www.eos-imaging.com

EOS™

X-Ray Imaging Acquisition System
QC Manual

10, rue Mercoeur
F-75011 Paris
t: +33 (0)1 55 25 60 60
f: +33 (0)1 55 25 60 61
info@eos-imaging.com
www.eos-imaging.com

EOS-DAS-Manual_QC-M-EN
19-sep-2019

X-Ray Warning

CAUTION

X-ray devices are dangerous for patients and technicians if the safety precautions are not strictly followed.

This equipment is manufactured according the highest safety standards. However, X-rays are dangerous when unqualified and untrained technicians make use of the equipment. Over exposure to X-rays causes physical harm.
As a result, every precaution must be taken to prevent unauthorized or unqualified persons from using this device to prevent them from endangering themselves and others.
Before each use, individuals who are qualified and authorized to use this equipment must familiarize themselves with the safety measures established by the International Commission on Radiological Protection in ICRP Publication 60: Recommendations of the International Commission on Radiological Protection and applicable national standards. Operators must also have received training on the use of this equipment.

Table of Contents

1 Foreword

1.1 Relevance of the Manual

This document, “QC Manual” is part of the Quality Assurance Program governing the radiography site. It contains quality control (QC) tests for EOS, a scanning X-ray acquisition system.

1.2 Objective of this manual

The objective of this manual is to provide the quality control (QC) tests to be used with EOS. QC tests used for display systems that are designed to show clinical images are not provided in this manual.

2 List of tests

Two types of QC tests are listed:

- Chapter *4 Tests- EOS-specific QCs* page *9*
- Chapter *5 QC tests not specific* to EOS page *16*

2.1 QC tests specific to EOS

- Optical position system (Section *4.1*, page *9*)
- Acquisition area (Section *4.2* page *13*)
- Levelness of X-ray beams (Section *4.3*, page *15*)

2.2 Non EOS-specific QC tests

- Accuracy and repeatability of kVp (Section *5.1.1*, page *16*)
- Half-value layer (Section *5.2*, page *18*)
- Reproducibility, repeatability and linearity of radiation output (Section *5.3*, page *20*)
- Relationship between kerma × surface, displayed and measured (Section *5.4*, page *26*)
- Spatial resolution and image quality (Section *5.5*, page *28*)

2.3 Frequency of tests

The periodicity of the tests is annual.

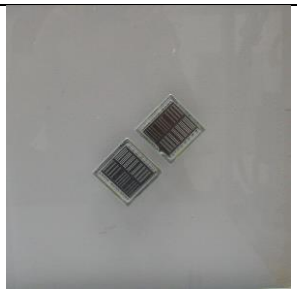
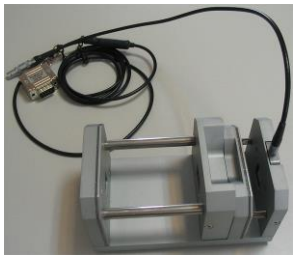
Operating mode

EOS offers two operating modes:

- Shutter Mode (a single additional filter available: 1.0 mm Al)
- Filtration Mode (two additional filters available: 1.0 mm Al or 0.1 mm Cu)

3 Equipment necessary to the quality control

Description	Parts list	Quantity	Photograph
Support for EOS phantom	103.01.001.00	1	
plate of PMMA 30 cm x 30 cm x 5 cm	103.01.006.00	4	

Resolution phantom	103.01.007.00	1	
Optical positioning phantom	103.01.010.00	1	
99.0% grade aluminium filter 5 cm x 5 cm x 2 mm	103.01.003.00	2	
1 mm thick	103.01.004.00	2	
0.5 mm thick	103.01.005.00	2	
Levelness phantom	103.01.008.00	1	
EOS acquisition area phantom	103.01.009.00	1	
EOS HVL support	103.01.002.00	1	

3.1.1 Equipment not supplied by EOS imaging

– Adhesive tape that does not leave any residue when removed

- 40 kV – 140 kV kVpmeter, which enables measurement using a thin plane beam of about 1 mm in thickness, and which scans the sensor at a speed of between 38 mm/s and 305 mm/s.
- Dosimeter, which enables measurement using a thin plane beam of about 1 mm in thickness, and which scans the sensor at a speed of between 38 mm/s and 305 mm/s. To make the measurement easier, check that the sensor is compatible with the EOS HVL support.
- Scientific calculator.

4 EOS-specific QCs

4.1 Optical positioning system

Equipment required

- Support for EOS phantom (Section 3, page 6)
- Optical positioning phantom (Section 3, page 6)
- Two 99.0% grade aluminium filters, 5 cm x 5 cm x 2mm (Section 3, page 6)
- Adhesive tape that does not leave any residue when removed (Section 3, page 6))

Operating mode

- QC procedure applicable in Shutter Mode or in Filtration Mode.

4.1.1 Centering control

1. Create a new patient:
    a. Patient ID: QC_EOS_REVQC_Centering (where REVQC is the current QC revision index, e.g. QC_EOS_E_Centering)
    b. Name: QC
    c. First name: Centering
    d. The other fields may be filled freely
2. Place the support for EOS phantom in the gantry (for this test, there is no need for the support to be applied against the carbon panels)
3. Activate the positioning lasers.
4. Place the optical positioning phantom on the phantom support, centering its tip at the intersection of the two beams projected by the positioning lasers.
5. Select both acquisition planes, for each one,
    a. Select 90 kV, 200 mA, level 4, standard Adult morphotype.
    b. Position the reference plane at 0 (very important for measurements made with the EOS visualization interface after exposure).
    c. Set a scanning range for imaging the entire optical positioning phantom. Maintain the collimation wide open.
6. Carry out a bi-planar acquisition.
7. Using the EOS visualization interface:
    a. Click on  . A vertical line should appear at the centre of both images.
    b. Using the measurement tool  , measure the distance between the tip of the positioning phantom and the central vertical line on each image. The measurement line should be perfectly horizontal.
8. Close the images after saving changes.

Acceptance criterion:

The distance between the tip of the positioning phantom and the central vertical line is less than or equal to 5 mm on both images.

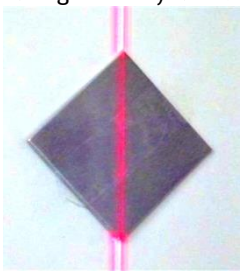
Processing of non-conformities:

In case of failure, stop using the positioning lasers and contact the EOS imaging technical support to return the device to conformity.

