1. Typical range of frequency US (2-20 MHz)
2. Tolerance of HDR dwell position (1 mm)
3. Frequency of laser alignment of CT scanner (daily for alignment of gantry lasers with imaging plane)
4. Four breast 3D dosimetry map, to reduce the hot spots on the two sides (increase the energy)
5. Two adjacent fields, to compensate hot spots in the middle, how much shift of each field? Given the range of two flat fields.
6. Calculate the Ptp for TG51
7. Whats “stem effect” of electrode
8. Cross-calibrate the IC using highest or lowest electron energy?
9. Given the Optical density, calculate the dose. (Simple interpolation)
10. Two calculate virtual SSD for electron questions
11. For a TPS, it uses equivalent path length for heterogeneity calculation. If it use relative mass density for bone instead of relative electron density, how much percentage the dose calculation will change?
12. For a 4 slice CT scanner with a slice thickness of 1mm a pitch 1.5 and a gantry rotation of 0.5 sec, how long will it take to scan 100mm? (~ 9s)
13. what is the dose limit for unrestricted area per week?
14. The purpose of range shifter in proton scanning system
15. What the purpose of scatter in double-scattering proton system
16. Shielding questions, See below for the examples and calculations
17. SRS was delivered in 1 fraction instead of 3 fractions. Did the brainstem and cochlea received more or less dose that the constraints (two questions together)
18. For survey what will be the most appropriate detector
19. Ethic issues: if a physicist colleague behaves unethical, what you should do
20. Proton weighted MRI image? (Long or short TR or TE)
21. Given same instruments dose measured at the beach and the mountain. Which dose is large without any corrections for T,P (effect of pressure on the measured dose. The dose at the

mountain will be higher since the correction factor will be smaller for the mountain)

1. Which detector should be used for 1)pdd; 2)Orthur; 3) 1X1 profile;
2. Treat electron for eye lid (~ add additional 1 mm lead for safety)
3. Universal wedge (60): if wedge angle is 30, what’s the weighting factor, to achieve 60
4. Imaging dose for kv, mv, CBCT
5. Proton prostate plan on DVH (femur head)
6. Breast tangents plan. Not used tangent, where is the hotspot? ()
7. Monte Carlo question
8. “near miss” in regulatory
9. Dose to fetus (S)
10. Thickness of lead to shield beyond 1 cm thick lip using 6 MeV electron
11. Midplane dose @ umbilicus is 150 cGy, femur 200 cGy, how many 2mm thick lead used to attenuate the beam within 3% (3 HVL)
12. How much shielding for linac head

Shielding

3. Simulator shielding question, NCRP 116 level to worker with office above simulator room. Occupation mentioned – I don’t recall but was an allied health profession not related to radiation oncology/ radiology. Floor to floor = 12 ft, iso = 48” above floor, SAD = 100cm, given U=1/4. W=800mA.min/wk. Asked to work out the thickness of concrete shielding required. Answers about 4 mm apart. Provided with a graph of R/(mA.min) at iso on vertical axis (log scale) vs concrete shielding thickness (cm) on horizontal scale – with the log scale, the plot was reasonably linear.

McGinley, p126, Ch8 gave a good example, we simply follow the B = Pd^2/(WUT) to get the B transmission in R/(mA x min) at 1 m, and then find the required concrete shielding thickness.  There is no need to project the R/mA.min at iso, coz B is already defined as 1 m.

The distance from target to the people sitting position is (12 – 4) ft x 0.3 + 0.3 + 1 m = 3.7 m

B = 2 mR/wk x 3.7^2 / (800 mAmin/wk) x ¼ = 0.14 mR/(mAmin) = 1.4 x 10^(-4) R/(mA.min) then find the concrete thickness based on B ()

The linac is only capable of producing 20 MeV, 15 MeV, 10 MeV and 6 MeV electrons, no photon beams are available for this linac.  The patient load is 20 per day… What is the workload that should be used in shielding calculations for such a vault.

The question is most likely about the “intraoperative electron beam therapy (IORT)”.  Good references are Int. J. Radiat. Oncol. Biol. Phys. 33, 725 (1995) and 18, 1215 (1990)

The pt. for IORT is usually treated with 1 fx (20 Gy).  The patient load is normal 20 pt/month rather than per day (pls see the 2nd reference).  The e beam exiting from the treatment cones is completed absorbed within patient so the x-ray contamination is the primary safety shielding concern.  The neutron is also the concern but it is generated by the x-ray and 2 order of magnitude lower than the conventional linac due to lower electron beam current.  For the board exam, I will just consider x-ray contamination for the highest electron energy

Workload / wk = 20 pts/4 wk x 20 Gy x 5%(x-ray contamination) = 500 cGy, the 100 Gy electron workload is consistent with the 2nd reference. ()

According to NRC-151, what is the most important factor for shielding of pregnant women to be treated for breast cancer? (A) Block (B) Distance (C) Dose prescribed (D) Fetus period

