Radiation Protection Officer

measurement and control applications
dispersible radioactive materials - D

Test exam
evaluation open questions

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Question 41

During maintenance on the X-ray device, the service engineer inadvertently keeps his hand in the direct beam.

Equivalent dose rate (in mSv per mAs) at 1 m from the focus.

tube voltage	thickness aluminum filter		
	1 mm	**2 mm**	**3 mm**
50 kV	0.07	0.05	0.03
70 kV	0.15	0.09	0.05.
90 kV	0.20	0.13	0.08

Additional data

tube voltage	90 kV
anode current	6 mA
filter	3 mm aluminum
exposure time	0.3 seconds
distance focus - skin	50 cm

Calculate the equivalent skin dose. (maximal 4 points)

Evaluation of question 41

reading Figure B at 90 kV and 3 mm aluminum
→ 0.08 mSv/mAs at 1 meter (1 pt)

mAs value = 6 mA × 0.3 s = 1.8 mAs (1 pt)

equivalent dose at 1 meter
= 0.08 mSv/mAs × 1.8 mAs = 0.14 mSv (1 pt)

equivalent dose at 50 cm = 0.5 m
= 0.14 mSv × $(1\ \text{m} / 0.5\ \text{m})^2$ = 0.56 mSv (1 pt)

Question 42

During inspection of welds, an encapsulated ^{192}Ir source falls on the street. The source is returned to the lead container by the RPO using a pair of tongues.

Additional data:

activity	100 GBq
source constant	0.12 μSv m^2 MBq^{-1} h^{-1}
length of tongues	50 cm
exposure time	10 s

The RPO is classified as exposed A-worker

Anser the next questions. (maximal 6 points)

(a) calculate the effective dose received by the RPO

(b) calculate the time that the job should have lasted until the annual limit for the effective dose of this worker is reached

Evaluation of question 42

activity = 100 GBq = 100×10^3 MBq (1 pt)

time = 10 s = 0.0028 h (1 pt)

equivalent dose at 1 meter
= 0.12 μSv m^2 MBq^{-1} h^{-1} × 100×10^3 MBq × 0.0028 h
= 34 μSv (1 pt)

equivalent dose at 50 cm = 0.5 m afstand
= 34 μSv × (1 m / 0,.5 m)^2 = 140 μSv = 0.14 mSv (1 pt)

annual limit exposed A-werker = 20 mSv (1 pt)
→ maximal time = 0.0028 h × (20 mSv / 0.14 mSv)
= 0.4 h (1 pt)

Question 50

If the nurse wants to inject a patient with tetrofosfine that is labeled with the radionuclide ^{99m}Tc, the needle slips and she inadvertently injects herself with a droplet of the injection dluid.

Additional data

activity injection fluid	600 MBq
volume injection fluid	2 ml
volume droplet	0.05 ml
$e(50)_{injection}$	1.1×10^{-11} Sv/Bq
$e(50)_{inhalation}$	$2,9 \times 10^{-11}$ Sv/Bq

the nurse is not an exposed worker

Answer the next questions. (maximal 4 points)

(a) calculate the activity of the droplet

(b) calculate the committed effective dose due to this accident

(c) check whether the annual limit for the nurse is exceeded - justify your answer

Evaluation of question 50

activity of droplet
= 600 MBq × (0.05 ml / 2 ml)
= 600 MBq × 0.025 = 15 MBq (1.5 pt)

$e(50) = e(50)_{injection} = 1.1\times10^{-10}$ Sv/Bq (0,5 pt)
$E(50) = 1.1\times10^{-11}$ Sv/Bq × 15×10^{6} MBq
= 17×10^{-5} Sv = 0.17 mSv (1 pt)
annual limit for nonexposed worker = 1 mSv (1 pt)
→ annual limit is not exceeded (0.5 pt)

Question 51

In the radionuclide laboratory, a nonvolatile compound is labeled with the radionuclide ^{35}S.

Additional data

laboratory class	D
workplace	table
$e(50)_{ingestion}$	1.4×10^{-10} Sv/Bq
$e(50)_{inhalation}$	8.0×10^{-10} Sv/Bq
working time per labeling	half a day = 4 hours per week
activity per labeling	100 kBq

Answer the next questions. (maximal 6 points)

(a) calculate the maximum activity A_{max} that may be handled

(b) calculate the contribution of this practice to the load factor B

Directive on radionuclide laboratories

p	phase of material / procedure
-4	gass / powder in opren system liquid close to boiling point strongly splashing manipulation
-3	volatile nuclide (^{3}H as vapour, iodine) powder in closed system boiling in closed system shaking, mixing on a vortex, centrifugation storage of noble gas in closed system
-2	simple procedure (RIA) labeling with nonvolatile material
-1	very simple wet work pipeting of nonvolatile material procedure in closed system eluting of tecnetium pulling up syringe labeling in closed system measurement on closed ampoule storage in working area

q	laboratory
0	outside laboratory
1	D-laboratory
2	C-laboratory
3	B-laboratory

r	local ventilation
0	table witout loca; ventilation
1	table with local ventilation fume hood (not NEN-EN 14175)
2	fume hood (NEN-EN 14175) biohazard cabinet (class 2)
3	biohazard cabinet (classe 3) glove box

Evaluation of question 51

labeling nonvolatile compound	$p = -2$	(0.5 pt)
D-laboratory	$q = 1$	(0.5 pt)
table	$r = 0$	(0.5 pt)
$e(50) = e(50)_{inhalation} = 8.0\times10^{-10}$ Sv/Bq		(1 pt)

maximum activity

$A_{max} = 0.02\times10^{p+q+r} / e(50)_{inhalation}$ (1 pt)

$A_{max} = 0.02\times10^{-2+1+0} / 8.0\times10^{-10}$

$= 2.5\times10^{6}$ Bq = 2.5 MBq (1.5 pt)

activity per practice = 100 kBq = 0.1 MBq

working time per practice = 4 hours per week

load factor

$B = (4 \text{ hours} / 40 \text{ hours}) \times (0.1 \text{ MBq} / 2.5 \text{ MBq})$

$= 0.1 \times 0.04 = 0.004$ (1 pt)