

NORM AND TENORM

What is Naturally Occurring Radioactive Material (NORM)?

NORM is any of the primordial radionuclides or radioactivity present in soils, rocks, and materials, present since the formation of the earth and undisturbed as a result of human activities.



What is Technologically Enhanced Naturally Occurring Radioactive Material (TENORM)?

NORM occurs everywhere in the environment. When NORM is disturbed or altered from natural settings or present in a technologically enhanced state due to past or present human activities and practices, the material is known as TENORM. “Technologically enhanced” refers to a relative increase in radionuclide concentrations above background radiation levels as a result of changes to the radiological, physical, and chemical properties of the radioactive material. In comparing background radioactivity or radiation levels with TENORM, the definition does not provide a point of reference, such as a level equivalent to a multiple of background, because this could lead to situations in which a material not considered TENORM in a high-background area could become TENORM when relocated to a lower-background area. TENORM does not include radiation emanating from or radioactivity present in ores, rocks, soils, and materials containing uranium and thorium subject to regulations under the Atomic Energy Act (ANSI/HPS N13.53-2009).

How are NORM and TENORM associated with Shale Oil and Gas Formations?

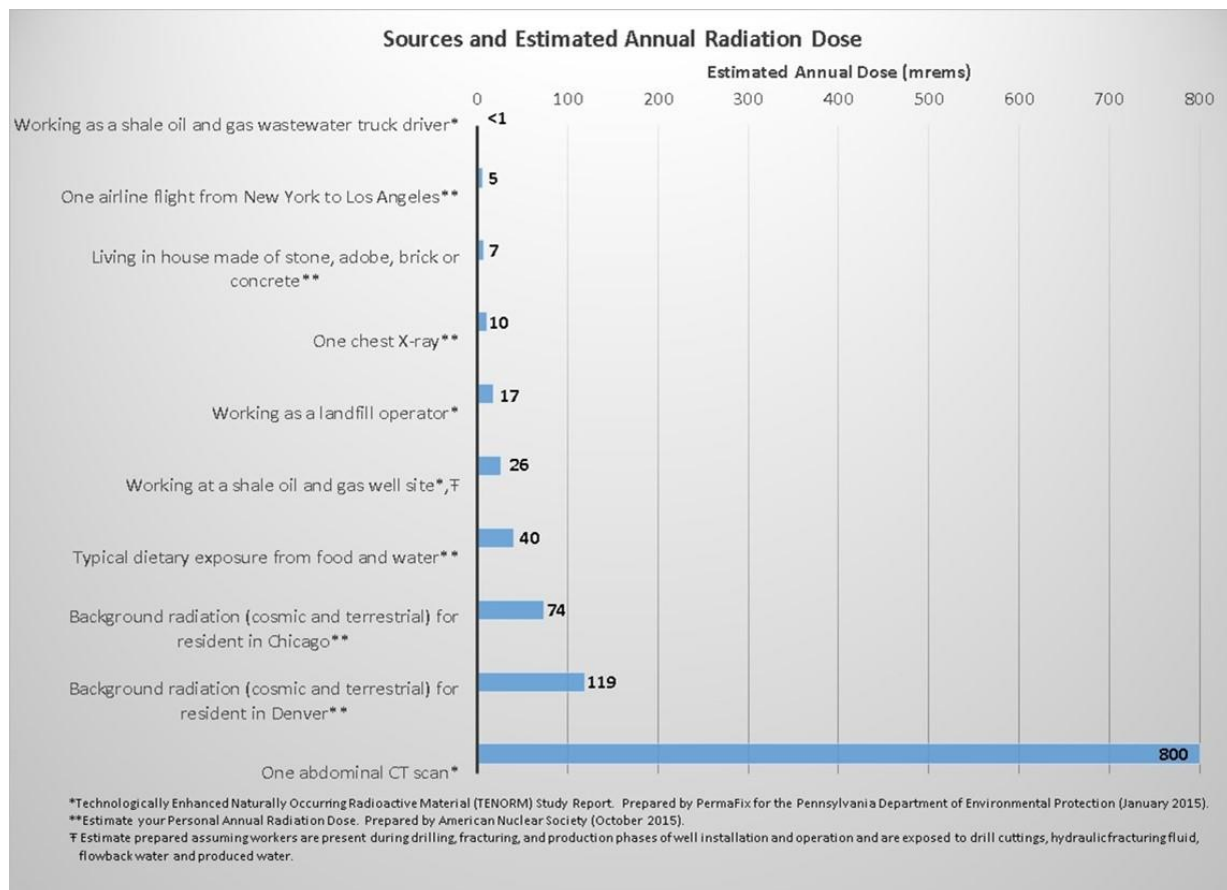
Naturally occurring radionuclides and their decay products are associated with various natural formations, including shale rock and oil and gas formations, because of the origin of these sedimentary rocks and their organic content. According to the [U.S. Environmental Protection Agency](#), much of petroleum and natural gas developed in the U.S. was created by the decay of ancient sea life. Oil and gas deposits often occur in aquifers containing brine (salt water). NORM and other dissolved minerals in the brine form various wastes when brought to the ground surface, including sludges/sediments and produced water (water extracted from the gas). These wastes are classified as TENORM because the extraction process concentrates the NORM.

