in range 150 - 200 newtons	Six monthly	<ul style="list-style-type: none"> <li>Protection of the compression paddle to prevent damage</li> <li>Measurement of the maximum motorised compression force using a suitable measuring device (eg. Analogue bathroom scales)</li> </ul>	Records of test date, maximum motorised compression force and any corrective actions
Test equipment quality control	Optical density measurement accurate to within: <ul style="list-style-type: none"> <li><math>\pm 0.03</math> for the OD range 0 to 3.0; and</li> <li><math>\pm 3\%</math> for the optical density range 3.0 to 4.0</li> </ul>	Six monthly	Verification of accuracy using an OD calibration strip traceable to an accepted standard	Records of test date and result (pass or fail)

<sup>BB</sup> See ACPSEM Position Paper<sup>4</sup> for interpretation of absorbed dose to image plate in terms of exposure indicator

Procedure	Control-Limits/Requirements	Minimum Frequency	Required Procedure Elements	Minimum Record Requirements
Cassette/Image plate condition and inter plate sensitivity variation	<ul style="list-style-type: none"> <li>Clean and dust free cassettes &amp; image plates</li> <li>No major inhomogeneities or artefacts on the images</li> <li>Coefficient of variation (COV) of absorbed dose to QC plate &lt;0.05</li> <li>Absorbed dose to individual plate should differ from mean for that size by less than <math>\pm 5\%</math></li> <li>Difference in mean absorbed dose to plates of different sizes &lt;20%<sup>CC</sup></li> </ul>	As required	<ul style="list-style-type: none"> <li>Cassette/image plate cleaning as per manufacturer's recommendations</li> <li>Image a standard test block at clinical settings.</li> <li>Pre-processing should be turned off as much as possible and no post processing should be applied.</li> <li>Evaluate for artefact on both monitor and hard copy (if applicable)</li> </ul>	Records showing: <ul style="list-style-type: none"> <li>Date test was performed.</li> <li>Person performing test.</li> <li>kVp, target/filter, AEC mode.</li> <li>Exposure indicator and mAs for each plate.</li> </ul>
Image plate erasure	Erasure of energy absorbed from scattered radiation or naturally occurring radiation by CR image plates before they are used.	Daily/Weekly	<ul style="list-style-type: none"> <li>On a daily basis or if left unused for more than 8 hours, all CR image plates should be subjected to a secondary erasure (following manufacturer's instructions).</li> <li>On a weekly basis all CR image plates should be subjected to a primary erasure (following manufacturer's instructions).</li> </ul>	Dated records that identify the person reporting the event
Maintenance and fault logging	Records for each imaging system, including diagnostic monitors and film printer if relevant	As required	Recording of equipment faults, incidents and occasions of maintenance (preventative and corrective) as they occur	Dated records that identify the person reporting the event
Infection control of breast imaging equipment	Clean equipment	As required	<ul style="list-style-type: none"> <li>All cleaning as per manufacturer's recommendations and/or suitable infection control advice.</li> <li>Cleaning of breast support and compression paddle between each examination.</li> </ul>	Documented procedures

<sup>CC</sup> See ACPSEM Position Paper<sup>4</sup> for interpretation of absorbed dose to image plate in terms of exposure indicator

**Table K.D: Quality control procedures and standards for digital stereotactic units**

Three different configurations of digital stereotactic units may be encountered in the field; (i) 'integrated', where the same detector is used for mammography and biopsy use, (ii) 'separate image receptor' where an x-ray system common to mammography but with a different image receptor assembly is used, and (iii) 'stand alone' where full testing must be completed. As such, it must be anticipated that in some cases little or no additional QC testing may be required for biopsy units (e.g. category (i)), whilst in other instances variations to the basic tests outlined below may be expected.

Procedure	Control-Limits/Requirements	Minimum Frequency	Required Procedure Elements	Minimum Record Requirements
Monitor cleanliness	Monitor screens must be free of dust, fingerprints and other marks that might interfere with image interpretation	Weekly	Clean all monitor screens gently with lint-free cloth as per manufacturer's instructions	Records that confirm the procedure has been performed for a given date
Viewing conditions	Appropriate viewing conditions	Weekly	Visual inspection of ambient lighting conditions to ensure conformance with acceptable viewing condition configuration.	Records that confirm the procedure has been performed for a given date
Printer QC (if applicable)	<p>Borders in TG18-QC pattern must be visible, lines must be straight, all corner patches must be visible, squares of different shades from black to white must be distinct, all high contrast resolution patterns and the two pixel low contrast patterns must be visible in all four corners, the 5% and 95% pixel value squares must be clearly visible, and no disturbing artefacts should be visible.</p> <ul style="list-style-type: none"> <li>The speed index (SI) = baseline <math>\pm</math> 0.15</li> <li>contrast index (CI) = baseline <math>\pm</math> 0.15</li> <li>Base + fog (B+F) = baseline <math>\pm</math> 0.03</li> <li>D<sub>max</sub> = baseline <math>\pm</math> 0.10</li> </ul>	Weekly	<ul style="list-style-type: none"> <li>Print the TG18-QC test pattern.</li> <li>Check visibility and distortion of several items used for evaluating the quality of the image.</li> <li>Check for disturbing artefacts.</li> <li>Monitoring of SI, CI, base + fog and D<sub>max</sub> where: <ul style="list-style-type: none"> <li>SI is defined as the optical density of the step with an optical density closest to, but above, 1.2.</li> <li>CI is defined as the difference in optical density between the step with an optical density closest to, but above, 2.2 and the step with an optical density closest to but not but not less than 0.45.</li> </ul> </li> </ul>	<p>Control chart showing:</p> <ul style="list-style-type: none"> <li>Plots against date of SI, CI, base plus fog and D<sub>max</sub></li> <li>A record of at least the last 25 results</li> <li>Clearly marked control limits</li> <li>Baseline values</li> <li>Step numbers used for calculation of CI and SI</li> <li>Dated remarks regarding corrective actions and baseline changes</li> </ul>

