US Army Corps of Engineers®
Buffalo District

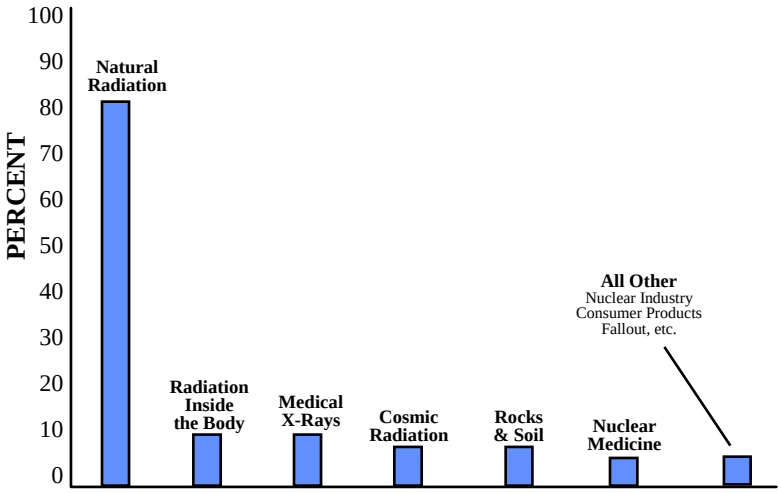
FUSRAP

Radiation in the Environment

Radiation is a natural part of our environment. When our planet was formed, radiation was present — and radiation surrounds it still. Natural radiation showers down from the distant reaches of the cosmos and continuously radiates from the rocks, soil, and water on the Earth itself.

During the last century, mankind has discovered radiation, how to use it, and how to control it. As a result, some manmade radiation has been added to the natural amounts present in our environment.

Many materials — both natural and manmade — that we come into contact with in our everyday lives are radioactive. These materials are composed of atoms that spontaneously release energetic particles or waves as they change into more stable forms. These emitted particles and waves are referred to as *radiation*, and the process resulting in their emission as *radioactivity*.



As the chart on the left shows, most environmental radiation (82%) is from natural sources. By far the largest source is radon, an odorless, colorless gas given off by natural radium in the Earth's crust. While radon has always been present in the environment, it's significance is better understood today. Manmade radiation — mostly from medical uses and consumer products — add about 18% to our total exposure.

Types of Ionizing Radiation

Radiation that has enough energy to disturb the electrical balance in the atoms of substances it passes through is called ionizing radiation. There are four basic forms of ionizing radiation.

Alpha

Alpha particles are the largest and slowest moving type of radiation. They are easily stopped by a sheet of paper or the skin. Alpha particles can move through the air only a few inches before being stopped by air molecules. However, alpha radiation is dangerous to sensitive tissue inside the body.

Beta

Beta particles are much smaller and faster moving than alpha particles. Beta particles pass through paper and can travel in the air for up to10 feet. However, they can be stopped by thin shielding such as a sheet of aluminum foil.

Gamma

Gamma radiation is a type of electromagnetic wave that travels at the speed of light. It takes a thick shield of steel, lead, or concrete to stop gamma rays. X-rays and cosmic rays are similar to gamma radiation. X-rays are produced by manmade devices; cosmic rays reach Earth from outer space.

Neutrons

Neutrons are small uncharged highly penetrating particles. The most common shielding for neutrons is water. They are formed by cosmic ray interactions with material in the environment. Neutrons make up a small amount of radiation in the environment.

Units of Measure

Radiation can be measured in a variety of ways. Units of measure show either (1) the total amount of radioactivity present in a substance or (2) the level of radiation being given off.

The radioactivity of a substance is measured in terms of the number of transformations (changes into more stable forms) per unit of time. The *curie* is the standard unit for this measurement and is based on the amount of radioactivity contained in 1 gram of radium. The amounts of radioactivity that people normally work with are in the millicurie (one-thousandth of a curie) or microcurie (one-millionth of a curie) range. Levels of radioactivity in the environment are in the picocurie or pCi (one trillionth) range.

