MPPG 8
LINAC QA From Paper to Practice

Rob Krauss, DMP, DABR
Chief Physicist, RSO
St. Francis Hospital
Memphis, TN

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No disclosures
How did we get here?

- AAPMs first crack at "Comprehensive quality assurance program"
- 5% dose benchmark

Task Group 40 (1994)
- Specifically supersedes Report No. 13
- ~40 pages; attempts to cover all aspects of radiation oncology
- Not completely superseded by other, newer documents (!)

Task Group 142 (2009)
- Update to TG-40 Table II (technological advances, IMRT, SRS, SBRT)
- Does not supersede the rest of TG-40

MPPG 2, 5, 8 & 9 / TG-100 (2014 – present)

Why MPPG 8/What’s wrong with TG-142?

Anecdotes/Opinions
- Not accessible to the solo/community/rural/??? Physicist
- Made by academics for academics
- Tolerances too tight
- Too many unnecessary tests
- Need too much new equipment
- I heard other physicists complaining about it

Reality
- Almost 10 years since TG-142
- Despite disclaimer, is being used as regulation/policy/accreditation
- Did not cover VMAT
- Some tests somewhat ambiguous
- Physicists want a “safety blanket” that definitively defines the critical minimum

MOST IMPORTANT:

- Fills gap between TG-40 and TG-100

Klein, E, “The Aftermath of TG-142,” Presented at AAPM Annual meeting 2015
What is MPPG 8?

- A list of critical performance tests
  - Gives basic reason for each test
  - Basic actions upon failure
  - General description of type of equipment

- Tests (mostly) based off of FMEA (TG-100)
  - Committee members/colleagues scored >> 25 physicists
  - Limited rearranging of test priority do to clinical experience
  - Dramatic departure from previous “expert consensus” approach

- Practical! (getting into personal opinion...)
  - Tests/frequency based on clinical impact of failures
  - “Generic” TG-100 test list
    - TG-100 will take a while to adopt
    - May not be realistic for some clinics

What is MPPG 8 Not?

- NOT a replacement for TG-142 (but)
  - Different methodology
  - Alternative perspective on what baseline is

- (Still) NOT a cookbook of what tests to perform
  - Does form a more explicit list of critical tests
  - More practical, data driven approach to QA (my opinion)
  - Does go into more detail about each test

- NOT a substitution for performing own analysis
  - Critical tests provide a starting point for all clinics
  - “Safety blanket” for local TG-100 analysis
### Dosimetry Tests

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Tolerance</th>
<th>Frequency</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>3%</td>
<td>Daily</td>
<td>3%</td>
</tr>
<tr>
<td>Monthly</td>
<td>2%</td>
<td>Monthly</td>
<td>2%</td>
</tr>
<tr>
<td>Annual</td>
<td>1%</td>
<td>Annual</td>
<td>1%</td>
</tr>
<tr>
<td>Weekly</td>
<td>3%</td>
<td>Daily</td>
<td>3%</td>
</tr>
<tr>
<td>Monthly</td>
<td>2%</td>
<td>Monthly</td>
<td>2%</td>
</tr>
<tr>
<td>Annual</td>
<td>1%</td>
<td>Annual</td>
<td>1%</td>
</tr>
</tbody>
</table>

#### Charts

- **Mechanical**
- **TG-142**
- **MPPG 8**

### Mechanical Tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Frequency</th>
<th>Tolerance</th>
<th>Frequency</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Law position/jaw</td>
<td>Daily</td>
<td>2 mm/jaw single field</td>
<td>Daily</td>
<td>2 mm/jaw clinical range</td>
</tr>
<tr>
<td>Jaw-position-sym</td>
<td>Monthly</td>
<td>2 mm</td>
<td>Monthly</td>
<td>1 mm</td>
</tr>
<tr>
<td>Jaw-position-asym</td>
<td>Monthly</td>
<td>2 mm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Charts**

