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Task Group 142 report: Quality assurance of medical accelerators 2009

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Many slides are borrowed from Eric Klein

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Task Group 142 report:
Quality assurance of medical accelerators

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Committee Tree

Task Group No. 142 QA of Medical Accelerators

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        - ⊟ **TG142 QA of Medical Accelerators** [Status]

» **Active Task Group listing**

» **AAPM Members Only Information**

Charge	1. To update, as needed, recommendations of Table 11 of the AAPM TG-40 Report on Quality Assurance. 2. To add recommendations for Asymmetric Jaws, Multileaf Collimation, and Dynamic/Virtual Wedges.
Bylaws	Not Referenced.
Rules	Not Referenced.
Approved Date(s)	Start: 11/21/2006 End: 12/31/2008

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Task Group Charge

Charge: 1. To update, as needed, recommendations of Table 11 of the AAPM TG-40 (1994) Report on Quality Assurance. 2. To add recommendations for asymmetric jaws, multileaf collimation, and dynamic/virtual wedges.

New Technology since TG 40

- MLC, Asymmetric Jaws, Dynamic & virtual wedges
- EPIDs
- Imaging: kV and cone beam
- Respiratory gating

Clinical procedures not emphasized in TG 40

- SRS, SBRT, TBI, IMRT

Refinements to linear accelerators since TG 40

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Since TG 40 (1994)

TG 50: AAPM REPORT NO. 72, Basic applications of multileaf collimators (2001)

TG 58: AAPM REPORT No. 75, Clinical use of electronic portal imaging: (2001)

TG 76: AAPM REPORT No. 91, The management of respiratory motion in radiation oncology (2006)

TG 106: Accelerator beam data commissioning equipment and procedures: A suggested protocol (2008)

TG 104: AAPM REPORT No. 104, The role of in-room kV x-ray imaging for patient setup and target localization (2009)

TG 100: Method for evaluating QA needs in radiation therapy (Future date??)

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Background to TG 142

The underlying principle behind TG-40 was the International Commission on Radiation Units and Measurements (ICRU) recommendation that the dose delivered to the patient be within ±5% of the prescribed dose.

Taking into consideration the many steps involved in delivering dose to a target volume in a patient, each step must be performed with accuracy better than 5% to achieve this recommendation.

The goal of a QA program for linear accelerators is to assure that the machine characteristics do not deviate significantly from their baseline values acquired at the time of acceptance and commissioning.

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Linac QA TG-40 (1994)

Daily

TABLE II. QA of medical accelerators.

Frequency	Procedure	Tolerance[a]
Daily	Dosimetry	
	X-ray output constancy	3%
	Electron output constancy[b]	3%
	Mechanical	
	Localizing lasers	2 mm
	Distance indicator (ODI)	2 mm
	Safety	
	Door interlock	Functional
	Audiovisual monitor	Functional

TG 40 Monthly

Monthly	Dosimetry	
	x-ray output constancy[c]	2%
	Electron output constancy[c]	2%
	Backup monitor constancy	2%
	x-ray central axis dosimetry parameter (PDD, TAR) constancy	2%
	Electron central axis dosimetry parameter constancy (PDD)	2 mm @ therapeutic depth
	x-ray beam flatness constancy	2%
	Electron beam flatness constancy	3%
	x-ray and electron symmetry	3%
	Safety Interlocks	
	Emergency off switches	Functional
	Wedge, electron cone interlocks	Functional
	Mechanical Checks	
	Light/radiation field coincidence	2 mm or 1% on a side[d]
	Gantry/collimator angle indicators	1 deg
	Wedge position	2 mm (or 2% change in transmission factor)
	Tray position	2 mm
	Applicator position	2 mm
	Field size indicators	2 mm
	Cross-hair centering	2 mm diameter
	Treatment couch position indicators	2 mm/1 deg
	Latching of wedges, blocking tray	Functional
	Jaw symmetry[e]	2 mm
	Field light intensity	Functional