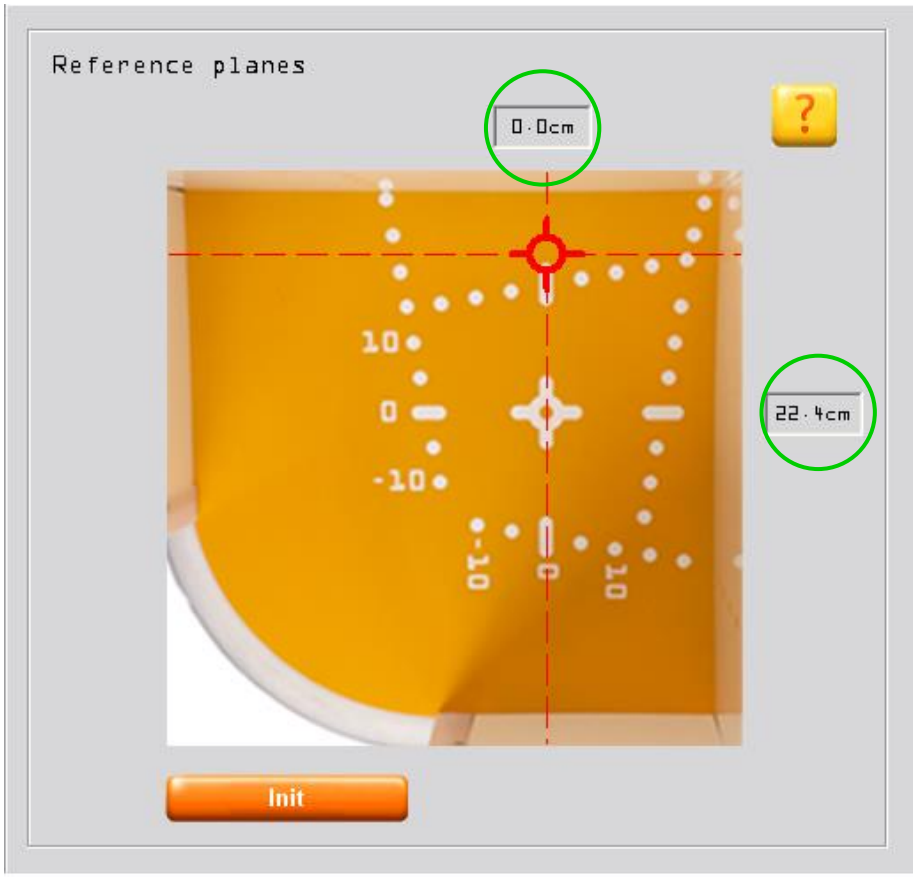
4.1.2 Verticality control

For each of the two acquisition planes,

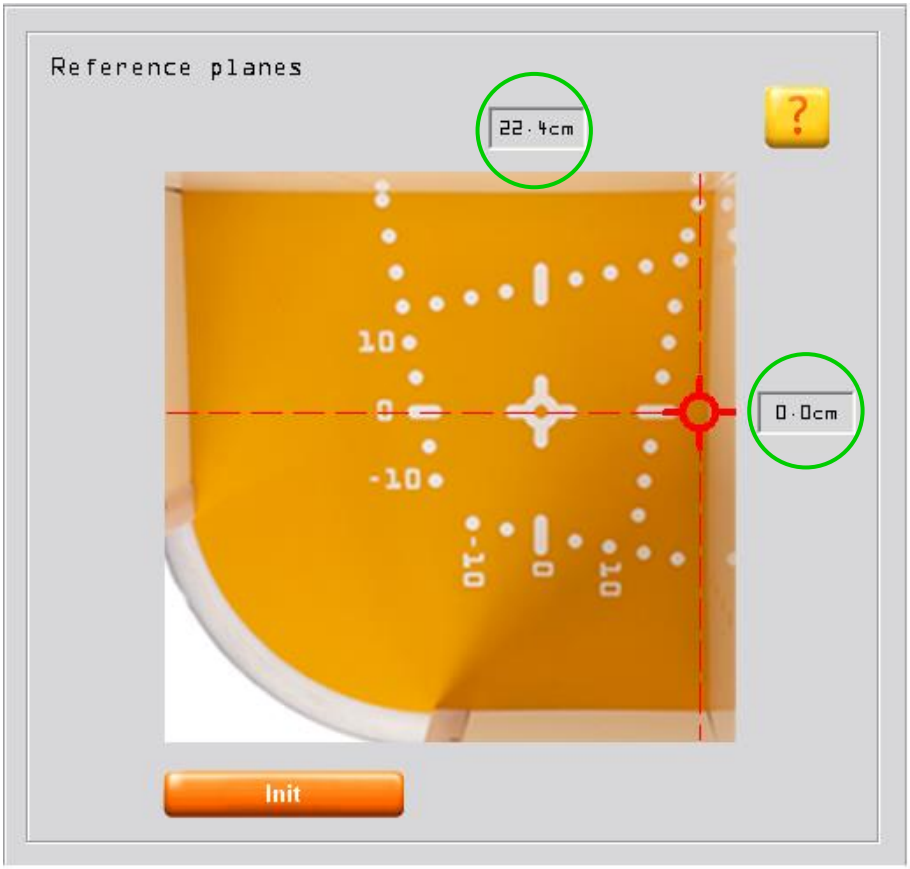
1. Modify patient information:
   a. Patient ID:
      i. If the tested plane is the frontal one:
      Patient ID: QC_EOS_REVQC_Vert_F1
      ii. If the tested plane is the lateral one:
      Patient ID: QC_EOS_REVQC_Vert_P1
   b. Name: QC
   c. First name: Verticality
   d. The other fields may be filled freely
2. The positioning lasers are still active.
3. Using the adhesive tape, fix both aluminium plates on the carbon detector panel of the tested plane by aligning their diagonal with the line drawn by the positioning laser (see photograph below) spacing them by about 1m on the vertical.



4. Select both acquisition planes, for each one,
   a. Select 90 kV, 200 mA, level 4, standard Adult morphotype.
   b. Reference plane positioning:
      i. If the tested plane is the frontal one, position the reference plane position sliders as shown in the figure below:

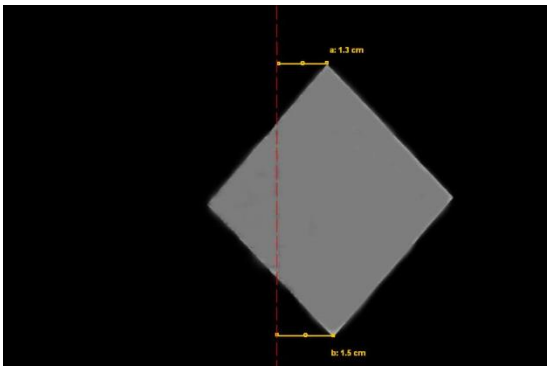


ii. If the tested plane is the lateral one, position the reference plane position sliders as shown in the figure below:



iii. The lateral collimations should remain wide open.

5. Define a scanning field of 10 cm in height in order to image the upper aluminium plate. There should be no other object in the imaged area.
6. Carry out a bi-planar acquisition.
7. Using the EOS visualization interface:
   a. Click on . A vertical line should appear at the centre of the image with the aluminium plate.
   b. Using the measurement tool , on image containing the aluminium plates, measure the distance between the plate corners that indicate the laser position and the central vertical line. The measurement lines should be perfectly horizontal, see figure below.



8. Close the images after saving changes.
9. Modify patient ID:

   a. If the tested plane is the frontal one:
      Patient ID: QC_EOS_REVQC_Vert_F2
   b. If the tested plane is the lateral one:
      Patient ID: QC_EOS_REVQC_Vert_P2
10. Define a scanning field of 10 cm in height in order to image the lower aluminium plate. There should be no other object in the imaged area.
11. Carry out a bi-planar acquisition.
12. Using the EOS visualization interface:
   a. Click on  . A vertical line should appear at the centre of the image with the aluminium plate.
   b. Using the measurement tool  , on image containing the aluminium plates, measure the distance between the plate corners that indicate the laser position and the central vertical line. The measurement lines should be perfectly horizontal.
13. Close the images after saving changes.

Acceptance criterion:

Every measured distance is less than or equal to 5 mm.

Processing of non-conformities:

In case of failure, stop using the positioning lasers and contact the EOS imaging technical support to return the device to conformity.

4.2 Acquisition areas

4.2.1 With interface sliders

Equipment required

- Acquisition area phantom (Section 3, page 6)
- Adhesive tape that does not leave any residue when removed (Section 3, page 6)

Operating mode

- QC procedure applicable in Shutter Mode or in Filtration Mode.

1. Create a new patient:
   a. Patient ID: QC_EOS_REVQC_AcqArea
   b. Name: QC
   c. First name: Acq Area
   d. The other fields may be filled freely
2. Using adhesive tape, position the frontal section (1) of the EOS acquisition area phantom on the carbon detector panel. The left side of the phantom's frontal section must match the angle made by the two panels. The vertical positioning lines must be set to the "100" scale marks. Then position the lateral section (2) against the lateral panel, at the same level as the frontal section and such that it is overlaid on the latter.
3. Select both acquisition planes, for each one:
   a. Select 90 kV, 200 mA, level 4, standard Adult morphotype.
   b. Position the reference plane at +22.4 cm.
   c. Position the left and right collimations at +150 mm.
4. Set the scanning range from 60 cm to 100 cm. There should be no other object in the imaged area.
5. Carry out a bi-planar acquisition
6. Using the EOS visualization interface, check the position of the metallic markers on the frontal and lateral images.

Acceptance criterion:

The acquisition area of interest must be visible on the acquired images, with a tolerance of +/- 5 mm on each edge. The inner limit of each metallic marker must be visible while the outer limit must remain out of view, which for each image corresponds to:

- The right limit of the **left marker** is visible, but the left limit is not.
- The left limit of the **right marker** is visible, but the right limit is not.
- The lower limit of the **top marker** is visible, but the upper limit is not.
- The upper limit of the **bottom marker** is visible, but the lower limit is not.

Processing of non-conformities:

Check that the carbon panels are correctly placed and that the phantom is accurately positioned before carrying out the test anew.

If the problem persists, contact EOS imaging technical support to return the device to conformity.

4.2.2 With Laser positioning system

The test described in this party applies only if the laser positioning system is installed on-site.

Equipment required

- Laser positioning system
- Acquisition area phantom (Section 3, page 6)
- Adhesive tape that does not leave any residue when removed (Section 3, page 6)

Operating mode

- QC procedure applicable in Shutter Mode or in Filtration Mode.

1. Create a new patient:
   a. Patient ID: QC_EOS_REVQC_AcqArea
   b. Name: QC
   c. First name: Acq Area
   d. The other fields may be filled freely
2. Using adhesive tape, position the frontal section (1) of the EOS acquisition area phantom on the carbon detector panel. The left side of the phantom's frontal section must match the angle made by the two panels. The vertical positioning lines must be set to the "100" scale marks. Then position the lateral section (2) against the lateral panel, at the same level as the frontal section and such that it is overlaid on the latter.
3. Select both acquisition planes, for each one:
   d. Select 90 kV, 200 mA, level 4, standard Adult morphotype.
   e. Position the reference plane at +22.4.

f. Position the left and right collimations at +150 mm.

4. Set the scanning range with the laser positioning system: to do this, position the markers. There should be no other object in the imaged area.
5. Carry out a bi-planar acquisition
6. Using the EOS visualization interface, check the position of the metallic markers on the frontal and lateral images.

Acceptance criterion:

The acquisition area of interest must be visible on the acquired images, with a tolerance of +/- 5 mm on each edge. The inner limit of each metallic marker must be visible while the outer limit must remain out of view, which for each image corresponds to:

- The right limit of the **left marker** is visible, but the left limit is not.
- The left limit of the **right marker** is visible, but the right limit is not.
- The lower limit of the **top marker** is visible, but the upper limit is not.
- The upper limit of the **bottom marker** is visible, but the lower limit is not.

Processing of non-conformities:

Check that the carbon panels are correctly placed and that the phantom is accurately positioned before carrying out the test anew.
If the problem persists, contact EOS imaging technical support to return the device to conformity.

4.3 Levelness of X-ray beams

Equipment required, supplied with the QC set:

- Support for EOS phantom (Section 3, page 6)
- Levelness phantom (Section 3, page 6)

Operating mode

- QC procedure applicable in Shutter Mode or in Filtration Mode.

