LSUHSC-Shreveport
Radiation Oncology
Proc. 19.9.1

MONTHLY EQUIPMENT PERFORMANCE CHECK: LINEAR ACCELERATORS

Policy:

The performance of the linac used for patient treatment shall be checked according to the QA program established by the physicist in Radiation Oncology. This check is to assure that the linac is working within Elekta's specifications and is in accordance with DEQ State Regulations. A record book properly identified shall be kept current by the physicist and be available for review. All entries shall have dates and initials. If one parameter is out of criterion, physicist or service engineer must adjust it to within its limits of tolerance. Physicist must sign and date review of the documentations.

Procedure:

1. Mechanical Front Pointer

    a. Check the accuracy of the mechanical front pointer length by comparing its length to the length recorded in the machine log book. The criterion is < 0.5 mm. Look for bends or abuse.

2. ODI

    a. With the gantry at 180°, place two precision nylon blocks, one on top of another, on the PSA on their 10-cm thick sides.

    b. Set 100 on the surface of the top block using the mechanical front pointer.

    c. Remove the mechanical front pointer, read the ODI, and record the reading.

    d. Remove top block, read the ODI, and record the reading.

    e. Remove the next block, read the ODI off the bottom block, and record the reading.

    f. Repeat the procedure for gantry angles of 90° or 270° and use other angles on the following month.

    g. Record the difference in the readings between the mechanical and optical indicators. The accuracy of the ODI should be kept within ± 2 mm at all distances and angles.

3. Collimator Angle Indicator

a. Rotate gantry to either 90° or 270° and alternate these angles every other month. Place level on jaws of Cl 4 or an assembly mount rail for other accelerators. Rotate collimators using level to angles of 90, and 270°. Record the mechanical and digital readouts. Criteria = 1 degree.

b. Return collimator to 180° rotation and record readouts. Rotate gantry back to 180°.

4. Patient Positioning Lasers

a. Turn off the lasers. Rotate gantry to 90 or 270°. Place torpedo level on jaws of Cl 4 or guard rail of other accelerators. Make sure collimators are level.

b. With the gantry and collimator rotation at 180°, place the isocenter test tool on the PSA and lower the table so that the ODI on the top of the isocenter test tool cube (head) reads 98 cm.

c. Align the anterior cross-hair of the isocenter test tool with the collimator cross-hairs.

d. Balance the isocenter test tool with the round bubble level and make sure the ODI still reads 98 cm.

e. Turn on the wall lasers and determine their alignment according to the cross-hairs of the isocenter test tool.

f. Record the misalignment in ± mm according to the axis of a supine patient.

g. Rotate the gantry approximately 45° so the ceiling laser falls across the top of the isocenter test tool and record the misalignment. The lasers should be kept within less than ± 2 mm from the isocenter.

5. Field Size Indicators

a. Place the PSA at isocenter (100 cm TAD) and the gantry at 180°. Place graph paper on top of the PSA so that the accelerator cross-hairs are aligned with the dark green lines of the graph paper. Set the collimator field size to OXO and open to a 4X4 cm field size according to the readouts. Record the discrepancy by looking at the light field on the graph paper. Subtract the mechanical/digital readout from the graph paper and record the difference. The accuracy of the field size indicators should be kept to within ± 3 mm. Repeat for collimator F.S.'s of 10x10 cm

b. On alternative months set 30x30 or 38 x 38 cm, instead of the small (4x4) FS and perform measurements.

c. For accelerators with asymmetric jaws, move jaws independently from a closed to an open position and record discrepancy from the graph paper. Take measurements for different field sizes.

d. Every other month, rotate from "close to open" to "open to close" so that hysteresis (slack) can be checked.

6. Gantry Angle Indicators

a. Set the gantry to 180° with a torpedo level. Record the mechanical and digital readouts and the difference from the torpedo level.

b. Repeat for angles of 0°, 90º, 270°, and 360°. The gantry angle indicators should be accurate to within ±1°.

