# TG-51 Worksheet A: Photon Beams

**1. Site data**

Institution: My Cancer Center
Physicist: Smart Physicist
Date: July 2000
Accel or $^{60}$Co Mfr.: Varian
Model & serial number: Clinac 2300
Nominal photon energy/beam identifier: 23 MV

**2. Instrumentation**

**a**. Chamber model: NEL 2571
Serial number: # 2952
Cavity inner radius ($r_{cav}$, Table III): 0.315 cm

Waterproof: yes [ ] no [X]

If no, is waterproofing ≤ 1 mm PMMA or thin latex?: yes [X] no [ ]

**b**. Electometer model: Kethley 602
Serial number: 30102A
i. $P_{elec}$, electrom. Corr factor ( Sec. VII.B): $0.998 \times 10^{-8}$ C/C or C/rdg.

**c**. Calibration factor $N_{D,w}^{60_{Co}}$ (Sec.V): $4.533 \times 10^{7}$ Gy/C (or Gy/rdg)

Date of report (not to exceed 2 years): 11/11/99

**3. Measurement Conditions** (10 x 10 cm$^2$, point of measurement at 10 cm depth (water equivalent)

**a**. Distance (SSD or SAD): 100 cm SAD [X] or SSD [ ]
**b**. Field size: 10 x 10 cm$^2$
on surface (SSD setup) [ ]
at detector (SAD setup): [X]
**c**. Number of monitor units: 200 MU (min for $^{60}$Co)

**4. Beam Quality** ( Sec. VIII.B – not needed for $^{60}$Co

If energy <10 MV, use no lead foil.

Measure %*dd* (10) [% depth-dose at 10 cm depth for curve shifted upstream by $0.6r_{cav}$]

Field size 10 x 10 cm$^2$ on surface, SSD = 100 cm: yes [ ] no [ ]

**a.** $\%dd(10)_x = \%\, dd(10)$

If energy ≥ 10 MV

Distance of 1 mm lead foil phantom surface 50 ± 5 cm [X] 30 ± 1 cm [ ]

Measure % $dd(10)_{Pb}$ [% depth-dose at 10 cm depth for curve shifted upstream by 0.6 $r_{cav}$]

Field size 10 x 10 cm$^2$ on surface, SSD = 100 cm: yes [X] no [ ]

$\%dd(10)_{Pb}$(includes e$^-$contamination): (0.7897/0.9795) x 100 = 80.62

50 cm: $\%dd(10)_x = [0.8905 + 0.00150\%dd(10)_{Pb}]\%dd(10)_{Pb}$ [$\%dd(10)_{Pb} \geq 73\%$] Eq.(13)

30 cm: $\%dd(10)_x = [0.8116 + 0.00264\%dd(10)_{Pb}]\%dd(10)_{Pb}$ [$\%dd(10)_{Pb} \geq 71\%$] Eq. (14)

If $\%dd(10)_{Pb} < 71\%$ (30 cm) or 73% (50 cm): $\%dd(10)_x = \%dd(10)_{Pb}$

**b**. $\%dd(10)_x$ (for open beam): [0.8905+0.00150(80.62)] [80.62]=81.54

Has lead foil been removed? yes [X] no [ ]

Interim alternative for energy > 10MV & with ≥ 45 cm clearance: using no lead foil

Measure %*dd*(10) [% depth-dose at 10 cm depth for curve shifted upstream by 0.6 $r_{cav}$]

%*dd*(10): No lead (0.8467/1.055) (100) = 80.26

$\%dd(10)_x = 1.267\ (\%dd(10) - 20.0$ [for 75% <%*dd*(10) ≥ 89%

**c.** $\%dd(10)_x$ = [(1.267) (80.26)] – 20.0 = 81.69

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**5 Determination of $k_Q$** (Sec. IX. B)

Chamber model used to get $k_Q$: NEL 2571

**a**. %dd(10)$_x$ (from 4, above): 81.54

**b.** $k_Q$ [Table I or Fig. 4]: 0.971

**6. Temperature/pressure Correction** (Sec.VII.C)

**a.** Temperature: 20.7 ºC

**b.** Pressure: 750.1 mmHg kPa $\left[= \text{mmHg}\frac{101.33}{760.}\right]$

**c.** $P_{TP}$: 1.009 $\left[Eq.(10) = \left(\frac{273.2+6a}{295.2}\right)\left(\frac{101.33}{6b}\right)\right]$

**7. Polarity correction** (Sec. VII. A.)

$M^{+}_{raw}$: + 4.061 C or rdg

$M^{-}_{raw}$ : - 4.073 C or rdg

**a.** $M_{raw}$ ( for polarity of calibration): - 4.073 C or rdg

**b.** $P_{pol}$: 0.9985 $\left[Eq.(9) = \left|\frac{M^{+}_{raw} - M^{-}_{raw}}{2M_{raw}}\right|\right]$

**8. $P_{ion}$ measurements** (Sec.VII. D. 2)

Operating voltage = $V_H$: - 300 V

Lower voltage $V_L$: - 150 V

$M^{H}_{raw}$: - 4.073 C or rdg

$M^{L}_{raw}$: - 4.0526 C or rdg

$^{60}$Co treated as general recombination

**a.** $P_{ion}(V_H)$ (Eq.(11)); $\left[\left(1.-\left(\frac{V_H}{V_L}\right)^2\right)\Big/\left(\frac{M^{H}_{raw}}{M^{L}_{raw}}-\left(\frac{V_H}{V_L}\right)^2\right)\right]$

Pulsed/swept beams

**b.** $P_{ion}$ ($V_H$) (Eq.(12)) 1.005 $\left[\left(1.-\frac{V_H}{V_L}\right)\Big/\left(\frac{M^{H}_{raw}}{M^{L}_{raw}}-\frac{V_H}{V_L}\right)\right]$

If $P_{ion}$ > 1.05, another ion chamber should be used.

**9. Corrected ion. ch. rdg. M** (Sec.VII) at 10 cm depth, water equivalent

$$M = P_{ion}P_{TP}P_{elec}P_{Pol}M_{raw} = [8(a\cdot or\cdot b)\cdot 6c\cdot 2bi\cdot 7b\cdot 7a]$$

Fully corrected M (Eq.(8)): 1.005 x 1.009 x 0.998 x $10^{-8}$ x 0.9985 x 4.073 = 4.116 x $10^{-8}$C

**10. Dose to water at 10 cm depth**: $D^{Q}_{w} = Mk_Q N^{60_{Co}}_{D,w} = [9\cdot 5b\cdot 2c]$ Eq. (3)

**a.** Dose to water at 10 cm depth = 4.116 x $10^{-8}$ x 0.971 x 4.533 x $10^{7}$ = 1.8116

**b.**Dose/ MU(or min $^{60}$ Co) at 10 cm depth 0.9058 x $10^{-2}$ Gy/MU [10*a*/3*c*]

**11. Dose to water/MU**(or min,$^{60}$Co) at $d_{max}$ (if relevant locally)

**a.** Clinical %*dd*(10) for SSD setup / 100.:

or clinical TMR(10, 10 x 10) for SAD setup: 0.901

**b.** Dose / MU(or min, $^{60}$Co) at $d_{max}$: 1.005 x $10^{-2}$ Gy/MU [10*b*/(11*a*)]

1.005 cGy (water)/MU