6.9. Worksheet

Determination of the absorbed dose to water in a high-energy photon beam

User: Patrícia Nicolucci Date: 25/09/2020

1. Radiation treatment unit and reference conditions for $D_{w,Q}$ determination

Accelerator: Mevatron XII Nominal Acc Potential: 10 MV

Nominal dose rate: 300 MU min^{-1} Beam quality, Q ($TPR_{20,10}$): 0,736

Reference phantom: water Set up: ☒ SSD ☐ SAD

Reference field size: 10x10 cm x cm Reference distance (cm): 100

Reference depth z_{ref}: 10 g cm^{-2}

2. Ionization chamber and electrometer

Ionization chamber model: NE 2571 farmer Serial no.: XB3216

Chamber wall material: grafite thickness: 0,065 g cm^{-2}

Waterproof sleeve material: latex thickness: 0,082 g cm^{-2}

Phantom window material: PMMA thickness: 1,2 g cm^{-2}

Absorbed-dose-to-water calibration factor [a] N_{D,w,Q_o} = 9,61 x 10^{-3} ☒ Gy nC^{-1} ☐ Gy rdg^{-1}

Calibration quality Q_0: ☒ ^{60}Co ☐ photon beam Calibration depth: 5 g cm^{-2}

If Q_0 is photon beam, give $TPR_{20,10}$: 0,568

Reference conditions for calibration P_o: 101,2 kPa T_o: 20 °C Rel. humidity: 60 %

Polarizing potential V_1: 300 V Calibration polarity: ☒ +ve ☐ −ve ☐ corrected for polarity effect

User polarity: ☒ +ve ☐ −ve

Calibration laboratory: IRD-CNEN Date: 23/03/2020

Electrometer model: PTW Unidos Serial no.: 880001

Calibrated separately from chamber: ☐ yes ☒ no Range setting: auto

If yes Calibration laboratory: ____________ Date: ____________

3. Dosimeter reading [b] **and correction for influence quantities**

Uncorrected dosimeter reading at V_1 and user polarity: 83,44 ☒ nC ☐ rdg
Corresponding accelerator monitor units: 100 MU

Ratio of dosimeter reading and monitor units: M_1 = 0,8344 ☒ nC MU^{-1} ☐ rdg MU^{-1}

(i) Pressure P: 101,2 kPa Temperature T: 22 °C Rel. humidity (if known): 48 %

$$k_{TP} = \frac{(273.2+T)}{(273.2+T_o)}\frac{P_o}{P} = 1{,}007$$

(ii) Electrometer calibration factor [c] k_{elec}: ☐ nC rdg^{-1} ☒ dimensionless k_{elec} = 1

(iii) Polarity correction [d] rdg at $+V_1$: M_+ = 83,44 rdg at $-V_1$: M_- = 83,47

$$k_{pol} = \frac{|M_+|+|M_-|}{2M} = 1{,}0002$$

(iv) Recombination correction (two-voltage method)

Polarizing voltages: V_1 (normal) = 300 V V_2 (reduced)= 150 V

Readings [e] at each V: M_1= 83,44 M_2= 83,33

Voltage ratio V_1 / V_2 = 2 Ratio of readings M_1 / M_2 = 1,001

Use Table 4.VII for a beam of type: ☒ pulsed ☐ pulsed-scanned

a_o = 2,337 a_1 = -3,636 a_2 = 2,299

$$k_s = a_0 + a_1\left(\frac{M_1}{M_2}\right) + a_2\left(\frac{M_1}{M_2}\right)^2 = 1,001$$ [f, g]

Corrected dosimeter reading at the voltage V_1:

$M_Q = M_1\ k_{TP}\ k_{elec}\ k_{pol}\ k_s$ = 0,8412 ☒ nC MU^{-1} ☐ rdg MU^{-1}

4. Absorbed dose to water at the reference depth, z_{ref}

Beam quality correction factor for user quality Q: k_{Q,Q_o} = 0,987

taken from ☒ Table 6.III ☐ Other, specify: ______

$$D_{w,Q}(z_{ref}) = M_Q N_{D,w,Q_o} k_{Q,Q_o} = 0{,}00798 \text{ Gy MU}^{-1}$$

5. Absorbed dose to water at the depth of dose maximum, z_{max}

Depth of dose maximum: z_{max} = 2,5 g cm^{-2}

(i) SSD set-up

Percentage depth-dose at z_{ref} for a 10 cm x 10 cm field size: PDD (z_{ref}= 10 g cm^{-2}) = 80,1 %

Absorbed-dose calibration of monitor at z_{max}:

$D_{w,Q}(z_{max}) = 100\ D_{w,Q}(z_{ref}) / PDD(z_{ref})$ = 0,00996 Gy MU^{-1} = 0,996 cGy/MU

(ii) SAD set-up

TMR at z_{ref} for a 10 cm x 10 cm field size: TMR (z_{ref}=____ g cm^{-2}) = ______

Absorbed-dose calibration of monitor at z_{max}:

$D_{w,Q}(z_{max}) = D_{w,Q}(z_{ref}) / TMR(z_{ref})$ = ______ Gy MU^{-1}

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[a] Note that if Q_o is ^{60}Co, N_{D,w,Q_o} is denoted by $N_{D,w}$.

[b] All readings should be checked for leakage and corrected if necessary

[c] If the electrometer is not calibrated separately set k_{elec} = 1

[d] M in the denominator of k_{pol} denotes reading at the user polarity. Preferably, each reading in the equation should be the average of the ratios of M (or M_+ or M_-) to the reading of an external monitor, M_{em}.

It is assumed that the calibration laboratory has performed a polarity correction. Otherwise k_{pol} is determined according to

rdg at $+V_1$ for quality Q_o: M_+ = ______ rdg at $-V_1$ for quality Q_o: M_- = ______

$$k_{pol} = \frac{\left[\left(|M_+| + |M_-|\right)/|M|\right]_Q}{\left[\left(|M_+| + |M_-|\right)/|M|\right]_{Q_o}} = \_\_\_\_\_\_$$

[e] Strictly, readings should be corrected for polarity effect (average with both polarities). Preferably, each reading in the equation should be the average of the ratios of M_1 or M_2 to the reading of an external monitor, M_{em}.

[f] It is assumed that the calibration laboratory has performed a recombination correction. Otherwise the factor $k_s' = k_s / k_{s,Q_o}$ should be used instead of k_s. When Q_o is ^{60}Co, k_{s,Q_o} (at the calibration laboratory) will normally be close to unity and the effect of not using this equation will be negligible in most cases.

[g] Check that $k_s - 1 \approx \dfrac{M_1/M_2 - 1}{V_1/V_2 - 1}$

[h] Note that if Q_o is ^{60}Co, k_{Q,Q_o} is denoted by k_Q, as given in Table 6.III.