Distance AA

Not in NCRP151 but possible explanation in TG36,

In my opinion, reducing the field edge to the fetus area is more important than the just using block

\*Using photon mode in the linear accelerator , which one from the following materials have the highest cross section for neutron production: high photon energy, does it related to high Z material as well

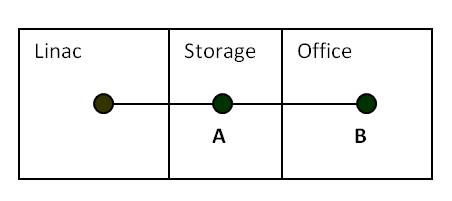
Besides being produced in the linac head, photoneutrons are also produced in the patient and in the bunker walls, floor and ceiling. The production in the linac head is particularly important because of the presence of a large amount of high-Z materials and their large photo- neutron production cross sections. Furthermore, these high-Z materials have low neutron capture cross sections and the generated photoneutrons will escape from the linac head.

\*Shielding calculation for a HDR room. Ir-192 source 10 Ci, exposure rate constant of Ir-192 given, weekly limit given (0.01 R/week), T = 1 given. And workload W = 100 min/week given. Distance 2.0 meters. Determine B.  
Exposure rate constant for Ir-192 is 4.69 R cm^2/(mCi - h),  and the formula can be written as  
10 x 10^3 (mCi) x 4.69 R cm^2/(mCi hr) x 100/60 (hr/wk) x 1/(200)^2xB = 0.01 R/wk, B = 5  x 10 ^-3, ()

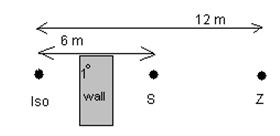
\*A simulator shielding problem. Exposure rate at 1 m was given= 0.01 R/ mAs at 1 m. Workload = 600 mA-hour / week. U = 1/4, d = 3 meters. Xp = 0.01 R/week. Determine how many TVL´s given the exposure rate limit.  
I think Xp is the dose limit we would like to achieve after the barrier,  
600x3600 (mAs/ wk) x ¼ x 1/9 x 0.01 R/mAs x B = 0.01 (R/wk), s = 4.78 TVL ()

\*Scatter and leakage shielding thickness calculations are equal. The shielding that should then be used is? TVL+HVL  
If the thicknesses of the two barriers differ by at least three HVLs, the thicker of the two will be adequate. If the difference is less than three HVLs, one HVL should be added to the larger one to obtain the required secondary barrier.  Khan P363

NCRP151 added 1 HVL ()

\*Distances given: Linac to A=6m, Linac to B=12m.  Survey meter measures 0.6 mrem/hr at point A. 200 cGy delivered at each treatment is also given. How many patients can be treated to limit the exposure at point B to below 2 mRem/wk  


\*The distance from isocenter to point S is 6m, and iso to point Z is 12m.   Point S is in a store room and point Z is in a room being considered as new office space.  A survey meter measures 0.2? cGy/hr at point S.  A beam is aimed toward this primary wall for 30 seconds per treatment.For a maximum dose of 0.08? cGy/week at point Z, what is the maximum number of patients you can treat per day?  Consider only photon interactions.

236. Shielding:  the distance from isocenter to point S is 6m, and iso to point Z is 12m.   Point S is in a store room and point Z is in a room being considered as new office space.  A survey meter measures 0.2? cGy/hr at point S.  A beam is aimed toward this primary wall for 30 seconds per treatment.  For a maximum dose of 0.08? cGy/week at point Z, what is the maximum number of patients you can treat per day?  Consider only photon interactions.                             

(6+1)^2/(12+1)^2 = 0.29; 0.2cGy/hr \*0.29 = 0.058cGy/hr at Z; 0.08/0.058 = 1.38hr → 1.38\*60/0.5 = 165 patients/wk → 33patients/day...

considering it’s primary beam so the distance from target to s and to z are 7 and 13 m, following the inverse square law, the dose at point z is reduced from 0.2 cGy/hr to 0.2 x 49/169 = 0.058 cGy/hr

The maximum accumulated dose at point z is 0.08 cGy/wk, it means 0.08 cGy/0.058 = 1.38 hr/wk.  The machine only can operate for 1.38 hr /wk, total patient amount is 1.38 x 60 /0.5 = 165 pt/wk so 165 pt/5 days = 33 pts/ day

\*If the thickness of a shielding barrier was calculated as per the 6 MV beam and the Exposure level was given at particular point. Calculate the exposure level if 18 MV beam is used for the same thickness. TVLs given.

