Montana Department of
ENVIRONMENTAL QUALITY

PERMITTING AND COMPLIANCE DIVISION
WASTE AND UNDERGROUND TANK MANAGEMENT BUREAU
SOLID WASTE SECTION

Naturally Occurring Radioactive Material (NORM) Fact Sheet

What is NORM?

NORM stands for "naturally occurring radioactive material"—in other words, a substance that naturally contains one or more radioactive isotopes, also called *radionuclides*. These radionuclides occur naturally at low levels in soils and rocks. NORM is present in geologic formations from which oil and gas are produced. NORM is not nuclear waste. The material generally consists of the radionuclides uranium and thorium and their daughter products, including radium.

NORM can be concentrated by processes associated with the recovery of oil and gas. Oil and gas production processes often mobilize the NORM in formations into the produced fluids (oil, gas, and water). Technologically Enhanced NORM (TENORM) is material that can be concentrated in oil production wastes such as sludge, drilling mud, used water filtration sleeves, and pipe scale. TENORM radioactivity levels tend to be highest in water-handling equipment.

Because NORM is usually associated with the water phase of produced fluids, as the produced water is extracted and fluid pressures and temperatures are reduced, the solubility of the NORM is changed and the radionuclides precipitate out of solution and deposit onto the walls of tubing, casing and surface processing equipment as scale. Production and processing equipment may contain elevated levels of NORM contaminated scale or sludge that can cause disposal problems when the equipment is taken off-line for maintenance, repair, or replacement.

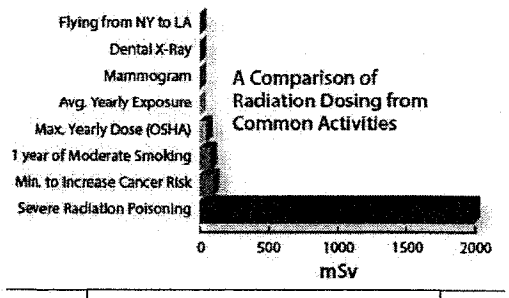
Radiation Fundamentals

Radiation is energy emitted by matter in the form of rays or high-speed particles. Radiation is all around us. There is a natural background radiation level throughout the universe. Radioactive materials in Earth's crust also contribute to terrestrial background radiation.

Radiation is either ionizing or nonionizing, depending on how it affects matter. Nonionizing radiation (light, heat, radio waves) transfers energy to materials through which it passes but does not break molecular bonds. Ionizing radiation (x-rays, gamma rays, high-energy particles) cuts bonds that hold molecules together, thus leaving molecular pieces, known as ions, in its wake. These ions may cause changes in living tissues or may change the physical properties of nonliving materials.

Radiation measurement is a confusing mix of terms and concepts. Radiation levels are measured in terms of total activity (emitted from source material), dosage (radiation absorbed), or exposure (e.g., millisievert [mSv]). Although dosage is often the most meaningful in public health discussions, most state rulings on NORM disposal regulate levels of radioactivity per unit weight.

(pCi/g)



source: University of North Dakota, Energy & Environmental Research Center

What Level of Radioactivity Is Hazardous?

To understand how much radiation is dangerous, we need to focus on equivalent dose numbers. Equivalent dosages accumulate over time of exposure, so intensity and duration are equal factors. More of either increases the risk of adverse health effects. A nuclear reactor core may trap huge amounts of total radioactivity, but because of engineered shielding between the reactor core and personnel operating the nuclear power plant, the personnel do not absorb hazardous levels of radioactivity. When the personnel must enter a zone of higher radioactivity, their exposure time is strictly limited. Comparing radioactivity with equivalent doses is like comparing apples and oranges.

Generally speaking, NORM/TENORM must be inhaled or ingested to pose a radiation health risk. This is because a vast majority of radiation emitted from NORM/TENORM is in the form of alpha particles. Alpha particles, emitted during alpha decay, are made of two neutrons and two protons. Their structure is similar to a helium nucleus. Most alpha particles created by alpha decay do not have high penetration, compared to other particles. Even a sheet of paper can stop them. Alpha particles pose little threat externally because even air can stop them if the wall of air between the radioactive source and the object is wide enough. Skin also stops alpha particles from entering the body. Because these wastes are typically landfilled or otherwise buried, there is little risk from external exposure.

Further protecting yourself from external exposure to alpha radiation is easy, since alpha particles are unable to penetrate the outer dead layers of skin or clothing. However, tissue that is not protected by the outer layer of dead cells, such as eyes or open wounds, must be carefully protected. The exposure pathways of concern are inhalation or ingestion of alpha emitters, which continue to emit alpha particles. Alpha emitting radionuclides that are inhaled or ingested release alpha particles directly to sensitive living tissues. As their high energy transfers directly to the tissue, it causes damage that may lead to cancer.

Since radium is present at low levels in the natural environment, everyone has some minor exposure to it. However, individuals may be exposed to higher levels of radium if they live in an area where there is an elevated level of radium in the surrounding rock and soil. Private well water in such areas can also be an added source of radium.