TG 40 Annually

Annual	Dosimetry	
	x-ray/electron output calibration constancy	2%
	Field size dependence of x-ray output constancy	2%
	Output factor constancy for electron applicators	2%
	Central axis parameter constancy (PDD, TAR)	2%
	Off-axis factor constancy	2%
	Transmission factor constancy for all treatment accessories	2%
	Wedge transmission factor constancy[f]	2%
	Monitor chamber linearity	1%
	x-ray output constancy vs gantry angle	2%
	Electron output constancy vs gantry angle	2%
	Off-axis factor constancy vs gantry angle	2%
	Arc mode	Mfrs. specs.
	Safety Interlocks	
	Follow manufacturers test procedures	Functional
	Mechanical Checks	
	Collimator rotation isocenter	2 mm diameter
	Gantry rotation isocenter	2 mm diameter
	Couch rotation isocenter	2 mm diameter
	Coincidence of collimetry, gantry, couch axes with isocenter	2 mm diameter
	Coincidence of radiation and mechanical isocenter	2 mm diameter
	Table top sag	2 mm
	Vertical travel of table	2 mm

MLC QA per TG-50 (2001)

Frequency	Test	Tolerance
Patient Specific	Check of MLC-generated field vs. simulator film (or DRR) before each field is treated	2 mm
	Double check of MLC field by therapists for each fraction	Expected field
	On-line imaging verification for patient on each fraction	Physician discretion
	Port film approval before second fraction	Physician discretion
Quarterly	Setting vs. light field vs. radiation field for two designated patterns	1 mm
	Testing of network system	Expected fields over network
	Check of interlocks	All must be operational
Annually	Setting vs. light vs. radiation field for patterns over range of gantry and collimator angles	1 mm
	Water scan of set patterns	50% radiation edge within 1 mm
	Film scans to evaluate interleaf leakage and abutted leaf transmission	Interleaf leakage <3%, abutted leakage <25%
	Review of procedures and in-service with therapists	All operators must fully understand operation and procedures

*This table is reproduced in part from Klein, Low, and Purdy (1996).

TG-58 (EPIDs) (2001)

TABLE IV. Frequency of QA tasks.

Interval	Task (P—physicist, M—manufacturer, E—engineer, T—therapist)
Daily	Inspect imager housing (T)
	Test collision interlock (T)
	Acquire day's first image during machine warm-up procedure to verify operation and image quality (T)
	Verify sufficient data capacity for day's images (P or designate)
Monthly	Acquire image and inspect for artifacts (P)
	Perform constancy check of SNR, resolution and localization (P)
	Review image quality
	Perform image and disk maintenance (P)
	Mechanical inspection [latches, collision sensors, optical components (P,E)]
	Electrical connections (P,E)
	Test collision interlock (P)
	Hardcopy output (P)
Annual	Perform full check of geometric localization accuracy (P)

The Resource Problem

- Lack of adequate guidance for resource allocation
- Lack of qualified personnel
- Rapid implementation of new technology
  - More sophisticated equipment
  - More resources
  - Clinics are under pressure to implement new technology
- Lack of timely guidelines

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Task Group No. 100: Method for Evaluating QA Needs in Radiation Therapy

- Initially “Replacement for TG-40”
- New approach compared to previous AAPM recommendations and philosophy
- Based on “Failure Modes and Effects Analysis”
- Individual departments responsible for development of unique QA programs
- Based on procedures and resources performed at individual institutions

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Failure Modes and Effects Analysis

- Three part system
  - Frequency of error
  - Severity of error
  - Probability that an error would be detected

Probability of error	Severity	Probability of detection	RPN
A	B	C	A*B*C

Risk Priority Number (RPN) = Frequency*Severity*Probability

Proposed Quality Assurance Process

- Custom designed QA programs
- AAPM Report will provide templates
- Scoring performed by individual departments
- Tolerances set by individual departments
- Annual evaluation and modifications based on score changes