\*Neutron dose equivalent (mSv) outside field per photon Gy at isocenter for 20MV beam.  
Measurements have shown that in the 15 - 25 MV x-ray therapy mode the neutron dose equivalent along CAX is approximately 0.5% of the x-ray dose-equivalent and falls off to about 0.1 % outside the field. (Hendee, p351)

0.1% x 1Gy = 1 mSv

\*How many TVL’s in a linac head?  
<0.1% head leakage requirement means 1/1000 attenuation so ⇒ 3TVL    AA

(Green p195, 0.1% that our leakage fraction for shielding calculation)

\*Weekly dose limit for unrestricted area. 0.02mSv/wk

\*Give a dose limit at lm, and the secretary office distance, ask the shielding calculation by ALARA principle. Office area U = 1, uncontrolled area 0.02 mSv/wk, hourly limit 0.02 mSv/hr

\*Energy at which theoretically neutrons can be produced a neutron in LINAC

8 MV is more accurate (NCRP151 and AAPM2011 review course, )

\*Using lead and concrete to shield Primary wall.  From the inside, what is the order of the materials?

From NCRP151 or AAPM 2011 review course (p25), it suggested lead and then concrete, because photoneutron can be produced in the lead itself, so concrete can then absorb neutron. ()

\*Shielding: Electron only machine has 4 electron energies, each with 3.5%, 2%, 1.5%, and 1% X-ray contamination. Workload 200 Gy/week, what is weekly workload for photon contamination?  
simple average? anyone?  The workload is the sum of the 4 electron energies since the information is limited, I used 200 Gy/4 x (0.035 + 0.02 + 0.015 + 0.01) = 4Gy ()

\*What is the dose rate at 1m from a patient receiving external beam treatment?  
Shouldn’t it be 0.1% = 0.001? if we consider 90 degree scatter 1 m away from patient (Kahn sec 16.6B, )

the rule of thumb is that the dose scattered laterally from a megavoltage beam has a max photon energy of about 500 keV and the dose at 1 m is about 1/1000th of the dose at the isocenter.

\*A lead pig with 2 cm wall thickness is inside a 30cm diameter polyurethane foam shipping drum. HVL of lead was given (=5.5mm). Exposure rate constant of 192 Ir was given (0.32 mR/mCi hr at 1 meter). Calculate max activity to keep exposure rate below 50mR/hr on the drum surface.  
0.32\*X/(0.17^2)\*(0.5)^(20/5.5)=50 →  X = 56.4mCi  I would think the distance be 15cm instead of 17cm ⇒ radius of drum is 15. Am I wrong?? I used 15 cm as well and I got 43 mCi () 0.32\*X/(0.15^2)\*(0.5)^(20/5.5)=50

163. Given Kersey’s formula and the distances and ratio of maze areas, neutron dose at isocenter (m Sv) per photon cGy at isocenter, what is neutron dose (mSv) at door per photon cGy at iso. given TVL of maze for neutrons is 5m.  
Hn,D = H0\*(S0/S1)\*(1.41/d1)^2\*10^(-d2/5meter)   
In Kersey’s formula, d0 is actually 1.41 m from target (NCRP151, p44 eq.2-18, )

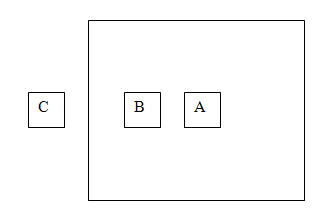
 

Hn,D is neutron dose equivalent in mSv/Gy, the d0 is the 1.41 distance from target not the SAD!!

\*Shielding: What’s peak energy of photons near door? 200 keV, 500 keV, etc.   
511 KeV 90 degree Compton scattering see Kahn 3rd Fig. 16.3, p412

\*Which will give the highest portion of the photon dose at the door of the maze: is it from the head, or from wall between the door and the accelerator or from the scattering wall facing both the accelerator and the door?

\*Point A and B are candidates for machine isocenter. Point C is outside the primary shielding and distances AC(=7m) and BC(=5m) are given. If isocenter is set at A, measurement at C is within the MPD specification. If isocenter is changed to B, how much more shielding (TVL) is needed for the wall to maintain same reading at C, given TVL. A) 4.7 TVLs (B) 3.7 TVLs (C) 2.7TVLs (D) 1.7 TVLs

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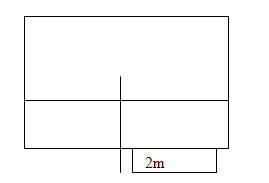
The distance for primary beam should be “target” to the point of measurement from NCRP151, so in this case it should be more accurately using 8^2/6^2 x 10 ^ (-n) and n = 0.25 TVL (), To LSK107 comment, we have 5 choices, so (E) may be our answer. ()

\*Given primary workload, distance to office, and TVL, calculate shielding thickness to achieve 1/10 of MPD. U, T, MPD were not given.

U = ¼; T=1; MPD = 0.02mSv/wk

W x U x T x 10^(-n/TVL) x (1/d^2) = 1/10 x MPD (just feel weird the design goal even 1/10 for uncontrolled area) (NCRP151, ) MPD for public frequent exposure is 1mSv/yr, so 0.02 mSv/wk

\*HDR shielding question.  How much thickness for 10 patients per week, 5 days a week, 500cGy/patient.  The drawing showed a distance of 2 meters ( I think that’s what it meant).



