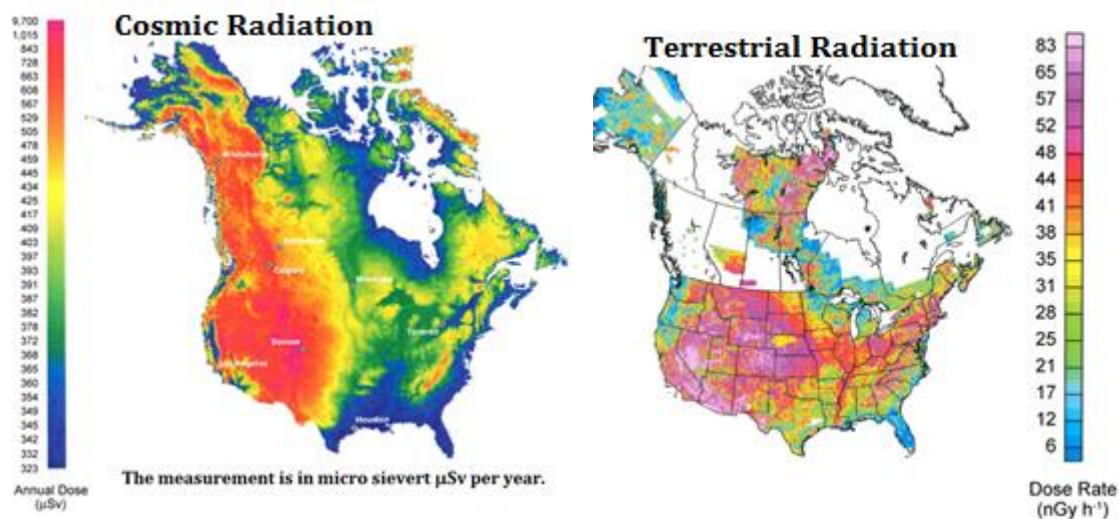


Basics of Wells: Naturally Occurring Radioactive Materials or NORM

Although radioactivity sounds dangerously scary, the fact is that we live in a world doused continuously with natural radioactivity and virtually all our surroundings have their own level of radioactivity. Some radioactive sources, like naturally occurring radon gas that leaks out of the soil, are dangerous in higher levels. Others, like false teeth, Brazil nuts, and old clay pots have more radiation than surroundings, but usually far below what is dangerous. The level of radiation varies with the type of food and how it comes in contact with radioactive atoms: Brazil nuts, from trees whose roots reach into radioactive rock layers, have nearly 15 times more natural radioactivity than the same weight of beer, whose components are shallow rooted. It is not the presence of radioactivity that is important, it is the level and type of radiation that makes the difference.

Natural background sources are cosmic radiation, terrestrial radiation and internal radiation. Cosmic radiation is produced as charged particles from our sun and other stars react with the earth's atmosphere and magnetic field, producing a steady stream of radiation. The amount of this radiation varies across the world with differences in elevation (higher elevation equals more radiation) and with variations in the earth's magnetic field. Red map areas have the highest levels of cosmic radiation while the dark blue areas are lowest. For example, a field high in the Rocky Mountains gets three times more cosmic radiation per year than a beach on the Gulf of Mexico.



(The preceding maps and analysis are from Health Physics Society Fact Sheet, January 2010, downloaded 31 August 2015, https://hps.org/documents/environmental_radiation_fact_sheet.pdf)

One cause of terrestrial radiation from soil, water and vegetation is by uranium and thorium atoms in the water and soil making their way into vegetation. This type of radiation is different from cosmic radiation because it may actually be absorbed into a body by eating food. Radiation absorbed in this manner is very low strength and usually only resides in the body for a short time before being expelled.

