

Properties of Some Commonly Used Beta Emitters

Property	³ H	¹⁴ C	⁴⁵ Ca	³² P	⁹⁰ Sr
Half Life	12.3 y	5730 y	163 d	14.3 d	28.1 y
Max beta energy (MeV)	0.0186	0.156	0.257	1.71	2.27 ^a
Average beta energy (MeV)	0.006	0.049	0.077	0.70	1.13 ^b
Range (cm) in unit density material	0.00052	0.029	0.06	0.8	1.1
HVL (cm), unit density absorber	---	0.0022	0.0048	0.10	0.14
Dose rate from 100 beta particles/cm ² sec ⁻¹ (mrad/hr) ^c	---	56	33	11	11
Fraction transmitted through dead layer of skin (0.007 cm)	---	0.11	0.37	0.95	0.97
Dose rate (mrad/hr) to basal cells ^d of epidermis per mCi/cm ²	---	1,400	4,000	9,200	17,000 ^e

- a. From the ⁹⁰Y decay product. ⁹⁰Sr emits 0.55 MeV (max) beta.
- b. ⁹⁰Sr (0.196) + ⁹⁰Y (0.93).
- c. The dose rate for 100 b particles/cm²-sec is for a parallel beam.
- d. The dose rate to basal cells of the epidermis is from beta particles emitted in all directions equally from contamination on the surface of the skin. Basal cells are considered to be 0.007 cm below the surface.
- e. The dose rate to basal cells of the epidermis listed for ⁹⁰Sr includes the ⁹⁰Y contribution. Data for half-lives and maximum and average beta energies taken from MIRD, 1975.

(J. Shapiro, *Radiation Protection--A Guide for Scientists and Physicians*)

Tissue Dose Rate (rads/hr) at Various Distances Around a 1 uCi Particle of Various Beta Emitters (Range in Tissue 1 - 10 mm.)

um	mm	¹⁴ C	⁹⁰ Sr	³² P	⁹⁰ Y
10	--	2,000,000	530,000	380,000	270,000
100	0.1	1,500	5,000	3,700	2,700
200	0.2	40	1,100	930	680
400	0.4	0.03	200	230	160
600	0.6	0	60	100	70
1,000	1.0	0	10	30	26
10,000	10.0	0	0	0	0.02

(From NATO AMedP-6, Part 1, 1973)