United States
Environmental Protection Agency

Office of Air and Radiation
Office of Radiation and Indoor Air

EPA-402-K-07-006
May 2007

Radiation
Risks and Realities

Understanding Radiation in Your Life, Your World.

Overview

It's natural and all around us. It comes up from the ground, down through the atmosphere, and even from within our own bodies. It can be man-made too. But it's nothing new. It's been present since the birth of the planet. It's radiation, and radiation is, quite simply, part of our lives.

Naturally-occurring radioactive materials were discovered in 1896. Less than 40 years later, physicists discovered that radioactive elements can be artificially created. Within a decade of this discovery, scientists had split the atom.

These findings allow us to use radioactive materials for beneficial purposes, such as generating electricity and diagnosing and treating medical problems. For these many benefits, excessive radiation exposure can also threaten our health and the quality of our environment.

We cannot eliminate radiation from our environment. We can, however, reduce our risks by controlling, to some extent, our exposure to it. This booklet presents the major sources and uses of radiation, the risks from exposure, and how we can limit and reduce these risks.

For additional radiation information, please visit our website: www.epa.gov/radiation

What is Ionizing Radiation?

Matter is composed of atoms. Some atoms are unstable. As unstable atoms change and become more stable, they give off invisible energy waves or particles called radiation.

There are different types of radiation, some more energetic than others. One type of radiation, non-ionizing radiation, has enough energy to move atoms but not enough to alter them chemically, like microwaves, radio waves and visible light. This booklet discusses the most energetic form, known as ionizing radiation. Ionizing radiation is capable of removing electrons from atoms and damaging living cells and the DNA of those cells. From here on ionizing radiation will be referred to simply as radiation.

In the United States, we measure radiation doses in units called rem. Under the metric system, dose is measured in units called sieverts. One sievert is equal to 100 rem. In this document millirems are used when talking about dose. A millirem is one thousandth (1/1000) of a rem.

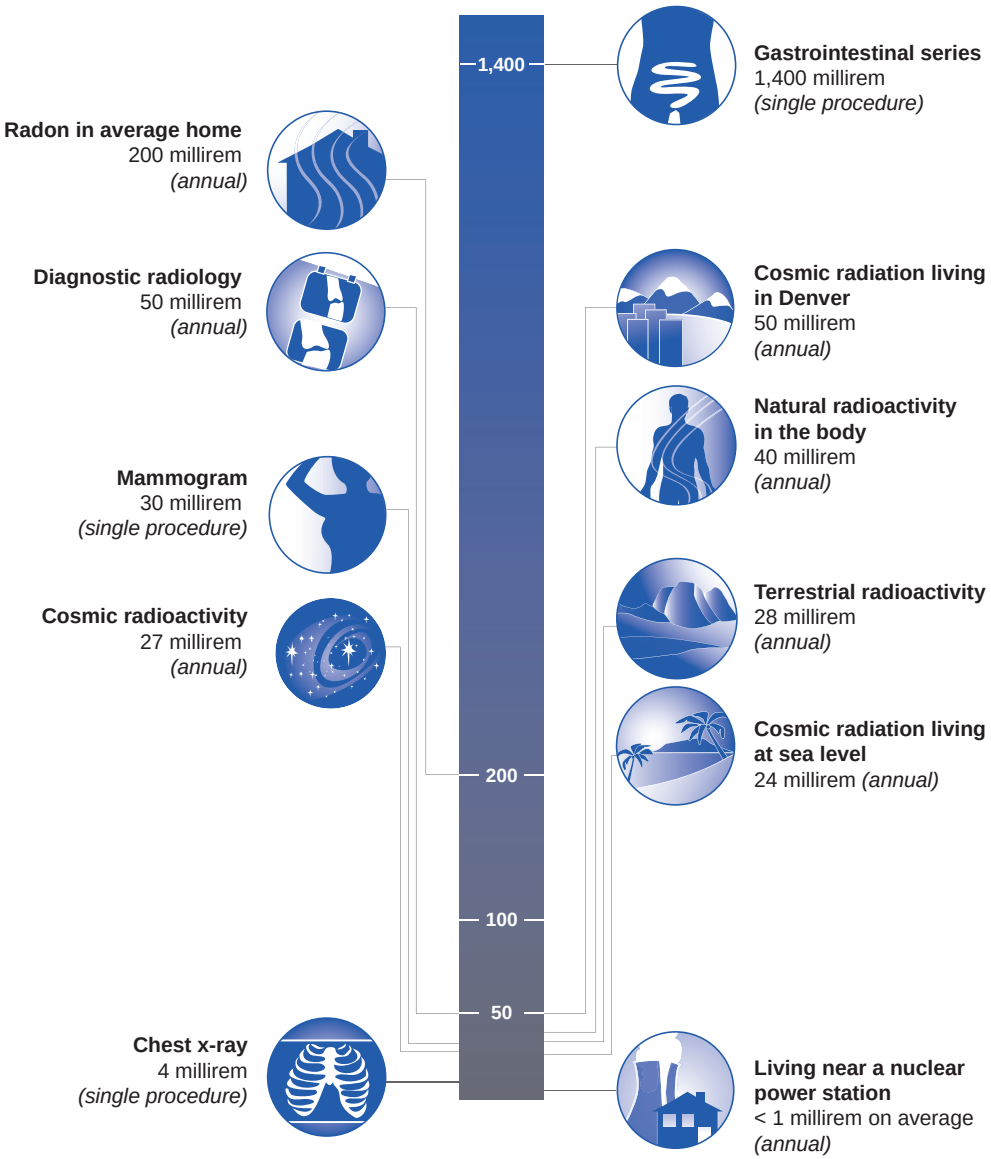
Scientists estimate that the average person in the United States receives a dose of about 360 millirem of radiation per year. Eighty percent of that exposure comes from natural sources – radon gas, the human body, outer space, and rocks and soil. The remaining 20 percent comes from man-made radiation sources, primarily medical x-rays.

