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# 3. What Are the Sources of Ionizing Radiation?

Naturally occurring radioactive materials are common in the environment and in the human body. These materials are continuously emitting ionizing radiation. Ionizing radiation from outer space (cosmic radiation) bombards the earth constantly. The ionizing radiation from these and similar natural sources is called **background radiation.** Human activities, such as making medical x-rays, generating electricity from nuclear power, testing nuclear weapons, and producing a variety of common products such as smoke detectors which contain radioactive materials, can cause additional exposure to ionizing radiation.

The percentage of the average annual radiation exposure contributed by each major source is illustrated in Figure 1. The total is about 360 millirems. About 82 percent is from nature; 18 percent is from industrial, medical, and consumer sources. The values given in Figure 1 are averages for the United States. Actual values vary, depending on where people live and how they spend their time.

This Fact Sheet describes sources of ionizing radiation and gives some reasons for the variations in radiation exposure received.

## Natural Sources of Radiation

### ➤ Radon

The largest natural source of radiation exposure to humans is radon gas. While radon gas has always been in the environment, awareness of its contribution to human radiation exposure has increased in recent years. Radon's primary pathway is through air space in soil and rock. Pressure differences between the soil and the inside of buildings may cause radon gas to move indoors. Depending on source strength and other variables, unacceptable amounts of radon gas can accumulate indoors, where building occupants will be exposed to the ionizing radiation emitted by radon and its decay products. The average American receives about 200 millirem (mrem) per year from radon.

Radon concentrations can vary depending on the soil and rock composition beneath buildings. The northwestern part of New Jersey is part of the "Reading Prong", a geological region with a high granite content. Granite can contain higher than average amounts of uranium, which decays to radon gas. Many people who live over this geological formation experience higher doses from radon than those who live elsewhere in New Jersey.

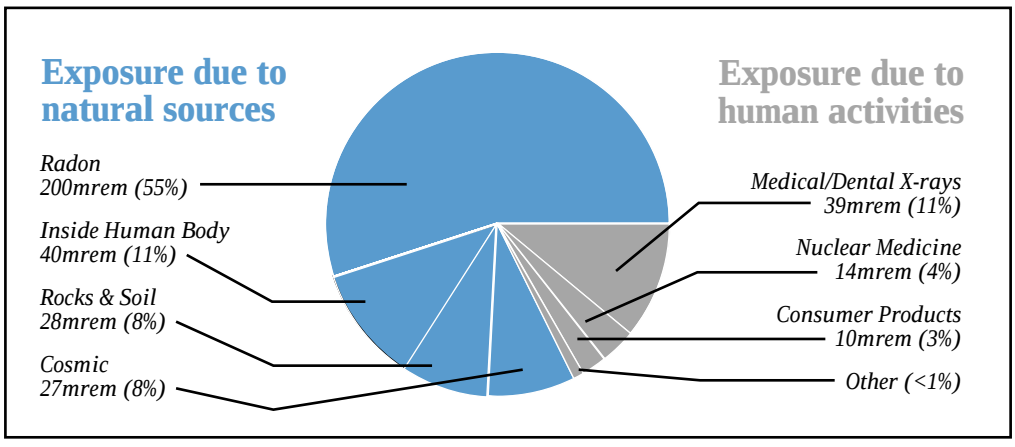


***Figure 1.*** **Average Annual Exposure to Ionizing Radiation in U.S.A.**

fact sheet

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### ➤ Internal Radiation

Internal radiation comes from radioactive materials that occur naturally in the human body. Isotopes of potassium and carbon are the primary sources of internal radiation exposures.

Potassium is an essential mineral for life. The Potassium-40 isotope (0.01 percent of all potassium) is naturally radioactive. Carbon makes up about 23 percent, by weight, of the human body. Cosmic radiation creates radioactive Carbon-14, which is an even smaller percentage of all carbon.

Potassium and carbon enter the body through the food chain. The average American receives a dose of about 40 mrem per year from internal radiation.

### ➤ Other Terrestrial Sources

Other terrestrial sources include naturally occurring radioactive materials that exist in rocks and soil. The main contributors are the radioactive isotopes that are products of the decay of uranium and thorium. The average American receives about 28 mrem per year from terrestrial sources.

### ➤ Cosmic Radiation

As the earth moves through space it is bombarded by high-energy particles and gamma rays, which add to the background radiation. The earth's atmosphere acts as a shield, absorbing much of the energy from cosmic radiation. People who live close to sea level are protected by a thicker blanket of atmosphere than those who live at high elevations, and thus have a lower exposure to cosmic radiation. For example, the exposure to cosmic radiation is about twice as high in Denver as it is in Atlantic City.

## Medical and Consumer Product Sources

### ➤ Medical Sources

The largest source of medical exposure, when averaged over all individuals, is from diagnostic x-rays, including both chest or limb x-rays and dental x-rays.

Other sources are lumped into the category of nuclear medicine. These include diagnostic procedures that use nuclear tracers. (Very small amounts of radioactive materials, called tracers, are put into the blood stream, and their progress through the body is monitored with a radiation detector. Blocked or restricted blood vessels can be identified, as can developing tumors.) Nuclear medicine also includes treatment of disease. Some examples are cobalt irradiation for the treatment of cancers, or the injection of radioactive iodine which concentrates in the thyroid for treatment of Graves' disease. The annual dose for the average American is about 53 mrem from medical sources.

### ➤ Consumer Products

Radiation is used in the manufacturing of many consumer products. It is used to sterilize products such as cosmetics and medical supplies and for shrink-wrap packaging. It can be used to determine the thickness of materials, how full cans are before sealing them, and the quality of welds in structures such as bridges and buildings. This use of radiation can expose workers in the factory, but it does not make the consumer product radioactive.

Radioactive materials also are used in many consumer products. The most common of these is some smoke detectors which use radioactive Americium-241 to detect smoke particles in the air.

Some consumer products naturally contain radioactive materials. They include tobacco products, natural gas, phosphate fertilizers, some brick or stone construction materials, gas mantles, some luminous signs, and certain ceramics.

The dose from medical, industrial, and consumer product sources varies from person to person, depending upon such factors as type of home, type of employment, smoking habits, and personal lifestyle. The dose for the average American is about 10 mrem per year from consumer products.

## ➤ Other Sources

This category includes the generation of electricity from both coal and nuclear power plants, the transportation of nuclear materials, and the storage of nuclear wastes. It also includes the exposures from fallout from the international nuclear weapons testing programs. These sources make up less than one percent of the annual radiation exposure — less than 3 mrem — to the average American.

## ➤ For More Information

If you want to read more about sources of ionizing radiation, some of the references and other Fact Sheets listed below may be helpful.


- Eric J. Hall, *Radiation and Life*, Second Edition, Pergamon Press, New York, 1984.
- Fred A. Mettler, Jr. and Robert D. Moseley, Jr., *Medical Effects of Ionizing Radiation*, Grune & Stratton, Inc., Orlando, Florida, 1985.
- National Research Council, Committee on the Biological Effects of Ionizing Radiation, *Health Effects of Exposure to Low Levels of Ionizing Radiation, BEIR V*, National Academy Press, Washington, D.C., 1990.
- James E. Turner, *Atoms, Radiation and Radiation Protection*, 2nd Edition, John Wiley & Sons, Inc., 1995
- Other Fact Sheets:

  *#1. What is Radioactive Material?*

  *#2. What is Ionizing Radiation?*


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