- **TG-142**
- **MPPG 8**

### More stringent tolerance and/or frequency

- **TG-142**
- **MPPG 8**

### Added test

- **TG-142**
- **MPPG 8**

### Relaxed tolerance/frequency

- **TG-142**
- **MPPG 8**

### Clarified/expansion/existing test to replace older test

- **TG-142**
- **MPPG 8**

### Clarified/new test

- **TG-142**
- **MPPG 8**

### Minor expansion clarification of existing tests

- **TG-142**
- **MPPG 8**

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**Note:** Assumes functional if other test performed.
More stringent tolerance and/or frequency

Added test

Relaxed tolerance/frequency

Not included

Clarified/expanded/existing test to replace older test

Replaced by above

Detail expansion/clarification of existing tests

### Safety

<table>
<thead>
<tr>
<th>TG-142</th>
<th>MPPG 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Door interlock</td>
<td>Frequency</td>
</tr>
<tr>
<td>Door closing</td>
<td>Daily</td>
</tr>
<tr>
<td>Audiovisual</td>
<td>Daily</td>
</tr>
<tr>
<td>Stereotactic lockouts</td>
<td>Daily</td>
</tr>
</tbody>
</table>

| Radiation area monitor | Daily | Functional |

| Beam on indicator | Daily | Functional | Daily | Functional (console; door) |

| Anti-collision test | Daily | Functional (single point) | Monthly | Functional (all) |

| Safety procedures | Monthly | Functional | GMP | Functional |

| Manufacturer’s tests | Annual | Functional |

### Wedges

<table>
<thead>
<tr>
<th>TG-142</th>
<th>MPPG 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard Wedge placement</td>
<td>Frequency</td>
</tr>
<tr>
<td>EOW check-run</td>
<td>Daily</td>
</tr>
</tbody>
</table>

| WF all energies | Monthly | 2% for 45 or 60 | Monthly | 2% for steepest wedge (if not measured daily) |

| 300 deg OCA exam (spot check other angles/hs) | Annual | 2% @ 80% field @ 10 cm | Annual | 2% of TPS OAFs |

| WF all angles | Annual | 2% of TPS |

### MPPG 8 Implementation

1. Decide what and when tests are critical for your clinic
   - (Recommend) include all of MPPG 8
   - Increase frequency, as necessary
   - TG-142 tests that were dropped
   - Other tests?
Tests Modified at SFH:

- Dose rate constancy >>> Monthly

Tests Added at SFH:

- FS dependent output factors
- Electron cone factors
- DLG/leaf-leakage semi-annual*

Tests Modified at SFH:

- Alternate WFs measured monthly

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<table>
<thead>
<tr>
<th>Item</th>
<th>Test</th>
<th>Frequency</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Photon and electron output constancy</td>
<td>Monthly</td>
<td>2% of reading</td>
</tr>
<tr>
<td>02</td>
<td>Photon and electron beam profile constancy</td>
<td>Monthly</td>
<td>2% of TPS DAP*</td>
</tr>
<tr>
<td>03</td>
<td>Electron beam energy</td>
<td>Annual</td>
<td>2 mm</td>
</tr>
<tr>
<td>04</td>
<td>Photon beam energy</td>
<td>Monthly</td>
<td>2% of TPS DAP at reference depth</td>
</tr>
<tr>
<td>05</td>
<td>Median deviation control</td>
<td>Monthly</td>
<td>2% of open field dose</td>
</tr>
<tr>
<td>06</td>
<td>Structure atlas (potted organism)</td>
<td>Annual</td>
<td>2% of TPS DAP for represented field</td>
</tr>
<tr>
<td>07</td>
<td>Electron-HV setup (Kinematic)</td>
<td>Annual</td>
<td>2% for collimated field</td>
</tr>
<tr>
<td>08</td>
<td>Electron output to dose rate</td>
<td>Monthly</td>
<td>2%</td>
</tr>
<tr>
<td>09</td>
<td>Photon and electron output in gantry angle</td>
<td>Annual</td>
<td>2% of TPS DAP for gantry angle</td>
</tr>
<tr>
<td>11</td>
<td>Photon and electron QA in gantry angle</td>
<td>Annual</td>
<td>2% of TPS DAP for gantry angle</td>
</tr>
<tr>
<td>12</td>
<td>Acid mode treatment for angle</td>
<td>Annual</td>
<td>2% for H1 and H2</td>
</tr>
</tbody>
</table>

*Tests are conducted within the limits identified in the ramping.