For a Workload of 10 patients for week we get : 5000 cGy/wk or 50,000mGy/wk, Weekly limit P = 0.02 mSv/wk, d=2meters B = Pd2/WUT = 0.02\*(4)/50,000 => 5.79 TVLs

For HDR, we still use 0.02 mSv/wk as the dose limit

500 (cGy)x 10 x 10 x (1/4) x 10^(-n) = 0.02, 5.79 TVL ()

\*Given density of lead and mass atten coeff. for a random energy…  what is TVL?

mu/rho \* rho = mu; TVL = ln10/mu

or exp(mu/rho x rho x d) = 1/10 🡺 d = ln10/(mu/rho x rho) ()

\*200 keV beam.  The density of copper is given in g/cm3, and the μ/ρ for copper is given in cm2/g.  If 3 mm of copper attenuates the beam to 63% of its original intensity, what is the TVL for copper?

density of copper = 8.92 g/*cm3*; μ/ρ = 0.1559cm2/g → mu  = 1.39cm^-1 → HVL = 4.5mm

 TVL = ln10/mu, so TVL = 1.65 cm ()

\*A Shielding calculation was performed assuming no IMRT.  If you will now be doing 50% IMRT, how much additional shielding will you need to add?

Increased MU usage for IMRT will only affect the secondary shielding for leakage, but i’m not sure what factor we need to apply to the workload when doing calculation.

Assume the original work load = W, and the IMRT factor = 5, so the total leakage workload WL= W/2 + W/2 X 5 = 3W which means the point behind the secondary barrier dose will receive 3 fold higher dose than without IMRT implemented.  We need 3 X 10^(-n) = 1, TVL = 0.47 ()

5. storage room 6m away from iso in primary direction reading 0.06mSv/hr for 6MV beam, if add 18MV beam and wanted the office next to storage room and 12m away from iso, if want the reading at office below 0.02mSv/hr, how many patient can treat everyday. Beam on time for each patient on this direction is 30 sec.

TVL(6X)= 13.7inches, 18X = 17.8inches, 6x:18x = 70%:30%

For this question, I assumed the thickness of the wall is given, because in practical situation, we should know the thickness of the wall.  Let’s assume the thickness is 5 TVL for the wall.  Therefore, the wall thickness is 5 x 13.7 in = 68.5 in.  
  
Now, we want to add 18x, and the beam usage is 6x: 18x = 0.7: 0.3, so the workload for 6x and 15x are 0.7W and 0.3W.  The wall penetration for 18x becomes 10^(-68.5/17.8) = 10^(-3.84), and we can calculate the dose at the storage room 6 m away as:  
[0.7 + (0.3 /10^(-5)) x 10^(-3.84)] x 0.06 = 0.3 mSv/h → at 12 m away using inverse square law 0.3 x [(6+1)/(12+1)]^2 = 0.08 mSv/h  
  
0.02/0.08 = 0.25 h, 0.25x3600/30 = 30 pts; I suspect the question giving the dose limit is weekly 0.02 mSv/wk (from other recalls).  Nevertheless, shielding needs to satisfy the hourly and weekly dose limit.  In this question, weekly dose limit is more stringent than the hourly limit.  1 wk we can treat 30 pts, so 6 pts per day ( this number is related to the assumption of wall thickness) ()

\*Neutron dose equivalent ratio 18MV vs 15 MV. Answers were fairly widely

separated ie 1, 2, 5, 10, 100.

**According to NCRP151, for varian machine 15MV H0 = 0.79-1.3mSv/Gy; for 18MV H0 = 1.02-1.6mSv/Gy, so it could be 1or 2, anyone?**

From AAPM review course, Peter Biggs shielding handout, page 24 “ At 10 MV, the production of neutrons is quite low, and by 15 MV, neutron production increaes by a factor 10, and by 18 MV, a further factor of 2.  Therefore, I will vote for 2. ()

Dose/MU calc:





Be careful of the inverse square law correction for PDD function of SSD. It does not always require!! only SSD changed!

Be careful of the inverse square law correction for TPR not function of SSD. So when only SPD changed not at ISO, we will need to correct using inverse square law.



The dose rate at 2 cm depth = 10 R/mA-s x 0.9 (cGy/R) x BSF x PDD

= 9 x 1.15 x 0.6 = 6.21 cGy/(mA-s)



Using SAD setup, TMR(d=9) and TMR(d=18), and prescription dose D is known

MU = D/(TMR(9));

Exit Dose = D/TMR(9) x TMR(d=18) x (118/100)^2

71. Had to do single field 125 cm SSD calculation. 300cGy to 10cm deep. Given output factor as a function of field size graph (no Sc or Sp which in my opinion makes it impossible to do this question accurately), given PDD table, TMR table, given output at dmax for a 10x10 at 100cm SSD. Answers all very close ie approx 1% apart.