For each of the two acquisition planes,

1. Create a new patient:
   a. Patient ID:
      i. If the tested plane is the frontal one:
         Patient ID: QC_EOS_REVQC_XRLev_F
      ii. If the tested plane is the lateral one:
         Patient ID: QC_EOS_REVQC_XRLev_P
   b. Name: QC
   c. First name: Levelness
   d. The other fields may be filled freely
2. Place the EOS phantom support **on the gantry floor against the carbon detector panel**
3. Place the levelness phantom on the support against the carbon panel, centred on the X-ray beam.
4. Only select the tested plane and configure it as follows:
   a. Select 90 kV, 200 mA, level 4, standard Adult morphotype.
   b. Position the reference plane at +22.4.
   c. The lateral collimations should remain wide open.
5. Set a scanning range that covers the top of the support up to the top of the phantom.
6. Carry out a mono-planar acquisition.
7. On the image obtained, use the "four-point angle"  tool in visualization mode to determine the angle α between the upper phantom edge and the upper image edge.

Acceptance criterion:

The angle α between the upper edge of the phantom and the upper edge of the image must be less than 0.5°.

Processing of non-conformities:

Immediately discontinue using the device and report the anomaly to EOS imaging technical support.

5 QC tests not specific to EOS

5.1 Accuracy and repeatability of kVp

Required equipment not supplied with the EOS QC set:

- kVpmeter (Section 3, page 6)
- Calculator (Section 3, page 6)
- Adhesive tape that does not leave any residue when removed (Section 3, page 6)

Operating mode

- QC procedure applicable in Shutter Mode or in Filtration Mode. For both these modes, manually select the focus (LARGE) and filtration (ALUMINIUM) in Tool/Control/Gen + Tube

For each of the two acquisition planes,

5.1.1 kVp accuracy

5.1.1.1 Generic test - except for Australia

1. Create a new patient:
   a. Patient ID: QC_EOS_REVQC_kVp_AL_LF
   b. Name: QC
   c. First name: Measurements_Al_LF
   d. The other fields may be filled freely
2. Place the kVpmeter at the centre of the beam, fixed with adhesive tape directly on the concerned carbon detector panel, and more than 40 cm above the floor. The kVpmeter must be correctly applied against the carbon panel.
3. Select 200 mA and level for mono-planar.
4. Note the measured voltages at the selected kVp values of 50 kV, 70 kV, and 140 kV.

Acceptance criterion:

Each of the measured values must correspond to the kVp value selected for acquisition to within ±10%.

Processing of non-conformities:

A return to conformity should be ensured as soon as possible.

5.1.1.2 Test specific to Australia

1. Create a new patient:
   a. Patient ID: QC_EOS_REVQC_kVp_AL_LF
   b. Name: QC
   c. First name: Measurements_Al_LF
   d. The other fields may be filled freely
2. Place the kVpmeter at the centre of the beam, fixed with adhesive tape directly on the concerned carbon detector panel, and more than 40 cm above the floor. The kVpmeter must be correctly applied against the carbon panel.
3. Select 200mA and level 4 for mono-planar.
4. Note the measured voltages at the selected kVp values of 50 kV, 60 kV, 70 kV, 80 kV, 90 kv, 100 kV, 110 kV, 120 kv, 130 kV and 140 kV.

Acceptance criterion:

a. Each of the measured values must correspond to the kVp value selected for acquisition to within ± (5% +1 kVp)
b. Each of the measured values must correspond to the kVp value selected for acquisition to within ±10%.

Processing of non-conformities:

If criterion a. is not verified, but criterion b. is met, enter it in the report.
If criteria b. is not respected, return to conformity is required as soon as possible.

5.1.2 kVp repeatability

1. Create a new patient:
   a. Patient ID: QC_EOS_REVQC_kVp_AL_LF
   b. Name: QC
   c. First name: Measurements
   d. The other fields may be filled freely
2. Set up the same conditions as for the voltage accuracy test.
3. Take five exposures at 70 kV.
4. Note the voltage measured at each of these five exposures.
5. Calculate the average of the five measured kV voltages.

Acceptance criterion:

None of the five measured kVp voltages should deviate by more than 5% from the average value.

Processing of non-conformities:

A return to conformity should be ensured as soon as possible.

5.2 Half-value layer (HVL)

Equipment required, supplied with the QC set:

- Support for EOS phantom (Section 3, page 6)
- HVL support (Section 3, page 6)
- Two 99.0% grade aluminium filters 5 cm x 5 cm x 2 mm (Section 3, page 6)
- Two 99.0% grade aluminium filters 5 cm x 5 cm x 1 mm (Section 3, page 6)
- Two 99.0% grade aluminium filters 5 cm x 5 cm x 0.5 mm (Section 3, page 6)
- Dosimeter (Section 3, page 6)
- Scientific calculator (Section 3, page 6)

Operating mode

- QC procedure applicable in Shutter Mode or in Filtration Mode. For both these modes, manually select the focus (LARGE) and filtration (ALUMINIUM) in Tool/ Control/Gen + Tube.

5.2.1 Generic test - except for Australia

For each of the two acquisition planes,

1. Create a new patient:
   a. Patient ID: QC_EOS_REVQC_HVL
   b. Name: QC
   c. First name: Measurements
   d. The other fields may be filled freely
2. Place the EOS phantom support **against the X-ray tube carbon panel**, aligning its corresponding axis (Frontal/Lateral) with the centre of the X-ray beam.
3. Place the EOS HVL support in its concerned Frontal/Lateral position.
4. Place the dosimeter sensor in the position reserved for it on the EOS HVL support.
5. Take two exposures (monoplanar) without additional filtration at 70 kV, 200 mA, level 4, with a scanning area of 10 cm centred on the dosimeter sensor, using an adjusted collimation (10 cm in width at the detector level). At each exposure, note the measured kerma.
6. Calculate the average K_o of the two preceding measurements.
7. **During the initial control,** repeat the same exposure with aluminium filters placed in the EOS HVL support, increasing the total filter thickness by 0.5 mm at each exposure (first 0.5 mm, then 1 mm, etc.) until the measured kerma is less than $K_o/2$. Determine the two filter combinations (X_{n-1} and X_{n+1}) that will enable taking the two kerma values (K_{n-1} and K_{n+1}) approximating $K_o/2$ as closely as possible.
8. **For routine testing**, only expose on the two thickness of aluminium (X_{n-1} and X_{n+1}) that cover the range of HVL determined during the initial test. If the chosen thickness range no longer includes the HVL, restart the initial testing procedure as described in 7.
9. From it, calculate the HVL value at 70kV by semi-logarithmic interpolation between the combinations of plate thickness determined as follows:

$$CDA = \frac{X_{n+1} * \ln(2 * \frac{K_{n-1}}{K_0}) - X_{n-1} * \ln(2 * \frac{K_{n+1}}{K_0})}{\ln(\frac{K_{n-1}}{K_{n+1}})}$$

Where:

- K_o is the average of the two unfiltered kerma measurements
- K_{n-1} is the kerma measurement that is slightly higher than $K_o/2$

– K_{n+1} is the kerma measurement that is slightly lower than $K_o/2$
– X_{n-1} is the filtration thickness corresponding to K_{n-1}
– X_{n+1} is the filtration thickness corresponding to K_{n+1}

Acceptance criterion:

At 70 kV, the HVL must be greater than or equal to 2.5 mm of aluminium.
Note: If X_{n-1} et X_{n+1} are both greater than or equal to 2.5 mm, then the HVL also is, rendering unnecessary to calculate it.

Processing of non-conformities:

– If there is a low HVL between 2 mm and 2.5 mm of aluminium, the required adjustments should be made for a return to conformity as soon as possible.
– An HVL of less than 2 mm of aluminium requires immediate discontinuation of use and notification of the anomaly to EOS imaging.

5.2.2 Test specific to Australia

Run the generic test described in Section *5.2.1* with the following changes:
5. Acquisition parameters: 80 kV, 200 mA, level 4.

Acceptance criterion:

At 80 kV, the HVL must be greater than or equal to 2.3 mm of aluminium.
Note: If X_{n-1} et X_{n+1} are both greater than or equal to 2.3 mm, then the HVL also is, rendering unnecessary to calculate it.

Processing of non-conformities:

– An HVL of less than 2.3 mm of aluminium requires immediate discontinuation of use and notification of the anomaly to EOS imaging.

5.3 Reproducibility, repeatability and linearity of radiation output

Required equipment not supplied with the EOS QC set:

- Dosimeter (Section 3, page 6)
- Scientific calculator (Section 3, page 6)
- Adhesive tape that does not leave any residue when removed (Section 3, page 6)

Operating mode

- QC procedure applicable in Shutter Mode or in Filtration Mode. For the Shutter Mode, manually select the focus (LARGE) and filtration (ALUMINIUM) in Tool/ Control/Gen + Tube. For the Filtration Mode, select the mostly used focus/filtration couple (LARGE/ALUMINIUM or SMALL/COPPER).
- Caution: In Filtration Mode, for Australia, the tests of sections 5.3.1, 5.3.2.2 and 5.3.3.2 are mandatory in both configurations (LARGE/ALUMINIUM and SMALL/COPPER)

For each of the two acquisition planes,

5.3.1 Reproducibility

1. Create a new patient:
   a. Patient ID: QC_EOS_REVQC_RX_Filter_Focus, where:
   i. Filter_Focus = AL_LF, for Shutter mode or for Filtration mode with Large focus aluminium.
   ii. Filter_Focus = CU_SF, for filtration mode with Small focus copper
   b.
   c. Name: QC
   d. First name:
   i. Measurements_Al_LF, for Shutter mode or for filtration mode with Large focus Aluminium.
   ii. Measurements_Cu_SF, for filtration mode with Small focus copper
   e. The other fields may be filled freely
2. Using adhesive tape, fix the dosimeter sensor, placed against the concerned detector panel in the centre of the field. The sensor must be correctly placed against the carbon panel.
3. Take three monoplanar exposures at 70 kV, using the three level-mA combinations given below. Note the measured kerma after each exposure.
   Combination No. 1: Level 4, 50 mA
   Combination No. 2: Level 2, 100 mA
   Combination No. 3: Level 1, 200 mA
   Note:
   The value of mAs/line is 0.1666 mAs/line for each of these three levels - mA combinations.
4. Calculate the average of the three kerma values.
5. Calculate the average +15% and the average -15%.
6. In Filtration Mode, for the specific case of Australia, perform steps 1 to 5 again with the second Filter/Focus configuration

Acceptance criterion:

None of the three kerma values should deviate by more than 15% from the average value.