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<th>Item</th>
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<th>Frequency</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-1</td>
<td>Localizing limit</td>
<td>Daily</td>
<td>3 mm</td>
</tr>
<tr>
<td>11-2</td>
<td>Optical density indicator</td>
<td>Monthly</td>
<td>2 mm at tolerance</td>
</tr>
<tr>
<td>11-3</td>
<td>Air gap indicators</td>
<td>Daily</td>
<td>2 mm per gantry for single gantry</td>
</tr>
<tr>
<td>11-4</td>
<td>Upright to radiation field collimator</td>
<td>Monthly</td>
<td>2 mm per gantry</td>
</tr>
<tr>
<td>11-5</td>
<td>Leaf gap accuracy</td>
<td>Monthly</td>
<td>1 mm</td>
</tr>
<tr>
<td>11-6</td>
<td>Gantry collimator angle indicators</td>
<td>Monthly</td>
<td>1°</td>
</tr>
<tr>
<td>11-7</td>
<td>Physical gantry arc test</td>
<td>Monthly</td>
<td>2 mm</td>
</tr>
<tr>
<td>11-8</td>
<td>Critical imaging</td>
<td>Monthly</td>
<td>1 mm</td>
</tr>
<tr>
<td>11-9</td>
<td>Treatment couch position</td>
<td>Monthly</td>
<td>1 mm over 0-10° over 10 cm and 0-5° over 5 cm</td>
</tr>
</tbody>
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<tr>
<td>12-1</td>
<td>Gantry collimator alignment</td>
<td>Daily</td>
<td>Tolerance based on acceptance criteria</td>
</tr>
</tbody>
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<th>Tolerance</th>
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<tbody>
<tr>
<td>14-1</td>
<td>Output reference for all detector system</td>
<td>Daily</td>
<td>Functional</td>
</tr>
<tr>
<td>14-2</td>
<td>Output reference for all detector system</td>
<td>Monthly</td>
<td>Functional</td>
</tr>
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<th>Item</th>
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</tr>
</thead>
<tbody>
<tr>
<td>15-1</td>
<td>Wedge angle check</td>
<td>Daily</td>
<td>2% of TPS DAP</td>
</tr>
<tr>
<td>15-2</td>
<td>Physical wedge placement accuracy</td>
<td>Monthly</td>
<td>1 mm</td>
</tr>
<tr>
<td>15-3</td>
<td>Wedge angle for all electronic wedges, all energies</td>
<td>Annual</td>
<td>2% of TPS DAP</td>
</tr>
<tr>
<td>15-4</td>
<td>Wedge angle for all electronic wedges, all energies</td>
<td>Annual</td>
<td>2% of TPS DAP</td>
</tr>
</tbody>
</table>

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<tbody>
<tr>
<td>16-1</td>
<td>Wedge angle for all electronic wedges, all energies</td>
<td>Monthly</td>
<td>2% of TPS DAP</td>
</tr>
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<tbody>
<tr>
<td>17-1</td>
<td>Wedge angle for all electronic wedges, all energies</td>
<td>Monthly</td>
<td>2% of TPS DAP</td>
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<th>Tolerance</th>
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<tbody>
<tr>
<td>18-1</td>
<td>Wedge angle for all electronic wedges, all energies</td>
<td>Monthly</td>
<td>2% of TPS DAP</td>
</tr>
</tbody>
</table>
Tests Modified at SFH:

• DLG
  • Measured at least annually
  • Can change, especially after MLC service (PMI)

• Interleaf Leakage
  • Measured at least annually
  • Can change from MLC wear, over-greasing or multiple leaf replacement

Note on Table 6:

• Review of Machine configuration settings
  • leaf offset (Elekta)
  • DLG (Varian)
  • Leaf leakage/transmission

• Review of Clinical Treatment Parameters
  • Collimator settings for electron cones
  • Default dose rates

