Canadian Association of Provincial Cancer Agencies

Standards for Quality Control at Canadian Radiation Treatment Centres

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Conventional Radiotherapy Simulators

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Developed, revised and approved by THE CANADIAN ORGANIZATION OF MEDICAL PHYSICISTS and THE CANADIAN COLLEGE OF PHYSICISTS IN MEDICINE

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Document development and review process: The quality control documents in this series originated from one of two sources. Some of the source documents were commissioned by CAPCA specifically for the purpose of developing national standards. This is one such document. Others had been previously developed for provincial use by the Physics Professional Affairs Committee of Cancer Care Ontario (formerly the Ontario Cancer Treatment and Research Foundation). The source documents were developed over an extended period of time from 1989 to the present. Each source document was reviewed by one or more independent Canadian medical physicists and the reviews accepted by the task group as they became available. The primary and secondary task group reviewers then examined the source document, the external review(s) and any appropriate published literature to propose quality control standards, objectives and criteria to the full task group. The full task group met electroncially and, by a consensus approach, developed the present document. The task group gratefully acknowledges the effort contributed by the author(s) of the source document and the reviewer(s) whose work forms the basis of this document. Review, updating and reformatting have been performed and, for any errors or omissions introduced in this process, the task group takes full responsibility.

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Acronyms, Synonyms and Definitions

AAPM	American Association of Physicists in Medicine
ADCL	Accredited Dosimetry Calibration Laboratory
Al	Aluminum
AMFPI	Active Matrix Flat Panel Imaging Devices
ANSI	American National Standards Institute
BSF	Back-scatter factor
CAPCA	Canadian Association of Provincial Cancer Agencies
CCO	CancerCare Ontario
CCPM	Canadian College of Physicists in Medicine
CNSC	Canadian Nuclear Safety Commission (Successor to the Atomic Energy Control Board - AECB)
COMP	Canadian Organization of Medical Physics
CSA	Canadian Standards Association
CT	Computed Tomography
CTV	Clinical target volume
Cu	Copper
EPI(D)	Electronic portal imaging (device)
FWHM	Full width at half maximum
Gleason score	A numerical system based on major and minor histological patterns
Gy	Gray, unit of absorbed dose (1J/kg)
HVL	Half-value layer
IAEA	International Atomic Energy Agency
ICRU	International Commission on Radiation Units and Measurements
IEC	International Electrotechnical Commission (Geneva, Switzerland)
IMRT	Intensity modulated radiation therapy
INMS-NRCC	Institute for National Measurement Standards of the National Research Council of Canada
IPEM	Institution of Physics and Engineering in Medicine
IPSM	Institute of Physical Sciences in Medicine

ISO	International Organization for Standardization
Isocentre	The intersection of the axes of collimator and gantry rotation
Linac	Electron linear accelerator
MLC	Multileaf collimator
mMLC	mini- or micro-Multileaf Collimator
MPPAC	Medical Physics Professional Advisory Committee
MRI	Magnetic Resonance Imaging
MU	Monitor unit
NCRP	National Council on Radiation Protection and Measurements
NIST	National Institute of Standards and Technology
NRCC	National Research Council of Canada
NTD	Normal treatment distance
ODI	Optical distance indicator
PMMA	Polymethyl methacrylate
PDD	Percentage depth dose
PSA	Prostate specific antigen
PTV	Planning target volume
QA	Quality assurance (the program)
QC	Quality control (specific tasks)
SSD	Source-to-surface distance
SRS	Stereotactic radiosurgery
SRT	Stereotactic radiotherapy
STP	Standard temperature and pressure
TBI	Total body irradiation
TG-	Publications of various AAPM Quality Assurance Task Groups
TLD	Thermoluminescent dosimeter
U	air-kerma strength (μGy m^2/h)
WHO	World Health Organization
σ	Standard deviation
ε_T	Timer/monitor end error

Frequencies:

Daily:	Once during every treatment day and separated by at least 12 hours.
Weekly:	On average once every 7 days and at intervals of between 5 and 9 days
Monthly:	On average once every four weeks and at intervals of between 3 and 5 weeks
Annually	On average once every 12 months and at intervals of between 10 and 14 months.

Output:

Output constancy check: a daily instrument reading (corrected for temperature and pressure) taken under reproducible geometrical conditions designed to check that the radiation output (e.g. cGy/MU) values in clinical use are not grossly in error.

