Background Radiation
Natural versus Man-Made

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Fact Sheet #10

Division of Environmental Health
Office of Radiation Protection

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Radiation is energy traveling through space. Sunshine is one of the most familiar forms of radiation. It delivers light, heat and suntans. We control its effect on us with sunglasses, shade, air conditioners, hats, clothes and sunscreen.

There would be no life on earth without lots of sunlight, but we have increasingly recognized that too much of it on our persons is not a good thing. In fact it may be dangerous, so we control our exposure to it.

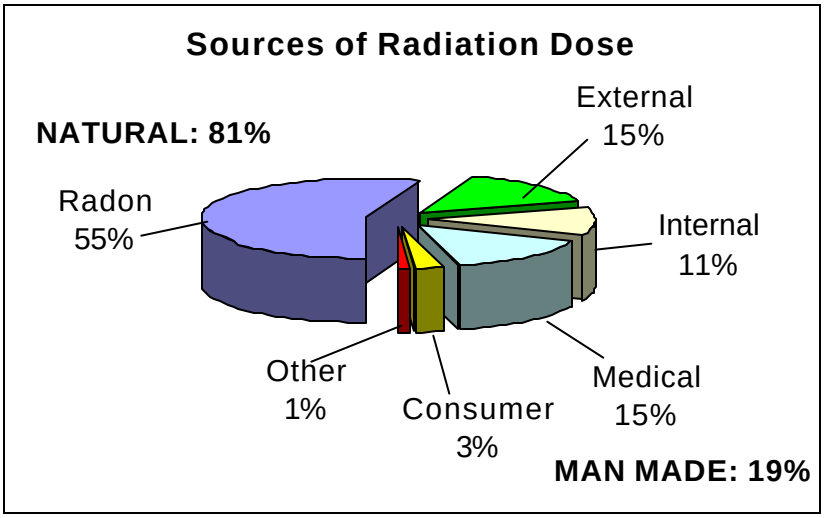
Sunshine consists of radiation in a range of wavelengths from long-wave infra-red to shorter wavelength ultraviolet.

Beyond ultraviolet are higher energy kinds of radiation which are used in medicine and which we all get in low doses from space, from the air, and from the earth. Collectively we can refer to these kinds of radiation as ionizing radiation. It can cause damage to matter, particularly living tissue. At high levels it is therefore dangerous, so it is necessary to control our exposure.

Living things have evolved in an environment that has significant levels of naturally occurring radiation. Furthermore, many of us owe our lives and health to man-made radiation, sometimes called artificially produced. Medical and dental X-rays discern hidden problems. Other radiation is used to diagnose ailments and some people are treated with radiation to cure disease. We all benefit from a multitude of products and services made possible by the careful use of radioactive materials.

BACKGROUND RADIATION

Background radiation dose consists of the radiation doses received from natural and man-made background. For someone residing in the US, the annual background dose is approximately 360 millirem (mrem), but in some locations can be much higher. The highest known level of background radiation affecting a substantial population is in Kerala and Madras States in India where some 140,000 people receive an annual dose rate which averages over 1500 mrem per year from gamma, plus a similar amount from radon, for a total of 3000 mrem.



Natural background radiation contributes about 81% of the annual dose to the population and man-made background radiation contributes the remaining 19%. Natural and man-made radiations do not differ in kind or effect. Man-made radiation is generated in a range of medical, commercial and industrial activities. The most familiar and, in national terms, the largest of these sources of exposure is medical X-rays.

NATURAL BACKGROUND RADIATION

We are all exposed to ionizing radiation from natural sources at all times. Natural background radiation is inevitably present in our environment. Levels can vary greatly. People living in granite areas or on mineralized sands receive more terrestrial radiation than others, while people living or working at high altitudes receive more cosmic radiation. A lot of our natural exposure is due to radon, a gas which seeps from the earth's crust and is present in the air we breathe.

The main sources of natural radiation are the following:

- Terrestrial Radiation
  - Soil
  - Gas

- Cosmic Radiation
- Natural Radioactivity in the Body

Terrestrial Radiation

When the earth was formed four billion years ago, it contained many radioactive isotopes. Since then, all the shorter lived radionuclides have decayed. Only those radionuclides with very long half lives (100 million years or more) remain, along with the radionuclides formed from the decay of the long lived radionuclides.

These naturally-occurring radionuclides include isotopes of uranium and thorium and their decay products, such as radon. The presence of these radionuclides in the ground leads to both external gamma ray exposure and internal exposure from inhalation of radon and its progeny.

Soil

Natural radioactive material in rocks and soil account for about 29 mrem or 8% of the radiation dose a person typically receives in a year from all sources (natural and man-made). The earth's crust contains small amounts of uranium, thorium, and radium as well as radioactive isotopes of several elements including potassium. The radiation dose comes from the gamma rays which are emitted from the rocks, soil, and some building materials (such as bricks and concrete).

Radon Gas

The Earth's crust contains small amounts of naturally radioactive materials such as uranium and thorium. Uranium and thorium decay to other radioactive atoms, including radium, which then decays to radon gas. Since radon is an inert (that is, chemically stable) gas, it moves from the soil, where it is produced, and into the air. Radon is a natural part of the earth's atmosphere. The amount of uranium and radium in soil varies greatly with geographic location and soil type. Therefore, the amount of radon gas released to the atmosphere also varies across the United States.

Cosmic Radiation

Cosmic radiation, from the sun and from outer space, varies with altitude and latitude; cosmic radionuclides (mainly carbon-14), are produced through interactions of the cosmic rays with atoms in the atmosphere.