Risks from Exposure to Radiation

Radiation is known to cause cancer in humans. Radiation can also cause other adverse health effects, including genetic defects in the children of exposed parents or mental retardation in the children of mothers exposed during pregnancy. The risk of these other effects is much less than the risk of developing cancer due to radiation exposure.

RELATIVE DOSES FROM RADIATION SOURCES

Millirem Doses



Much of our knowledge about the risks from radiation is based on studies of more than 100,000 survivors of the atomic bombs at Hiroshima and Nagasaki and of people receiving large doses of medical radiation. In these studies, scientists observed health effects across a wide range of radiation doses, including single doses comparable to an average person's lifetime dose from naturally-occurring background radiation (about 20,000 millirem). We learned many things from these studies.

The most important are:

- The more radiation dose a person receives, the greater the chance of developing cancer.
- It is the chance of cancer occurring, not the severity of cancer, that increases as the radiation dose increases.
- Radiation induced cancers do not appear until years after the radiation dose is received.
- The risk from radiation exposure will vary among individuals.

Current evidence suggests that any exposure to radiation poses some risk, however, risks at very low exposure levels have not been definitively demonstrated. While experts disagree over the definition of "low dose,"radiation protection measures are based on an assumption that even small amounts of radiation exposure may pose some small risk. Factoring in the entire dose of natural background radiation accumulated over a lifetime, the risk of developing cancer as a result of this exposure is estimated to be roughly 1 in 100. The additional contribution from all man-made sources of radiation is much smaller. It should be noted that all of the long-term health effects associated with exposure to radiation can also occur in people due to other causes.

Natural Radiation

Naturally-occurring radiation accounts for approximately 80 percent of our exposure. Most of our exposure is from indoor radon, followed by radiation from outer space and from the Earth's crust.

Radon

Approximately 55 percent of our exposure to radiation comes from radon. Radon is a colorless, odorless, tasteless radioactive gas, which comes from the natural decay of radium that is found in nearly all rock and soils. Radon usually moves from the ground up and migrates into homes and other buildings through openings in any ground contact floor or wall. Buildings trap radon inside, where it accumulates and may become a health hazard. Any home or building may have a radon problem, including new and old homes, well-sealed and drafty homes, and homes with or without basements.

Radon is the second leading cause of lung cancer in the United States. EPA's risk model predicts 20,000 Americans die each year from radon-related lung cancer, though the actual number could be somewhat higher or lower. Only smoking causes more lung cancer deaths and smokers exposed to radon are at an even higher risk than nonsmokers.

Radon in the air is measured in picocuries per liter (pCi/L). 1.25 pCi/L is the national average for radon levels in homes. Where radon levels are 4 pCi/L or higher, the U.S. Environmental Protection Agency and the U.S. Surgeon General recommend that homeowners take action to reduce the radon level. It is estimated that nearly one in 15 American homes has a radon level that should be reduced. Testing your home is the only way to know.

Controlling the Risks from Radon Exposure

Testing for radon is easy and only takes a few minutes. There are many kinds of low-cost, "do-it-yourself " radon test kits available by phone, online and in many retail

outlets. You can also hire a professional to do the testing. If an elevated radon level is detected in your home, you can reduce it in a variety of ways. Short of building your house with radon protection in mind, the preferred radon reduction technique is an active soil depressurization (ASD) system. Installation also requires the sealing of unwanted entry points for the ASD system to function effectively. An ASD system is basically a vent pipe with an inline centrifugal fan that operates continuously to vent radon (and other soil gases) from beneath the house.