Output Measurement: a determination of the absorbed dose to water (cGy) at a reference point in the photon beam for a chosen field size and beam quality.

Introduction

Patients receiving treatment in a Canadian cancer centre have a reasonable expectation that the quality of their treatment is independent of their geographic location or the centre they are attending. Insofar as medical physicists contribute to treatment quality, this expectation will be more closely met through the harmonisation of quality control standards across the country. The Canadian Association of Provincial Cancer Agencies (CAPCA) has initiated the process of standardisation of treatment quality in Canada through its draft document "Standards for Quality Assurance at Canadian Radiation Treatment Centres". This present document is an appendix to the CAPCA document and is concerned with quality control standards for use with conventional radiotherapy simulators. It is based on a report originally prepared for the Medical Physics Professional Advisory Committee of Cancer Care Ontario.

A quality control program on equipment used to deliver radiotherapy in a Canadian cancer centre must be carried out by, or under the direct supervision of, a qualified medical physicist. Here, a qualified medical physicist is one who is certified in Radiation Oncology Physics by the Canadian College of Physicists in Medicine or who holds equivalent certification. This individual, known as the supervising physicist, is responsible for ensuring compliance with the local quality control protocol, maintaining appropriate documentation, taking appropriate remedial actions and communication with other members of the radiation therapy team concerning the operational state of the equipment. Depending on local circumstances and organisational structure, one physicist may supervise quality control on all equipment or the responsibilities may be dispersed. However, the supervising physicist for a particular piece of equipment must have a direct line of communication to the Quality Assurance Committee for the Radiation Treatment Program.

This document contains specific performance objectives and criteria that the equipment should meet in order to assure an acceptable level of treatment quality. However, it does not recommend how the tests should be carried out. It is the responsibility of the supervising physicist to ensure that the locally available equipment and procedures are sufficiently sensitive to establish compliance or otherwise with the objectives and criteria specified here. There are many other publications dealing with the performance, specifications and quality control of radiation therapy simulators (Bomford, 1981; Bomford, 1989; Connors, 1984; Doppke, 1987; Heintz, 1991; McCullough, 1979; Van Dyk, 1993; IPEM 1999; AAPM 1994). Many of these publications have extensive reference lists. Some have detailed descriptions indicating how to conduct the various quality control tests.

Radiation safety activities are beyond the scope of this report. However, such activities may be integrated into routine quality control programs of equipment.

A successful quality assurance program is critically dependent upon adequately trained staff and a culture of continuous quality improvement. Educational opportunities to be offered to quality control staff must include new staff orientation, in-house continuous

education, conference participation and manufacturer's courses as appropriate. All such educational activities must be documented as part of the quality assurance program. Continuous quality improvement embodies the concepts of documentation, monitoring, review and feedback.

The standards promoted in this document are based on the experience of the authors and reviewers and are broadly consistent with recommendations from other jurisdictions (AAPM, 1994; IPEM, 1999; IAEA, 2003)). Although this document has undergone extensive review it is possible that errors and inaccuracies remain. It is hoped that the users of these standards will contribute to their further development through the identification of shortcomings and advances in knowledge that could be incorporated in future versions.

Performance Objectives and Criteria

Objectives and criteria for the evaluation of the performance of radiotherapy equipment fall into several categories.

1. Functionality. Equipment systems and sub-systems for which the criterion of performance is "Functional" are either working correctly or not. Such systems are commonly associated with the safety features of the equipment or installation. Operating a facility which has failed a test of functionality has the potential to expose patients and staff to hazardous conditions.

2. Reproducibilty. The results of routine quality control tests, for which reproducibility is the criterion, are assessed against the results obtained at installation from the accepted unit. Tolerances and action levels may be set for parameters that can be quantified.

3. Accuracy. Accuracy is the deviation of the measured value of a parameter from its expected or defined value. Examples are isocentre diameter and reference dosimetry (cGy/MU).

4. Characterisation and documentation. In some cases it is necessary to make measurements to characterise the performance of a piece of equipment before it can be used clinically. An example is the measurement of the ion collection efficiency of an ionization chamber.

5. Completeness. The use of this term is restricted to the periodic review of quality control procedures, analysis and documentation.

