

IONIZING RADIATION AND PUBLIC HEALTH

A UniStar Issue Brief



Ionizing radiation is everywhere—and always has been. It's in the air, it's in the sun, it's in the ground, and it's in the buildings we live in. It's in the food we eat, the beverages we drink, and it's inside each of our bodies.

It's also an indispensable part of many things that make our lives easier and safer, such as lifesaving medical procedures and medicines that help us live longer, healthier lives. Radiation is used in consumer products and works behind the scenes in a wide variety of industries producing products and services we use every day. In addition, the fission from radioactive materials provides the energy for one out of every five homes in the U.S.¹

Radiation is a form of energy that is one of the most analyzed phenomena in our world. It's predictable, it's manageable, it's regulated and monitored, and its risks are well known. And those risks are far outweighed by the benefits we receive from its use.

WHAT IS RADIATION?

Radiation is the term applied to all forms of energy transmission over a distance, both as particles and electromagnetic waves. Visible light makes up only a small portion of the electromagnetic wave spectrum. Radiowaves, microwaves, and infrared radiation, all with energies below the visible spectrum, as well as ultraviolet, x-rays, and gamma rays, all with energies above the visible spectrum are all invisible to the human eye. Ionizing radiation includes the portion of the spectrum with the most energetic waves, mainly x-rays and gamma rays. This type of radiation has enough energy to break chemical bonds and remove electrons from atoms, hence the term ionizing radiation. Radioactive particles with the energy to alter chemical structures, for example, alpha and beta particles, are also termed ionizing radiation.

Discussion of the potential hazards of nuclear energy facilities focuses on ionizing radiation that could be released from their operations. In this context, this Issue Brief will often refer to radiation when we mean ionizing radiation.

In addition, as we will see, nuclear energy is not the only source of ionizing radiation. There are many other sources, including man-made and unavoidable natural background sources.

Sources of Radiation

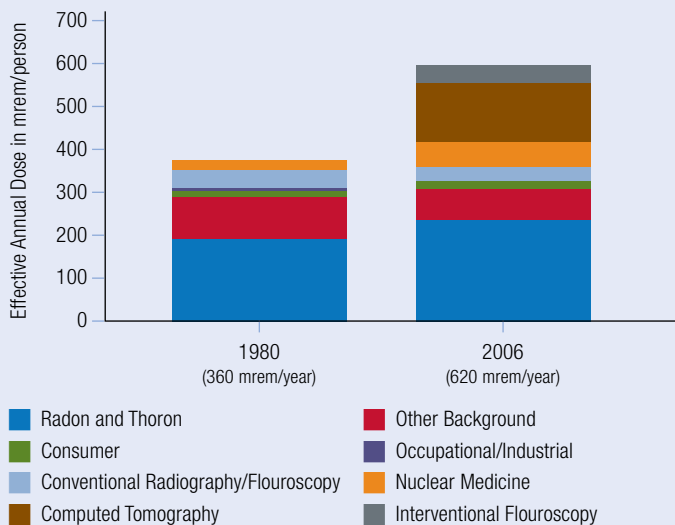
The sources of radiation break down into three general categories. Natural background, medical, and non-medical, man-made radiation.

Until the last couple of decades, unavoidable radiation from natural background was by far the predominant radiation exposure received by humans. Most of this exposure comes from radon and thoron gases which escape from all soils and natural building materials to some degree. These gases can build up to significant concentrations in homes and other structures, where they can be inhaled into our lungs before undergoing a series of radioactive decays, each of which produces a small amount of radiation. Other contributors to background include cosmic radiation from space, direct radiation from other radioactive elements in soil, and self irradiation from radioactive

What's a millirem?

Without going through the technical jargon, a millirem is the amount of radiation a person gets from two dental x-rays.

U.S. Radiation Exposure Change Over Time²



Source: "Ionizing Radiation Exposure of the Population of the United States," Report No. 93, National Council on Radiation Protection and Measurements, 1987.

"Ionizing Radiation Exposure of the Population of the United States," Report No. 160, National Council on Radiation Protection and Measurements, 2009.

elements in our food and water, some of which are incorporated into our bodies. Of the approximate 300 millirems per year of natural radiation exposure, about 70 percent comes from radon and thoron exposure and 30 percent comes from other natural sources, such as soil and cosmic radiation. Although variable with local altitude and geology, estimates of these natural exposures have remained fairly constant over time.

