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COLLEGE ON MEDICAL PHYSICS

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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, eg. 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

IONIZING 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 $\begin{cases} \text{CURRENT} \rightarrow D \\ \text{CHARGE} \rightarrow D \end{cases}$

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 e.g. NAI (TL)

PHOSPHORESCENCE

FLUORESCENCE

LUMINESCENCE

THERMO- (TLD)

STIMULATED (IMAGING METHOD)

LYOLUMINESCENCE (SUGARS)

RADIO-PHOTO- (RPLD) GLASSES.

CALORIMETRIC METHODS

RISE IN TEMPERATURE OF GRAPHITE

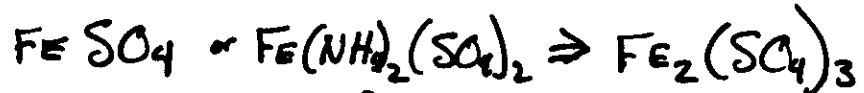
PHOTOACOUSTIC (PARD) (MASCARENHAS)

PYROELECTRIC (PERD) "

CHEMICAL EFFECTS

FRICKE

FERROUS SULPHATE \Rightarrow FERRIC SULPHATE



$$4 \text{ Gy} - 4 \times 10^3 \text{ Gy}$$

BIOLOGICAL EFFECTS

ERYTHEMA (RED SKIN)

CELL KILLING

LOSS OF HAIR

MUTATIONS

HORMESIS EFFECTS (LUCKY)

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 x QF) (Gy x Q)

PARTIAL BODY DOSES \Rightarrow WHOLE

BODY DOSE EQUIVALENTS ^{LE} C.R.A.P

EFFECTIVE DOSE EQUIVALENT =

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

EG. 33 RADS TO THYROID \Rightarrow \sim 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 TIME - BERT

AVERAGE BACKGROUND ~ 300 mREM or 3 mSV.

BERT_i = $\frac{\text{EFFECTIVE DOSE EQUIVALENT}}{3 \text{ mSV/YEAR (OR 300 mREM/YR)}}$

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