For quantities that can be measured, tolerance and action levels may be defined.

i. Tolerance Level. For a performance parameter that can be measured, a tolerance level is defined. If the difference between the measured value and its expected or defined value is at or below the stated tolerance level then no further action is required as regards that performance parameter.

ii Action Level. If the difference between the measured value and its expected or defined value exceeds the action level then a response is required immediately. The ideal response is to bring the system back to a state of functioning which meets all tolerance levels. If this is not immediately possible, then the use of the equipment must be restricted to clinical situations in which the identified inadequate performance is of no or acceptable and understood clinical significance. The decision on the most appropriate response is made by the supervising physicist in conjunction with the users of the equipment and others as appropriate. If the difference between the measured value and its expected or defined value lies between the tolerance and action levels, several courses of action are open. For a problem that is easily and quickly rectifiable, remedial action should be taken at once. An alternative course of action is to delay remedial intervention

until the next scheduled maintenance period. Finally, the decision may be made to monitor the performance of the parameter in question over a period of time and to postpone a decision until the behaviour of the parameter is confirmed. Once again, this will be a decision made by the supervising physicist in consultation with the users of the equipment and others as appropriate.

Documentation of equipment performance is essential and is discussed later. However, at the conclusion of a series of quality control tests it is essential to inform the users of the equipment of its status. If performance is within tolerance verbal communication with the users is sufficient. If one or more parameters fails to meet Action Level criteria, and immediate remedial action is not possible, then the users of the equipment must be informed in writing of the conditions under which the equipment may be used. Compliance with Action Levels but failure to meet Tolerance Levels for one or more parameters may be communicated verbally or in writing depending on the parameters and personnel involved. The judgement of those involved will be required to make this decision.

It is recognized that older equipment, which either was not designed to or is currently unable to meet the standards described here, is still providing a useful service to patients in many centres. In such cases, the equipment may fail to meet all action level requirements and the use of such equipment must be restricted to clinical situations in which the identified inadequate performance is of no or acceptable and understood clinical significance.

System Description

Simulators are essentially general radiography/fluoroscopy units with mechanical and optical capabilities extended to reproduce the geometric conditions of megavoltage radiation treatment machines. The mechanical and optical systems for simulators, therefore, must duplicate those for linear accelerators and Cobalt teletherapy units if appropriate. The radiation production systems, however, are very different for simulators and accelerators, the former being low dose and low energy imaging systems, the latter being high dose and high energy treatment systems.

Radiotherapy simulators have two roles in the preparation of patients for radiotherapy. The first is localisation in which the high contrast and resolution achievable with kilovoltage X-rays is used to guide the oncologist in the determination of the anatomical volumes to receive therapeutic radiation doses and those to be avoided. The information obtained during localisation can be used as the input to 2 dimensional dose computation. The second role is that of true simulation. Beams, which may have been designed during a 3 dimensional treatment planning process, are set up on the patient and the oncologist confirms that the geometric aspects of the treatment intent are being met. A limitation of current equipment in this regard is the inability to simulate non-coplanar and multi-leaf collimated fields.

Basic simulator design varies little across manufacturers. A rotatable gantry C-arm is mounted on a stand. The source end of the C-arm supports an X-ray head consisting of a shielded X-ray tube, field delineation and collimation systems; the opposing end supports an image receptor and film cassette holder. The X-ray head is translatable to enable different focus-to-axis distances. A treatment couch capable of translation, elevation and full rotation on a turntable is used to position the patient. A control console is located in a shielded area adjacent to the simulator room. Some of the mechanical and optical systems may also be operated using controls inside the simulator room, for example, a hand pendant.

Traditionally the image receptor mostly used has been an image intensifier. A permanent record of the X-ray image has been acquired either through digitally capturing the image as presented on the TV monitor connected to the camera viewing the output phosphor of the image intensifier or through the use of film. More recently, large area flat panel detectors have become widely available and these are finding increasing use in radiotherapy simulation.

A major difference between conventional radiography and therapy simulation is the large distance (typically 120 to 170 cm) between the X-ray focal spot and the image receptor. Since the simulator must have geometric flexibility (to rotate around the patient), the image receptor is further away from the patient. Furthermore, simulation often requires beam-patient geometries not normally used in conventional radiography/fluoroscopy, such as lateral or oblique views through large body thicknesses. These requirements result in higher skin exposures than would be encountered in diagnostic radiography. The requirement for geometric flexibility also limits the amount of shielding that can be attached to the X-ray image intensifier and precludes restrictions on X-ray beam size

Acceptance Testing and Commissioning

Simulators that are newly acquired or substantially upgraded require acceptance testing before being put into clinical service. Acceptance tests have three purposes:

- to ensure that the unit meets stated specifications,
- to establish baseline parameters for the future quality control program,
- to familiarize the customer with operation of the unit.

