



INTERNATIONAL ATOMIC ENERGY AGENCY
UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION



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College on Medical Physics
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Radiation Quantities: Definition and Measurement

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**** These notes are intended for internal distribution only**

RADIATION QUANTITIES: ①

definition and measurement

J.R. Cameron 11 Oct 1988 ICTP

BASIC QUANTITIES

	old units	SI unit
<u>EXPOSURE</u> (ionization in air)	roentgen (R) ($1 \text{ R} = 2.58 \times 10^4 \text{ C/kg}$)	C/kg

<u>ABSORBED DOSE</u> (energy absorbed)	rad (mgy/g)	grey (Gy) (J/kg)
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<u>DOSE EQUIVALENT</u> ($\text{rad} \times \text{Q.F.}$)	rem ($\text{Gy} \times \text{Q.F.}$)	sievert (Sv)
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<u>Integral Dose</u>	g·rad	kg·Gy
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<u>RADIO ACTIVITY</u>	curie (Ci) $3.7 \times 10^{10} \text{ s}^{-1}$	becquerel (Bq) 1 s^{-1}
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MEASUREMENT

EXPOSURE - collection of air ions

Dose - measurement of thermal energy

Dose Equivalent - measurement of linear energy transfer (LET) (dE/dx) to determine "Quality Factor" - Q.F. - A radiation protection concept.

Integral Dose - You need to know the dose distribution.

RADIOACTIVITY - You need to know the detection efficiency and the geometry

How Do You Add Partial Body^o Dose Equivalents?

1) Consider only the probability of cancer induction using a linear hypothesis - equate it to an equivalent whole body dose with the same risk of fatal cancer.

E.g. NCRP used to give natural background as $\sim 0.125 \text{ REM/yr}$.

The dose to the lungs from radon daughters ($\sim 1 \text{ REM/yr}$) brings the current annual dose equivalent to about 0.375 REM/yr .

How do you add doses from various medical exposures?

A simple approach - add $R \cdot \text{cm}^2$ values,

SOME TYPICAL EXPOSURES

AND $R \cdot cm^2$ VALUES:

STUDY	EXPOSURE	AREA	$RAP_0 (100 R \cdot cm^2)$
CHEST	40 mR	$1535 cm^2$	0.6
DENTAL	500 mR	$60 cm^2$	0.3
MAMMO.	~ 1000 mR	$200 cm^2$	2.0

BACKGROUND " 875 mR" $15000 cm^2 \sim 56$

"RAP" = Roentgen Area Product ($100 R \cdot cm^2$)

Concept of "Probability of Causation"
.. of cancer by ionizing radiation.
What is the probability that a former
radiation worker with lung cancer
developed the cancer because of the
radiation?

You need to know the dose, the age at
the time of the dose, the "man-rem"
to produce 1 lung cancer.
Compare to data on lung cancer incidence.

