

Equivalent dose (Sv) = Radiation weighting factor w_R × Absorbed dose (Gy)

Type of radiation	Tissue weighting factor w_R
γ-rays, X-rays, β-particles	1
Proton beams	2
α-particles, heavy ions	20
Neutron beams	2.5~21

Effective dose (Sv) = Σ (Tissue weighting factor w_T × Equivalent dose)

Tissue	Tissue weighting factor w_T
Red bone marrow, colon, lungs, stomach, breasts	0.12
Gonad	0.08
Bladder, esophagus, liver, thyroid	0.04
Bone surface, brain, salivary gland, skin	0.01
Total of the remaining tissues	0.12

Sv: sieverts; Gy: grays

Source: 2007 Recommendations of the ICRP

Recommendations issued by the International Commission on Radiological Protection (ICRP) in 2007 presented new radiation weighting factors and tissue weighting factors. It is stated that α (alpha)-particles have 20 times larger effects on the human body than γ-rays and β (beta)-particles with the same absorbed doses. Neutron beams are also given high radiation weighting factors and are expected to have 2.5 to 21 times larger effects on the human body than γ-rays and β-particles depending on the energy quantities (p.37 of Vol. 1, “Conversion from Gray to Sievert”).

A survey on the health effects of radiation on atomic bomb survivors revealed which organs and tissues are more prone to the cancer-causing effects of radiation (p.114 of Vol. 1, “Tissues and Organs Highly Sensitive to Radiation”). These tissues are assigned high tissue weighting factors.

Surveys on the health effects of radiation were also conducted on the children and grandchildren of atomic bomb survivors but no heritable effects of radiation were observed (p.109 of Vol. 1, “Chromosomal Aberrations among Children of Atomic Bomb Survivors”). Therefore, the ICRP lowered the tissue weighting factor for the gonads from 0.2 in the 1990 Recommendations to 0.08 in the 2007 Recommendations. In this way, the factors used in the calculation of effective doses are updated to accommodate new findings.

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