In addition acceptance testing of the equipment and facility will include establishing compliance with applicable radiation safety codes. These are included in federal and/or provincial regulations and it is the supervising physicist or designate's responsibility to be familiar with these requirements and to demonstrate compliance. Decommissioning of radiotherapy equipment and facilities may also be regulated by provincial and/or federal authorities.

Acceptance tests are customarily described in a document prepared by the vendor, although the purchaser may wish to specify additional tests. The document is signed by the purchaser upon satisfactory completion of testing, before which formal purchase of the unit should not be completed.

The standards for simulator acceptance testing should be consistent with routine quality control objectives and criteria applied subsequently. In particular, there is no reason why a new or upgraded simulator, and its associated safety systems, should not meet the Tolerance Levels detailed later in this document (Table 1). Optical, mechanical, radiographic and safety tests must be included. Several of these tests are based on an existing HARP (Healing Arts Radiation Protection) document, the X-ray Safety Code, Reg. 543 (Healing Arts Radiation protection Act, Ontario, 1990). The tests should be performed by, or under the supervision of, a qualified medical physicist.

Adherence to these standards (Table 1) must be demonstrated and documented, in or outside of the vendor's acceptance testing protocol, before a new simulator or major upgrade is accepted, and put into clinical service. Also, an appropriate subset of acceptance tests must be performed after any repair or preventive maintenance interventions on the simulator. The extent of testing required must be judged by a qualified medical physicist.

Commissioning generally refers to the acquisition of additional measured data from a unit after most acceptance testing is completed, with two purposes:

- for subsequent operating/performance calculations, for example, involving radiation dose,
- to establish baseline parameters for the future quality control program.

For simulators, the latter purpose dominates commissioning. Clearly all the tests listed in Table 1 must be performed at this time with the intended local test equipment and protocols if meaningful baselines are to be established.

Quality Control of Equipment

The purpose of a quality control program is to assure that operational standards for a unit that were considered acceptable at time of purchase continue to be maintained, as closely as possible, over the life of the unit. Thus, quality control tests typically are periodic repetitions, partial or full, of acceptance and commissioning tests. For simulators, tests are required for optical, mechanical, radiographic and safety systems.

The minimum standards for simulator quality control are listed in Table 1. These standards consist of a series of tests to be performed, along with their minimum frequency. The tests are derived from the published literature and, in particular, the standards laid out in the AAPM document, TG-40, (AAPM, 1994) and the IPEM document, Report 81 (IPEM, 1999). The Tolerance Level is typically set at 50-75% of the Action Level.

The tests should be performed by a qualified medical physicist, or a suitably trained individual working under the supervision of a qualified medical physicist. Independent verification of the results of quality control tests is an essential component of any quality control program. To ensure redundancy and adequate monitoring, a second qualified medical physicist must independently verify the implementation, analysis and interpretation of the quality control tests at least annually. This independent check must be documented.

Daily tests must be scheduled at the beginning of each working day. For other tests, testing at less than the minimum frequency is permissible only if experience has established that the parameters of interest are highly stable. Documentary evidence supporting this decision is essential. It is unlikely that a frequency of less than half that specified here could be justified. Conversely, a higher frequency of testing may be necessary in some circumstances where a parameter shows unacceptable instability. More frequent testing is at the discretion of the supervising physicist.

In the event that the equipment does not meet the stated performance objectives and criteria, an adjustment or repair should be effected. If it is not possible to restore the equipment to full performance immediately, then the use of the equipment must be restricted to clinical situations in which the identified inadequate performance is of no or acceptable and understood clinical significance. The decision on the most appropriate response is made by the supervising physicist in conjunction with the users of the equipment and others as appropriate

Preventive maintenance schedules and interventions are recommended by the manufacturer of the equipment and should be adhered to diligently. Following preventive maintenance or repair, the appropriate quality control tests selected from those listed in Table 1 must be performed before the unit is returned to clinical service. The extent of testing required must be judged by a qualified medical physicist. Frequently, equipment repairs and quality control testing are performed by different individuals. In such cases, good communication and reporting between the various staff involved are essential.

