

Radioactivity

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1. Units

1	Radioactivity	Becquerel	Bq	Emission /s	
		Curie	Ci	1 Ci = 3.7×10^{10} Bq	
2	Energy	Gray	Gy	1 Gy = J/kg	
		Rad	Rad, R	1 rad = .01 Gy	
3	Biological effect	Siebert	Sv		
		Rem	rem	1 rem = 0.01 Sv	

Sv and Rem includes the biological effects as follows:

Radiation	Q
$\beta, \gamma, X\text{-ray}$	1
n (Thermal)	3
n (Fast), $\alpha, p+$	10
Heavy nuclei	20

2. Measurement

Geiger Counter: **cpm** (Counts per minute)

Converting cpm to mR/hr 1200 cpm \div 1 mR/h
 120 cpm \div 1 μ Sv/h

3. Safety - How much radiation is safe? NRC (U.S. Nuclear Regulatory Commission)

Occupational exposure: < 5000 mrem /y (= 50 mSv/y) above Background

General population: < 500 mrem/y (= 5 mSv/y) above Background

Multi-year exposure: < 100 mrem/y (= 1 mSv/y) above Background

100 mSv (accumulation) is a measure for safety.

Common Radiation Exposure

Background Radiation(US)*	620 mrem/y	(= 6.2 mSv/y)
(Jpn)	240 mrem/y	(= 2.4 mSv/y)
Flight from NRT to NY	10 mrem	(= 0.1 mSv)
Dental X ray	9 mrem	(= 0.09 mSv)
Chest X ray	10 mrem	(= 0.1 mSv)

* Background a) Cosmic, b) Terrestrial (Earth) U, Th, c) Internal ⁴⁰K, ¹⁴C, ²¹⁰Pb

4. Radioactive Sources

A) Needle source

Isotope: Pb-210
 Activity: 0.01 μ Ci
 Half Life: 22.3 y (= 370 Bq)
 Decay mode: β^- (100%), α (1.9 x 10⁻⁶ %)
 Daughter isotopes: ²¹⁰Bi, ²⁰⁶Hg





B) Mantle for lantern (Coleman Co.)

Isotope: Th-232
 Activity:
 Half Life: 1.41 x 10¹⁰ y
 Decay mode: α (100 %)
 Daughter: ²²⁸Ra



5. Geiger-Muller Counters

GM-1 (SE International Monitor-4)	GM-2 (NDS Products ND-200P)
	

6. Lab – Measurement of radioactivity

	GM-1 (SE)	GM-2 (ND)
Background count [CPM]	5	12
Needle (CPM / mR/h)	2000 CPM/2.0 mR/h	
Lantern (CPM / mR/h)	150 CPM/0.15 mR/h	1.8 mR/h
Lantern /Paper (CPM / mR/h)	150 CPM	
Lantern /Glass (CPM / mR/h)	5 -10 CPM	
Lantern /Acrylic (CPM / mR/h)	30 CPM	