

Understanding Radiation

What Is Radiation and Where Does It Come From?

Radiation is part of nature. Since the Earth's formation, it has been immersed in radiation from space. Radiation is in our air, in the rocks and soil from the Earth's crust, in the oceans and in our bodies. Yet it is only within the past 150 years that we have begun to know what radiation is, to tap its widespread benefits, and to understand its effects.

Radiation is a form of energy that can move through empty space, like light and radio waves. When radiation passes through any kind of matter- solid, liquid or gas- it transfers some of its energy into that matter. Ionizing radiation transfers enough energy to change the physical state of atoms with which it interacts, causing them to become electrically charged or "ionized."

Everyone is exposed to radiation every day. It is simply a part of nature. The largest source- radon- is a naturally occurring radioactive gas that comes from the Earth's crust. Cosmic rays from the sun are a source of radiation, as are materials in the rocks and soil. About 11 % of the average person's total exposure to radiation comes from the person's body itself. Radioactivity found in air, water, and soil is absorbed into food naturally, and then into the body.

Radiation also is used in medical diagnosis and treatment, helping cure the deadliest cancers and other diseases. About 10 million nuclear medicine procedures are performed each year. For example, radiation in combination with imaging devices and computers, assess the function of various body organs, like the heart, lung, brain, liver and kidneys. Radiation treatments also help to prolong and improve the quality of life of cancer patients, and to treat scores of other serious diseases. Radiation is used to sterilize medical products, such as adhesive bandages, surgical dressing, sutures, catheters and syringes.

The science behind radiation and its health effects is extremely precise, based on more than a century of study. The quantity of radiation people are exposed to is called a "dose." Dose is measured in "rems" or "millirems"- which is one-thousandth of a rem. "Millirem" is more commonly used to measure human doses. A millirem is a measurement of the amount of radiation received in the human body in a designated period to time, adjusted to account for different types of radiation. It is expressed, for example, as "millirems per hour" or "millirems per year."

On average, about 80 percent of the radiation to which the public is exposed every year comes from natural sources, and the rest from man-made sources. In the United States, naturally occurring radiation exposes residents to an average of 300 millirems each year. The amount varies across the country, depending on altitude and the concentration of radioactive minerals in the ground. On coastal plains- like Florida- a typical person gets

about 290 millirems annually. At higher altitudes- in Colorado, for example, where there is more exposure to cosmic rays- the average person gets about 380 millirems annually.

The largest man-made source of radiation is medical diagnosis and treatment, such as medical and dental X-rays, and radiopharmaceuticals. The annual dose to an individual in the U.S. from medical and dental irradiation averages about 50 millirems. Much smaller doses come from consumer products such as televisions, smoke detectors and fertilizers, nuclear weapons fallout and production of nuclear power and its associated fuel cycle. The annual doses from these sources combined contribute an additional 10 millirems to the average individual.

The average annual dose from natural and man-made sources combined is about 360 millirems.

Radiation and the Public

During the past 70 years, numerous studies of populations exposed to radiation from medical, occupational or military purposes have been conducted. The lowest dose at which statistically significant health effects from radiation have been shown is about 10,000 millirems- nearly 1,000 times the dose received from medical X-rays. At lower levels of radiation, health effects, if any, have not been distinguished from those associated with everyday life. There is no evidence of any increase in cancer even among people living in areas where radiation levels are several times higher than average, whether due to natural source, man-made sources, or both.

Although nuclear power plants represent one of the smallest sources of radiation to which the public is exposed, exhaustive scientific studies have been carried out to ensure that they pose no risk to people living nearby.

A National Cancer Institute study in 1990 found no evidence of any increase in cancer mortality- including childhood leukemia- among people living in 107 U.S. counties that host, or are adjacent to, 62 major nuclear facilities. The conclusions of the NCI study, the broadest ever conducted, are supported by many other scientific studies in the United States, Canada and Europe.