Task Group No. 142:
QA of Medical Accelerators

I. INTRODUCTION
A. Purpose
B. Background

II. QUALITY ASSURANCE OF MEDICAL ACCELERATORS
A. General
B. Test Frequencies
C. Guidelines for Tolerance Values
D. Ancillary Devices Not in TG-40
- Asymmetric Jaws
- Dynamic/Virtual/Universal Wedges
- MLC
- TBI/TSET
- Radiographic Imaging
  - Megavoltage Planar Imaging (Portal Imagers)
  - Planar kV Imaging
  - Serial and Cone-Beam CT
- Respiratory Gating

III. SUMMARY OF RECOMMENDATIONS/IMPLEMENTATION SCHEME

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BACKGROUND

- Baseline values are entered into treatment planning systems to characterize and/or model the treatment machine, and therefore can directly affect treatment plans calculated for every patient treated on that machine
- Machine parameters can deviate from their baseline values as a result of many reasons
  - Machine malfunction
  - Mechanical breakdown
  - Physical accidents
  - Component failure
  - Major component replacement
  - Gradual changes as a result of aging
- These patterns of failure must be considered when establishing a periodic QA program

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QA of MEDICAL ACCELERATORS

- **What This Report Doesn't Do**
  - **Describe the techniques for performing QA tests (TG 198)**
  - **Accelerator beam data commissioning equipment and procedures – TG-106**
  - **QA for TomoTherapy –TG-148**
  - **QA for Robotic Radiosurgery – TG-135**
  - **QA for Non-Radiographic Radiotherapy Localization & Positioning Systems – TG-147**
- **Does add Specific Recommendations / Supplements the Work of**
  - **Basic Applications of Multileaf Collimators – TG-50**
  - **Clinical use of electronic portal imaging - TG-58**
  - **Management of Respiratory Motion– TG-76**
  - **Kilovoltage localization in therapy – TG-104**

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TG198 - An implementation guide for TG-142: QA of medical linear accelerators

1) Provide specific procedural guidelines for performing the tests recommended in TG-142.
2) Provide estimate of the range of times, appropriate personnel and qualifications necessary to complete the tests in TG-142. 3) Provide Sample Daily/Weekly/Monthly/Annual QA forms.

Task Group No. 142:
QA of Medical Accelerators

"The recommendations of this task group are not intended to be used as regulations. These recommendations are guidelines for qualified medical physicists (QMP) to use and appropriately interpret for their individual institution and clinical setting. Each institution may have site-specific or state mandated needs and requirements which may modify their usage of these recommendations."

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Task Group No. 142:
Guidelines for Tolerance Values

- **The recommendations of TG-142 should be flexible enough to take into account quality, costs, equipment condition, available test equipment, and institutional needs.**
- **We do recommend using the tests and frequencies outlined in the tables that follow, until methods such as TG-100 supersede this report.**

Task Group No. 142: General

- **A *Consistent beam profile* is an important quantity for accurate and reproducible dose delivery in radiotherapy.**
- **In our tables, the monthly tolerance values are specific to a consistent beam shape, whereby baseline off axis factors were measured with a QA device immediately following commissioning or annual data.**
- **Ongoing QA measurements are compared to the baseline off axis factors.**

Task Group No. 142: General

Chosen O.A. point locations will generally fall within core of the field

$$\frac{1}{N} \cdot \sum_{L=1}^{N} \left| \frac{TP_L - BP_L}{BP_L} \right| \cdot 100\% \leq Tolerance\ \%$$

- **where: TP_L and BP_L are off-axis ratios at Test and Baseline Points, respectively, at off axis Point L**
- **N is the number of off-axis points**
- **TPL = (MP_L/MP_C) where M represents the measurement value and C is the central axis measurement.**
- **Similarly, the baseline points are represented by BP_L = (MBP_L/MBP_C)**

Task Group No. 142: QA of Medical Accelerators

- **The types of treatments delivered with the machine should also have a role in determining the QA program that is appropriate for that treatment machine.**
- **For example, machines that are used for SRS/SBRT treatments, TBI or IMRT require different tests and/or tolerances.**