Processing of non-conformities:

A return to conformity should be ensured as soon as possible.

5.3.2 Linearity

5.3.2.1 Generic test - except for Australia

1. Keep the same patient:
   a. Patient ID: QC_EOS_REVQC_RX_Filter_Focus, where:
      i. i. Filter_Focus = AL_LF, for Shutter mode or for Filtration mode with Large focus aluminium.
      ii. Filter_Focus = CU_SF, for filtration mode with Small focus copper
   a. Name: QC
   b. First name:
      i. Measurements_Al_LF, for Shutter mode or for filtration mode with Large focus Aluminium
      ii. Measurements_Cu_SF, for filtration mode with Child morphotype
   c. The other fields may be filled freely
2. The dosimeter sensor must always be correctly placed against the carbon detector panel.
3. Take an exposure at 70 kV, in each of the three speed level - mA combinations given below. Note the measured air kerma after each exposure.
   Configuration No. 1: Level 1, 50 mA.
   mAsl1=0.0417 mAs/line, corresponding measured kerma: *K1*.
   Configuration No. 2: Level 2, 100 mA.
   mAsl2=0,1666 mAs/line, corresponding measured kerma: *K2*.
   Configuration No. 3: Level 6, 200 mA.
   mAsl3=0.9996 mAs/line, corresponding measured kerma: *K3*.
   CAUTION: for Cu/SFS, the acquisition area must be the smallest possible (at the limits of the dosimeter probe).
4. Calculate the distance between the source and dosimeter sensor:
   Distance between source and dosimeter sensor
   d = (Distance between source and detector panel) – (Thickness of sensor including Velcro)

   Note:
   Distances known by EOS are as follows:
   Source – frontal and lateral detector panel: *d1*=1.2383 m.
5. For each of the three measured kerma values (K1, K2 and K3), calculate the kerma/(mAs/line) ratio calculated for 1 meter:
   Kerma/(mAs/line) ratio calculated for 1 meter $ri = \frac{Ki * d}{mAsli}$, where *Ki* is the measured air kerma, *d* the distance between the source and the dosimeter sensor, and *mAsli* the mAs/lines corresponding to the exposure.
6. Calculate the average *Rm* of the three kerma/(mAs/line) ratio values calculated for 1 meter (*r1*, *r2*, *r3)*.
7. In addition, take ten exposures at 70 kV, in each of the two level - mA configurations given below. Note the measured air kerma after each exposure.
   Configuration No. 4: Level 4, 200 mA.
   mAsl4 = 0.6664 mAs/line, average of the measured kerma: *Km4*.
   Configuration No. 5: Level 4, 250 mA.
   mAsl5 = 0.833 mAs/line, average of the measured kerma: *Km5*.

Acceptance criterion:

– None of the three *r1*, *r2* and *r3* ratio values deviates by more than 15% from the average value *Rm*.

– **In case of a periodic test:** The average value *Rm* of these ratios (*r1*, *r2* and *r3*) is not less than 65% of the value of the initial test.

– $$\left|\frac{Km4}{mAsl4}-\frac{Km5}{mAsl5}\right| \le 0.1\times\left(\frac{Km4}{mAsl4}+\frac{Km5}{mAsl5}\right)$$

Processing of non-conformities:

A return to conformity should be ensured as soon as possible.

5.3.2.2 Test specific to Australia

1. Keep the same patient:
   a. Patient ID: QC_EOS_REVQC_RX_Filter_Focus, where:
      i. Filter_focus=AL_LF, for Shutter mode or for filtration mode with Large focus Aluminium
   b. Name: QC
   c. First name:
      i. Measurements_Al_LF for Shutter mode or filtration mode with standard Adult morphotype
   d. The other fields may be filled freely
2. The dosimeter sensor must always be correctly placed against the carbon detector panel.
3. Take an exposure at 70 kV, in each of the four level-mA combination pairs given below. Note the measured air kerma after each exposure.

Comparison	Configuration a (Dose measured: Ka)				Configuration b (Dose measured: Kb)			
	kV	mA	Level	mAs/l (mAsla)	kV	mA	Level	mAs/l (mAslb)
1	70	10	1	0.00833	70	10	2	0.01666
2	70	200	3	0.49980	70	200	4	0.666400
3	70	200	5	0.83300	70	200	6	0.999600
4	70	400	7	2. 3324	70	400	8	2.6656

4. Perform steps 1 to 3 again with the following changes:
   i. 1.a.i Filter_Focus=Cu_SF, for filtration mode with Small focus copper
   ii. 1.c.i Measurements_Cu_SF, for filtration mode with Child morphotype
   iii. 3 Take an exposure at 70 kV, in each of the four level-mA combination pairs given below. Note the measured air kerma after each exposure

Comparison	Configuration a (Dose measured: Ka)				Configuration b (Dose measured: Kb)			
	kV	mA	Level	mAs/l (mAsla)	kV	mA	Level	mAs/l (mAslb)
1	70	10	1	0.00833	70	10	2	0.01666
2	70	200	3	0.49980	70	200	4	0.666400
3	70	200	5	0.83300	70	200	6	0.999600
4	70	360	7	2.0992	70	360	8	2.3990

Acceptance criterion:

For each of the four comparison points, the Ka and kb doses measured must be verified:

– $\left|\frac{Ka}{mAsla} - \frac{Kb}{mAslb}\right| \leq 0.1 \times \left(\frac{Ka}{mAsla} + \frac{Kb}{mAslb}\right)$

Processing of non-conformities:

A return to conformity should be ensured as soon as possible.

5.3.3 Repeatability

5.3.3.1 Generic test - except for Australia

1. Keep the same patient:
   a. Patient ID: QC_EOS_REVQC_RX_Filter_Focus, where:
      i. Filter_focus=AL_LF, for Shutter mode or for filtration mode with Large focus Aluminium
      ii. Filter_Focus=Cu_SF, for filtration mode with Small focus copper
   b. Name: QC
   c. First name:
      i. Measurements_Al_LF for Shutter mode or for filtration mode with Large focus Aluminium.
      ii. Measurements_Cu_SF, for filtration mode with Small focus copper.
   d. The other fields may be filled freely
2. Take ten exposures at 70 kV level 4, 200 mA noting the measured kerma for each.
   Note: The ten measurements in configuration No. 4 of Section *5.3.2* may be reused.
3. Calculate the average of the ten preceding kerma values.
4. Calculate the average +10% and the average -10%.
5. Calculate the standard deviation of the ten kerma values.
6. Calculate the coefficient of variation (standard deviation/average of kerma values)

Acceptance criterion:

- None of the ten kerma values noted deviates by more than 10% from the average value.
- The coefficient of variation (standard deviation/average of kerma values) must be equal to or less than 0.05

Processing of non-conformities:

A return to conformity should be ensured as soon as possible.

5.3.3.2 Test specific to Australia

1. Keep the same patient:
   a. Patient ID: QC_EOS_REVQC_RX_Filter_Focus, where:
      i. Filter_Focus=Al_LF for Shutter mode or for filtration mode with Large focus Aluminium
   b. Name: QC
   c. First name:
      i. Measurements_Al_LF for Shutter mode or for filtration mode with Large focus Aluminium.
   d. The other fields may be filled freely
2. Take five exposures at 70 kV level 4, 200 mA noting the measured kerma for each.
   Note: The five measurements in configuration No 4 of Section *5.3.2* may be reused.
3. Calculate the average of the five preceding kerma values.
4. Calculate the standard deviation of the five kerma values.
5. Calculate the coefficient of variation (standard deviation/average of kerma values).
6. Perform steps 1 to 5 again with the following changes:
   i. 1.a.i Filter_Focus Cu_SF, for filtration mode with Small focus copper
   ii. 1.c.i Measurements_Cu_SF, for filtration mode with Child morphotype

Acceptance criterion:

- The coefficient of variation (standard deviation/average of kerma values) must be equal to or less than 0.05

Processing of non-conformities:

A return to conformity should be ensured as soon as possible.

5.4 Relationship between kerma x surface, displayed and measured

Required equipment not supplied with the EOS QC set:

- Dosimeter (Section 3, page 6)
- Scientific calculator (Section 3, page 6)
- Adhesive tape that does not leave any residue when removed (Section 3, page 6)

Operating mode

- In Filtration Mode, run the whole procedure (stages 1 to 9); in Shutter Mode, perform steps 1 to 8 only. In both operating modes, manually select Aluminium filtration and large focus.

