• **Natural annual background**, all sources: Most world areas, whole-body equivalent dose rate $\approx$ (0.4–4) mSv (40–400 millirems). Can range up to 50 mSv (5 rems) in certain areas. U.S. average $\approx$ 3.6 mSv, including $\approx$ 2 mSv ($\approx$ 200 mrem) from inhaled natural radioactivity, mostly radon and radon daughters (0.1–0.2 mSv in open areas. Average is for a typical house and varies by more than an order of magnitude. It can be more than two orders of magnitude higher in poorly ventilated mines).

• **Cosmic ray background** in counters (Earth's surface): ~ 1 min^{-1} cm^{-2} sr. For more accurate estimates and details, see the Cosmic Rays section (Sec. 14 of this *Review*.

• **Fluxes** (per cm^2) to deposit one Gy, assuming uniform irradiation:

$\approx$ (**charged particles**) $6.24\times10^9/(dE/dx)$, where dE/dx (MeV g^{-1} cm^2), the energy loss per unit length, may be obtained from the Mean Range and Energy Loss figures.

$\approx 3.5 \times 10^9$ cm^{-2} minimum-ionizing singly-charged particles in carbon.

$\approx$ (**photons**) $6.24\times10^9/[Ef/\lambda]$, for photons of energy E (MeV), attenuation length λ (g cm^{-2}) (see Photon Attenuation Length figure), and fraction $f \lesssim 1$ expressing the fraction of the photon's energy deposited in a small volume of thickness $\ll \lambda$ but large enough to contain the secondary electrons.

$\approx 2 \times 10^{11}$ photons cm^{-2} for 1 MeV photons on carbon ($f \approx 1/2$).

(Quoted fluxes are good to about a factor of 2 for all materials.)

• **Recommended limits to exposure (whole-body dose):***

CERN: 15 mSv yr^{-1}

U.K.: 15 mSv yr^{-1}

U.S.: 50 mSv yr^{-1} (5 rem yr^{-1})†

• **Lethal dose**: Whole-body dose from penetrating ionizing radiation resulting in 50% mortality in 30 days (assuming no medical treatment) 2.5–3.0 Gy (250–300 rads), as measured internally on body longitudinal center line. Surface dose varies due to variable body attenuation and may be a strong function of energy.

For a recent review, see E. Pochin, *Nuclear Radiation: Risks and Benefits* (Clarendon Press, Oxford, 1983).

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* The ICRP recomendation [1] is 20 mSv yr^{-1} averaged over 5 years, with the dose in any one year $\leq$ 50 mSv.

† Many laboratories in the U.S. and elsewhere set lower limits. See full *Review* for reference.