Assuming 6x and output at SSD 100 cm + dmax 1.5 as 1 cGy/MU, when we move to SSD 125 cm, the output becomes 1 x (101.5/126.5)^2 = 0.64 cGy/MU

If we want to use PDD

PDD2(SSD=125,d=10, FZ) = PDD1(SSD=100,d=10,FZ) x (125+1.5/125+10)^2 x (100+10/100+1.5)^2 = 1.03xPDD1

MU = 300/(0.64xPDD2(SSD=125, d=10, FZ)) = 300/(0.64x1.03 PDD1)

If we want to use TMR

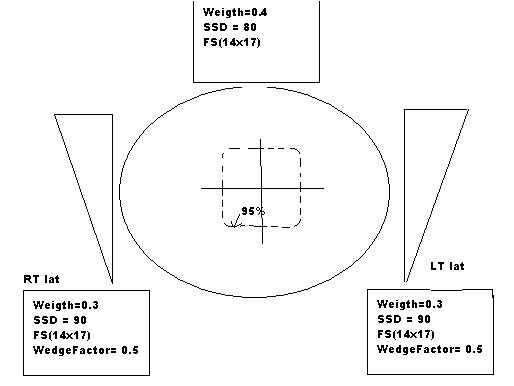
The output at SAD 100 will be 1 cGy x (101.5/100)^2 = 1.03 cGy/MU

MU = 300/(1.03XTMR(d=10,FZ) x (100/135)^2) = 300/(1.03 x 0.55 x TMR), ()

70. A 60Co single field calc 100SSD, cGy/min at dmax given. PDD table given, BSF table given, TAR table given. Prescribed dose was 300cGy to 10cm deep. Had to use 4A/P to convert to square field (had to use 4A/P on numerous rectangular field questions.

I assuming the output is actually measured in air S cGy/min

Time = D/(S x %DD(10, FZ) x BSF (FZ)), ()Kahn sec. 9.4 ex: 3

32.  What is the ratio of MU´s given the weights of AP = 0.4, RT lat and LT lat = 0.3 to deliver 200 cGy to 95 % Isodose line. Fsize for every was given. WFactor for lat. Fields given. SSD for every field given. Table with TMR´s (FS, depth). Calibration 1cGy/ MU at SSD + dmax.  
My guess: this could just be SAD MU calc. ()  
Yes but be careful; The SCD is given at SSD+dmax not at SAD=100cm. JPS

Assuming this is isocentric 15x treatment, but the calibration was done at dmax + SSD. The output should be corrected by inverse square as 1 cGy/MU x ((100+2.5)/100)^2 = 1.05 cGy/MU

Equivalent square field size = 2 x 14 x 17 / (14+17) ~ 15

Dose for AP at iso (D\_AP) = 200 x 0.4 /0.95

Dose for RT Lat at iso (D\_RT) = 200 x 0.3 /0.95

Dose for LT Lat at iso (D\_LT) = 200 x 0.3/0.95

MU\_AP = D\_AP/(1.05 x TMR(d=20,15) x Sc(15) x Sp(15))

MU\_RT = D\_RT/(1.05 x TMR(d=10,15) x Sc(15) x Sp(15) x 0.5)

MU\_LT = D\_LT/(1.05 x TMR(d=10,15) x Sc(15) x Sp(15) x 0.5)

The ratio of MU = 0.4/TMR(20,15) : 0.6/TMR(10,15) : 0.6/TMR(10,15) ()

13.  Calibrated in SSD100+dmax, TPS set SAD, depth 10cm, what is the dose/MU shoule be?

convert calibration at 100SSD Dmax: 100 SAD Dmax by inverse square law as:

(100+dmax)^2 / 100^2 --> calc D10cm by TMR ()

This question may ask calibrating machine at SSD = 100, dmax (6x 1.5 cm) with 1 cGy/MU and what’s the dose/MU at SAD 100 d = 10 cm; the output will be changed from 1 cGy/MU x (101.5/100)^2 = 1.03 cGy/MU  and then 1.03 cGy x TMR(10) to get the Dose/MU at depth 10 cm

Find the MU's to deliver 90cGy (isocentric) with a wedge (WF=0.77) and open field size of 17x17 and blocked field of 11x11.  Machine calibrated at SSD, dmax=3.3cm, 1cGy/MU.  Current SSD=88cm (so treating 12 cm depth), Sc, Sp, and TMR tables given for all field sizes and all depths.

inverse square: 1cGy/MU \* 1.033^2 / 1^2--> 1.07cGy/MU for SAD setup --> SAD MU calc (please correct me if I'm wrong)

Assuming the machine was calibrated at SSD = 100, and dmax = 3.3 cm at 1cGy/MU, we will need to correct the output using the inverse square law

MU = 90cGy/(TMR(12,11) x Sc(17) x Sp(11) x 0.77 x 1 cGy/MU x (103.3/100)^2) ()

\*A dose calc where you have SSD, Dose rate at Dmax for 100 ssd setup, and a depth of 10 (PDD given).  For the given setup, they give you the MU required to give the dose.  For the same dose delivered to an SAD field at a depth of 10 (They stated the TMR), how many MU’s do you need?