For each of the two acquisition planes,

1. Create a new patient:
   a. Patient ID: QC_EOS_REVQC_PDS_AL_LF
   b. Name: QC
   c. First name: Measurements_Al_LF
   d. The other fields may be filled freely
2. Fix the dosimeter sensor against the concerned carbon detector panel at the centre of the beam. The sensor must be correctly placed.
3. Take a monoplanar exposure at 70 kV, level 4, 200 mA, 20 cm high, lateral collimation at 20 cm on each side.
4. Note the kerma x surface displayed (Dose-surface area product), *DAP1*.
5. Calculate the distance between the source and dosimeter sensor:

   Distance between source and dosimeter sensor
   d = (Distance between source and detector panel) – (Thickness of sensor including Velcro)

   Note:
   Distances known by EOS are as follows (frontal, lateral):
   Source – detector: *do*=1.300 m
   Source – detector panel: *d1*=1.2383 m
6. Apply a corrective coefficient of *d*/*do* to *K1*to obtain the dose in the detector plane *K2* = *K1* x *d*/*do*.
7. Calculate the surface area *S*, in cm^2, of the X-ray field in the detector plane using information in the interface. Include the positioning error of the side collimation blades in the calculation.

   Note:
   The maximum positioning error of the side collimation blades needs to be known. This value is verified and measured during scheduled maintenance. Contact the EOS imaging service to obtain this value.
8. Calculate the kerma x surface product *DAP2*= *K2* x *S*.
9. In Filtration Mode, perform the test sequence with the following changes:
   1a. Patient ID: QC_EOS_REVQC_PDS_CU_SF
   1c. First name: Measurements_Cu_SF
   3 Manually select Copper filtration and small focus.

Acceptance criterion:

– The difference between the displayed kerma x surface area product, *DAP1*, and the kerma x surface area product measured and calculated, *DAP2*, must be less than 15%.

Processing of non-conformities:

– An absolute deviation between 15% and 25%, requires that compliance be re-established as soon as possible.
– For an absolute deviation greater than 25% immediately discontinue use of EOS and contact the EOS imaging after-sales service.

5.5 Spatial resolution and image quality

Required equipment supplied with the EOS QC set:

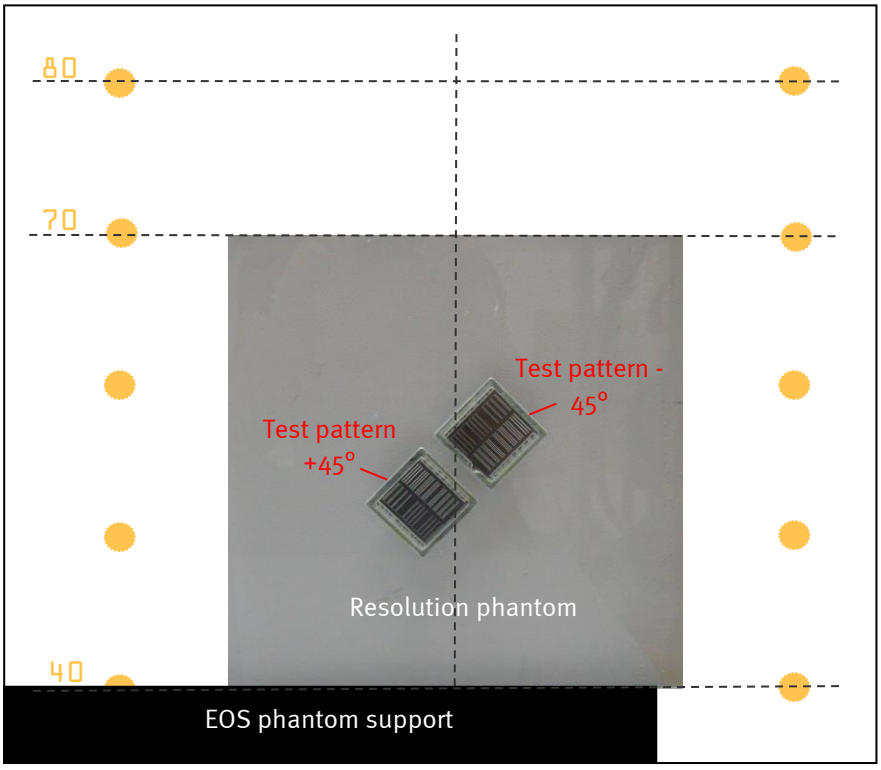
- Support for EOS phantom (Section 3, page 6)
- 4 plates of PMMA 30 cm x 30 cm x 5cm (Section 3, page 6)
- Resolution phantom (Section 3, page 6)

Operating mode

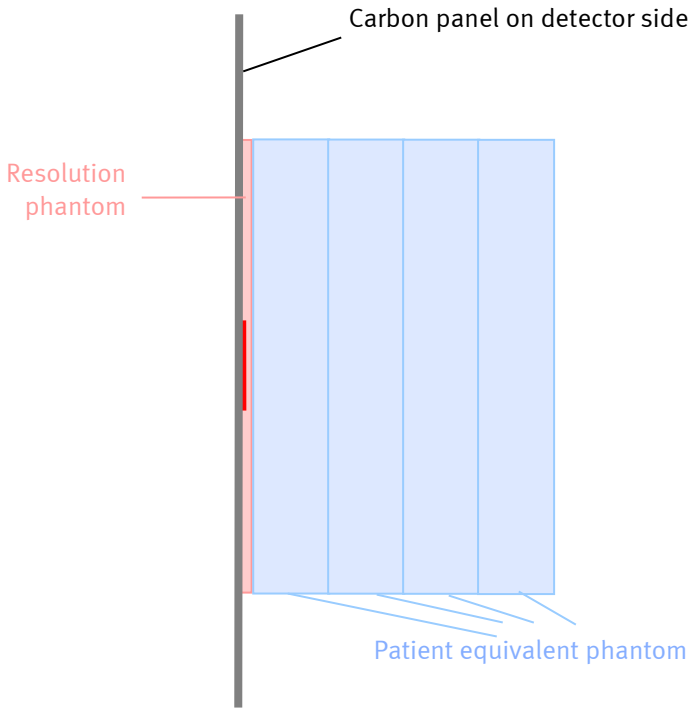
- In Filtration Mode, run the whole procedure (stages 1 to 11); in Shutter Mode, perform steps 1 to 10 only. In both operating modes, manually select Aluminium filtration and large focus.

For each of the two acquisition planes,

1. Create a new patient:
   a. Patient ID:
      i. If the tested plane is the frontal one:
      Patient ID: QC_EOS_REVQC_RESOL_F_AL_LF
      ii. If the tested plane is the lateral one:
      Patient ID: QC_EOS_REVQC_RESOL_P_AL_LF
   b. Name: QC
   c. First name: Resolution_Al_LF
   d. The other fields may be filled freely
2. Place the support for EOS phantom **on the gantry floor against the carbon detector panel.**
3. Place the resolution phantom on the EOS phantom support against the carbon panel on the detector side, and the patient equivalent phantom on the resolution phantom in the centre of the field.



Place the resolution phantom against the carbon detector panel



Position of the resolution phantom and the patient equivalent phantom, viewed from above

4. Select the Pelvis anatomical area, large morphotype (aluminium filtration, large focal spot).
5. Select 70 kV and 400 mA, level 8.
6. Set scanning height to at least 10 cm, centred on the resolution test patterns.
7. Set the left and right limits of the lateral collimation at 15 cm.
8. Place the concerned reference plane cursor at +22.4 cm.
9. Display the image in 1/1 mode, i.e. one image pixel to one screen pixel.
10. Starting with the lowest frequencies, identify the last group of lines that can be distinguished on each test pattern.
11. Also note any imperfection (horizontal, vertical lines, etc.)

Acceptance criterion:

For a detector collimation blade aperture of 500 µm, the spatial resolution must be in excess of 1.60 pl/mm.
For a detector collimation blade aperture of over 500 µm, the spatial resolution must remain compliant with the criterion provided by the applicable local regulation or in the absence of a specified minimum must be equal to 1.20 pl/mm.

Processing of non-conformities:

A resolution strictly less than the above criteria requires compliance to be re-established as soon as possible.

6 Reference of standards and texts used

This document is based on the following standards and texts:

- Decision setting the quality control modes for certain radiographic diagnosis facilities, (France)
- NF EN 60601-1, NF EN 60601-2-54 (European Union)
- 21CFR-1020.30 and .31, (United States)
- Radiation Emitting Devices Regulations, C.R.C., c. 1370, Part XII (Canada)
- Radiation Safety Standard HR001 (Queensland, Australia)

The table below matches the points of those applicable documents with the EOS quality control and the Sections of this document.

Standard/Text		Corresponding Section in present document
Document title	Section	
Quality control radiographic diagnosis decision	6.1.1.1	*5.1* Accuracy and repeatability of kVp page *16*
	6.1.1.2	*5.2 Half-value layer (HVL)* page *18*
	6.1.1.3	*5.3 Reproducibility, repeatability and linearity of radiation output* page *20*
	6.1.1.4	*5.4 Relationship between kerma x surface, displayed and measured* page *26*
	6.1.2	*4.2 Acquisition areas* page *13*
	6.1.4	*5.5 Spatial resolution and image quality* page *28*
NF EN 60601-1-3	7.1	*5.2 Half-value layer (HVL)* page *18*
21CFR-1020	1020.30.m	*5.2 Half-value layer (HVL)* page *18*
	1020.31.b and c	*5.3 Reproducibility, repeatability and linearity of radiation output* page *20*
	1020.31.e	*4.2 Acquisition areas* page *13*
Radiation Emitting Devices Regulation PART XII	6.k	*5.2 Half-value layer (HVL)* page *18*
	22	*5.3 Reproducibility, repeatability and linearity of radiation output* page *20*
	25	*5.3Reproducibility, repeatability and linearity of radiation output* page *20*
NF EN 60601-2-54	203.7	*5.2 Half-value layer (HVL)* page *18*
	203.8.5.3 and 203.8.102.6	*4.2 Acquisition areas* page *13*
Radiation Safety Standard HR001:Queensland Australia	1	*5.3.3.2Test specific to Australia* page *25*
	2	*5.3.2.2Test specific to Australia* page *23*
	3	*5.1.1.2 Test specific to Australia* page *16*
	5	*5.2.2Test specific to Australia p*age *19*

7
7

7 Customer Support

Please contact Customer EOS Support for all questions, remarks and suggestions about our products.