EPA leads the national commitment to educate citizens about residential radon risks. To achieve this goal, the Agency coordinates regional and state-level efforts to reduce exposure to radon. or

Radiation from the Ground and from Space

Radon is not the only source of naturally-occurring radioactivity. We receive about eight percent of our total exposure to natural background radiation from other radioactive elements in Earth's crust, such as thorium and potassium. Radiation levels from these sources vary in different areas of the country.

Another eight percent of our radiation exposure comes from cosmic radiation from the sun, our galaxy, and other galaxies. Exposure to cosmic radiation depends, in part, on the elevation of where we live. For example, people who live in Denver, Colorado, which is more than 5,000 feet above sea level, are exposed to more cosmic radiation than people living in Chicago, Illinois, which is approximately 700 feet above sea level. Exposure to cosmic radiation increases as you rise above sea level. Chicago's thicker atmosphere filters out more cosmic radiation than Denver's thinner atmosphere.

For more information about radon, its risks, and what you can do to protect yourself, or to request a free copy of EPA's "A Citizen's Guide to Radon," call the ***National Radon Hotline*** *at* ***1-800-SOS-RADON*** *or contact your state's radon office.*

Man-Made Radiation

Since the discovery of radiation, people have benefited from the use of radiation in medicine and industry. Man-made sources of radiation account for about 20 percent of our total exposure to radiation.

MEDICINE

Radiation in Medicine

Radiation used in medicine is the largest source of man-made radiation to which people in the United States are exposed. The majority of our man-made radiation 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. In the field of nuclear medicine, radioactively labeled compounds (radiopharmaceuticals) are also used to support diagnoses.

Another source of radiation exposure is radiation therapy. One-third of all successful cancer treatments involve radiation. Precisely targeted radiation destroys cancerous cells while limiting damage to nearby healthy cells. In nuclear medicine, radiopharmaceuticals can also be used to treat tumors. For example, radioactive iodine will concentrate in the thyroid gland and can be used to treat thyroid tumors.

Controlling the Risks of Medical Radiation

The Nuclear Regulatory Commission (NRC), the Food and Drug Administration (FDA) and other federal and state agencies regulate medical procedures that use radiation. These agencies also issue guidance designed to reduce unnecessary use of radiation in diagnosis and treatment and ensure that technicians, equipment, and techniques meet standards for minimizing radiation exposure. Since any radiation exposure may carry some risk, it is necessary to decide whether the benefits of radiation justify its use. Health care providers must make the decision to use radiation on a case-by-case basis. Before receiving x-rays or any other type of medical treatment involving radiation exposure, you may want to discuss the need for and benefits of the procedure and its alternatives with your physician.

NUCLEAR POWER

Nuclear Power

Nuclear power reactors, which use uranium, supply the United States with about 20 percent of its electricity. Nuclear power plant operations account for less than one-hundredth (1/100) of a percent of the average American's total radiation exposure.

Controlling the Risks from Nuclear Materials

Existing radiation standards have been developed by a number of regulatory authorities, can come with a variety of units and are set at different levels for different issues. What they all have in common is the objective to reduce radiation exposure as much as practical. For example, radiation exposures to workers are allowed at levels significantly higher than for exposure to the public from releases to the environment. Although the radiation exposures differ, in both cases exposures are controlled to levels that are as low as reasonably achievable under the circumstances.

In 1979, EPA issued environmental standards designed to protect the public from radiation from nuclear energy. Additionally, in 1987, EPA issued guidance for federal agencies to use in the development of radiation exposure standards for workers. These standards limit the amount of radiation that workers in medicine, nuclear power, industry, mining, and waste management may receive. The Nuclear Regulatory Commission (NRC) is the federal agency responsible for implementing some of EPA's radiation exposure standards and regulating nuclear power reactors and other uses of nuclear materials. The Department of Energy (DOE) also implements these standards at their facilities.

All domestic nuclear power plants must have emergency plans for protecting the public from radiation exposure from the potential release of radioactive material into the environment. EPA developed guidance for exposure levels at which actions are recommended to protect the public. State and local governments retain primary responsibility for protecting the public and the environment during radiological

emergencies. Several federal agencies also respond to radiological emergencies, including EPA, the NRC, and the Departments of Homeland Security, Energy, Agriculture, and Health and Human Services.