Here is my calculation, assuming machine is calibrated 1 cGy/MU at dmax, SSD = 100 for 6x, field size S, and Sc and Sp measured at dmax; MU\_ssd = D/(1cGy/MU x %DD(10) x Scp(S)).  Scp(S) = D(10)/(%DD(10) x MU\_ssd)-(1)

Changing to SAD setup; 1 cGy/MU x (100+1.5/100)^2 = 1.03 cGy/MU at dmax with SAD setup.

MU\_SAD = D/(1.03 cGy/MU x TMR(10) x Scp(S)) - (2)

We put eq. (1) into (2), we can get the MU\_SAD =    0.97x(%DD(10)/TMR(10)) x MU\_ssd ()

\*The Sc(S) does not change from SSD to SAD setup, and for Sp, even the field size change due to divergence at dmax from SSD to SAD setup,  Sp(S) normalized to the same 10 x 10 field or 10 x (90+1.5)/(100+1.5) field, so the Sp still won’t change

Another observation for this problem is that; we can get the dose from the SSD setup, and then plug into the SAD setup to calculate the MU but changing the output with inverse square law.

\*When transferring a patient to a Co-60 unit after being simulated and treated in a SAD = 100 cm calculate the changes to the setup in linac. The treatment in Co-60 had to be done with SSD setup. Thickness of patient given.  
The MU will be corrected by the inverse square law, and also the change of the collimator scattering factor Sc, assuming we treat the patient at the same depth and same field size at that depth.  Therefore, the phantom scatter Sp will not be changed.  A good example is shown in the ESTRO booklet, <http://www.estro-education.org/publications/Documents/Booklet_n6PhysicsforClinRTcorected17May2011.pdf> Example 6 p74-75 ()

1. Tables of 4 MV and 6 MV PDD and TMR VS field size given.  Also.  BSF, not Normalized Peak Scatter Factors were given. Know how to obtain MU settings for different field sizes:  
     
   -In general: most of the time the calibrations were at SSD + dmax.  
   -In some problems the Scp was not given.  
   - Use of SAD and SSD setups, change in SSD´s (to require one to use the Mayneord factor to get the new PDD at a different SSD). (Kahn Ch9 sec c)   
   - Calculate the dose to cord at 4 cm, given everything needed for a SAD setup.
2. Be able to find cord dose given CAX dose from AP/PA treatments.





Check my personal note





The timer error of a orthovoltage unit is + 0.02 secs. The dose rate was 125 cGy/min in water. PDD was 60 % at 2 cm. Determine what is the maximum dose that can be delivered with less than 1 % error without having to take into account the + 0.02 secs.  
@2cm, the dose rate is 75cGy/min → 1.25cGy/sec; 1.25\*0.02(dose within this 0.02s) / 0.01(this dose only can be 1%) = 2.5cGy (, ) Basically, 0.02s needs to be with 2 s to be 1% uncertainity, so 2.5 cGy/1.25cGy/s = 2 sec, reasonable number

\*What is the definition of wedge angle?  
The angle through which an isodose curve is titled at the central ray of a beam at a specified depth, currently the depth is 10 cm. khan sec. 11.4.a ()

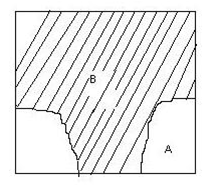
\*Given mixed energy, electron and photon, dose to surface = 40 Gy and PDDs at surface for each given, and dose to d=5 cm = 55 Gy, PDDs for each at d=5 given, what are the relative contributions of photons and electrons at dmax?  
My try: X\*PDDe (surface) + Y\*PDDx(surface) = 40; X\*PDDe(5cm)+Y\*PDDx(5cm) = 55 ()

\*Why does the equivalent square technique work?  
The equivalent square gives the same PDD and output because it emulates the same scattering property of the true field (Metcalf, p391, )

32. Mayneord’s Factor is more accurate for: 6MV, 6x6, 110 SSD; 6MV, 30x30, 150 SSD; 15MV, 6x6, 110 SSD; 15MV, 6x6, 150 SSD; etc.

the Mayneord F factor is not considering scattering, so it’s more accurate for the beam that has less scatter.  So, smaller field size will be more accurate to use the Mayneord’s factor,large SSD will have beam divergence so we will have large field size on the surface (Kahn sec. 9.3.c, ) F factor doesn’t work well for 1. Low energy, 2. Large field, 3. Large SSD and 4. Deeper depth due to scatter (Kahn 3rd p163,and MetCalf p272)

\*Three isocentric beams 120 deg apart, AP and post obliques. Each goes through 15 cm depth to isocenter. 180Gy at isocenter weighted equally for three beams. Post beams transfer 9cm lung (electron density= 0.33), TMRs given at 3,6,9,12,15 cm. Calculate MU(post obliques)/MU(AP).  
Here is my formula; MU(oblique)/MU(AP) = TMR(15)/TMR(radiological depth) = TMR(15)/TMR(9/3+6) = TMR(15)/TMR(9), (TG114, )