8 Technical support

EOS

Technical Support in Europe:
Tel: +33 1 55 25 63 90

Service Representative in North America:
Tel: +1-866-933-5301 (toll-free call)

Annexe A EOS Quality Control-Unit entry

This appendix summarizes all information necessary for the proper archiving of the EOS quality control system.

It may be photocopied in order to provide a permanent record of test results.

1 Information to fill in during quality control

- Control type:
  - Audit and conditional controls or complete external control
  - Initial control, periodic control, check survey
    - In the case of a periodic control, date of initial control
    - In the case of a check survey, date of referenced control
  - Annual/monthly

- Name and function of the person in charge of the control:

- EOS system serial number:

- Acquisition software version:

- Date of control:

- QC manual revision:

- Dosimeter:
  - Brand:
  - Model:
  - Serial number:
  - Date of standardization expiration:

- kVpmeter:
  - Brand:
  - Model:
  - Serial number:
  - Date of standardization expiration:

- Other measurement tool:
  - Brand:
  - Model:
  - Serial number:
  - Date of standardization expiration:

- Other software tool:
  - Publisher:
  - Version:

2 Images to save during control

Display images corresponding to the Sections and patients listed below must be saved on a CD during control and kept with the test results.

- Optical positioning system (Section 4.1, page *9)*
  Patient ID: *QC_EOS_REVQC_Centering, QC_EOS_REVQC_Vert_F1, QC_EOS_REVQC_Vert_F2, QC_EOS_REVQC_Vert_P1 and QC_EOS_REVQC_Vert_P2.*

- Acquisition area (Section 4.2, page *13*)
  Patient ID: *QC_EOS_REVQC_ZoneAcq*

- Levelness of X-ray beams (Section 4.3, page *15)*
  Patient ID: *QC_EOS_REVQC_HorRX_F and QC_EOS_REVQC_HorRX_F_P.*

- Spatial resolution and image quality (Section 5.5, page *28)*
  Patient ID: *QC_EOS_REVQC_RESOL_F_AL_LF and QC_EOS_REVQC_RESOL_P_AL_LF.*

3 Results to save

3.1 Spatial resolution and image quality (Section 5.5, page 28)

3.1.1 Standard Test

Filter / Focus	Plane	Test pattern	Expected result	Measured result	Pass/Fail
Al / LF	Frontal	Test pattern +45°	Spatial resolution greater than or equal to 1.6.6 pl/mm	Spatial resolution=	
		Test pattern -45°	Spatial resolution greater than or equal to 1.6.6 pl/mm	Spatial resolution=	
	Lateral	Test pattern +45°	Spatial resolution greater than or equal to 1.6.6 pl/mm	Spatial resolution=	
		Test pattern -45°	Spatial resolution greater than or equal to 1.6.6 pl/mm	Spatial resolution=	

Filter / Focus	Plane	Type of imperfection	Description	Imperfection troublesome?
Al / LF	Frontal	Vertical lines		
		Horizontal lines		
		Others:		
	Lateral	Vertical lines		
		Horizontal lines		
		Others:		

Filter / Focus	Plane	Type of imperfection	Description	Imperfection troublesome?
Cu / SF	Frontal	Vertical lines		
		Horizontal lines		
		Others:		
	Lateral	Vertical lines		
		Horizontal lines		
		Others:		

Note: Table to be completed in Filtration Mode only.

3.1.1.2 Test specific if the detector collimation blades are opened above 500 µm

Filter / Focus	Plane	Test pattern	Expected result	Measured result	Pass/Fail
Al / LF	Frontal	Test pattern +45°	Spatial resolution greater than or equal to 1.2 pl/mm	Spatial resolution=	
		Test pattern -45°	Spatial resolution greater than or equal to 1.2 pl/mm	Spatial resolution=	
	Lateral	Test pattern +45°	Spatial resolution greater than or equal to 1.2 pl/mm	Spatial resolution=	
		Test pattern -45°	Spatial resolution greater than or equal to 1.2 pl/mm	Spatial resolution=	

Filter / Focus	Plane	Type of imperfection	Description	Imperfection troublesome?
Al / LF	Frontal	Vertical lines		
		Horizontal lines		

		Others:		
	Lateral	Vertical lines		
		Horizontal lines		
		Others:		

3.2 Optical positioning system tests (Section 4.1, page 9)

3.2.1 Centering control (Section 4.1.1 page 9)

Plane	Expected result	Obtained result	Pass/Fail
Frontal	The distance between the tip of the positioning phantom and the vertical line at the centre is inferior or equal to 5 mm.	Measured distance frontal plane =	
Lateral	The distance between the tip of the positioning phantom and the vertical line at the centre is inferior or equal to 5 mm.	Measured distance lateral plane =	

3.2.2 Verticality control (Section 4.1.2, page 10)

Plane	Expected result	Measured result	Pass/Fail
Frontal	Every measured distance is less than or equal to 5 mm.	Longest distance measured on the frontal image =	
Lateral	Every measured distance is less than or equal to 5 mm.	Longest distance measured on the lateral image =	

3.3 Acquisition area With interface sliders (Section 4.2.1, page 13)

Plane	Expected result Frontal and Lateral	Pass/Fail
Frontal	The right limit of the **left marker** is visible, but the left limit is not.	
	The left limit of the **right marker** is visible, but the right limit is not.	
	The lower limit of the **top marker** is visible, but the upper limit is not.	
	The upper limit of the **bottom marker** is visible, but the lower limit is not.	
Lateral	The right limit of the **left marker** is visible, but the left limit is not.	
	The left limit of the **right marker** is visible, but the right limit is not.	
	The lower limit of the **top marker** is visible, but the upper limit is not.	
	The upper limit of the **bottom marker** is visible, but the lower limit is not.	

3.4 Acquisition area With Laser positioning system (Section 4.2.2 page 14)

Plane	Expected result Frontal and Lateral	Pass/Fail
Frontal	The right limit of the **left marker** is visible, but the left limit is not.	
	The left limit of the **right marker** is visible, but the right limit is not.	
	The lower limit of the **top marker** is visible, but the upper limit is not.	
	The upper limit of the **bottom marker** is visible, but the lower limit is not.	
Lateral	The right limit of the **left marker** is visible, but the left limit is not.	
	The left limit of the **right marker** is visible, but the right limit is not.	
	The lower limit of the **top marker** is visible, but the upper limit is not.	
	The upper limit of the **bottom marker** is visible, but the lower limit is not.	

3.5 Levelness of X-ray beams (Section 4.3, page 15)

Plane	Expected result	Measured result	Pass/Fail
Frontal	The angleα measured between the upper edge of the phantom and the upper edge of the image, and check that it is less than 0.5°.	α =	
Lateral	The angleα measured between the upper edge of the phantom and the upper edge of the image, and check that it is less than 0.5°.	α =	

3.6 Accuracy and repeatability of kVp (Section 5.1, page 16)

3.6.1 Accuracy – Generic test – excluding Australia (Section 5.1.1.1, page 16)

Plane	Selected kVp	Expected result	Measured result	Pass/ Fail
Frontal	50 kV	Between 45 and 55 kV	measured kVp =	
	70 kV	Between 63 kV and 77 kV	measured kVp =	
	140 kV	Between 126 kV and 154 kV	measured kVp =	
Lateral	50 kV	Between 45 and 55 kV	measured kVp =	
	70 kV	Between 63 kV and 77 kV	measured kVp =	
	140 kV	Between 126 kV and 154 kV	measured kVp =	

3.6.2 Accuracy – Test specific to Australia Section 5.1.1.2, page 16)

Plane	kVp (kV)	Expected result				Measured result	Pass/Fail	
		Criterion a		Criterion b			Criterion a	Criterion b
		min	max	min	max			
Frontal	50	46.5	53.5	45.0	55.0			
	60	56.0	64.0	54.0	66.0			
	70	65.5	74.5	63.0	77.0			
	80	75.0	85.0	72.0	88.0			
	90	84.5	95.5	81.0	99.0			
	100	94.0	106.0	90.0	110.0			
	110	103.5	116.5	99.0	121.0			
	120	113.0	127.0	108.0	132.0			
	130	122.5	137.5	117.0	143.0			
	140	132.0	148.0	126.0	154.0			
Lateral	50	46.5	53.5	45.0	55.0			
	60	56.0	64.0	54.0	66.0			
	70	65.5	74.5	63.0	77.0			
	80	75.0	85.0	72.0	88.0			
	90	84.5	95.5	81.0	99.0			
	100	94.0	106.0	90.0	110.0			
	110	103.5	116.5	99.0	121.0			
	120	113.0	127.0	108.0	132.0			
	130	122.5	137.5	117.0	143.0			
	140	132.0	148.0	126.0	154.0			

3.6.3 kVp repeatability (Section 5.1.2, page 16)

Plane	kVp measure-ments	Average of kVp measure-ments	*kV1* = Average of kVp -5%	*kV2* = Average of kVp +5%	Expected result	Pass/ Fail
Frontal					The five measured kVp are comprised between *kV1* and *kV2*.	
Lateral					The five measured kVp are comprised between *kV1* and *kV2*.	