As pointed out previously, radiation safety activities are beyond the scope of this report. However, such activities may be integrated into routine quality control programs of equipment.

Documentation

Appropriate documentation is an essential component of a quality assurance program. All documents associated with the program should contain, as a minimum, the following information:

1. the name of the institution
2. the name of the originating department
3. the name(s) of the document's author(s)
4. the name of the individual(s) or group who approved the document for clinical use
5. the date of first issue
6. the number and date of the current revision

Further guidelines on the design of appropriate documentation may be found elsewhere (ISO 1994, Quality 2000)

Documents for use in a quality control program may be conveniently separated into two major categories: protocols and records. The protocols must be included in the Policy and Procedure Manual of the Radiation Treatment Quality Assurance Committee.

The quality control protocol contains the standards, or performance objectives and criteria, to be applied to the piece of equipment. Such standards are based on documents such as this. In addition to the specification of standards, the protocol should provide sufficient detail concerning the test equipment and procedures to be followed that there can be no residual ambiguity in the interpretation of the test results.

The quality control record contains the results of the tests, the date(s) on which they were performed and the signatures and qualifications of the tester and the supervising physicist. When the number of tests to be performed on a particular occasion is limited and the test procedure is simple it may be advantageous to combine the protocol and record into a single document.

In addition to the protocol and record, it is essential to have a means of documenting any corrective action that takes place together with any subsequent tests. Deviations from the locally approved protocol, such as those resulting from clinical pressure to access the equipment, must, of course, also be documented.

It is also necessary to maintain appropriate records of education, training, skills and experience of those involved with any aspect of the quality control program.

The documentation may be in any form or type of medium according to institutional policies.

Finally, all documentation related to the quality control program must be retained for at least ten years.

Table 1: Quality Control Tests

Designator	Test	Performance	
		Tolerance	Action
Daily			
DS1	Door interlock	Functional	
DS2	Motion interlock	Functional	
DS3	Beam status indicators	Functional	
DS4	Emergency off buttons	Functional	
DS5	Collision avoidance	Functional	
DS6	Lasers/crosswires	1	2
DS7	Optical distance indicator	1	2
DS8	Crosswires/Reticle/Block tray	1	2
DS9	Light/radiation coincidence	1	2
DS10	Field size indicators	1	2
Monthly			
MS1	Gantry angle readouts	0.5^{o}	1^{o}
MS2	Collimator angle readouts	0.5^{o}	1^{o}
MS3	Couch position readouts	1	2
MS4	Alignment of FAD movement	1	2
MS5	Couch isocentre	2	3
MS6	Couch parallelism	1	2
MS7	Couch angle	0.5^{o}	1^{o}
MS8	Laser/crosswire isocentricity	1	2
MS9	Optical distance indicator	1	2
MS10	Crosswire centring	1	2
MS11	Light/radiation coincidence	1	2
MS12	Field size indicators	1	2
MS13	Records	Complete	
Six monthly			
SS1	Lead apron	Functional	
SS2	kV_p	5%	10%
SS3	Reference dosimetry	5%	10%
SS4	Beam quality (HVL)	5%	10%
SS5	Automatic exposure control	5%	10%
SS6	Focal spot	Reproducible	
SS7	Contrast	Reproducible	
SS8	Resolution	Reproducible	
SS9	Fluoroscopic timer	5%	10%

Annually			
AS1	Redefine isocentre	1	2
AS2	Couch deflection	3	5
AS3	Alignment of focal spots	0.5	1
AS4	Independent quality control review	Complete	

Tolerance and Action Levels are specified in millimetres unless otherwise stated

Notes

Daily Tests

DS1,2,3,4,5 The configuration of these tests will depend on the design of the facility and equipment. Safety is the concern and tests should be designed accordingly. As a minimum, manufacturer's recommendations and applicable regulations must be followed.

DS6 Alignment of crosswires and appropriate lasers for collimator angle 0^o, gantry angles 0^o, 90^o and 270^o at an SSD of 85cm.

DS7 Gantry angle 0^o and at isocentre

DS8 Coincidence of crosswires and/or reticle and/or block tray axes for collimator angle 0^o, gantry angle 0^o and SSD 85cm.

DS9 Coincidence of the X-ray and optical images of the field defining wires for a $10x10cm^2$ field with a gantry angle 0^o, collimator angle 0^o and SSD 100cm. The Tolerance and Action Levels apply to each field border. With an appropriate tool the test may be performed using the real time imaging device.

