

# Ionizing Radiation Dose Ranges

(Rem)



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

**Cancer Radiotherapy**  
total doses to tumor

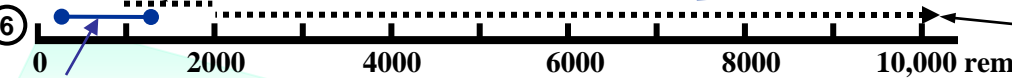
acute exposure = all at once;  
chronic = hours, days, years

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

**Charged particle event**  
(Solar flare) dose on moon, no shielding

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

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)\*

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

**Human LD<sub>50</sub> range** acute exposure with medical intervention

Evidence for small increases in human cancer above 10 rem acute exposure or 20 rem chronic exposure

Typical mission doses on International Space Station (ISS)

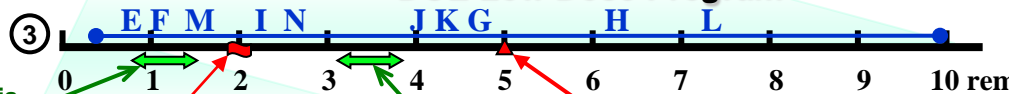


Ramsar, Iran high natural bkg/yr

**DHS emergency guideline to save a life: 25 rem**

Interplanetary Space natural bkg/yr

**DOE Low Dose Program**



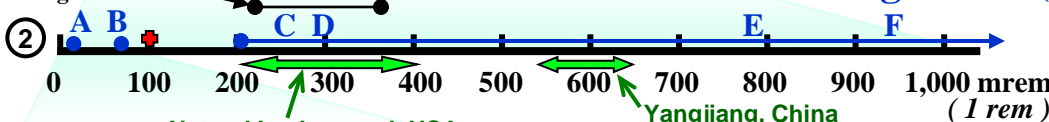
Kerala coast, India high natural bkg/yr

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

Guarapari, Brazil high natural bkg/yr

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

Typical added annual dose for commercial airline flight crews



Airport x-ray whole body scanner: 0.007 mrem/scan

DOE facility releases

Natural background, USA average ≈ 310 mrem/yr (includes radon)

Yangjiang, China high natural bkg/yr

(Limit = 25 mrem/yr ≈ 4000 scans/yr)

**Regulations & Guidelines**

(TIPS: Transjugular Intrahepatic Porto-systemic Shunt)

Round-trip Los Angeles - New York (≈ 3.7 mrem)

**EPA dose limit public drinking water systems: 4 mrem/yr**

**EPA dose limit from release in air: 10 mrem/yr**

**NRC cleanup criteria for site decommissioning / unrestricted use: 25 mrem/yr**

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

**LD<sub>50</sub> = Lethal Dose to 50%**  
(whole body dose that results in lethality to 50% of exposed individuals in 30-60 days)

**Dose Equivalent: 100 rem = 1 Sievert**  
**= (absorbed dose x radiation quality)**

**Absorbed Dose: 100 rad = 1 Gray**

1 rem ≈ 1 rad for x- and gamma-rays

("≈" stands for "approximately equal to")

**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. (NRC = Nuclear Regulatory Commission; EPA = Environmental Protection Agency; DHS = Department of Homeland Security) **Disclaimer:** Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information disclosed.

Chart compiled by NF Metting, Office of Science, DOE/BER. "Orders of Magnitude" revised June 2010 <http://www.lowdose.energy.gov/>

Source: Office of Biological and Environmental Research (BER), Office of Science, U.S. Department of Energy <http://www.science.doe.gov/ober/>

