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F o m U id t s D p t m of E n g , N d O p t i Off i , Augus 199

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Radiation occurs in the form of energy or as atomic particles. The term "radiation," although broad enough to include sunlight and heat, radiowaves and microwaves, is most often used to mean "ionizing" radiation. That is radiation which changes the physical state of atoms, causing them to become electrically charged or "ionized." The earth itself is a source of naturally occurring radioactive material which emits ionizing radiation. Still other kinds of ionizing radiation are produced and used by man in the everyday course of living and improving our lives.

The biological effects of ionizing radiation vary, depending on the type, the amount, and where and how the body receives the radiation. Some forms of radioactive materials, at low levels, are naturally taken into the body through eating, drinking, and breathing; for example, Potassium-40 in table salt, Radium-226 in drinking water, and Radon-222 in the air we breathe. Manmade radiation, such as x-rays, is a vital tool for our doctors. On the other hand, accidental large intakes of radioactive materials or exposure to radiation can severely damage the body and increase the chances of exposed persons developing cancer or passing genetic defects to their children.

When high levels of ionizing radiation penetrate living tissue, normal biological processes can be disrupted. The atoms and molecules in the path of radiation can be altered, and a chain of events begins that can destroy cells or make them function abnormally, This creates a health hazard if the cell becomes cancerous. However, the radiation may kill only the cell, which is what happens naturally to millions of cells every day.

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There are five basic kinds of ionizing radiation:

Al p radiation is a heavy, positively charged particles given off by atoms of elements such as uranium. Alpha radiation often can be simply washed off the skin. It can be blocked by a sheet of paper. It enters the body through cuts, breathing or food or water.

B t radiation consists of electrons. More penetrating than the alpha radiation, the beta electrons can pass through several millimeters of skin. A sheet of aluminum a minute fraction of an inch thick will stop beta radiation.

G m rays are a form of electromagnetic radiation, similar to x-rays, light and radiowaves and are very penetrating. Gamma rays readily pass into the human body, but can be almost completely blocked by about 40 inches of concrete, 40 feet of water, or a few inches of lead.

X- ys are a more familar form of electromagnetic radiation, usually with a limited penetrating power. Typically, they are used in medical or dental examinations. A tungsten target is bombarded with high energy electrons to create x-rays which are then focused into a beam directed at the site to be investigated, Television sets, esepcially color, give off soft x-rays; thus, they are shielded to greatly reduce the risk of radiation exposure.

N uro**n**are uncharged heavy particles contained in the nucleus of every atom heavier than hydrogen. They induce ionization only indirectly in atoms which they strike, but can damage body tissues. Neutrons, which are released, for example during the fission (splitting) of uranium atoms in the fuel of nuclear power plants, can also be very penetrating. In general, efficient shielding against neutrons can be provided by water.

"N a l b c g ou d" is the term used to describe radiation we receive from n a l sou c s All life on the planet lives with natural radiation. Almost all radiation exposure comes from natural sources (82% in the United States). Ionizing radiation from the sun and outer space flow to earth constantly, but the atmosphere and magnetic sphere shield us from most of this cosmic radiation. Naturally occurring radioactive material, such as uranium and radium, is found in the earth and can be detected in buildings made of bricks, concrete, mortar, etc. Radon coming from these materials exposes the entire population. There are radioactive elements in our food and water, and in the radioactive aerosols and gases in the air we breathe. Our bodies contained naturally occurring radioactive elements when we were born.

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Everyone reeives varying amounts of natural radiation, depending on the amount of naturally occurring radioactive elements in the soil and the elevation above sea level and other factors. Some averages in various regions of the United States have been compiled by the U.S. Environmental Protection Agency (EPA).

A g N a l B c g ou d d i n
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C i	d i n(m /m)
Las Vegas, NV	69.5
Denver, CO	164.6
Tampa, FL	63.7
Portland, OR	86.7
Los Angeles, CA	73.6
St. Louis, MO	87.9
Rochester, NY	88.1
Wheeling, WV	111.9
Richmond, VA	64.1

New Orleans, LA	63.7
Fort Worth, TX	68.7

Hu▰m▰n ou c s of radiation are created through certain kinds of activities (18% in the United States). Radiation, coupled with human ingenuity, has produced highly sophisticated medical diagnostic techniques that have changed and saved the lives of uncounted numbers of people (for example, x-rays, magnetic resonance imaging, CAT scan). Radiation can destroy cancerous cells in a tumor, sterilize medical products and foods, track medicine thoughout the body, date archaelogical and geological events, and turn water into steam for electricity. Radioactive sensors are in smoke detectors, and uranium puts the gleam in dentures.

More than one million people in the United States safely work in occupations involving radaition, involving naval and civilian nuclear reactor engineering, health physics, radiochemistry, radiology, nuclear medical technology, and x-ray technology. Although they normally accumulate an average of about 100 millirems of radiation per year, guidelines developed by the U.S. Environmental Protection Agency allow workers in these occuptation to accumulate up to 5,000 mrem annually, in addition to their natural background exposures. For the general public, EPA guidlines set the acceptable limit of additional exposure from manmade sources at 100 mrem over background. Background averages about 300 mrem/yr from all natural sources.

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The following statistics and comparisons help clarify the actual exposure to radiation that we may experience in our daily routines.

	M▪▪ ▪ ▰s/
Smoking 1 1/2 packs of cigarettes a day	8000
Smoking 1 cigarette a day	267
Flying for 720 hours (airline crew)	360
Inhaling radon from our environment	200
Medical x-ray	100
Global Fallout	4
Nuclear power	0.3

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- Below 100 rem (100,000) scientists assume that the risk of long-term effects is about 4 in 10,000 for each 1,000 mrems of exposure over background.

- A dose of 300 rem (300,000 mrem) is fatal to about 50% of the person so exposed if no medical treatment is available.

- 1,000 rem (1 million rem) exposure to the whole body is normally fatal, but this dose level is used for some medical treatments of small portions of the body.

Because we cannot see or feel radiation, people tend to magnify the perception of its risk. Almost any activity or product can be dangerous if not conducted or used properly. As with all hazardous materials, in any actitivity involving radiation, (from sunbathing to undergoing radiation therapy), appropriate safeguards must be used and the risk balanced against the potential benefits to humanity.

For More Information Contact:
Office of External Affairs
U.S. Department of Energy
P.O. Box 98518
Las Vegas, NV 89193-8518
(702)295-3521