3.7 Half-value layer (Section 5.2, page 18)

3.7.1 Measurements within an initial control

Additional filtration (mm Al)	Measured kerma	
	Frontal	lateral
0		
0		
0.5		
1.0		
1.5		
2.0		
2.5		
3.0		
3.5		
4.0		
4.5		
5.0		
5.5		
6.0		
6.5		
7.0		

Note on calculating HVL:

$$CDA = \frac{X_{n+1} * \ln(2 * \frac{K_{n-1}}{K_0}) - X_{n-1} * \ln(2 * \frac{K_{n+1}}{K_0})}{\ln(\frac{K_{n-1}}{K_{n+1}})}$$

Where:

- K_o is the average of the two unfiltered kerma measurements
- K_{n-1} is the kerma measurement that is slightly higher than $K_o/2$
- K_{n+1} is the kerma measurement that is slightly lower than $K_o/2$
- X_{n-1} is the filtration thickness corresponding to K_{n-1}
- X_{n+1} is the filtration thickness corresponding to K_{n+1}

Note: If X_{n-1} et X_{n+1} are both greater than or equal to 2.5 mm, then the HVL also is, rendering unnecessary to calculate it.

3.7.2 Summary table (initial and routine controls) - Generic test - excluding Australia

Filter/ Focus	Plane	Kerma without filtration		Average of *Ko1* and *Ko2*	Kerma slightly higher than $K_o/2$ and corresponding Al filtration		Kerma slightly lower than $K_o/2$ and corresponding Al filtration		HVL calcu-lated	Expected result	Pass/Fail
		Ko1 (µGy)	*Ko2* (µGy)	K_o (µGy)	K_{n-1} (µGy)	X_{n-1} (mm)	K_{n+1} (µGy)	X_{n+1} (mm)			
Al / LF	Frontal									HVL ≥ 2.5	
	Lateral									HVL ≥ 2.5	

3.7.3 Summary table (initial and periodic controls) - Test specific to Australia

Filter / Focus	Plane	Kerma without filtration		Average of *Ko1* and *Ko2*	Kerma slightly higher than $K_o/2$ and corresponding Al filtration		Kerma slightly lower than $K_o/2$ and corresponding Al filtration		HVL calcu-lated	Expected result	Pass/Fail
		Ko1 (µGy)	*Ko2* (µGy)	K_o (µGy)	K_{n-1} (µGy)	X_{n-1} (mm)	K_{n+1} (µGy)	X_{n+1} (mm)			
Al / LF	Frontal									HVL ≥ 2.3	
	Lateral									HVL ≥ 2.3	

3.8 Reproducibility, repeatability and linearity of radiation output (Section 5.3, page *20*)

3.8.1 Reproducibility (Section 5.3.1, page 20)

Filter / Focus	Plane	Level	mA	Measured kerma (µGy)	Average of the three kerma values	*K1* = Average of the three kerma values -15%	*K2* = Average of the three kerma values +15%	Expected result	Pass/Fail
Al / LF	Frontal	4	50					The three measured kerma values are comprised between *K1* and *K2.*	
		2	100						
		1	200						
Al / LF	Lateral	4	50					The three measured kerma values are comprised between *K1* and *K2.*	
		2	100						
		1	200						

Note: Table to be completed for Shutter and Filtration Mode if Al/LFS configuration is used

Filter/ Focus	Plane	Level	mA	Mea-sured kerma (µGy)	Average of the three kerma values	*K1* = Average of the three kerma values -15%	*K2* = Average of the three kerma values +15%	Expected result	Pass/Fail
Cu / SF	Frontal	4	50					The three measured kerma values are comprised between *K1* and *K2.*	
		2	100						
		1	200						
Cu	Lateral	4	50					The three	

/ SF		2	100					measured kerma values are comprised between *K1* and *K2*.	
		1	200						

Note: Table to be completed for Filtration Mode only if Cu/SFS configuration is used.

3.8.1.1 Linearity – Generic test – excluding Australia (Section 5.3.2.1, page 22)

Note on distances used in this section:

– Distance between source and dosimeter sensor:
d = (Distance between source and detector panel) – (Thickness of sensor including Velcro)

– Source – frontal and lateral detector panel distance: *d1*=1.2383 m.

Note on level-mA configurations for exposures 1.2 and 3 (at 70 kV):

– Configuration No. 1: Lev1, 50 mA.
mAsl1=0.0417 mAs/line, corresponding measured kerma: *K1*.

– Configuration No. 2: Lev2, 100 mA
mAsl2=0.1666 mAs/line, corresponding measured kerma: *K2*.

– Configuration No. 3: Lev6, 200 mA.
mAsl3=0.9996 mAs/line, corresponding measured kerma: *K3*.

Al/LF filter											
Plane	**Measured kerma (µGy)**		**mAs/l**	***d*** **(m)**	**kerma/mAs×** ***d***	***RM*** **= Average of r1, r2 and r3**	***RM1*** **=** ***RM*** **- 15%**	***RM2*** **=** ***RM*** **+15%**	***RM3*** **=** ***RM*** **initial control* 0.65**	**Expected result**	**Pass/ Fail**
Fron-tal	Config 1		0.0417		*r1*=					*r1*, *r2* and *r3* are between *RM1* and *RM2*.	
	Config 2		0.1666		*r2*=					If routine control: *RM*≥ *RM3*	
	Config 3		0.9996		*r3*=						
Late-ral	Config 1		0.0417		*r1*=					*r1*, *r2* and *r3* are comprised between *RM1* and *RM2*.	
	Config 2		0.1666		*r2*=					If routine control: *RM*≥ *RM3*	
	Config 3		0.9996		*r3*=						

Note: Table to be completed for Shutter and Filtration Mode only if Al/LFS configuration is used.

Note on level-mA configurations for exposures 4 and 5 (at 70 kV):

– Configuration No. 4: Lev4, 200 mA.
  mAsl4 = 0.6664 mAs/line, average of the measured kerma: *Km4*.
– Configuration No. 5: Lev4, 250 mA.
  mAsl5 = 0.833 mAs/line, average of the measured kerma: *Km5*.

Al/LF filter								
Plane	**Measured kerma (µGy)**		**Average of Kerma values**	**mAs/line**	***R4 = Km4/ mAsl4***	***R5 = Km5/ mAsl5***	**Expected result**	**Pass/Fail**
Frontal	**Config 4**		*Km4* =	*mAsl4* = 0.6664			$\|R4-R5\| \leq 0.1 \times \|R4 + R5\|$	
	Config 5		*Km5* =	mAsl5= 0.833				
Lateral	**Config 4**		*Km4* =	*mAsl4* = 0.6664			$\|R4-R5\| \leq 0.1 \times \|R4 + R5\|$	
	Config 5		*Km5* =	*mAsl5* = 0.833				

Note: Table to be completed for Shutter and Filtration Mode only if Al/LFS configuration is used.

Cu/SF filter											
Plane	Measured kerma (µGy)		mAs/l	*d* (m)	kerma/mAs× *d*	*RM* = Average of r1, r2 and r3	*RM1* = *RM* - 15%	*RM2* = *RM* +15%	*RM3* = *RM* initial control *0.65	Expected result	Pass/ Fail
Frontal	Config 1		0.0417		*r1*=					*r1*, *r2* and *r3* are between *RM1* and *RM2*.	
	Config 2		0.1666		*r2*=						
	Config 3		0.9996		*r3*=					If routine control: *RM*≥*RM3*	
Lateral	Config 1		0.0417		*r1*=					*r1*, *r2* and *r3* are comprised between *RM1* and *RM2*.	
	Config 2		0.1666		*r2*=						
	Config 3		0.9996		*r3*=					If routine control: *RM*≥*RM3*	

Note: Table to be completed for Filtration Mode only if Cu/SFS configuration is used.

Cu/SF filter							
Plane	Measured kerma (µGy)		Average of Kerma values	mAs/line	*R4* = *Km4*/ *mAsl4*	*R5* = *Km5*/ *mAsl5*	Expected result	Pass/Fail
Frontal	Config 4		*Km4* =	*mAsl4* = 0.6664			$\|R4-R5\| \leq 0.1 \times \|R4 + R5\|$	
	Config 5		*Km5*=	*mAsl5* = 0.833				

Lateral	Config 4		*Km4* =	*mAsl4* = 0.6664			$\|R4-R5\| \leq 0.1 \times \|R4+R5\|$	
	Config 5		*Km5* =	mAsl5= 0.833				

Note: Table to be completed for Filtration Mode only if Cu/SFS configuration is used.

