Annual Dose from Natural Radiation Sources in the Environment (in areas of normal background radiation)

	Annual effective dose (micro-sievert)		
Source	**External**	**Internal**	**Total**
Cosmic rays	380		380
Cosmogenic radionuclides		12	12
Terrestial radionuclides			
Potassium-40	130	170	300
Uranium-238 series:			
^{238}U *to* ^{234}U *to* Thorium-230	140	1	
Radium-226		4	1400
Radon-222 *to* Polonium-214		1200	
Lead-210 *to* Polonium-210		50	
Thorium-232 series	190	80	270
Total (rounded)	**840**	**1520**	**2400**

Long Term Committed Doses from Man-Made Sources

Source	**Main radionuclides**	**Collective effective dose (man-Sv)**
Atmospheric nuclear testing	Carbon-14 Caesium-137 Strontium-90 Zirconium-95	30 000 000
Chernobyl accident	Caesium-137 Caesium-134 Iodine-131	600 000
Nuclear power production	Carbon-14 Radon-222	400 000
Radioisotope production and use	Carbon-14	80 000
Nuclear weapons fabrication	Caesium-137 Ruthenium-106 Zirconium-95	60 000
Kyshtym accident	Cerium-144 Zirconium-95 Strontium-90	2 500
Satellite re-entries	Plutonium-238 Plutonium-239 Caesium-137	2 100
Windscale accident	Iodine-131 Polonium-210 Caesium-137	2 000
Other accidents	Caesium-137 Xenon-133 Cobalt-60 Iridium-192	300
Underground nuclear testing	Iodine-131	200

Most significant releases of radionuclides to the environment from human activities have been from atmospheric nuclear weapons testing. Next in importance is the Chernobyl accident, followed by long-term exposures from carbon-14 and radon-222 associated with nuclear power production. A large part (86%) of the collective dose from nuclear weapons testing is due to long-term exposure from carbon-14. Some perspective on these estimated doses from human activities can be gained by

comparison with those from natural sources. An estimated 13,000,000 man-sievert due to natural sources (e.g., cosmic rays, potassium-40 in the body, and radon gas) is delivered each year to the world population (2400 micro-sievert x 5.4 x 10^9 persons).