Task Group No. 142:
Test Frequencies

- **In this report there are additional factors that affect the frequency of the tests, specifically: the type of treatments delivered on the machine; and the manufacturer of the machine.**

- **For example, electron output is to be tested more frequently on a Siemens machine which possesses an electron beam specific, unsealed monitor chamber system, compared to the Varian machine with a multi-modality sealed monitor chamber.**

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Task Group No. 142: **Guidelines for Tolerance Values**

- **Acceptance Testing Procedure (ATP) Standards**
  - *Acceptance testing sets the baseline for future dosimetric measurements for beam performance constancy, verifies that the equipment is mechanically functional and operates within certain tolerances from absolute specified values.*
- **Tolerances and Action Levels**
  - **Level 1 – Inspection Action**
  - **Level 2 – Scheduled Action**
  - **Level 3 – Immediate Action or Stop Treatment Action or Corrective Action**

With these 3 action levels, there is an institutional need to specify the thresholds associated with Levels 2 and 3. Level 1 threshold isn't a critical requirement but can lead to improvements in the QA program.

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TG-142: Daily

Procedure	Tolerance (non-IMRT machines)	Tolerance (IMRT machines)	Tolerance (Stereotactic machines)
Dosimetry			
X-ray output constancy (all energies)	3%		
Electron output constancy (Weekly, except for machines with unique e- monitoring requiring daily)			
Mechanical			
Laser localization	2 mm	1.5 mm	1 mm
Distance indicator (ODI)@ iso	2 mm	2 mm	2 mm
Collimator size indicator	2 mm	2 mm	1 mm
Safety			
Door interlock (beam off)	Functional		
Door closing safety	Functional		
Audiovisual monitor(s)	Functional		
Stereotactic interlocks (lockout)	NA	NA	Functional
Radiation area monitor (if used)	Functional		
Beam on indicator	Functional		

Daily

Procedure	Tolerance (non-IMRT machines)	Tolerance (IMRT machines)	Tolerance (Stereotactic machines)
Dosimetry			
X-ray output constancy (all energies)	3%		
Electron output constancy (Weekly, except for machines with unique e- monitoring requiring daily)			
Mechanical			
Laser localization	2 mm	1.5 mm	1 mm
Distance indicator (ODI)@ iso	2 mm	2 mm	2 mm
Collimator size indicator	2 mm	2 mm	1 mm
Safety			
Door interlock (beam off)	Functional		
Door closing safety	Functional		
Audiovisual monitor(s)	Functional		
Stereotactic interlocks (lockout)	NA	NA	Functional
Radiation area monitor (if used)	Functional		
Beam on indicator	Functional		

TG-142: Monthly

Procedure	Tolerance (non-IMRT machines)	Tolerance (IMRT machines)	Tolerance Stereotactic machines
Dosimetry			
X-ray output constancy	2%		
Electron output constancy			
Backup monitor chamber constancy			
Typical dose rate[2] output constancy	NA	2% (@ IMRT dose rate)	2% (@ stereo dose rate, MU)
Photon beam profile constancy	1%		
Electron beam profile constancy			
Electron beam energy constancy	2%/2mm		

Monthly

Procedure	Tolerance (non-IMRT machines)	Tolerance (IMRT machines)	Tolerance Stereotactic machines
Mechanical			
Light/radiation field coincidence*	2 mm or 1% on a side		
Light/radiation field coincidence* (Asymmetric)	1 mm or 1% on a side		
Distance check device used for lasers/ODI (vs. front pointer)	1mm		
Gantry/collimator angle indicators (@ cardinal angles) (Digital only)	1.0 deg		
Accessory trays (i.e. Port film graticle tray)	2 mm		
Jaw position indicators (Symmetric)3	2 mm		
Jaw position indicators (Asymmetric)1	1 mm		
Cross-hair centering (walk-out)	1 mm		
Treatment couch position indicators4	2 mm/1 deg	2 mm/ 1 deg	1 mm/ 0.5 deg
Wedge placement accuracy	2mm		
Latching of wedges, blocking tray5	Functional[5]		
Localizing lasers	±2 mm	±1 mm	<±1 mm