Given dose to point A 200 cGy, calculate thickness of block to achieve point B dose 90 cGy. TMR, %DD, and HVL given, depth may be different for B.  
Here is my thought, following Kahn sec 10.3 example 8: Assume depth at point A, and B = d\_A, and d\_B, respectively.  The field size for the whole field as S, and for B block field as S\_B, and A field as S\_A;   
The MU can be obtained from field A; MU = 200/(%DD(d\_A,S\_A)\*Sp(S\_A)\*Sc(S)\*OAR(pointA)), if no OAR was given in the question, we can just assume it’s CAX for point A.  
  
For point B, 90 = MU\*%DD(d\_B,S\_B)\*Sp(S\_B)\*Sc(S)\*0.5^(n), we can solve this equation to get block thickness n. ()

Here assuming the corner block contribution to the point B is small.

\*Sim film taken at 102cm SSD, SFD 140cm. Want to treat at 120cm SSD. What distance to film should be used when cutting blocks.102/140 = 120/X →  X=164.7

\*If the patient thickness is 22 cm, SAD=100 cm, source to film distance is 130 cm, d=11 cm if technique is changed from SAD to SSD, What is the new source to film distance.  
 100/130 = 111/X → X = 144.3

\*Field size is measured 56 cm on patient skin and collimator 40 cm with table at its lowest position 167 cm from the source. What’s patient size (including setup bag etc.)?  
40/56=100/X → X=140 → 167-140=27cm, patient thickness is 27cm

\*Given diagram of one dimension blocked field with distance from CAX and table of SARs (0cm 6cm 9cm 10cm etc), calculate SAR.  
CLARKSON’s method, simple subtraction?  
Agree (Kahn sec. 9.5.A )

Yes.  I think Bentel has a detailed example of this calculation. JPS

\*Given readings at 10 cm depth for 10 x 10 and 20 x 20 fields with 100 cm SAD, and two TMRs, calculate the Scp(20).  
It may calculate in this way; Dose1(reading1) = MU/(TMR(d=10,FZ = 10)\*Scp(10)), where Scp(10) = 1, I assumed d = 10 cm is the reference depth, and Dose2(reading2) = MU/(TMR(d=10,FZ = 20)\*Scp(20)), so Scp(20) = (D1\*TMR(10,10))/(D2\*TMR(10,20)) ()

15 x 15 field with 3 x 15 block in the center, which has 5% transmission factor. Depth at 7 cm, dose to point A given with 1.01 OCR, calculate dose to CAX under block, given table like:

|  |  |
| --- | --- |
| FS | 5, 7, 10, 15, 20 |
| OF |  |
| TMR(7cm) |  |
| %dd(7cm) |  |



my try:

Assume point A is under one of the open portions of the  field. Assuming no scatter from the other open field.

for the open field, it’s 6x15 → Feq = 8.57; the block 3x15;   Feq = 5

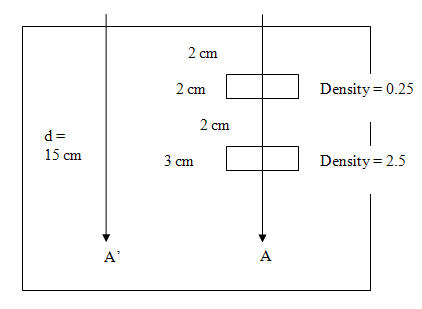
Not sure if this question gives correct information, output factor is Sc, but we will need Sp as well, so

MU = Dose at A/(Sc(15)\*Sp(8.57)\*OCR\*TMR(7, 8.57))

Dose at CAX = MU(Sc(15)\*Sp(15)\*TMR(7,15) - Sc(15)\*Sp(5)\*TMR(7,5)\*95%) ()

179. From source to point A, there are: 100 cm SSD to surface, then 3 cm tissue, 2 cm inhomogeneity (re=0.25), 3 cm tissue, another 3 cm inhomogeneity (re=2.5), finally 4 cm tissue. So depth is 15 cm. 4MV beam delivers 200 cGy to point A with inhomogeneities. What’s the dose to point A without the inhomogeneities? TMRs were given.

3+2\*0.25+3+3\*2.5 +4= 18cm → use TMR

-          

  Dose to point A’ without inhomogeneity = (200/(TMR(depth = 18))\*TMR(depth = 15) ()

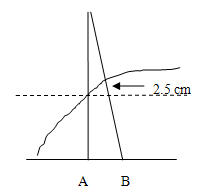
Similar question: Lung correction given dose with no correction - the corrected dose has 2 cm of lung and 4 cm of dense medium (4x tissue) - what is the dose at that second point?

Patient is treated to 10cm depth of chest wall with SAD of 100cm. There is 6cm lung within the central axis of beam. How much more dose will be delivered without heterogeneous correction? TMR for different depth are given.