3.8.1.2 Linearity – Test specific to Australia (Section 5.3.2.2, page 23)

Al/LF filter										
Plane	Acquisition parameters			mAs/l		*K* (µGy)		*R = K/ mAsl*		Expected result	Pass/Fail
	kVp	mA	Lev.								
Fron-tal	70	10	1	***mAsla***	0.00833	***Ka***		***Ra***		$\|Ra-Rb\| \leq 0.1 \times \|Ra+Rb\|$	
	70	10	2	***mAslb***	0.01666	***Kb***		***Rb***			
	70	200	3	***mAsla***	0.4998	***Ka***		***Ra***		$\|Ra-Rb\| \leq 0.1 \times \|Ra+Rb\|$	
	70	200	4	***mAslb***	0.6664	***Kb***		***Rb***			
	70	200	5	***mAsla***	0.833	***Ka***		***Ra***		$\|Ra-Rb\| \leq 0.1 \times \|Ra+Rb\|$	
	70	200	6	***mAslb***	0.9996	***Kb***		***Rb***			
	70	400	7	***mAsla***	2.3324	***Ka***		***Ra***		$\|Ra-Rb\| \leq 0.1 \times \|Ra+Rb\|$	
	70	400	8	***mAslb***	2.6656	***Kb***		***Rb***			
lateral	70	10	1	***mAsla***	0.00833	***Ka***		***Ra***		$\|Ra-Rb\| \leq 0.1 \times \|Ra+Rb\|$	
	70	10	2	***mAslb***	0.01666	***Kb***		***Rb***			
	70	200	3	***mAsla***	0.4998	***Ka***		***Ra***		$\|Ra-Rb\| \leq 0.1 \times \|Ra+Rb\|$	
	70	200	4	***mAslb***	0.6664	***Kb***		***Rb***			
	70	200	5	***mAsla***	0.833	***Ka***		***Ra***		$\|Ra-Rb\| \leq 0.1 \times \|Ra+Rb\|$	
	70	200	6	***mAslb***	0.9996	***Kb***		***Rb***			
	70	400	7	***mAsla***	2.3324	***Ka***		***Ra***		$\|Ra-Rb\| \leq 0.1 \times \|Ra+Rb\|$	
	70	400	8	***mAslb***	2.6656	***Kb***		***Rb***			

Note: Table to be completed for Shutter and Filtration Mode only with Al/LFS configuration.

Cu/SF filter											
Plane	Acquisition parameters			mAs/l		*K* (µGy)		*R = K/ mAsl*		Expected result	Pass/Fail
	kVp	mA	Lev.								
Fron-tal	70	10	1	*mAsla*	0.00833	*Ka*		*Ra*		$\|Ra-Rb\| \leq 0.1 \times \|Ra+Rb\|$	
	70	10	2	*mAslb*	0.016666	*Kb*		*Rb*			
	70	200	3	*mAsla*	0.4998	*Ka*		*Ra*		$\|Ra-Rb\| \leq 0.1 \times \|Ra+Rb\|$	
	70	200	4	*mAslb*	0.6664	*Kb*		*Rb*			
	70	200	5	*mAsla*	0.833	*Ka*		*Ra*		$\|Ra-Rb\| \leq 0.1 \times \|Ra+Rb\|$	
	70	200	6	*mAslb*	0.9996	*Kb*		*Rb*			
	70	360	7	*mAsla*	2.0992	*Ka*		*Ra*		$\|Ra-Rb\| \leq 0.1 \times \|Ra+Rb\|$	
	70	360	8	*mAslb*	2.3990	*Kb*		*Rb*			
lateral	70	10	1	*mAsla*	0.00833	*Ka*		*Ra*		$\|Ra-Rb\| \leq 0.1 \times \|Ra+Rb\|$	
	70	10	2	*mAslb*	0.01666	*Kb*		*Rb*			
	70	200	3	*mAsla*	0.4998	*Ka*		*Ra*		$\|Ra-Rb\| \leq 0.1 \times \|Ra+Rb\|$	
	70	200	4	*mAslb*	0.6664	*Kb*		*Rb*			
	70	200	5	*mAsla*	0.833	*Ka*		*Ra*		$\|Ra-Rb\| \leq 0.1 \times \|Ra+Rb\|$	
	70	200	6	*mAslb*	0.9996	*Kb*		*Rb*			
	70	360	7	*mAsla*	2.0992	*Ka*		*Ra*		$\|Ra-Rb\| \leq 0.1 \times \|Ra+Rb\|$	
	70	360	8	*mAslb*	2.3990	*Kb*		*Rb*			

Note: Table to be completed for Filtration Mode, only with Cu/SFS configuration.

3.8.2 Repeatability – Generic test – excluding Australia (Section 5.3.3.1, page 25)

Al/LF filter								
Plane	Mea-sured kerma (µGy)	*KM* = Average of the ten measured kerma	*KM1* = *KM* – 10%	*KM1* = *KM* + 10%	σ = Standard deviation of kerma values	Coefficient of variation $C = \sigma/KM$	Expected result	Pass/ Fail
Frontal							The ten measured kerma values are comprised between KM1 and M2.	
							$C \leq 0.05$	
Lateral							The ten measured kerma values are comprised between KM1 and M2.	
							$C \leq 0.05$	

Note: Table to be completed for Shutter and Filtration Mode only if Al/LFS configuration is used.

Cu/SF filter								
Plane	mea-sured kerma (µGy)	*KM* = Average of the ten measured kerma	*KM1* = *KM* – 10%	*KM1* = *KM* + 10%	σ = Standard deviation of kerma values	Coefficient of variation $C = \sigma/KM$	Expected result	Pass/Fail
Frontal							The ten measured kerma values are comprised between KM1 and M2.	
							$C \leq 0.05$	
Lateral							The ten measured kerma values are comprised between KM1 and M2.	
							$C \leq 0.05$	

Cu/SF filter								
Plane	mea-sured kerma (µGy)	*KM* = Average of the ten measured kerma	*KM1* = *KM* – 10%	*KM1* = *KM* + 10%	σ = Standard deviation of kerma values	Coefficient of variation $C = \sigma/KM$	Expected result	Pass/Fail

Note: Table to be completed for Filtration Mode only if Cu/SFS configuration is used.

3.8.3 Repeatability – Test specific to Australia (Section 5.3.3.2, page 25)

Al/LF filter						
Plane	mea-sured kerma (µGy)	*KM* = Average of five measured kerma values	σ = Standard deviation of kerma values	Coefficient of variation $C = \sigma/KM$	Expected result	Pass/Fail
Frontal					$C \leq 0.05$	
Lateral					$C \leq 0.05$	

Note: Table to be completed for Shutter and Filtration Mode only if Al/LFS configuration is used.

Cu/SF filter						
Plane	measured kerma (µGy)	*KM* = Average of five measured kerma values	σ = Standard deviation of kerma values	Coefficient of variation $C = \sigma/KM$	Expected result	Pass/Fail
Frontal					$C \leq 0.05$	
Lateral					$C \leq 0.05$	

Note: Table to be completed for Filtration Mode only if Cu/SFS configuration is used.

3.9 Relationship between kerma × surface, displayed and measured (Section *5.4*, page *26*)

Note on distances used in this section:

– Distance between source and dosimeter sensor
d = (Distance between source and detector panel) – (Thickness of sensor including Velcro)

Note:
Distances known by EOS are as follows:

– Source – detector: *do* = 1.300 m
– Source – frontal and lateral detector panel: *d1*=1.2383 m.

Integration of lateral collimation errors in the calculation of surface *S*:

	Information provided by the acquisition interface		Maximum lateral collimation error	Calculation of the surface *S*
Scanning height	Upper limit	*Ls* (cm) =		
	Lower limit	*Li* (cm) =		
Frontal plane	Left limit	Lg_F(mm) =	Eg_F(mm)=	S_F(cm²) = (*Ls*-*Li*)×(Lg_F+Eg_F+Ld_F+Ed_F)/10 =
	Right limit	Ld_F(mm) =	Ed_F(mm)=	
Lateral plane	Left limit	Lg_P(mm) =	Eg_P(mm)=	S_P(cm²) = (*Ls*-*Li*)×(Lg_P+Eg_P+Ld_P+Ed_P)/10 =
	Right limit	Ld_P(mm) =	Ed_P(mm)=	

Note:
The maximum positioning error of the side collimation blades needs to be known. This value is verified and measured during scheduled maintenance. Contact the EOS imaging service to obtain this value.

Al/LF filter										
Plane	*DAP1* Dose-surface area product displayed (mGy×cm²)	Kerma measured against carbon panel *K1* (µGy)	*d* (m)	Kerma in the plane of detector *K2* = *K1* × *d*/*do* (µGy)	Surface imaged in detector plane *S* (calculated above) (cm²)	Dose-surface area product deduced from measurement *DAP2* = *K2* × *S* (mGy×cm²)	*P1* = *DAP2* - 15%	*P2* = *DAP2* +15%	Expected result	Pass/Fail
Frontal									*DAP1* must be comprised between *P1* and *P2*	
Lateral									DAP1 must be between P1 and P2	

Cu/SF filter										
Plane	*DAP1* Dose-surface area product displayed (mGy×cm²)	Kerma measured against carbon panel *K1* (µGy)	*d* (m)	Kerma in the plane of detector *K2* = *K1* × *d*/*do* (µGy)	Surface imaged in detector plane *S* (calculated above) (cm²)	Dose-surface product deduced from measure *DAP2* = *K2* × *S* (mGy×cm²)	*P1* = *DAP2* - 15%	*P2* = *DAP2* +15%	Expected result	Pass/Fail
Frontal									*DAP1* must be comprised between *P1* and *P2*	
Lateral									DAP1 must be between P1 and P2	

Note: Table to be completed with Filtration Mode.

4 Result round up

Test	Pass /Fail
Spatial resolution and image quality (Section *5.5*, page *28*)	
Optical positioning system (Section *4.1*, page *9*)	
Acquisition area (Section *4.2* page *13*)	
Levelness of X-ray beams (Section *4.3*, page *15*)	
Accuracy and repeatability of kVp (Section *5.1*, page *16*)	
Half-value layer (Section *5.2*, page *18*)	
Reproducibility, repeatability and linearity of radiation output (Section *5.3*, page *20*)	
Relationship between kerma × surface, displayed and measured (Section *5.4*, page *26*)	

4.1 Actions

Check the box(es) below corresponding to the actions to undertake following the quality control.

EOS system use maintained	
Contact customer service	
EOS system use discontinued until compliance is re-established	