Ionizing Radiation
Dose Ranges
(Sievert)

Office of Environment, Health, Safety and Security

Cancer Radiotherapy
total doses to tumor

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)*

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

Acute exposure detectable in blood

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

Solar Particle Event (**SPE**; Solar flare) dose on **lunar surface**, no shielding

Estimated dose for 3-year Mars mission (current shielding, no SPE)

Early, transient skin erythema (2-24 hr onset)

Temporary epilation (3 wk onset)

Main erythema reaction (10 day onset)

Permanent epilation (3 wk onset)

Human $LD_{50/30}$ range acute exposure*

Human $LD_{50/30}$ range acute exposure with medical intervention

*Note: Whole body acute prognoses assume no medical intervention (G-I = gastrointestinal)

Cancer Epidemiology

Evidence is weak and inconsistent for excess human cancers from exposures below 100 mSv acute or 300 mSv chronic (acute exposure in seconds/minutes; chronic exposure in days/months/years)

Typical mission doses on International Space Station (ISS; no SPE)

Ramsar, Iran high natural bkg/y

DHS emergency guideline to save a life: 250 mSv

Acute exposure detectable in blood

Interplanetary Space natural bkg/y; no SPE

(1 Sv)

DOE Low Dose Research Program

Kerala coast, India high natural bkg/y

DHS emergency guideline for public relocation: 20 mSv/y (2 rem/y)

Guarapari, Brazil high natural bkg/y

DOE, NRC dose limit for workers: 50 mSv/y (5 rem/y)

Lunar mission ~ 88 d (no SPE)

Typical added annual dose for commercial airline flight crews

Medical Diagnostics (A-O)

see chart >>

Airport x-ray whole body scanner: 0.00007 mSv/scan

(Limit = 0.25 mSv/y ~ 4000 scans/y)

Natural background, USA average of 3.1 mSv/y

Yangjiang, China high natural bkg/y

DOE facility releases

Regulations & Guidelines

(**TIPS**: Transjugular Intrahepatic Porto-systemic Shunt)

Round-trip Los Angeles – New York (~ 0.037 mSv)

EPA dose limit public drinking water systems: 0.04 mSv/y

EPA dose limit from release in air: 0.1 mSv/y

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

DOE, NRC dose limit for the public: 1 mSv/y (100 mrem/y) (ICRP, NCRP)

Medical Diagnostics mGy
(Estimated maximum organ dose ◆)

X-ray films	
A – Chest (PA & Lat)	0.1 - 0.23
B – Dental Panoramic	0.7
C – Lumbar Spine	0.7 -1.9
D – Mammogram	0.6 - 2.9
Radiotracer Imaging	
E – Heart Stress (Tc-99m)	6 – 12
F – Bone (Tc-99m)	4 – 15
G – Dual Isotope Stress Test	40 – 45
H – PET: F-18 FDG (bladder)	55 – 80
CT Scans (X-ray) (multiple scan average dose)	
I – Chest CT	20 – 30
J – Head CT	30 – 50
K – Abdominal CT	22 – 60
L – Full Body CT	50 – 100
Fluoroscopy/Procedures	
M – Barium Contrast G.I.	10 – 22
N – Cardiac Catheterization	12 – 40
O – TIPS Procedure	400 – 1400

$LD_{50/30}$ = **Lethal Dose 50/30** is the whole body dose that results in lethality to 50% of exposed individuals in 30 days

Absorbed Dose: 100 rads = 1 Gray
1 rem ~ 1 rad for x- and gamma-rays
Dose Equivalent: 100 rem = 1 Sievert
= (absorbed dose x radiation quality)

NOTE: This chart was constructed with the intention of providing a simple, user-friendly, "order-of-magnitude" reference for radiation exposures of interest to scientists, managers, and the general public. In that spirit, most quantities are expressed as "dose equivalent" in the more commonly used radiation protection units, the rem and Sievert. Medical diagnostics are expressed as estimated maximum organ dose; as they are not in "effective dose" they do not imply an estimation of risk (no tissue weighting). Dose limits are in effective dose, but for most radiation types and energies the difference is numerically not significant within this context. It is acknowledged that the decision to use these units is a simplification, and does not address everyone's needs. (**DHS** = Department of Homeland Security; **EPA** = Environmental Protection Agency; **NRC** = Nuclear Regulatory Commission)

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"Orders of Magnitude" revised **Jan 2017**

Source: Office of Public Radiation Protection, Office of Environment, Health, Safety and Security, U.S. Department of Energy
http://energy.gov/ehss/environment-health-safety-security