True radiological depth = 6x0.25 + (10 – 6) = 5.5 cm.

TMR(5.5)/TMR(10)

\*If dose to point A (depth 10 cm) is 200 cGy, calculate dose to point B ignore beam divergence. %DD(10)=65%, %DD(12.5)=56%, 100 SSD along CAX.



Dose at Dmax with SSD = 100 is: 200/0.65 = 307.7cGy → Dmax with SSD = 97.5 is: 307.7\*100^2/97.5^2 = 323.7cGy

Assume 6MV: %DD(12.5) with SSD = 97.5 is: 0.56\*((97.5+1.6)/(100+1.6))^2\*((100+12.5)/(97.5+12.5))^2 = 0.557

Dose at B: 323.7\*0.557 = 180.3cGy.

Observe here that the PDD(12.5) does NOT change (0.56 ⇒ 0.557) with the Mayneard Factor. In fact in Khan’s discussion, the PDD correction factor by Mayneard Factor is not considered at all with the assumption that it does not change much. AA

Dose at Dmax with SSD = 100 is: 200/0.65 = 307.7cGy → Assuming 6x, Dmax with SSD = 97.5 is: 307.7\*(100+1.5)^2/(97.5+1.5)^2 = 323.4cGy, Dose at B: 323.4\*0.56 = 181cGy.

\*Parallel opposed fields with equal weighting.  60 Gy in 30 fractions is prescribed to the isocenter.  The fields are equally weighted. (SAD setup with iso at midsep).  The patient separation is given, as well as the depth to the cord.

\*Cord sits 5cm posterior to midplane of a 24 cm thick patient treated 180cGy/day AP/PA to 12cm.  How many fractions can be treated to keep the cord below the 45Gy tolerance.  TMR's for d=5, d=12, and d=19 given.  ---> needed to use ratio of TMR's to solve.

PA field MU = 90/TMR(12 cm)

PA to cord = MU x TMR(5cm) x (100/93)^2 = 90/TMR(12) x TMR(5) x (100/93)^2- (1)

AP to cord = 90/TMR(12cm) x TMR(19cm) x (100/107)^2 - (2)

fx = 4500 / (eq(1) + eq(2)) ()

Shouldn’t there be an inverse sq factor here too since the cord is at extended distance to the isocenter? JPS

thank you for catching this!

If we consider more difficult version, the field size changed at the depth of cord

FZc = field size at iso

FZ at Cord from PA (FZo1) = FZc x 93/100

PA field MU = 90/[TMR(12 cm, FZc) x Sc(FZc) x Sp(FZc)] – (1)

PA to cord = MU x TMR(5cm, FZatCord) x Sc(FZc) x Sp(FZo1) x (100/93)^2 = 90x[TMR(5,FZo1)/ TMR(12, FZc)] x [Sp(FZo1)/Sp(FZc)] x (100/93)^2- (1)

\*Treating with parallel opposed wedge fields for 60 Gy in 30 fxs and the MU per beam in 160 MU.  After 10 fx you realize WF was not in calc.  How many MUs required for remaining 20 fxs to get to 60 Gy?

Assuming the WF is given, the correct MU/field = 160/WF, so (160/WF - 160) = the missing MU/field, so the MU/field from 11 to 30 fx should be ((160/WF - 160)x10/20 + 160/WF)/field ()

\*Prescription is 200 cGy/day delivered by parallel opposed, equally weighted beams.  They say they gave 147 MU per beam, but left out a wedge factor of 0.8 for the first 10 treatments.  The patient is to receive 30 treatments total.  What is the MU required (per beam) for the remaining 20 treatments in order to deliver the prescribed dose for the entire course of treatment?

Assume the wedge was used for both beams. 1/0.8 = 1.25 → 200\*1.25\*10 = 2500cGy; 200\*30 - 2500 = 3500cGy →  
3500/20 = 175 → 175/200\*147 = 129MU  
I think the wedge was in the treatment but it wasn’t taken into account in the MU calculation; so (147/0.8 - 147) x 10 /20 + 147/0.8 = 202 MU /per field for 11 - 30 fx, ()

Give a tangential plan, with open and wedge combination, and wedge factor, if the MU for open was delivered to wedge,

     and vice versa, what is the real dose.

MU1 is open beam, and MU2 is the wedge beam

Prescribed Dose (T) =  MU1 + MU2 x WF

Real Dose (R) = MU1 X WF + MU2

R = ((MU1 x WF + MU2) /(MU1+MU2xWF) ) x T ()

\*Multiple beams plan: AP weighted to 100% at dmax, laterals weighted to 100% at dmax. 200 cGy delivered to 238% isodose line. What is the dose delivered by AP beam?  
200cGy / 238% = 84cGy???  
This is what I got. 3 equally weighted beams giving 200cGy to the 238% isodose line will each contribute 84 cGy. JPS

From Bentel’s example, 200/2.38 = 84 cGy

TG51: