

Text summary of measured data for the Rocky Flats National Wildlife Refuge

16 April 2024: Reminder: the diagrams and bibliography are available at <https://rockyflatsneighbors.org/flyer-and-bibliography/>



1. There is no evidence that **background radiation** around the Front Range or Rocky Flats causes excess cancers or other health risks. (We care because we're going to compare this to what plutonium contributes.)
2. Plutonium (Pu) in RF soil [NIST data] contributes about 0.8% of total soil *radioactivity* (decays/second). **This measurement alone strongly constrains possible health effects, given 1.** Radiation *dose* depends on what comes out per decay: alpha particles, beta particles, gamma rays.
3. Pu is very similar to natural alpha-particle emitting radioisotopes [nuclear tables], but emits very few gamma rays, which produce whole-body doses. The only hazard it presents (because alpha particles are stopped by skin) is via inhalation or swallowing of dust. How much dust/dirt is inhaled and ingested per year is reasonably well agreed on internationally.
4. From **direct** alpha particle measurements during the Superfund cleanup, 99.4% of alpha particle radiation comes from natural RF radioisotopes. **This presents a profound problem for those who'd like to blame Pu for ANY health problems.**
5. On the eastern edge of the Refuge [2019 measurements] more than 80% of samples show Pu below 1 pCi/g (compare with the cleanup requirement 50 pCi/g). To the extent these represent a fairly uniform area sampling, you have a $(100\%-80\%)=20\%$ chance of encountering areas where there is more than 1 pCi/g Pu in soil. Ignoring Pu, there is 53.0 pCi/g total radioactivity in RF soil.
6. 'Hot particles' (very radioactive small plutonium dioxide grains) exist on the eastern boundary of the Refuge. Using 2019 Ketterer data, they are found to be smaller than 2 microns and to contribute not more than 0.5 pCi/g where they are present. The single large (8.8 micron, 264 pCi) Jefferson Parkway hot particle (out of about 440 samples) was a very rare anomaly. If stuck in the lung, it's estimated to raise the risk of lung cancer by about 1 in 135,000. (On the other hand, 10,000-100,000 smaller hot particles were inhaled by workers during the 1965 Rocky Flats fire with no known health effects after 10 years.)
7. Published data from 1996-2002 show that **95% of Pu is in the top 6 inches of soil**, and that removing three feet of soil from highly contaminated areas during the cleanup dropped Pu radioactivity to less than 0.1 pCi/g. Other articles show a **drop** in surface Pu concentrations over time.
8. Careful, sophisticated internationally accepted radiation biokinetic frameworks permit calculations of doses from inhaling and swallowing dust contaminated by Pu and Am (and many natural radioisotopes). For yearly dose estimates **we use 2019 Jefferson Parkway data. 90% of all samples have soil values less than 1.175 pCi/g (239+240) Pu (0.198 pCi/g 241Am)**, and we include 0.5 pCi/g as a slight overestimate of contributions from Ketterer's hot particle sampling (only present in some places).
9. Relevant annual **doses** using this data are (in the 'effective dose' unit milliSievert)
Measured total background radiation (soil gammas+cosmic rays), no radon): 1.23 mSv
Pu inhalation+ingestion on eastern boundary: 0.0014 mSv
Am inhalation+ingestion on eastern boundary: 0.00067 mSv
Unmitigated radon (5.2 pCi/l):12.5 mSv

Total estimated yearly dose rad dose (all sources): 17.2 mSv

Thus Pu contributes about 1/12,000 of a typical total yearly dose or 880 times less than background dose (cosmic rays+terrestrial gamma rays).

10. Within the 'linear, no threshold' framework for relating radiation dose to cancer risk, **Pu contributes a risk 800 times smaller than natural radioisotopes.** We established in point 1 above that is *no evidence* of excess cancer **risk** from background radiation (whose **dose** is 880 times larger than the **dose** from Pu).
11. The published history of Pu releases via fires and other plant releases and the incubation time of leukemias and solid cancers imply that, if there *were* a health effect for those living downwind, it would have been apparent by the late 1970s. Although early work by Johnson was discredited by 1983, others did careful epidemiology searches for plausible radiation-sensitive cancers and found **no association with distance from Rocky Flats.** No publications have shown any elevated cancer risks from living around Rocky Flats. Viewed differently, with the estimated yearly doses from Pu given above, **finding any health effects is extremely unlikely in the future.**
12. ICRP Publication 150 (RISKS FROM PLUTONIUM AND URANIUM EXPOSURE) from 2021 considered mostly nuclear plant workers, but noted “For radon, there is good evidence from studies of exposure in homes to suggest that the risk of lung cancer is consistent with that estimated from studies of miners exposed at low levels...**In contrast, epidemiological studies of environmental exposure to plutonium and uranium do not indicate increased risk of cancer overall.** [for the public]
13. [Statements made by anti-Refuge spokespeople are generally factually wrong and reflect no familiarity with the relevant scientific literature or the extensive documentation about Rocky Flats.](#)