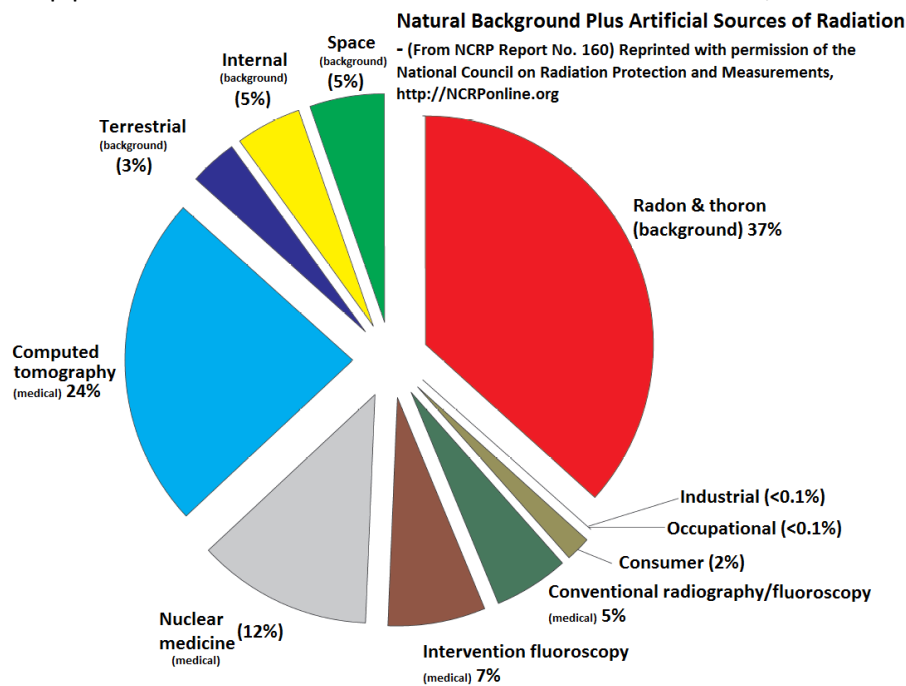
In addition to cosmic and terrestrial radiation, people also have other radioactive isotopes in their bodies from birth. The variation in internal radiation between people is very small. Man's life-time exposure to radiation is most significant from medical procedures such as X-rays, nuclear medicine and

Radiation Sources (EPA)	Est. Exposure
Inhaled (radon areas)	2290 $\mu\text{Sv}/\text{year}$
Internal	310 $\mu\text{Sv}/\text{year}$
Terrestrial	190 $\mu\text{Sv}/\text{year}$
Cosmic	270 $\mu\text{Sv}/\text{year}$
Medical	3100 $\mu\text{Sv}/\text{year}$
Smoking 1 pk/day (Radon decay)	80,000 $\mu\text{Sv}/\text{year}$

radiation therapy. Exposure from natural sources is usually very low, but medical investigation or other human based activities can raise this exposure substantially.

NORM in the oilfield is sometimes associated with water produced along with oil & gas or accumulated in gas processing equipment over years of operation. The

areas of the country where oil & gas NORM levels are above the background levels include areas where produced water volumes are high as reflected by presence of water borne scale or precipitation in tanks and pipelines. Most of the NORM levels remain below EPA limits, but as elevated readings are found,



regulations require marking of equipment and disposal or cleaning of the equipment by licensed professionals.

Strength of oilfield NORM is usually low in oil and gas production, but, like other forms of terrestrial radiation, it is higher in places where naturally occurring uranium deposits are more concentrated. While dissolved or dispersed in water, NORM poses little or no risk, but evaporation, precipitation

or filtration; basically anything that concentrates large volumes of water with marginal levels of radioactivity; can result in higher levels of radioactive ions and may produce a hazard.

The concentration of radioactive material from fresh or saline groundwater extends beyond oil and gas to any significant amount of water produced from formations with higher background radiation. This may include drinking water production, irrigation water handling, steam generation facilities and many waste water streams. Groundwater in some areas, such as locations in southern New York and Arizona may be above government radioactivity standards as it is produced and without any other contamination.

Disclosure: George E. King is a Texas Registered Professional Engineer with over 44 years oilfield experience. His technical background includes fracturing, workovers, chemicals, acidizing, well integrity and horizontal wells.