This is emphatically not true of exposures due to medical procedures, whether diagnosing or treating a health problem. In the early 1980s, a typical person in the U.S. might have received on the order of 55 millirems from conventional x-ray and nuclear medicine procedures. The advent of computed tomography (CT) and interventional fluoroscopy have changed the playing

Relative Doses from Radiation Sources: Millirem Doses

Living near a nuclear power station	< 1 millirem on average (annual)
Chest x-ray	4 millirem (single procedure)
Cosmic radiation living at sea level	24 millirem (annual)
Cosmic radioactivity	27 millirem (annual)
Terrestrial radioactivity	28 millirem (annual)
Mammogram	30 millirem (single procedure)
Natural radioactivity in the body	40 millirem (annual)
Diagnostic radiology	50 millirem (annual)
Cosmic radiation living in Denver	50 millirem (annual)
Radon in average home	200 millirem (annual)
Gastrointestinal series	1,400 millirem (single procedure)

Source: U.S. EPA³

field almost beyond recognition. CT allows 3-D visualization of body structures by processing multiple, sequential layers of x-ray images. The real-time imaging of interventional fluoroscopy has allowed less invasive techniques of treatment such as angioplasty and arterial stents to become commonplace. However, where a diagnostic x-ray might have required 50 millirems, a CT series could require 1000 to 1500 millirems due to the multiple images and interventional fluoroscopy could be a factor of ten higher than that due to the long exposure times required for continuous viewing. In the 1980s medical procedures accounted for 15 percent of all exposures. By 2006, medical procedures accounted for 48 percent of radiation exposures, virtually equal to the background contribution of 50 percent.

In contrast, non-medical, man-made radiation exposures, including all consumer, industrial, and occupational sources, have always been a very small contribution to average human exposures.

Consumer exposures to radiation come predominantly from cigarette smoking, building materials, and air travel, which together account for almost 90 percent of consumer exposure.

Occupational exposures to radiation are highest for medical and airline flight crew workers, which together account for about 75 percent of radiation exposure on the job. Radiation sources are used in a variety of industries for testing, inspection, manufacturing, and other applications. Jobs in commercial nuclear energy account for less than 10 percent of all occupational exposures.

Radiation received from consumer products account for about two percent of the total radiation exposure to the U.S. population. This is roughly ten times the radiation received from all non-medical occupational and industrial exposures.

BENEFITS OF RADIATION

It would be difficult to overstate the importance of the beneficial uses of radiation in our society. From the life-saving tools of modern medicine to the static eliminators in industrial equipment, radiation-based technologies are ubiquitous, indispensable, and often invisible to the public. Radiation is used for emergency illumination, smoke detection, inspecting airline luggage, checking weld integrity, cold pasteurization of food, oil and gas exploration, and measuring the thickness of everything from paper to steel.

The use of nuclear energy to generate reliable electricity without harm to the environment or the public is one of the most important and safest uses of radiation producing technologies. Nuclear energy produces 20 percent of all electricity used in the U.S. and 70 percent of our carbon-free electricity, all with virtually no risk of health effects.



RADIATION EFFECTS

The many benefits of radiation-based technologies come with a certain amount of risk. Fortunately these risks are very small in the context of a much greater benefit for that person. For example, placing stents to hold a coronary artery open, a common procedure today, has immediate life-saving benefits that are balanced against a small but increased chance of developing cancer many years later from the fluoroscopy radiation. In the case of medical exposures, the risk-reward ratio can be very personal and urgent.

For consumer, occupational, and industrial exposures to the public, the benefits are tangible and widespread, while the risks are very small. The overall effect of the applications of ionizing radiation in our lives is an improved standard of living, more reliable consumer products, and safer infrastructure and industrial facilities.

Risk Comparison⁴

Compared to your risk of dying from cancer caused by living near a nuclear generating facility, you are:

- 630,000 times more likely to die from an auto accident
- 85,000 times more likely to die as a pedestrian in an auto accident
- 50,000 times more likely to die from drowning
- 45,000 times more likely to die in a fire
- 37,000 times more likely to die from complications of medical care
- 27,000 times more likely to die in a fall
- 1,000 times more likely to die from a bee sting
- 670 times more likely to die from a lightning strike
- 500 times more likely to die in an earthquake
- 450 times more likely to die from overexertion



The use of nuclear energy to generate electricity is a great example of the more general risk-reward payoff. In return for reliable, inexpensive, environmentally friendly electricity, the public must accept an infinitesimally small risk. How small? After more than a half-century of commercial nuclear power plant operations, including the Three Mile Island accident, there is no credible evidence that shows any negative effects from the operations of nuclear power facilities, on the health of the public, plant workers, or the environment.

Studies by anti-nuclear groups that claim to show negative health effects in the vicinity of nuclear generating facilities based on selected data and biased methods have been disproven by United Nations Scientific Committee of the Effects of Atomic Radiation, National Research Council's BEIR VII study group, National Cancer Institute, American Cancer Society, the American Academy of Pediatrics, numerous state departments of health and other independent researchers, often in very critical terms.⁵

On Excess Cancers Being Caused by Nuclear Facilities:

“...over 50 critical examinations of these types of allegations by numerous reputable scientists have found the ...methodology scientifically deficient and consisting principally of selected evidence.”

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GETTING TO A SAFER FUTURE

With no negative health or environmental effects, new nuclear energy is the safest choice for reliable abundant electricity in the future. It is the only electrical generation source with expansion potential that produces no greenhouse gases or other air emissions and is available 24 hours a day, seven days a week. Of the available clean air sources of energy, nuclear has the least impact, by a huge margin, on land and natural resources, and the use and enjoyment of those resources by the public. We cannot afford to forego the promise of clean, reliable, inexpensive nuclear energy based on misperceptions about its safety.



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