Determine Dose to Skin

ACADs (08-006) Covered

3.3.4.1 3.3.4.2 3.3.12.5 3.3.13.10

Keywords

Discrete radioactive fuel particle, Co-60, skin dose, hot particle.

Description

This document provides references to readings and other resources to support a lesson on how to determine dose to skin, as well as provides scenarios and questions to engage students.

Supporting Material

Headquartered at Indian River State College | 3209 Virginia Avenue Fort Pierce, FL 34981 | 772-462-7172
www.gonuke.org
This material is based upon work supported by the National Science Foundation under Grant No. 1104238. Any opinions, findings, conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Module 9: Determine Dose to the Skin

Table of Contents:

Resources Key 2

Module Readings and Homework 2
Primary Scenario "Determine Dose to the Skin from an Exposure to a Discrete Radioactive Fuel Particle" 2
Transfer Scenario "Determine Dose to the Skin from an Exposure to a Discrete Radioactive Particle of Co-60" 2

Module Assessment Items 3
Primary Scenario "Determine Dose to the Skin from an Exposure to a Discrete Radioactive Fuel Particle" 3

ACAD References 5

A Product of DOL Grant # HG-15355-06-60

Resources Key

This refers to:	This reference:
ACAD	National Academy for Nuclear Training, Uniform Curriculum Guide for Nuclear Power Plant Technician, Maintenance, and Nonlicensed Operations Personnel Associate Degree Programs, ACAD 08-006.
DOE-SG	Office of Environmental, Safety and Health: Radiological Control Technician Training Site Academic Training Study Guide Phase I, Project Number TRNG-0003 Available at: http://nsedu.rnet.missouri.edu/docshare/. File is located under the Docs/General Curriculum/DOE materials folder.
G.	Gollnick, D. (2006). Basic Radiation Protection Technology, 5th Ed. Pacific Radiation Corporation, Altadena, CA.

Module Readings and Homework

Primary Scenario "Determine Dose to the Skin from an Exposure to a Discrete Radioactive Fuel Particle"

Core Concept: Radiation interactions with tissue		
	Homework (end of chapter)	
Readings	Calculation Items	Non-calculation Items
G. Chap 4, 83-92 DOE-SG-Mod 1.08-3 to 1.08-7	G. Chap 4, page 88, sample problem 2	G. Chap 4, page 86, sample problem 1 G. Chap 4, # 2, 4
Core Concept: Radio-sensitivity of cells		
	Homework (end of chapter)	
Readings	Calculation Items	Non-calculation Items
G. Chap 4, 90-92 DOE-SG-Mod 1.08-7 to 1.08-8		G. Chap 4, # 6, 8
Core Concept: Skin dose		
	Homework (end of chapter)	
Readings	Calculation Items	Non-calculation Items
G. Chap 5, 146-148 G. Chap A-2, 810-815	G. Chap 5, page 148, sample problem 8 G. Chap 5, # 9	G. Chap 8, # 21

Transfer Scenario "Determine Dose to the Skin from an Exposure to a Discrete Radioactive Particle of Co-60"

Refer to readings and homework for primary scenario above.

A Product of DOL Grant # HG-15355-06-60

Module Assessment Items

Note: If instructors wish to increase the difficulty of any item, then we suggest you use it as the basis for an in-class discussion, and / or require students to write an explanation for why a particular choice is correct.

Primary Scenario "Determine Dose to the Skin from an Exposure to a Discrete Radioactive Fuel Particle"

1. What characteristics do all discrete radioactive particle (DRP) have? Select ALL that are correct.
    a. Low levels of radioactivity
    b. Microscopic in size CORRECT
    c. Large alpha decay component
    d. High energy gamma emission
    e. Beta emissions CORRECT
    f. Highly charged particle CORRECT
    g. Exposes large areas of skin

2. A radiation worker has contamination on the outside surface of his worker's glove from a discrete hot particle. What would you do in assigning skin dose?
    a. The skin dose can be assumed to be negligible due to glove attenuation
    b. The skin dose can't be calculated and must be estimated
    c. The skin dose should be calculated assuming the glove is not present
    d. The skin dose can be calculated based upon radiation attenuation by the glove. (CORRECT)

3. Why did you choose the response above for assigning skin dose? Select ALL that apply.
    a. The number of beta particles reaching the skin will decrease (CORRECT)
    b. There will be little effect on the skin dose because the gamma-rays will easily penetrate the glove.
    c. The energy of the beta particles will be reduced from attenuation through the glove (CORRECT)
    d. The thickness of a glove will stop all beta particles from a discrete hot particle.

4. You have been asked to develop a new computer program to calculate dose to the skin from skin contamination. What are some of the parameters that will be needed in your code to calculate dose? Select ALL that apply.
    a. The gamma-ray exposure coefficient for calculating dose from gamma-rays
    b. The range of beta particles CORRECT
    c. The penetration ability of alpha particles

d. The dose as a function of depth in skin CORRECT
e. The types of cells in the skin receiving the dose.
f. The amount of clothing between the hot particle and the skin CORRECT
g. The distance a hot particle is from the skin CORRECT
h. The energy of beta particles CORRECT

5. Why is it important to know the energy of beta particles coming from the DRP to accurately assess skin dose? Select ALL that apply.
   a. The energy is important to calculating the amount of dose delivered as a function of depth in skin. (CORRECT)
   b. The energy is needed to determine if the beta particles can penetrate any clothing covering the skin. (CORRECT)
   c. The energy is likely to be monoenergetic, so the precise depth of penetration of the beta particles can be calculated.
   d. The energy remaining in the beta particles as they pass through the basal layer is needed to calculate dose. (CORRECT)

6. A new model has been developed to predict the amount of energy deposited in the basal layer of skin from a hot particle. This calculation estimates 10^{-8} J of energy deposited in a 1 cm^2 area over the basal layer depth of 0.002 cm. Assume a tissue density of 1 gm/cm^3. What is the dose to the skin in Gy and Rads?

   Answer – Recall, dose is defined as energy deposited per unit of mass.
   Volume of skin exposed = 1 cm^2 x 0.002 cm = 0.002 cm^3
   Mass of skin exposed = 0.002 cm^3 * 1 gm/cm^3 = 0.002 gm = 2 x 10^{-6} kg
   Dose = energy/mass = 10^{-8} J / 2 x 10^{-6} kg = 0.05 J/kg * 1 Gy/(J/kg) = 0.05 Gy
   Dose = 0.05 Gy * 100 Rads/Gy = 5 Rad

7. Rate the following cell types from most to least radiosensitive.

Cell Type:	**Rate from most (1) to least (5) radiosensitive:**
Skin cells	
Fetal tissue	
Bone	
Nerves	
Blood cells	

Answer:
Skin cells 3
Fetal tissue 1
Bone 4
Nerves 5
Blood cells 2

A Product of DOL Grant # HG-15355-06-60

ACAD References

ACAD
3.3.4 BIOLOGICAL EFFECTS AND RISKS ASSOCIATED WITH EXPOSURE TO IONIZING RADIATION
• Describe the mechanisms of radiation interactions with cells (primary, secondary/free radicals).
• Identify cell characteristics that affect radiosensitivity (cells with a longer dividing future, division rate and cell type).
3.3.12 RADIOLOGICAL INCIDENT EVALUATION AND CONTROL
• Describe how to estimate skin dose resulting from skin contamination including hot particles.
3.3.13 DECONTAMINATION
• Identify conditions in which skin dose calculations should be performed as a result of skin contamination.