DS10 Both the optical and X-ray images of the field defining wires for each field border should agree with the electronically indicated field size within the specified Tolerances and Action Levels and for the geometry in DS9 above. With a verified reticle these tests can be performed with the aid of the real time imaging device.

Monthly Tests

MS1 Mechanical and digital gantry angle readouts must be verified using a spirit level, or other appropriate leveling device, for at least 0^o, 90^o, 180^o and 270^o

MS2 Mechanical and digital collimator angle readouts must be verified using a spirit level,or other appropriate leveling device, for at least 0^o, 90^o and 270^o.

MS3	Mechanical and digital couch position readouts must be verified over an appropriate clinical range in the directions of the three cardinal axes.
MS4	Automatic setting of the Focus-Axis-Distance must be checked, if relevant, using mechanical devices.
MS5	The couch isocentricity must be checked over a range of couch angles from 90^o to 270^o.
MS6	With a couch angle 0^o, couch motions must parallel the cardinal axes of the simulator geometry over an appropriate clinical range.
MS7	The couch rotation angle must be verified over an appropriate clinical range.
MS8	The radiation isocentre is established radiologically using the real time imaging device. Alignment of the optical and mechanical systems at the isocentre is then confirmed for gantry angles of 0^o, 90^o and 270^o.
MS9	A mechanical device, calibrated against the true radiation isocentre, is used to provide the base reading for the check of the optical distance indicator. The standards stated in the Table apply at the isocentre. The optical distance indicator should be checked over a clinically relevant range of SSD and gantry angle. The tolerance and action level may be twice as large (i.e. 2 and 4mm) at the clinical limits of the optical distance indicator's range.
MS10	The coincidence of both the optical and radiological images of the crosswires are measured with respect to radiological isocentre at 100cm SSD for collimator angles of 0^o, 90^o and 270^o. Tolerances and Action Levels refer to the coincidence with the radiation isocentre.
MS11	Geometric alignment of the X-ray and optical images of the field defining wires must be established over a range of field sizes from $5x5cm^2$ to $35x35cm^2$ at gantry angles 0^o, 90^o and 270^o. Representative half blocked fields must be included. A minimum of six field sizes will be required for this test. Tolerances and Action Levels apply to each edge of a rectangular field.
MS12	Compliance of the X-ray and optical images of the field defining wires with the indicated dimensions must be established over a range of field sizes from $5x5cm^2$ to $35x35cm^2$ at gantry angles 0^o, 90^o and 270^o. Representative half blocked fields must be included. A minimum of six field sizes will be required for this test. Different field sizes may be examined at different gantry angles if appropriate and efficient. Tolerances and Action Levels apply to each edge of a rectangular field..
MS13	Documentation relating to the daily quality control checks, preventive maintenance, service calls and subsequent checks must be complete, legible and the operator identified.

Six monthly tests

SS1	Any available lead aprons, gloves and other protective wear should be visually and radiologically inspected for cracks and appropriate action taken should cracks be found

SS2	kV_p should be measured at at least three settings over the range from 60-120 kV_p. When measured non-invasively, Tolerances and Action Levels refer to baseline values established at acceptance and referenced to invasive measurements.
SS3	Tolerance and Action Levels refer to the coefficient of variation of 10 measurements of relative exposure at a typical set of operating parameters. These tests should be performed with and without Automatic Exposure Control.
SS4	Half value layer is to be compared at three kV_p values with the baseline values established at acceptance.
SS5	Where more than one detector can be used for Automatic Exposure Control consistency between the exposures delivered should be established.
SS6,7,8	A variety of equipment is available for performing these tests. In general the tests are subjective and the results are observer dependent. Tolerances and Action Levels will need to be developed locally depending on the equipment available and the performance variability of the observers. Routine monitoring of these parameters should be based on performance at installation.
SS9	The limit on fluoroscopy time is verified.

Annual tests

AS1	The mechanical, optical and radiation isocentre should be redefined and optical and mechanical systems re-aligned.
AS2	Couch deflection is measured with 70kg at the end with the couch extended to the isocentre.
AS3	Typical exposure factors are used
AS4	To ensure redundancy and adequate monitoring, a second qualified medical physicist must independently verify the implementation, analysis and interpretation of the quality control tests at least annually.

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