Ionizing Radiation

Dose Ranges

(Sievert)

Office of Science
U.S. DEPARTMENT OF ENERGY

Cancer Radiotherapy
total dose to tumor

acute exposure = all at once; chronic = hours, days, years

Whole body, acute: G-I destruction; lung damage; cognitive dysfunction (death certain in 5 to 12 days)*

Whole body, acute: cerebral/ vascular breakdown (death in 0-5 days)*

0 10 20 30 40 50 60 70 80 90 100 Sv

Life Span Study (A-bomb survivor epidemiology)

Total Body Irradiation (TBI) Therapy

Whole body, acute: circulating blood cell death; moderate G-I damage (death probable 2-3 wks)*

Acute Radiation Syndromes

Whole body, acute: marked G-I and bone marrow damage (death probable in 1-2 wks)*

Solar flare dose on moon, no shielding

0 1 2 3 4 5 6 7 8 9 10 Sv

Estimated dose for 3-yr **Mars** mission (current shielding)

Human **LD_{50}** range, acute exposure with **no** medical intervention (50% death in 3-6 weeks)*

Human **LD_{50}** range, acute exposure with medical intervention

***Note:** Whole body acute prognoses assume **no** medical intervention.

Cancer Epidemiology

Evidence for small increases in human cancer above 0.1 Sv acute exposure, 0.2 Sv chronic exposure

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 Sv

Typical mission doses on Intl. Space Station (ISS)

Natural bkg /yr Ramsar, Iran

EPA guideline for lifesaving: 0.25 Sv

DOE Low Dose Program

EPA radiological emergency guideline for public relocation

"Storefront" full-body CT screening (one scan)

0 10 20 30 40 50 60 70 80 90 100 mSv

H I J

Natural bkg /yr Kerala coast, India

DOE administrative control: 20 mSv/yr = 2 rem/yr

DOE, NRC Dose Limit for Workers: 50 mSv/yr = 5 rem/yr

Medical Diagnostics (A-J)

Typical annual doses for commercial airline flight crews

A B C D E F G

0 1 2 3 4 5 6 7 8 9 10 mSv

Natural background, U.S. average ≅ 3 mSv/yr (includes radon)

Natural bkg /yr Yangjiang, China

Regulations & Guidelines

NRC cleanup criteria for site decommissioning / unrestricted use: 0.25 mSv/yr

Max releases DOE facilities

Round-trip NY to London

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 mSv

EPA dose limit applicable to public drinking water systems: 0.04 mSv/yr

EPA dose limit from releases in air: 0.10 mSv/yr

ANSI Standard N43.17 Limit Security Personnel Scanners 0.25 mSv/yr /person (0.1-10 μSv /scan)

DOE, NRC Dose Limit for Public: 1 mSv/yr = 100 mrem/yr (ICRP, NCRP)

Medical Diagnostics, mSv

A- Chest x-ray (1 film)	0.1
B- Dental oral exam	1.6
C- Mammogram	2.5
D- Lumbosacral spine	3.2
E- PET	3.7
F- Bone (Tc-99m)	4.4
G- Cardiac (Tc-99m)	10
H- Cranial CT (MSAD) (multiple scan average dose)	50
I- Barium contrast G-I fluoroscopy (2 min scan)	85
J- Spiral CT- full body	30-100

LD_{50} = Lethal Dose to 50%
(the acute whole body dose that results in lethality to 50% of the exposed individuals)

Absorbed dose: 1 Gray = 100 rad
Dose equivalent: 1 Sievert = 100 rem
1 mSv = 100 mrem
(1 Sv = 1 Gy for x- and gamma-rays)

Note: This chart was constructed with the intention of providing a simple, user-friendly, "order-of-magnitude" reference for radiation quantities of interest to scientists, managers, and the general public. In that spirit, most quantities were expressed in the more commonly used radiation protection unit, the rem (or Sievert, 2nd page), and medical doses are not in "effective" dose. It is acknowledged that the decision to use one set of units does not address everyone's needs. (NRC—US Nuclear Regulatory Commission; EPA—US Environmental Protection Agency)

Chart compiled by NF Metting, Office of Science, DOE/BER
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Source: Office of Biological and Environmental Research (BER), Office of Science, U.S. Department of Energy
http://www.science.doe.gov/ober/