Cosmic rays are extremely energetic particles, primarily protons, which originate in the sun, other stars, and from violent cataclysms in the far reaches of space. Cosmic ray particles interact

with the upper atmosphere of the earth and produce showers of lower energy particles. Many of these lower energy particles are absorbed by the earth's atmosphere. At sea level, cosmic radiation is composed mainly of muons, with some gamma-rays, neutrons and electrons.

The exposure of an individual to cosmic rays is greater at higher elevations than at sea level. The cosmic radiation dose increases with altitude, roughly doubling every 6,000 feet. Therefore, a resident of Florida (at sea level) on average receives about 26 mrem, one-half the dose from cosmic radiation as that received by a resident of Denver, Colorado, and about one-fifth of that by a resident of Leadville, Colorado (about two miles above sea level). A passenger in a jetliner traveling at 37,000 feet would receive about 60 times as much dose from cosmic radiation as would a person standing at sea level for the same length of time.

Natural Radioactivity in the Body

Small traces of many naturally occurring radioactive materials are present in the human body. These come mainly from naturally occurring radioactive nuclides present in the food we eat and in the air we breathe. These isotopes include tritium (^{3}H), carbon-14 (^{14}C), and potassium-40 (^{40}K).

About 11% (40 mrem) of our radiation dose comes from naturally occurring radioactive materials in the body. Most of the dose comes from a radioactive isotope of potassium. Radioactive potassium-40, as well as other radioactive materials (such as carbon-14) which occur naturally in air, water, and soil, are incorporated into the food we eat and then into our body tissues.

MAN-MADE RADIATION

We are also exposed to ionizing radiation from man-made sources, mostly through medical procedures. On the average, doses from a diagnostic x-ray are much lower, in dose effective terms, than natural background radiation. Radiation therapy, however, can reach levels many times higher than natural background radiation but this is usually targeted only to the affected tissues. Besides medical applications, extremely small amounts of man-made background radiation are received from consumer products and facilities using radioactive material including research and teaching institutions, nuclear reactors and their supporting facilities such as uranium mills and fuel preparation plants, and Federal facilities involved in nuclear weapons production as part of their normal operation. People who smoke receive additional radiation from radionuclides in tobacco smoke.

Medical Procedures

Radiation used in medicine is the largest source of man-made radiation to which people in the United States are exposed. Most of our exposure is from diagnostic x-rays. Physicians use x-rays in more than half of all medical diagnoses to determine the extent of disease or physical injury. Radiation is also used in cancer treatments, where precisely targeted radiation destroys diseased cells without killing nearby healthy cells. Radiopharmaceuticals, another medical treatment, are used to locate tumors in a patient's body and to treat cancer. One-third of all successful cancer treatments involve radiation.

The U.S. national annual background dose for humans is approximately 360 mrem. A mrem, or millirem, is a standard measure of radiation dose. Examples of radiation doses from common medical procedures are:

- Chest x-ray (14 x 17 inch area) - 15 mrem
- Dental x-ray (3 inch diameter area) - 300 mrem
- Spinal x-ray (14 x 17 inch area) - 300 mrem
- Thyroid uptake study – 28,000 mrem to the thyroid
- Thyroid oblation - 18,000,000 mrem to the thyroid

Consumer Products

Small amounts of man-made background radiation is attributable to consumer products like color televisions, smoke detectors, gas lantern mantles, natural gas heating and cooking fuel, and mining and agriculture products, such as coal, granite and potassium salt.

Radioactive Fallout

Nuclear weapons derive their explosive power from the uncontrolled radioactive break-up of plutonium and uranium. This yields a large number of radioactive daughter products that are blown high into the atmosphere and are carried around the earth. These radioactive elements gradually fall back (fall-out) to earth over a period of many years. During the 1950s and early 1960s, many test explosions were carried out in the atmosphere. In 1963 an Atmospheric Test Ban Treaty was signed and most subsequent tests have been conducted underground. The peak year for radioactive fallout was 1963 and levels have been declining since then. Levels of fallout are now less than ten per cent of what they were at peak. We each receive approximately 1 mrem from this source each year.

Nuclear Power

Nuclear power reactors, which use uranium, supply the United States with about 20 percent of its electricity. Our ability to produce power using radioactive materials reduces our reliance on fossil fuels. Nuclear power plant operations account for less than a hundredth of a percent of the average American's total radiation exposure.

Background Annual Average Radiation Doses to the U.S. Population

Radiation Source		Average Annual Whole Body Dose (mrem/year)
Natural:	Cosmic	26
	Terrestrial	29
	Radon	200
	Internal (K-40, C-14, etc.)	40
Manmade:	Diagnostic X-Ray	39
	Nuclear Medicine	14
	Consumer Products	11
	All Others (fallout, nuclear power plants, air travel, occupational, etc.)	2
	Average Annual Total	**361 mrem/year**

Tobacco (If You Smoke, Add ~ 280 mrem)

The tobacco in cigarettes contains lead-210. Lead-210 is a naturally occurring radionuclide that precipitates out of the atmosphere and deposits on the leaves of tobacco. When the tobacco is inhaled, the smoker receives a dose from the inhaled lead-210 as well as polonium-210, the decay product of lead-210. Lead-210 is deposited on the surfaces of bones and polonium-210 is deposited in the liver, kidney and spleen.

Sources

Princeton University Initial Radiation Safety Training,
http://web.princeton.edu/sites/ehs/about/services.htm
Health Physics Society,
http://www.hps.org/publicinformation/ate/
Environmental Protection Agency,
http://www.epa.gov/radiation/docs/402-k-07-006.pdf
Environmental Protection Agency,
http://www.epa.gov/radiation/docs/402-f-06-061.pdf
National Institutes of Health,
http://www.nih.gov/health/chip/od/radiation/#xone

Links to external resources are provided as a public service and do not imply endorsement by the Washington State Department of Health.