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INTRODUCTION TO RADIATION DOSIMETRY

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INTRODUCTION TO RADIATION DOSIMETRY

Reference: Attix: Intro. to Radiological Physics & Rad. Dosimetry
Publisher - Wiley 1986

Background -
physical quantities, e.g. motion may be specified in more than one way. MOTION can be indicated by SPEED, VELOCITY, MOMENTUM OR ENERGY - which is correct?

Ionizing Radiation can be measured in many ways. The ICRU specifies the basic quantities and units

DOSIMETRY = measurement of ABSORBED DOSE or DOSE RATE

Generally includes determination of these quantities and related quantities:

EXPOSURE

KERMA

FLUENCE

DOSE EQUIVALENT

ENERGY IMPARTED

ONIZING RADIATION HAS MANY

PHYSICAL

CHEMICAL

BIOLOGICAL

effects that can be used to measure it.

Some of these are listed below:

PHYSICAL METHODS:

IONIZATION IN AIR → CURRENT → $\dot{D}$
→ CHARGE → D

TRANSFER OF CHARGE - COMPTON DOSIMETER (GROSS)

LOSS OF CHARGE ON AN ELECTRET (Mascarenhas)

PHOTOGRAPHIC EFFECTS: DARKENING

CHANGE OF COLOR OF A DYE

INCREASED OPTICAL DENSITY OF A GLASS

CHANGE OF CONDUCTIVITY (DIODE)

METHODS USING LIGHT EMISSION:

SCINTILLATION eg. NAI (TL)

PHOSPHORESCENCE

FLUORESCENCE

LUMINESCENCE

THERMO- (TLD)

STIMULATED (IMAGING METHOD)

LYOLUMINESCENCE (SUGARS)

RADIO-PHOTO- (RPLD) GLASSES.

CALORIMETRIC METHODS

RISE IN TEMPERATURE OF GRAPHITE

PHOTOACOUSTIC (PARD) (Mascarenhas)

PYROELECTRIC (PERD) "

CHEMICAL EFFECTS

FRICKE

FERROUS SULPHATE ⇒ FERRIC SULPHATE

$FeSO_4$ or $Fe(NH_4)_2(SO_4)_2 \Rightarrow Fe_2(SO_4)_3$

4 Gy – 4×10^3 Gy

BIOLOGICAL EFFECTS

ERYTHEMA (RED SKIN)

CELL KILLING

LOSS OF HAIR

MUTATIONS

HORMESIS EFFECTS (LUCKEY)

STIMULATED GROWTH

INCREASED LONGEVITY

INCREASED WHITE CELLS + ANTIBODIES

REVIEW OF RADIATION QUANTITIES AND UNITS:

		SI
EXPOSURE	IONIZATION	R or C/kg
KERMA	ENERGY	Gy
DOSE	ENERGY	rad Gy
DOSE EQUIVALENT	+BIO	REM Sv

(RAD × QF) (Gy × Q)

PARTIAL BODY DOSES ⇒ WHOLE BODY DOSE EQUIVALENTS

CRAP

EFFECTIVE DOSE EQUIVALENT =

$$\sum_i \text{Organ dose}_i \times \text{ICRU FACTOR}_i$$

E.G. 33 RADS TO THYROID ⇒ ~1 REM or 10 mSv TO WHOLE BODY

COLLECTIVE DOSE EQUIVALENT

$$\sum_i \text{EXPOSED POPULATION}_i \times \text{DOSE}_i \Rightarrow \text{PERSON-Sv}$$

COLLECTIVE DOSE EQUIVALENT IN USA. (ANNUAL)

BACKGROUND ~ 900,000 PERSON-Sv

MEDICAL-DIAGNOSTIC ~ 100,000 PERSON-Sv.

RADIATION WORKERS ~ 2,000 PERSON-Sv

A SUGGESTED RADIATION UNIT FOR THE PUBLIC (by John Cameron)

QUANTITY = IONIZING RADIATION

UNIT = BACKGROUND EQUIVALENT RADIATION TIMG - BERT

AVERAGE BACKGROUND ~ 300 mREM or 3 mSv.

$$\text{BERT.} = \frac{\text{EFFECTIVE DOSE EQUIVALENT}}{3\ \text{mSv/YEAR (OR 300 mREM/YR)}}$$

EG. CHEST X-RAY = $\frac{8.3\ \text{mrem}}{300\ \text{mrem/yr}} \approx$ 2 WEEKS.