MPPG 8 Implementation

1. Decide what and when tests are critical for your clinic
2. Decide what equipment you have (need) to perform the tests
   • Most equipment you should already have
   • MPPG 8 flexible
   • 10,000 foot or better guidance on ways to perform tests
Minimum Equipment

- Calibrated Ionization Chamber
- 2D Water Tank
- Solid Water

Recommended Equipment

- Calibrated Ionization Chamber
- 3D Water Tank
- Solid Water
- Morning QA array
- EPID
- Diode/ion chamber array
- Gantry mount

Minimum Equipment

- Graph paper
- Film
- Level
- Ruler
- Solid Water

Recommended Equipment

- Graph Paper
- Level
- Ruler
- Morning QA array
- EPID
- Winston-Lutz phantom/software
Minimum Equipment

- Ionization Chamber
- Ruler
- 2D Water Tank

Recommended Equipment

- Ionization Chamber
- Ruler
- Daily QA array
- Solid Water
- Ion Chamber/Diode array

Minimum Equipment

- Calibrated Ionization Chamber
- 3D Water Tank
- Solid Water
- Daily QA array
- EPID
- Diode/ion chamber array
- Gantry mount
- Graph Paper
- Level
- Ruler
- Winston-Lutz phantom
- Software
MPPG 8 Implementation

1. Decide what and when tests are critical for your clinic
2. Decide what equipment you have (need) to perform the tests
3. After assessing equipment, evaluate what tests you should perform that is practical with said equipment or any other available equipment
   - What additional (useful) tests can be performed efficiently with my equipment?
   - Cost/benefit

Examples of additional tests run at SFH:

Daily QA array
- Daily electron energy
- Daily light/rad (rough)

Ion chamber/diode array
- Multiple wedge profiles
- Spot-check open profiles

TG-142 software/EPID/Trajectory Files
- Field size/energy
- Picket fence at cardinal angles
- MLC position
- MLC leaf speed

EPID/portal dosimetry
- Extra MLC checks
MPPG 8 Implementation

1. Decide what and when tests are critical for your clinic
2. Decide what equipment you have (need) to perform the tests
3. After assessing equipment, evaluate what tests you should perform that is practical with said equipment or any other available equipment
4. Reassess all tests and tolerances at ______ interval

MPPG 8 Implementation Obstacles

- Equipment
  - Typical clinic QA equipment required
  - But: Not efficient
  - The old “I have the minimum equipment needed, but....”

- Rethinking traditional QA
  - “Why have we always done xxxx?”
  - “OMG. MPPG doesn’t even include yyyy.”

- Deciding what is “Good enough” for your clinic
  - Do I need to add anything?
  - “I can’t do a full FMEA analysis!”
### MPPG 8 Implementation Time

<table>
<thead>
<tr>
<th>Component</th>
<th>Time Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical Tests Assessment</td>
<td>2-4 Hours (no FMEA)</td>
</tr>
<tr>
<td>Equipment Assessment</td>
<td>2 Hours</td>
</tr>
<tr>
<td>Additional Test Assessment</td>
<td>Few hours – Few days</td>
</tr>
<tr>
<td>Critical Test Implementation</td>
<td>&lt;Previous QA</td>
</tr>
<tr>
<td>Additional Test Implementation</td>
<td>Some Days</td>
</tr>
<tr>
<td>Reassessment</td>
<td>Ongoing</td>
</tr>
</tbody>
</table>

### Is it worth it?

YES!!
Why is it “worth it”? 

- Fundamentally changes the way we think about QA (in a practical way) 
  - “Every-clinic” TG-100 analysis 
  - Forces us to ask why we are performing a test 
- Gives the closest thing to the “minimum required” list that physicists want 
- Eliminates much “over-QAing” 
  - QA is quicker without feeling like I’m losing information 
- Clarifies and streamlines previous tests 
- Test guidance is more in depth and clear than previous documents 
  - Even clarified a few tests I’ve done for years 
- Practical approach “makes sense” to me

Acknowledgements

Koren Smith
William Myers
Jonathan Gray
Adam Farmer
Eric Klein