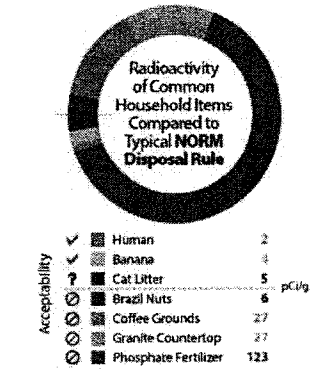
The concentration of radium in drinking water is generally low, but there are specific geographic regions in the United States where higher concentrations of radium occur in water due to geologic sources. Limited information is available about the amounts of radium that are typically present in food and air, but they are very low.

Radium is a naturally-occurring radioactive metal. Its most common isotopes are radium-226, radium 224, and radium-228. Radium is a radionuclide formed by the decay of uranium and thorium in the environment. In the natural environment, it occurs at low levels in virtually all rock, soil, water, plants, and animals. In areas where uranium (or thorium) occurs in high levels in rock, radium is often also found in high levels. In the NORM associated with the oil and gas industry, radium-226 is typically present in the form of radium/barite sulfate. Radium/barium sulfate is a relatively insoluble material with a solubility limit of $2x10^{-6}$ g/L.

The most significant way people come in contact with alpha emitters is in their home, school, or place of business. Radon, is a heavy gas and tends to collect in low-lying areas such as basements. Testing for radon in your home and taking any corrective action necessary is the most effective way to protect you and your family from alpha emitters.

How Is NORM Regulated?

NORM was not subject to regulatory control under the Atomic Energy Act of 1954 or the Low Level Radioactive Waste Policy Act. NORM is not nuclear waste. Wastes containing NORM are not regulated by federal agencies. Instead, it has been left to states to regulate handling of NORM. Currently, 15 states specifically regulate NORM, while other states more generally regulate radioactive wastes. Of course, the language of these NORM regulations varies, but many states have similar regulations limiting disposal of NORM-containing waste in municipal landfills. The table to the right suggests a comparison between common landfill wastes and their radioactivity levels. It is not suggested that these wastes fall under NORM disposal rules, but it does present an interesting comparison.



source: University of North Dakota, Energy & Environmental Research Center

How Is NORM Disposed Of?

Disposal protocols differ greatly across states and across oil and gas producers. Generally, NORM-contaminated equipment is tagged, sent to a decontamination service, decontaminated, and then shipped to a landfill. Alternately, some companies opt to send low-level contaminated material directly to licensed NORM disposal sites. Occasionally, companies unwittingly transport NORM-contaminated waste to local landfills not approved to accept this waste. Most oil patch landfills have their own radioactivity-monitoring protocol in place to prevent this.

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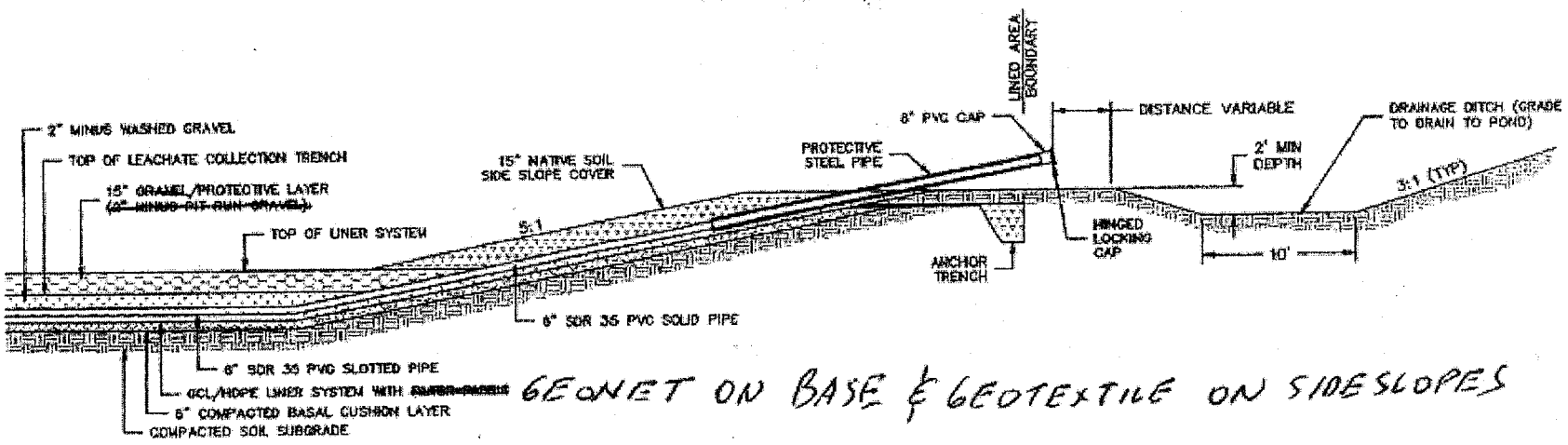
Landfill side cut-a-way



TYPICAL PERIMETER CELL
SIDE SLOPE DETAIL

NO SCALE