Levels of radiation are measured in various units. The level of gamma radiation in the air is measured by the *roentgen*. This is a relatively large unit, so measurements are often calculated in milliroentgens. Radiation absorbed by humans is measured in either *rad* or *rem*. The *rem* is the most descriptive because it measures the ability of the specific type of radiation to do damage to biological tissue. Typical measurements will often be in the millirem (*mrem*), or one-thousandth of a rem, range.

Radiation in the Environment

Because the radioactivity of individual samples varies, the numbers given here are approximate or represent an average. They are shown to provide a perspective for concentrations and levels of radioactivity rather than dose.

mrem = millirem
pCi = picocurie
1 Ci = activity of 1 gram of radiation

Cosmic Radiation

Cosmic radiation is radiation that originates in outer space and filters through our atmosphere.

Sea Level.....26 mrem/year
Atlanta (1,050 ft)..... 31 mrem/year
Denver (5,300 ft).....50 mrem/year
Minneapolis (815 ft.....30 mrem/year
Salt Lake (4,000 ft).....46 mrem/year

Terrestrial Radiation

Terrestrial sources are naturally radio-active elements in the soil and water such as uranium, radium, thorium and Potassium-40. Some examples of doses resulting from these elements in the soil:

U.S. (average).....26 mrem/year
Denver, CO.....63 mrem/year
Nile Delta, Egypt.....350 mrem/year
Paris, France.....350 mrem/year
Kerala, India.....400 mrem/year
McAlpe, Brazil.....2,448 mrem/year
Pocos de Caldas,
Brazil.....7,000 mrem/year

Buildings

Many building materials, especially granite, contain naturally radio-active elements.

U.S. Capitol Bldg.....85 mrem/year
Statue of Liberty.....325 mrem/year
Grand Central Sta.....525 mrem/year
The Vatican.....800 mrem/year

Radon

Radon levels in buildings vary, depending on geographic location.

Average indoor radon levels....1.5 pCi/liter
Occupational working limit...100.0 pCi/liter

Food

Food contributes an average of 20 mrem/year, mostly from potassium-40, carbon-14, hydrogen-3, radium-226, and thorium-232.

Beer.....390 pCi/liter
Tap Water.....20 pCi/liter
Milk.....1,400 pCi/liter
Salad Oil.....4,900 pCi/liter
Whiskey.....1,200 pCi/liter
Brazil Nuts.....14 pCi/g
Bananas.....3 pCi/g
Flour.....0.14 pCi/g
Peanuts & Peanut Butter.....0.12 pCi/g
Tea.....0.40 pCi/g

Medical Treatment

The exposures from medical diagnoses vary widely according to the required procedure, the equipment, and film used for X-rays, and the skill of the operator.
Chest X-Ray..... 10 mrem
Dental X-Ray.....100 mrem

Consumer Goods

Cigarettes-2 packs/day...8,000 mrem/year (polonium-210)
Color Television..... <1 mrem/year
Gas Lantern Mantle.....2 mrem/year (thorium-232)
Highway Construction..... 4 mrem/year
Airplane Travel-39,000 ft....0.5 mrem/year (cosmic)
Natural Gas/Heating and Cooking (radon-222).....2 mrem/year
Phosphate Fertilizers.....4 mrem/year

Natural Radioactivity in Florida Phosphate Fertilizers (in pCi/gram)

	xxxxx	xxxxx	xxxxx
Ra-226	**21.3**	**21.0**	**33.0**
U-238	**20.1**	**58.0**	**6.0**
Th-230	**18.9**	**48.0**	**13.0**
Th-232	**0.6**	**1.3**	**0.3**

Porcelain Dentures.....1,500 mrem/year (uranium)
Radioluminescent Clock.....<1 mrem/year (promethium-147)
Smoke Detector.....0.01 mrem/year (americium-241)

International Nuclear Weapons Test Fallout

From pre-1980 atmospheric tests
Average for a U.S. citizen.....1 mrem/year

For More Information

For more information on radiation or FUSRAP Sites, call the U.S. Army Corps of Engineers, Buffalo District toll-free at **1-800-833-6390**, e-mail us at **fusrap@usace.army.mil** or write to us at **1776 Niagara St, Buffalo, NY 14207**.