Lab 6: Shielding Design for a Co-60 Vault

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Abstract

Shielding designs for two walls in a Co-60 vault are determined. The exposure rate was 2458 R/hr at 1 m from the source, which equates to a workload of the beam of 492 Gy/wk.

Theory

Shielding of radioactive sources in any facility that houses them is required to protect personnel and the general public.

$$P_c = 5\,\text{mSv/yr} = 0.1\,\text{mSv/wk} \tag{1a}$$

$$P_u = 1\,\text{mSv/yr} = 0.02\,\text{mSv/wk}. \tag{1b}$$

The weekly rate is based on fifty 5-day workweeks (allowing for 10 days of holiday.) As the data section will show,

$$n = -\log(B_T) \tag{2}$$

Finally, a schematic of the UWMRRC Co-60 vault is shown in Fig 1.

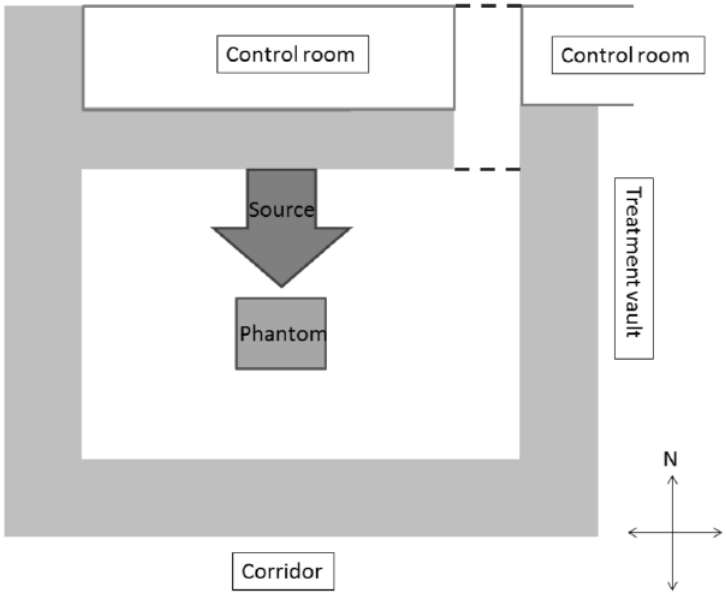

Figure 1: Schematic of the UWMRRC Co-60 vault.

Data

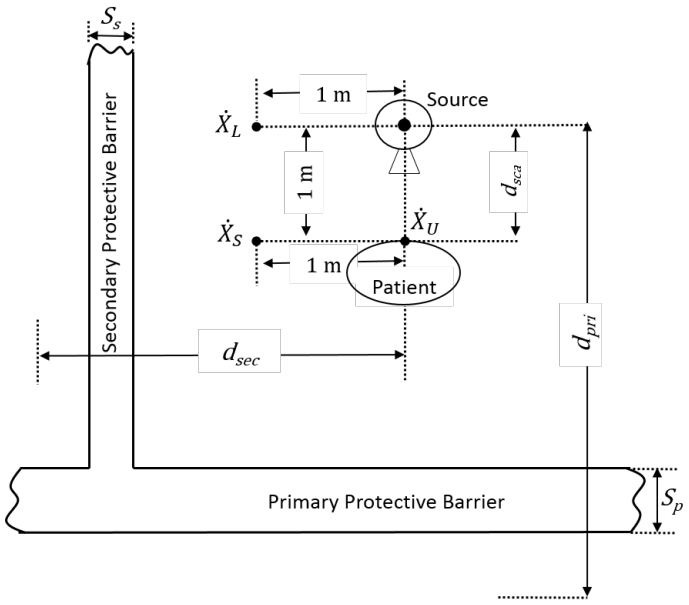

Figure 2: Schematic of parameters required in shielding calculations.

Table 1

Parameter	Value	Unit	Description
d_{pri}	6.71 ± 0.01	m	distance from source to 1 m past the primary barrier
d_{sec}	4.88 ± 0.01	m	distance from source to 1 m past the secondary barrier
d_{sca}	1.0 ± 0.01	m	distance from source to phantom
$\dot{X}_U$	2458 ± 4	R/hr	unattenuated exposure rate 1 m from the source
$\dot{X}_S$	1520 ± 100	mR/hr	scattered exposure rate 1 m from patient surface
$\dot{X}_L$	1800 ± 300	μR/hr	exposure rate due to leakage 1 m from the source
S_p	*to be determined*	m	thickness of primary barrier
S_s	*to be determined*	m	thickness of secondary barrier

Table 2: Ion chamber measurements. M_U values are in nC/30-sec; M_S values are in pC.

	Trial 1	Trial 2	Trial 3	Avg	σ	N_x [R/C]
M_U	4.09	4.10	4.10	4.10	0.01	4.997×10^{9}
M_S	356.44	356.47	356.69	356.53	0.001	3.545×10^{7}

Discussion

References

[1] NCRP Report 151. Structural shielding design and evaluation for megavoltage x- and gamma-ray radiotherapy facilities. Technical report, National Council on Radiation Protection and Measurements, 2005.

[2] NCRP Report 49. Structural Shielding Design and Evaluation for Medical Use of X-rays and Gamma Rays of Energies up to 10 MeV. Technical report, National Council on Radiation Protection and Measurements, 1976.

[3] NRC. Code of federal regulations, title 10 part 20: Standards for protection against radiation. Technical report, Nuclear Regulatory Commision, 2015.