What is the range of typical radiation dose from exposures to typical NORM and TENORM sources?

The chart below presents several potential sources of NORM and TENORM exposure and the estimated annual dose associated with each source. The radiation dose is expressed as millirems (mrem), which is a common unit utilized to quantify the amount of radiation absorbed by the body. The Nuclear Regulatory

Commission (NRC) maintains a personal annual radiation dose calculator available at: <http://www.nrc.gov/about-nrc/radiation/around-us/calculator.html>. According to the NRC, the average American receives a dose of about 620 mrems each year from a combination of natural and man-made sources of radiation. The chart below shows the estimated dose associated with different exposures.

In any given setting, the actual doses are expected to vary somewhat from the precise estimates provided. Even so, we can assume that the annual radiation dose resulting from driving a shale oil and gas wastewater truck is likely to be less than 1 mrem, or less than one-tenth of the dose from a single chest X-ray. Similarly, the annual radiation exposure to workers at a shale oil and gas well site is expected to be less than 30 mrems, or less than one-half of the expected annual dose experienced by a resident of Chicago.



What is the industry doing to manage the risks from TENORM?

A comprehensive study performed in 2014 by the PA Department of Environmental Protection in cooperation with other public and private organizations, determined that NORM and TENORM materials associated with the oil and gas industry are well managed and do not present a risk to the public. The oil and gas industry characterizes and profiles waste materials for ultimate disposal at appropriate permitted facilities. Further, while the majority of waste streams generated by the oil and gas industry do not pose a risk to workers or the general public, industry professionals are able to make proper adjustments to handling, processing, and disposal protocols based on screening, monitoring, and analytical data.

The Marcellus Shale Coalition supports its members' compliance with regulatory requirements and recommended management practices for NORM and TENORM. These waste materials must be handled, stored and disposed of in compliance with regulations that ensure the safety of workers and the public.

Appropriate member company personnel are trained on NORM protection, proper handling and proper disposal of NORM and TENORM-containing waste. All potential NORM exposures to workers and members of the public from TENORM are either eliminated or reduced to levels that are well below acceptable radiation protection standards.

In Pennsylvania, depending on predicted radiation dose levels from TENORM waste, additional protective actions may include:

- Sampling waste and determining radionuclide levels, using these to determine proper protection and disposal.
- Monitoring truckloads of waste when it leaves the well site and when it arrives at a landfill.
- Performing work area surveys to determine radiation exposure levels.
- Performing contamination surveys of personnel and equipment prior to leaving work areas.
- Segregating TENORM to a holding area to limit exposures; and
- Preparing and implementing a radiation action plan.