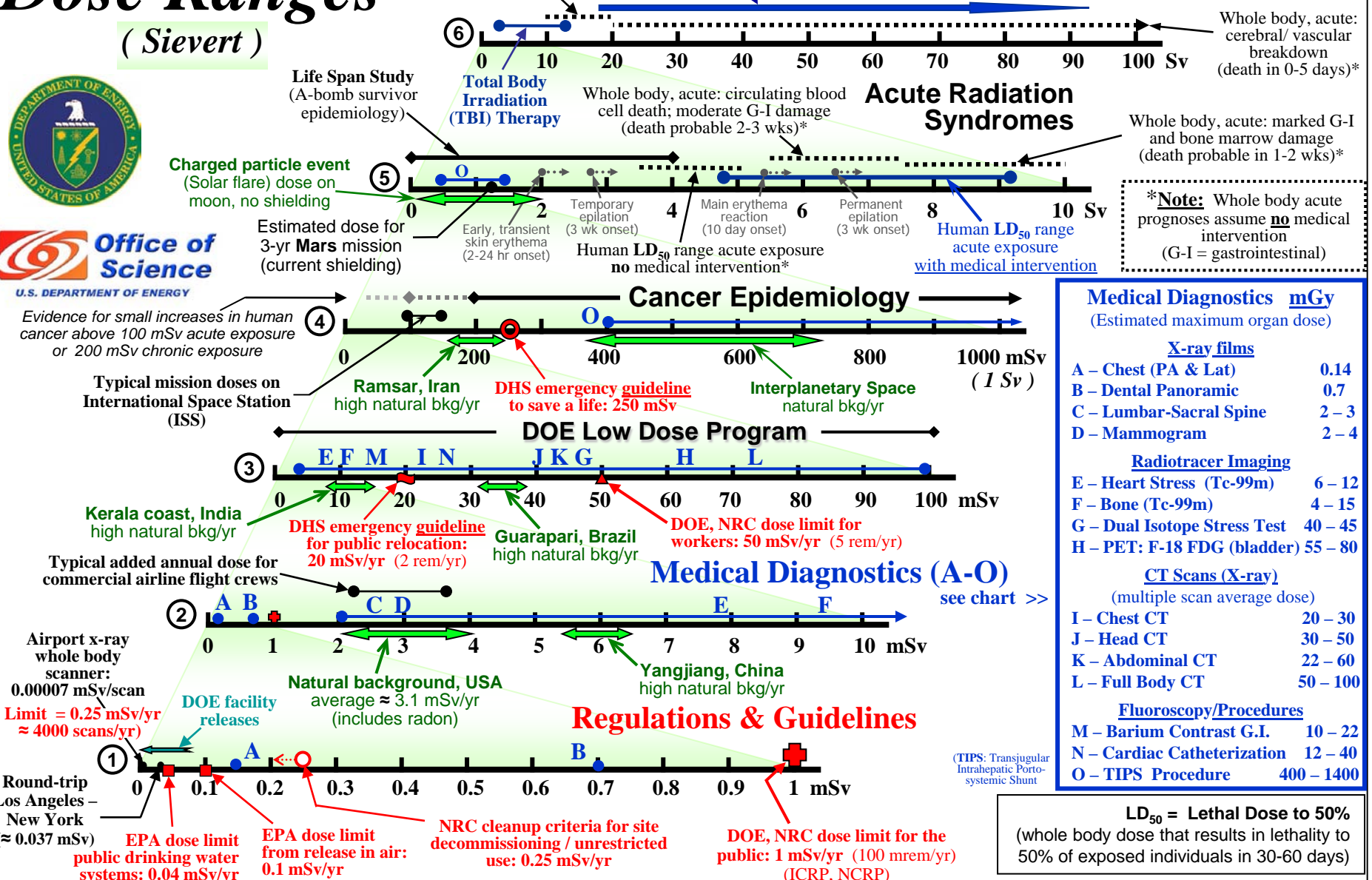
# Ionizing Radiation Dose Ranges (Sievert)



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

## Cancer Radiotherapy total doses to tumor

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



### Medical Diagnostics mGy (Estimated maximum organ dose)

X-ray films

A - Chest (PA & Lat)	0.14
B - Dental Panoramic	0.7
C - Lumbar-Sacral Spine	2 - 3
D - Mammogram	2 - 4

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

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