Monthly

Procedure	Tolerance (non-IMRT machines)	Tolerance (IMRT machines)	Tolerance Stereotactic machines
Mechanical			
Light/radiation field coincidence*	2 mm or 1% on a side		
Light/radiation field coincidence* (Asymmetric)	1 mm or 1% on a side		
Distance check device used for lasers/ODI (vs. front pointer)	1mm		
Gantry/collimator angle indicators (@ cardinal angles) (Digital only)	1.0 deg		
Accessory trays (i.e. Port film graticle tray)	2 mm		
Jaw position indicators (Symmetric)3	2 mm		
Jaw position indicators (Asymmetric)1	1 mm		
Cross-hair centering (walk-out)	1 mm		
Treatment couch position indicators	**2 mm/1 deg**	**2 mm/ 1 deg**	**1 mm/ 0.5 deg**
Wedge placement accuracy	2mm		
Latching of wedges, blocking tray5	Functional[5]		
Localizing lasers	±2 mm	±1 mm	<±1 mm

Monthly

Procedure	Tolerance (non-IMRT machines)	Tolerance (IMRT machines)	Tolerance Stereotactic machines
Respiratory gating			
Beam output constancy	2%		
Phase, Amplitude beam control	Functional		
In room respiratory monitoring system	Functional		
Gating interlock	Functional		

TG-142: Annual

Procedure	Tolerance (non-IMRT machines)	Tolerance (IMRT machines)	Tolerance Stereotactic machines
Dosimetry			
X-ray flatness change from baseline	1%		
X-ray symmetry change from baseline	±1%		
Electron flatness change from baseline	1%		
Electron symmetry change from baseline	±1%		
SRS Arc rotation mode (range: 0.5 to 10 MU/deg)	NA	NA	Monitor units set vs. delivered:1.0 MU or 2% (whichever is greater) Gantry arc set vs. delivered: 1.0 deg or 2% (whichever is greater)
X-ray/electron output calibration (TG-51)	±1%(absolute)		
Spot check of field size dependent output factors for X-ray (2 or more FS)	2% for field size < 4x4 cm^2, 1% ≥4x4 cm^2		
Output factors for electron applicators (spot check of 1 applicator/energy)	±2% from baseline		
X-ray beam quality (PDD_{10}, TMR_{10}^{20})	±1% from baseline		
Electron beam quality (R_{50})	±1mm		
Transmission factor constancy for all treatment accessories	±1% from baseline		
Physical wedge transmission factor constancy	±2%		

Annual

Procedure	Tolerance (non-IMRT machines)	Tolerance (IMRT machines)	Tolerance Stereotactic machines
X-ray monitor unit linearity [output . constancy]	±2% ≥5MU	±5% (2-4 MU), ±2% ≥5MU	±5% (2-4), ±2% ≥5MU
Electron monitor unit linearity [output . constancy]	±2% ≥5MU		
X-ray output constancy vs dose rate	±2% from baseline		
X-ray output constancy vs gantry angle	±1% from baseline		
Electron output constancy vs gantry angle	±1% from baseline		
Electron and X-ray Off-axis factor constancy vs gantry angle	±1% from baseline		
Arc mode (expected MU, degrees)	±1% from baseline		
TBI/TSET Mode	Functional		
PDD or TMR and OAF constancy	1% (TBI) or 1mm PDD shift (TSET) from baseline		
TBI/TSET Output calibration	2% from baseline		
TBI/TSET accessories	2% from baseline		

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Annual

Procedure	Tolerance (non-IMRT machines)	Tolerance (IMRT machines)	Tolerance Stereotactic machines
Mechanical			
Collimator rotation isocenter	±1 mm from baseline		
Gantry rotation isocenter	±1 mm from baseline		
Couch rotation isocenter	±1 mm from baseline		
Electron applicator interlocks	Functional		
Coincidence of radiation and mechanical isocenter	±2mm from baseline	±2mm from baseline	±1mm from baseline
Table top sag	2mm from baseline		
Table Angle	1 degree		
Table travel maximum range movement in all directions	±2mm		
Stereotactic accessories, lockouts, etc	NA		Functional
Safety			
Follow manufacturers test procedures	Functional		
Respiratory gating			
Beam energy constancy	2%		
Temporal accuracy of Phase/Amplitude Gate-on	100 ms of expected		
Calibration of surrogate for respiratory phase/amplitude	100 ms of expected		
Interlock testing	Functional		

