

# Appendix F

## Radiation Dosages

## 29. RADIOACTIVITY & RADIATION PROTECTION

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### 29.1. Definitions

The International Commission on Radiation Units and Measurements (ICRU) recommends the use of SI units. Therefore we list SI units first, followed by cgs (or other common) units in parentheses, where they differ.

- **Unit of activity** = becquerel (curie):

$$1 \text{ Bq} = 1 \text{ disintegration s}^{-1} [= 1/(3.7 \times 10^{10}) \text{ Ci}]$$

- **Unit of absorbed dose in any material** = gray (rad):

$$1 \text{ Gy} = 1 \text{ joule kg}^{-1} (= 10^4 \text{ erg g}^{-1} = 100 \text{ rad})$$

$$= 6.24 \times 10^{12} \text{ MeV kg}^{-1} \text{ deposited energy}$$

- **Unit of exposure**, A measure of photon fluence at a certain point in space integrated over time, in terms of ion charge of either sign produced by secondary electrons in a small volume of air about the point:

$$= 1 \text{ C kg}^{-1} \text{ of air (roentgen; } 1 \text{ R} = 1 \text{ esu cm}^{-3} \text{ in air} = 2.58 \times 10^{-4} \text{ C kg}^{-1})$$

Implicit in the definition is the assumption that the small test volume is embedded in a sufficiently large uniformly irradiated volume that the number of secondary electrons entering the volume equals the number leaving (so-called charged particle equilibrium). This unit is somewhat historical, but appears on many measuring instruments.

- **Unit of equivalent dose** (for biological damage) = sievert [= 100 rem (roentgen equivalent for man)]: Equivalent dose  $H_T$  (Sv) in an organ  $T$  is equal to the absorbed dose in the organ (Gy) times the radiation weighting factor  $w_R$  (formerly the quality factor  $Q$ , but  $w_R$  is defined for the radiation incident on the body). It expresses long-term risks (primarily cancer and leukemia) from low-level chronic exposure. It depends upon the type of radiation and other factors, as follows [1]:

**Table 29.1:** Radiation weighting factors.

Radiation	$w_R$
X- and $\gamma$ -rays, all energies	1
Electrons and muons, all energies	1
Neutrons < 10 keV	5
10–100 keV	10
> 100 keV to 2 MeV	20
2–20 MeV	10
> 20 MeV	5
Protons (other than recoils) > 2 MeV	5
Alphas, fission fragments, & heavy nuclei	20