Evidence of harm to humans from exposure to radiation is almost entirely related to relatively short-term exposures to high doses. Although an increased incidence of some cancers has been observed following very large doses of radiation about 10,000 millirems, radiation is considered to be a relatively weak carcinogen as compared to chemical and other cancer-causing agents. It is also much better controlled and regulated.

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If you live adjacent to a nuclear power plant, you may be exposed to minute amounts of radiation annually- less than one-hundredth of a millirem. Approximately two million people in the United States are exposed to man-made radiation through their work, including about 100,000 workers at nuclear power plants. On average, nuclear power plant workers receive less than 200 millirems per year- well below federal safety limits.

How Is Radiation Controlled?

To help control the radiation exposure of workers and the public, the world's scientists have developed radiation safety standards. Actual exposure is well below limits set by these standards.

The National Academy of Sciences and the United Nations Scientific Committee on the Effects of Atomic Radiation provide the scientific basis for these standards. They periodically examine recent research about radiation effects. When appropriate, they update the scientific basis.

The International Commission on Radiological Protection and the National Council on Radiation Protection and Measurements in the United States use this scientific basis to establish radiation protection policy. U.S. regulatory agencies base their regulations on the recommendations of these bodies.

In the unlikely event that radioactivity is released from one of the Indian Point plants, some members of the general public may be exposed to ionizing radiation. The possibility of health effects of such exposure would be extremely small and nearly impossible to detect since the levels of exposure would be relatively small even in a release of a significant amount of radioactive material.

At each of the country's more than 100 nuclear power plants, every safety precaution is taken to isolate, shield and prevent radioactive materials from escaping to the environment.

Even though cause radioactive fuel in a nuclear plant has very low levels of the element that could cause a nuclear explosion, the plant can not "explode" like a nuclear bomb. It should be noted nevertheless that even at low concentrations, precautions must be taken so that radioactive materials produced by the uranium do not reach the environment. All nuclear power plants in the U.S. are designed with containment buildings of concrete and steel. The 1986 accident in Chernobyl, Russia occurred in a nuclear plant that did not have a containment building, among other also very important differences.

Health Effects

The most widely studied health effect from radiation exposure is the increased risk of developing cancer. The National Academy of Sciences Committee in the *Biological Effects of Ionizing Radiation* (BEIR V) estimates that the increased potential for

developing cancer is about 4 in 10,000,000 per one millirem of exposure. This increase in cancer could not be detected since the “background” risk (without nuclear power plants) of developing cancer is about 1 in 4. In other words, the normal incidence of cancer in the U.S. is about 25%. A person who was exposed to 1000 millirems of ionizing radiation would have a cancer risk of 25.04%.

It is important to note that these types of estimates are derived from statistical models, not from medical records. Technical studies have shown no health effects resulting from background radiation found near nuclear power plants. Studies conducted by various government agencies, including the National Institutes of Health (NIH), show that people living in the vicinity of nuclear plants do not have higher cancer rates than those living in other places.

Radiation Exposure and Nuclear Plants

The operation of nuclear power plants constitutes less than one-tenth of one percent of average annual radiation exposure. Nuclear plants do, however, contain large amounts of radioactive substances within the fuel assemblies. In the United States there are more than 100 commercial nuclear reactors, many of which have more than one operating unit per site, like Indian Point. In more than 30 years of commercial operation in the United States, there has never been a reactor accident that exposed the general public to radiation levels that are near natural background.

The most serious commercial reactor accident in the U.S. occurred at the Three Mile Island (TMI) site in March 1979. A few individuals within 2 miles of the plant may have received estimated maximum doses of 20-70 millirems. The average exposure to the population nearby was about 1 millirems.

The accident at TMI did not result in significant exposure to the public because most of the radioactivity was trapped as designed inside the reactor vessel and the containment building. All the U.S. power reactors are designed with backup safety systems including a containment building to limit the release of radioactivity even during a complex accident situation.