Dynamic/Universal/Virtual Wedges

Dynamic-incl. EDW (Varian), Virtual (Siemens), Universal (Elekta) Wedge quality assurance				
Frequency	**Procedure**	**Tolerance**		
		Dynamic	**Universal**	**Virtual**
Daily	Morning Check-out run for 1 angle	Functional		
Monthly	Wedge factor for all energies	C.A. Axis 45º or 60° WF (within 2%)*	C.A. Axis 45º or 60° WF (within 2%)*	5% from unity, otherwise 2%
Annual	Check of wedge angle for 60°, full field & spot check for intermediate angle, field size	Check of Off-center ratios @ 80% field width @ 10cm to be within 2%		

* Recommendation to check 45º if angles other than 60º are used.

Multileaf Collimation

Multi-leaf collimation quality assurance (with differentiation of IMRT vs. non-IMRT machines)		
Frequency	**Procedure**	**Tolerance**
Weekly (IMRT machines)	Qualitative test (i.e. matched segments, aka, “picket fence”)	Visual inspection for discernable deviations such as an increase in interleaf trransmission
Monthly	Setting vs. radiation field for two patterns (non-IMRT)	2mm
	Backup diaphragm settings (Elekta only)	2mm
	Travel speed (IMRT)	Loss of leaf speed > 0.5 cm/sec
	Leaf position accuracy (IMRT)	1mm for leaf positions of an IMRT field for 4 cardinal gantry angles. (*Picket fence* test may be used, test depends on clinical planning – segment size)

Multileaf Collimation: Annual Tests

MLC Transmission (Average of leaf and interleaf transmission), All Energies	±0.5% from baseline
Leaf position repeatability	±1.0 mm
MLC spoke shot	≤1.0 mm radius
Coincidence of Light Field and X-ray Field (All energies)	±2.0 mm
Arc dynamic leaf-speed test	<0.35 cm Max Error RMS, 95% of error counts <0.35 cm (Varian)
Arc dynamic interlock trip test	Leaf position interlock occurs (Varian)
Arc dynamic typical plan test	<0.35 cm Max Error RMS, 95% of error counts <0.35 cm (Varian)
Segmental IMRT (Step and Shoot) Test	<0.35 cm Max Error RMS, 95% of error counts <0.35 cm (Varian)
Moving window imrt (4 cardinal gantry angles)	<0.35 cm Max Error RMS, 95% of error counts <0.35 cm (Varian)

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Imaging Tests: Daily

Procedure	Non-SRS/SBRT Applications Tolerances	SRS/SBRT Applications Tolerances
Daily		
MV imaging (EPID)		
Collision interlocks	Functional	Functional
Spatial linearity1 (x and y) (single gantry angle)	< 2 mm	≤ 1 mm
Imaging & Treatment coordinate coincidence (single gantry angle)	< 2 mm	≤ 1 mm
Positioning/repositioning	< 2 mm	≤ 1 mm
KV imaging[2]		
Collision interlocks	Functional	Functional
Imaging & treatment coordinate coincidence	< 2 mm	≤ 1 mm
Positioning/repositioning	< 2 mm	≤ 1 mm
Cone-beam CT (kV & MV)		
Collision interlocks	Functional	Functional
Positioning/repositioning	< 2 mm	≤ 1 mm

