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 dose to tumor

Whole body, acute: cerebral/ vascular breakdown (death in 1-5 days)*

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

Total Body Irradiation (TBI) Therapy

Life Span Study (A-bomb survivors)

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

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

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

Estimated dose for 3-yr **Mars** mission

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

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

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

Cancer Epidemiology

Typical mission doses on **Int. Space Station (ISS)**

0 0.2 0.4 0.6 0.8 1 Sv

NRC guideline for lifesaving ~ 0.25 Sv

"Radiological Emergency" guidelines for public relocation

DOE Low Dose Program

"Full-body CT screening" (one scan)

H I J

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

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

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

Typical annual doses for **commercial airline flight crews**

Medical Diagnostics (A-J)

A B C D E F G

0 2 4 6 8 10 mSv (= 1 rem)

Cleanup criteria for site decommissioning/ license termination 0.25 mSv/yr

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

Temporary "Special Case" annual Public Limit (NRC, DOE)

Regulations & Guidelines

(~ four orders of magnitude)

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

NCRP "Negligible Dose"

Typical maximum doses from DOE facility releases

ANSI standard N43.17 Personnel scanner, max = 0.25 mSv/yr

NRC Dose Limit for Public = 1 mSv/yr = 100 mrem/yr (DOE, 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)	7.5
H- Cranial CT (MSAD) (multiple scan average dose)	50
I- Barium contrast G-I fluoroscopy (2 min scan)	85
J- Spiral CT	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. **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; 24Jan2005,"Orders of Magnitude")