Procedure	Control-Limits/Requirements	Minimum Frequency	Required Procedure Elements	Minimum Record Requirements
Printer area Cleanliness (if applicable)	Clean and dust free environment	Weekly	Wet cleaning of printer area floor and open shelves. Inspect and clean air intake filters on the film printer.	Checklist/logbook entry showing: <ul style="list-style-type: none"> <li>• Date performed</li> <li>• Person performing task</li> </ul>
Monitor QC (monitors used for interpretation and attached to the acquisition workstation)	Borders in TG18-QC pattern must be visible, lines must be straight, all corner patches must be visible, squares of different shades from black to white must be distinct, all high contrast resolution patterns and the two pixel low contrast patterns must be visible in all four corners, the 5% and 95% pixel value squares must be clearly visible, and no disturbing artefacts should be visible. The number of letters visible in the phrase "Quality Control" for the dark, mid-grey and light renditions should = baseline values	Weekly	<ul style="list-style-type: none"> <li>• Display the TG18-QC test pattern.</li> <li>• Ensure viewing conditions are acceptable</li> <li>• Use window width set to maximum and window level set to half of maximum</li> <li>• Check visibility and distortion of several items used for evaluating the quality of the image.</li> <li>• Check for disturbing artefacts.</li> </ul>	Control chart showing: <ul style="list-style-type: none"> <li>• Monitor identification</li> <li>• Monitor settings (window and level)</li> <li>• A record of at least the last 25 results</li> <li>• Baseline values</li> <li>• Dated remarks regarding corrective actions and baseline changes</li> </ul>
Phantom images	Clearly visualize in ACR mini-phantom: <ul style="list-style-type: none"> <li>• 3 fibres</li> <li>• 2 speck groups</li> <li>• 1.5 masses</li> </ul>	Weekly	<p>Obtaining the phantom image:</p> <ul style="list-style-type: none"> <li>• Use of an ACR mini accreditation mammography phantom</li> <li>• Light contact between the compression paddle and the phantom surface</li> <li>• Consistent positioning of the phantom</li> <li>• Consistent selection of a clinically relevant kVp and target/filter combination</li> <li>• Selection of the density setting in current clinical use (if applicable)</li> </ul> <p>Evaluating the phantom image:</p> <ul style="list-style-type: none"> <li>• Use of consistent viewing conditions that reflect those used to read clinical images</li> <li>• Image quality scoring by the same person, if possible</li> <li>• Use of a control chart to display results</li> </ul>	<p>Control chart showing:</p> <ul style="list-style-type: none"> <li>• Plots against date of mAs and image quality scores</li> <li>• A record of at least the last 25 results</li> <li>• Clearly marked control limits</li> <li>• Baseline values</li> <li>• Radiographic settings (kVp, target/filter combination, density setting).</li> <li>• Dated remarks regarding corrective actions and baseline changes</li> </ul> <p>Dated phantom images from at least the last six months showing x-ray system and radiographic settings</p>

