Radiation Quantities and Units

1. Purpose

This brief outlines common radiological terminology and radiation units for those personnel working with radioactive or radiation producing devices.

2. Instruction

Activity: The curie is the unit of activity most often used in the United States and expresses the rate of radioactive disintegrations per unit time, based on the following:

1 curie (Ci) = 3.7×10^{10} dps (disintegrations per second)

1 millicurie (mCi) = 3.7×10^{7} dps = 1×10^{-3} Ci

1 microcurie (µCi) = 3.7×10^{4} dps = 10^{-6} Ci

1 nanocurie (nCi) = 3.7×10^{1} dps = 10^{-9} Ci

1 picocurie (pCi) = 3.7×10^{-2} dps = 1×10^{-12} Ci

dps = cps(counts per second)/efficiency of detector for specific radionuclide

1 becquerel (Bq) = 1 disintegration per second

Radiation Exposure: The Roentgen (pronounced rank-kin) is the unit of radiation exposure in air and is expressed as the amount of ionization per unit mass of air due to x or gamma radiation.

1 Roentgen (R) = 2.58×10^{-4} Coulomb/Kg air

1 milliroentgen (mR) = 2.58×10^{-7} Coulomb/Kg air = 1×10^{-3} R

Absorbed Dose: Radiation absorbed dose (rad) represents the amount of energy deposited per unit mass of absorbing material.

1 rad = 100 ergs/gram

1 rad = 1×10^{-2} Joule/kg

1 millirad (mrad) = 1×10^{-5} Joule/kg = 1×10^{-3} rad

Dose Equivalent: The measure of the biological effect of radiation requires a variable called the quality factor (QF). The quality factor takes into account the different degrees of biological damage produced by equal doses of different types of radiation.

1 rem (Roentgen equivalent man) is the product of the amount of energy absorbed (rad) times the efficiency of radiation in producing biological damage (the quality factor, QF)

$$1 \text{ rem} = 1 \text{ rad} \times QF$$

$$1 \text{ mrem} = 1 \times 10^{-3} \text{ rem}$$

For X and gamma radiations and for most beta particles, the QF = 1. Therefore, 1 rem = 1 rad

Alpha radiation has a QF of 20. QF for neutrons ranges from 2 to 11

Regulatory exposure limits and dosimetry results are usually expressed in rem or mrem

S.I. System: The S.I. system is widely used in Europe and is gradually being adopted in the United States. The traditional and S.I. units are shown below with their conversion factors

Current Unit	S.I. Units	Conversion
Curie (Ci)	Becquerel (Bq)	1 Ci = 3.7×10^{10} Bq
rad	Gray (Gy)	1 rad = 10^{-2} Gy
rem	Sievert (Sv)	1 rem = 10^{-2} Sv

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