Schedule I　Weighting Factors used in Radiation Protection

Schedule I-1　Quality Factor and Radiation Weighting Factor

(1) **Quality factor**

Q(L) is the quality factor in terms of the unrestricted linear energy transfer L in water as specified in ICRP publication 60.

For radiation types and energy which are not included in Table I-1, an approximation of W_R can be obtained by calculation of $\overline{Q}$ at a 10 mm depth in the ICRU sphere:

$$\overline{Q} = \frac{1}{D}\int_0^\infty Q(L)D(L)dL \quad \text{.....(1.1)}$$

where D(L)dL is the absorbed dose at 10 mm between linear energy transfer L and L+dL.

$$Q(L) = \begin{cases} 1 & (L \leq 10) \\ 0.32L - 2.2 & (10 < L < 100) \\ 300/\sqrt{L} & (L \geq 100) \end{cases} \quad \text{.....(1.2)}$$

the unit of L in (1.1) and (1.2) is keV・μm^{-1}.

(2) **Radiation weighting factor**

For the purpose of radiation protection, the radiation weighting factor, W_R, is a modifying factor which applies to the tissue or organ absorbed dose for calculating their equivalent dose, and is based on the type and quality of the external radiation field or on the type and quality of the radiation emitted by an internally deposited radionuclide. It may represent the relative biological effect of various radiations. The specified values are given in Table I-1.

Table I-1　Radiation weighting factors [1]

Type and energy range[2]	Radiation weighting factor W_R
Photons, all energies	1
Electrons and muons, all energies[3]	1
Neutrons[4], energy < 10 keV	5
10 keV to 100 keV	10
> 100 keV to 2 MeV	20
> 2 MeV to 20 MeV	10
> 20 MeV	5

(See also Figure I-1)	
Protons, other than recoil protons, energy >2 MeV	5
Alpha particles, fission fragments, heavy nuclei	20

(1) All values relate to the radiation incident on the body or, for internal sources, emitted from the source.

(2) The radiation weighting factors may be calculated by equations (1.1) and (1.2) for radiation types and energy range not included in Table I-1.

(3) Excluding Auger electrons emitted from nuclei bound to deoxyribonucleic acid (DNA) .

(4) The smooth fit to the W_R values for neutrons is given in Figure I-1.

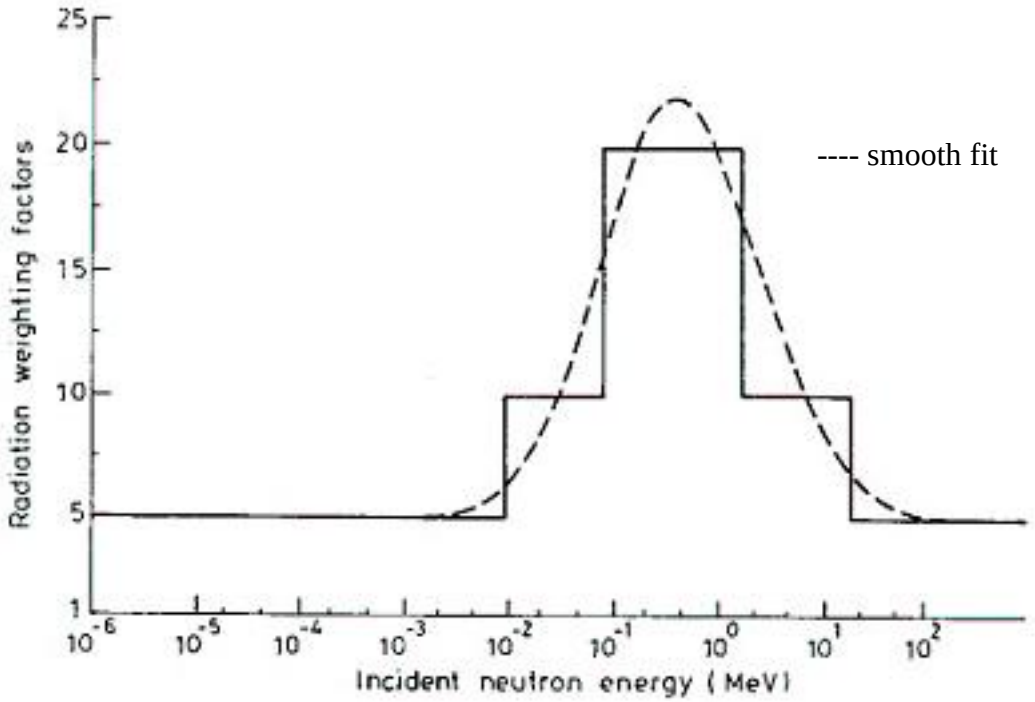

Figure I-1 Radiation weighting factors for neutrons.

The mathematical relationship for the smooth fit to the W_R of neutrons is:

$$W_R = 5 + 17e^{-(\ln(2E))^2/6} \quad \text{.....(1.3)}$$

where E is the neutron energy in MeV.

Schedule I-2 Tissue Weighting Factor

For the purpose of radiation protection, the tissue weighting factor, W_T, is multiplied to the tissue or organ equivalent dose, H_T, for calculating effective dose. The tissue weighting factor is applied in consideration of the probability of stochastic effects and equivalent doses in various organs or tissues irradiated. The specified values are given in Table I-2.

Table I-2 Tissue weighting factors(1)

Tissue or organ	Tissue weighting factor W_T	Tissue or organ	Tissue weighting factor W_T
Gonads	0.20	Liver	0.05
Bone marrow (red)	0.12	Oesophagus	0.05
Colon	0.12	Thyroid	0.05
Lung	0.12	Skin	0.01
Stomach	0.12	Bone surface	0.01
Bladder	0.05	Remainder	0.05(2)(3)
Breast	0.05		

(1) The values have been developed from a reference population of equal numbers of both sexes and a wide range of ages. In the definition of effective dose, they apply to workers, to the whole population, and to either sex.

(2) For purposes of calculation, the remainder is composed of the following additional tissues and organs: adrenals, brain, upper large intestine, small intestine, kidney, muscle, pancreas, spleen, thymus and uterus. The list includes organs which are likely to be selectively irradiated. Some organs in the list are known to be susceptible to cancer induction. If other tissues and organs subsequently become identified as having a significant risk of induced cancer, they will then be included either with a specific W_T or in this additional list constituting the remainder. The latter may also include other tissues or organs selectively irradiated.

(3) In those exceptional cases in which a single one of the remainder tissues or organs receives an equivalent dose in excess of the highest dose in any of the twelve organs for which a weighting factor is specified, a weighting factor of 0.025 should be applied to that tissue or organ and a weighting factor of 0.025 to the average dose in the rest of the remainder as defined above.