7. Isocentric Volume (tested annually)

a. Gantry Rotation

1. Insert the mechanical front pointer and set it 100 cm.

2. Set the isocenter ball pointer (or another mechanical front pointer) at the isocenter of the machine. Stand at the head of the couch and rotate the gantry, noting if the mechanical front pointer veers from the ball pointer at that particular angle.

3. After rotating the gantry to 0° both CW and CCW, measure the extremes from the isocenter and record the diameter of the isocenter rotation. The diameter of the circle of rotation should be less than 2 mm.

b. Couch Rotation

1. Set the gantry to 180° and the PSA to 100 SAD.

2. Put tape on the PSA under the cross-hairs.

3. Unlock the PSA. Mark the cross-hair. Rotate the PSA to the CW extreme and mark the cross-hair on the tape. Rotate the PSA to the CCW extreme and mark the cross-hair on the tape. Attach the tape to the QM form. Measure the diameter of the rotation. The diameter of the circle of rotation should be less than 2 mm.

c. Collimator Cross-Hair Alignment

1. With the gantry at 180° and the surface of the PSA at the SAD, place a piece of masking tape on the PSA so the cross-hair shadow falls across it. Mark the CAX on the tape.

2. Rotate the collimators, stopping every 45°, and re-mark the cross-hair shadow on the tape. Do this in both directions and measure the rotational diameter. The diameter should be less than 2 mm.

3. Cut the tape and place it on the QM Log Sheet.

8. PSA Vertical Alignment (Annual)

a. Set up the PSA to Isocentric and gantry to 180º. Place the tape on the PSA under the cross-hairs.

b. Mark the tape at the CAX. Raise the PSA as high as it will go and mark the tape over the CAX. Lower the PSA 15 cm below isocentric and mark the tape. Measure the difference in extremes and record the measurement on the QM form. Place the tape on the QM form. The PSA should not deviate more than ± 3mm from the vertical.

9. PSA X and Y Slack (Annual)

a. Place PSA at 80 cm or 100 cm. Place tape at CAX on table. With PSA locked, push table laterally and mark CAX on tape. Next pull PSA toward you and mark CAX again. Push PSA along its length and mark CAX. Pull PSA toward gantry and mark CAX.

b. Measure lateral and vertical extremes and record on QA forms.

10. Light vs. X-ray Quarterly)

a. Place XV2 film on Lucite phantoms on top of PSA. Set TAD to 100 cm.

b. Set field size to 10X10 cm. Prick upper right hand corner of films nearest gantry to mark orientations. Prick film at margin of light field about 1 cm from each side of square field. This will result in eight pricks defining the field limits.

c. Place D'max amount of buildup on top of film.

d. Leave room and expose film to 45 monitor units. Develop film.

e. Use Macbeth TD504 to read center density of film after zeroing densitometer to film background. Locate 1/2 of the density in the middle

of each of the four sides of the exposure. Mark this spot with a film marker. Connect the prick holes on each side of the film.

f. Measure the difference between the 50% mark and the connected pricks line. Criteria = ± 3 mm. Record on QA form.

g. Repeat for collimator angle of 90° and 270°.

11. Symmetry/Flatness/Energy Check

a. Place the barometer near the console and take the thermometer inside the room. Calculate TPC by $\frac{273.15 + C°}{295.15} * \frac{760}{P(mmHg)}$

b. Place the chamber inside the proper cavity in the jig according to the energy being checked (only the 6 MeV and 9 MeV electrons and 6MV photons are checked on the shallow depth). Be sure to remove the white cardboard.

c.. Connect the chamber cable to the electrometer (where applicable).

d. Turn on the bias voltage.

e. Record the pressure reading and room temperature and calculate the temperature and pressure correction factor (TPC).

f. Irradiate the chamber for 100 mu and record the reading. Repeat two more times, resetting display each time. If $\frac{Rdg * TPC}{JigRdg}$ is not within $\pm$ 2.0% i.e., if it is greater than 1.020 or less than 0.980. Deviations require prompt attention.

g. Collect all equipment and clean the table.

h. Calculate unsymmetry, unflatness, and energy ratio. Record calculation results on QA form. Criteria = 2% symmetry, 3% for photon flatness, 5% for e- flatness, and 2% for energy ratio.