BASIC RADIOLOGICAL PHYSICS COURSE

CLASS GROUP: _____
(Radiation Therapy, Radiation Oncology Resident, Post Doctoral..)

YEAR: _____
(2004, 2005 …)

Objective:

After completing this Study Guide #7, the students should be able to understand various of shielding techniques. The initial components are the issue of minimizing radiation for radioiodine therapy, and then barrier calculations for diagnostic and radiotherapy installations. This section also deals with radiation survey, quality management and compliance with regulations.

Study Guide #7:	Health Protection II (Part 2 of 2)
Read Sections:	Foundation of Radiological Physics (CBSaw) Chapter 14 – Health Physics II **Sections 14.7 to 14.13**
Suggested Reference:	Faiz Khan's text – Chapter 16
Assignments:	Answer all questions as directed in this handout
Clinical Rotation Assignment:	What type of radiation is produced in an low energy radiographic unit?

STUDY GUIDE

14.1 In your own words, define the following terms:

(i) workload	(j) use factor
(k) occupancy factor	(l) transmission factor
(m) primary radiation	(n) secondary radiation
(o) scattered radiation	(p) leakage radiation

14.17 List the dose equivalent limits used for protective barrier calculations for controlled and non-controlled areas.

14.18 Explain the difference in the two statements: "exposure should not exceed 2 mrem per hour" and "exposure should not exceed 2 mrem in any one hour".

14.19 Identify the advantage of using paraffin or borated materials as shielding materials in high-energy linear accelerator (> 10 MV).

14.20 Explain the function of the maze in a radiotherapy treatment room.

14.21 Explain why the console cannot be located inside a radiotherapy treatment room.

14.22 Explain the purpose of area surveys after the construction of a radiation facility.

14.23 Explain why a Geiger-Muller counter should not be used to survey a newly constructed radiation facility.

14.24 Explain the function of a quality management program.

14.25 A surgeon was performing lung exploration and decided that it was necessary for prophylactic radiation treatment on an artery to minimize occlusion. A radiation oncologist was called for this new and unusual treatment using the iridium-192 high dose rate remote unit. Discuss whether such treatment is a violation of the NRC regulations.

PROBLEMS

14.1 A treatment room was designed to house a 10 MV linear accelerator with the following assumptions. The maximum number of patients to be treated per day is 40. Based on past experience, the estimated dose delivered per patient is 200 cGy. What is the workload if the machine is energized for 5 days a week?

14.2 Show that the transmission factor through a sidewall of the treatment room in Problem 14.1 to an office is 1.8×10^{-6}. Assume that the source is 3 m away from the wall and the occupancy factor for the office is unity.

14.3 Express the transmission factor of Problem 14.2 in TVLs.

14.4 Determine the transmission factor if the other side of the wall in Problem 14.1 is a walkway with an assigned occupancy factor of 1/8.

14.5 Determine the transmission factor for scattered radiation to the same location in Problem 14.1. Assume α has a value of 1×10^{-3}, a field size of 40 cm x 40 cm and a distance of 1 meter between the source and the scatterer. The distance from the scatterer to the point of interest is 3 m.

14.6 Determine the transmission factor for leakage radiation to the same location in Problem 14.2. Maximum radiation leakage occurs when the source is on the same side as the point of interest relative to the isocenter. The distance of the location of interest from the source is 1 meter.

14.7 What is the overall required secondary barrier thickness, based on the results of Problems 14.5 and 14.6?

14.8 A primary barrier has been designed to shield a well-collimated photon beam. If the source is moved 4 m to 2 m from the barrier, the barrier thickness has to be increased by _____ HVL to give the same exposure limit.

14.9 An old linear accelerator will be replaced with the anticipation that the workload would double. How many HVLs are required to maintain the previous exposure limit to the console, assuming that the use factor and occupancy factor are not changed?

14.10 A storage room adjacent to a hot lab was converted into a clerical office. Previous measurement indicates that the worker in that room would receive an annual dose of 1 rem. Is any additional shielding required?

14.11 What is the weekly exposure to a secretary sitting at a distance of 1.5 m from a 25 mCi cesium-137 source? The exposure rate constant for cesium-137 is 3.27 $R \cdot cm^2/(mCi \cdot h)$, and assumes that the work time is 40 hours per week. Show that the weekly exposure is 1.45×10^2 mR. Compute the shielding thickness, expressed in TVLs, required to reduce the exposure to 10 mrem/week.

Multiple Choice Questions
Select the one correct answer.

14.6 Which of the following is NOT considered in shielding calculations?
a) Workload
b) Occupancy factor
c) Use factor
d) Distance
e) none of the above

14.7 The use factor refers to the fractional time
a) an area that is being occupied.
b) an area that is actually being used.
c) a radiation beam is directed to an area.
d) a radiation beam is ON.
e) none of the above.

14.8 A swinging door was designed in layers of materials from the outside towards the inside of the machine room, ¾" of lead, 4" of 5% borated polyethylene, and ¼" of lead. The room was designed to house
a) a 250 kVp radiation unit.
b) a 1 MV photon machine.
c) a 4 MV photon linear accelerator.
d) a 6 MV linear accelerator.
e) a 15 MV photon beam machine.

14.9 The dose equivalent limit for shielding calculations is
a) 1 mSv per week for controlled areas.
b) 0.1 mSv per week for controlled areas.
c) 1 mSv per week for uncontrolled areas.
d) 0.01 mSv per week for uncontrolled areas.
e) none of the above.

14.10 Which of the following statement is NOT TRUE about Quality Management Program (QMP)?

a) QMP requires that the patient be identified by at least two methods.
b) QMP considers that the route of administration of radioisotopes be specified.
c) QMP is intended to ensure that byproduct materials are administered as directed by the authorized user.
d) QMP requires a written directive before administrating radiation to the patient.
e) none of the above.

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