Procedure	Control-Limits/Requirements	Minimum Frequency	Required Procedure Elements	Minimum Record Requirements
Full field artefact evaluation	<p>There must be no evidence of:</p> <ul style="list-style-type: none"> <li>Structures that are more conspicuous than the objects in the phantom used for weekly testing.</li> <li>Blotches or regions of altered noise appearance.</li> <li>Observable grid lines or table top structures.</li> <li>Bright or dark pixels.</li> <li>Significant stitching or registration artefacts</li> </ul>	Monthly	<ul style="list-style-type: none"> <li>Expose a uniform thickness of PMMA so that MPV is within 10% of weekly phantom value.</li> <li>View image on a monitor used for interpretation of digital mammography images</li> <li>Print image if interpretation performed using hard copy.</li> </ul>	<p>Records showing:</p> <ul style="list-style-type: none"> <li>Date test was performed.</li> <li>Listing of significant artefacts</li> <li>Person performing test</li> </ul>
Mechanical inspection	<ul style="list-style-type: none"> <li>No hazardous, inoperative, out of alignment or improperly operating items on the system.</li> <li>All items listed on the visual check list have received a pass.</li> <li>The image receptor &amp; compression plate biopsy window is free of wobble</li> <li>The vernier table drive &amp; needle guide is rigid and is free of wobble</li> <li>The localisation system zeroes coordinates properly</li> <li>The biopsy device is properly immobilised to prevent recoil.</li> </ul>	Monthly	<ul style="list-style-type: none"> <li>Visual inspection of the system to ensure safe and optimum operation.</li> </ul>	<p>Records showing:</p> <ul style="list-style-type: none"> <li>Date inspection performed</li> <li>Inspection results</li> <li>Person performing test</li> </ul>
Repeat analysis	Overall repeat rate <20%	Six monthly	Analysis of the proportion of repeats attributable to positioning, a range of equipment faults and other reasons for 6 months or from at least 150 consecutive client examinations	Records of date analysis was performed, analysis results and any corrective actions

Procedure	Control-Limits/Requirements	Minimum Frequency	Required Procedure Elements	Minimum Record Requirements
Image receptor homogeneity	<ul style="list-style-type: none"> <li>Maximum deviation in MPV in ROI &lt; <math>\pm 15\%</math> of MPV in central ROI.</li> <li>Maximum variation of the MPV in central ROI between successive images &lt; <math>\pm 10\%</math>.</li> </ul>	Quarterly or more frequently if recommended by the manufacturer	<p>Use manufacturer's protocol if available or otherwise:</p> <ul style="list-style-type: none"> <li>Image a standard test block at clinical settings.</li> <li>Note the MPV in centre ROI and each of the four corner ROIs</li> </ul> <p>Note: If the MPV of a ROI deviates by more than 15% from the MPV in the central ROI, the detector gain map may require re-calibration</p>	<p>Records showing:</p> <ul style="list-style-type: none"> <li>Date test was performed.</li> <li>X-ray system identification.</li> <li>kVp, target/filter, density setting and mAs.</li> <li>Test results</li> <li>Person performing test.</li> </ul>
AEC calibration test	The AEC shall be able to maintain mean pixel value (MPV) to within $\pm 10\%$ of the baseline MPV for each thickness.	Quarterly	<ul style="list-style-type: none"> <li>Light contact between the compression paddle and the phantom surface</li> <li>Imaging of 2, 4 and 6 cm phantom thicknesses</li> <li>Selection of clinically relevant kVp, target/filter combination and mode</li> <li>Measurement of MPV in a ROI of area 4 cm<sup>2</sup> centred in image</li> </ul> <p>Note: Some image receptor systems, do not allow positioning of ROIs on the image. In that case, it is suggested that the MPV from the entire image area meet the specification.</p>	<p>Records showing:</p> <ul style="list-style-type: none"> <li>Date test was performed</li> <li>kVp, target/filter, mode, mAs and MPV for each phantom thickness</li> <li>Note departure from tolerance in MPV for each thickness of PMMA</li> </ul>
Compression	Maximum motorised compression force in range 150 - 200 newtons	Six monthly	<ul style="list-style-type: none"> <li>Protection of the compression paddle to prevent damage</li> <li>Measurement of the maximum motorised compression force using a suitable measuring device (e.g. Analogue bathroom scales)</li> </ul>	Records of test date, maximum motorised compression force and any corrective actions
Test equipment quality control	Optical density measurement accurate to within:	Six monthly	Verification of accuracy using an OD calibration strip traceable to an accepted standard	Records of test date and result (pass or fail)
<ul style="list-style-type: none"> <li>Densitometer calibration check</li> </ul>	<ul style="list-style-type: none"> <li><math>\pm 0.03</math> for the OD range 0 to 3.0; and</li> <li><math>\pm 3\%</math> for the optical density range 3.0 to 4.0</li> </ul>			
Stereotactic accuracy confirmation	Localisation within $\pm 1$ mm	Prior to first use on day of procedures	Procedure as per manufacturer's recommendations	<p>Checklist/logbook entry showing:</p> <ul style="list-style-type: none"> <li>Date test performed</li> <li>Test results</li> <li>Person performing test</li> </ul>

<b>Procedure</b>	<b>Control-Limits/Requirements</b>	<b>Minimum Frequency</b>	<b>Required Procedure Elements</b>	<b>Minimum Record Requirements</b>
Maintenance & fault logging	Records for each imaging system, including diagnostic monitors and film printer if relevant	As required	Recording of equipment faults, incidents and occasions of maintenance (preventative and corrective) as they occur	Dated records that identify the person reporting the event
Infection control of breast imaging equipment	Clean equipment	As required	<ul style="list-style-type: none"> <li>All cleaning as per manufacturer's recommendations and/or suitable infection control advice.</li> <li>Cleaning of breast support and compression paddle between each examination.</li> </ul>	Documented procedures

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