Imaging Tests: Monthly

Procedure	Non-SRS/SBRT Applications Tolerances	SRS/SBRT Applications Tolerances
MV imaging (EPID)		
Imaging & treatment coordinate coincidence (4 Cardinal angles)	< 2 mm	≤ 1 mm
Scaling3	< 2 mm	< 2 mm
Spatial resolution	Baseline[4]	Baseline
Contrast	Baseline	Baseline
Uniformity and noise	Baseline	Baseline
kV imaging		
Imaging & treatment coordinate coincidence (4 Cardinal angles)	< 2 mm	≤ 1 mm
Scaling	< 2 mm	≤ 1 mm
Spatial linearity (x and y) (single gantry angle)	< 2 mm	≤ 1 mm
Spatial resolution	Baseline	Baseline
Contrast	Baseline	Baseline
Uniformity and noise	Baseline	Baseline
Cone-beam CT (kV & MV)		
Imaging & treatment coordinate coincidence	< 1.5 mm	≤ 1 mm
Geometric distortion	< 2 mm	≤ 1 mm
Spatial resolution	Baseline	Baseline
Contrast	Baseline	Baseline
HU constancy	Baseline	Baseline
Uniformity and noise	Baseline	Baseline
Spatial linearity (x and y) (single gantry angle)	< 1 mm	≤ 1 mm

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Imaging Tests: Annual

Procedure	Non-SRS/SBRT Applications Tolerances	SRS/SBRT Applications Tolerances
MV imaging (EPID)		
Full range of travel SDD	±5 mm	±5 mm
Imaging dose5	Baseline	Baseline
Beam quality / energy	Baseline	Baseline
kV imaging		
Beam quality / energy	Baseline	Baseline
Imaging dose	Baseline	Baseline
Cone-beam CT (kV & MV)		
Imaging dose	Baseline	Baseline

SUMMARY OF RECOMMENDATIONS/ IMPLEMENTATION SCHEME

The tabulated items of this report have been considerably expanded as compared with the original TG 40 report and the recommended tolerances accommodate differences in the intended use of the machine functionality (non-IMRT, IMRT, and Stereotactic Delivery).

SUMMARY OF RECOMMENDATIONS/ IMPLEMENTATION SCHEME

1) A QA team support all QA activities and draft policies and procedures. The policy should establish roles and responsibilities. For QA measurements, detailed instructions on equipment use, cross-calibration, measurement frequency, and documentation of the results should be provided.

2) The 1st step is to establish institution-specific baseline and absolute reference values. The QA team needs to meet and monitor the results against the established values.

SUMMARY OF RECOMMENDATIONS/ IMPLEMENTATION SCHEME

3) A QMP should lead the QA team. The QMP provides action level and methods of notification when tolerances are exceeded.

4) Daily QA tasks may be carried out by a RTT using a cross-calibrated dosimetry system that is robust and easy-to-setup. Correction factors should be documented in a permanent electronic or hardcopy format for inspection purposes. The QMP should review and sign off on the reports at least once per month.

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SUMMARY OF RECOMMENDATIONS/ IMPLEMENTATION SCHEME

5) Monthly tasks should be performed by (or directly supervised by) a QMP. It is recognized there is overlap of tests for daily, monthly, and annual. This overlap should have independence achieved with independent measurement devices. This will identify trends that may go undetected.

6) It is recommended annual measurements be performed by a QMP. QA devices should be checked prior to measurements. The measurements should be carried out using commissioning quality equipment as recommended the TG-106 report.

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SUMMARY OF RECOMMENDATIONS/ IMPLEMENTATION SCHEME

7) End-to-end system checks ensure fidelity of overall system. This can be done by creating plans typical of the facility's clinic, transferring the plan data across the data network, and delivering them.

8) During the annual QA, absolute outputs should be calibrated as per TG51. Subsequently, all secondary QA dosimeters should be cross-checked against such calibrations.

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SUMMARY OF RECOMMENDATIONS/ IMPLEMENTATION SCHEME

Upon completion of the measurements, an annual QA report be generated. The report should state significant findings based on tolerance values. The report can be divided into sections; (1) Dosimetry, (2) Mechanical, (3) Safety, (4) Imaging, and (5) Special Devices/Procedures. The QA report should be signed and reviewed by the QMP and filed for future machine maintenance and inspection needs.

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