Radioactive Waste

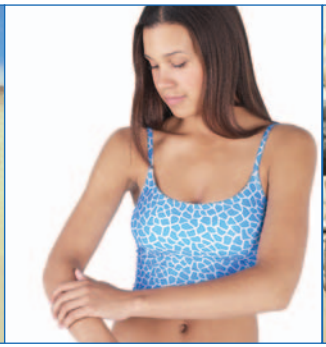
Any activity that produces or uses radioactive material generates radioactive waste that must be disposed of properly. Radioactive waste can be in liquid or solid form, and its level of radioactivity can vary. Mining, nuclear power generation, and various industrial processes, defense weapons production, nuclear medicine, and scientific research all can produce radioactive waste. Items and equipment used during these types of industrial processes and research activities, such as rags, glassware, plastic bags, protective clothing, tools, and machinery, can become contaminated with radioactive material and must be disposed of as radioactive waste. Radioactive waste can remain radioactive for anywhere from days to hundreds or even thousands of years. Waste not properly isolated from the public and the generally accessible environment may contaminate air, soil, and water supplies.

Controlling the Risks of Radioactive Waste

Federal agencies and some states control the risks associated with radioactive waste by establishing standards and regulations that disposal facilities must meet so the waste is effectively isolated. For example, EPA is responsible for setting generally applicable environmental standards for disposal of radioactive waste. The federal government is continually investigating new technologies and disposal methods to effectively manage, treat, and dispose of radioactive waste.

Conclusion

Natural sources of radioactivity are all around, and man-made radioactive materials are a vital part of medicine and industry. Exposure to some radiation, natural or man-made, is inevitable. We live with radiation everyday, therefore we must understand both its risks and benefits.


Many federal agencies and the states maintain important roles in protecting the public and the environment from radiation.

States

The states have agencies responsible for regulating the use of radiation and for addressing radiation questions and problems. Your respective state agency is the best first-source of information about radiation issues affecting you. The states regulate the use of x-ray machines. Some are also responsible for regulating other sources of radiation within their state on behalf of federal agencies, such as NRC.

U.S. Environmental Protection Agency (EPA)

EPA issues standards and guidance to limit human exposure to radiation. EPA works with the public, industry, the states, and other government agencies to inform people about radiation's risks and promote actions that reduce human exposure. EPA measures environmental levels of radiation and assesses radiation's effects on people and the environment.

U.S. Nuclear Regulatory Commission (NRC)

NRC implements standards for protecting the public from radiation. NRC regulates the civilian uses of nuclear materials in the United States by: *licensing facilities that possess, use, or dispose of nuclear materials; establishing standards governing the activities of licensees; and inspecting licensed facilities to ensure compliance with its requirements.* These regulatory functions relate to both nuclear power plants and to other users of nuclear materials for purposes including nuclear medicine at hospitals, academic activities at educational institutions, research work, and industrial applications such as gauges and testing equipment.

U.S. Department of Homeland Security (DHS)

In the event of a terrorist attack, natural disaster or other large-scale emergency, the Department of Homeland Security has primary responsibility for ensuring that emergency response professionals are prepared. DHS coordinates the comprehensive federal response to any large-scale crisis and mounts a swift recovery effort. Additionally, DHS educates citizens to prepare themselves, their families and homes for major emergencies.

U.S. Department of Health and Human Services (HHS)

HHS's Food and Drug Administration's Center for Devices and Radiological Health establishes standards for x-ray machines and other electronic products to ensure that human health is protected through the safe operation of these radiation producing devices.

U.S. Department of Energy (DOE)

DOE is responsible for the development of the disposal system for spent nuclear fuel from the nation's civilian nuclear power plants. This activity is totally funded by a tax paid by the users of nuclear-generated electricity. DOE is also responsible for the management and disposal of nuclear waste and other radioactive materials associated with nuclear weapons production at federally-owned facilities. The Department of Energy is working to clean up its present and former nuclear sites. DOE is cooperating with state governments and private industry to clean up other locations around the United States that were contaminated with radiation as a result of government programs. DOE provides technical advice and assistance to states and the private sector in the management and disposal of low-level radioactive waste.

U.S. Department of Defense (DOD)

While DOE is responsible for the safe handling of radioactive material at defense production facilities, DOD is responsible for the safe handling and storage of nuclear weapons in its custody and for other military uses of nuclear energy.

U.S. Department of Transportation (DOT)

DOT, in cooperation with NRC and the states, governs the packaging and transport of radioactive materials. The Department also regulates carriers of radioactive materials.

Occupational Safety and Health Administration (OSHA)

OSHA, a division of the U.S. Department of Labor, develops and enforces regulations to protect workers not covered by other agencies from radiation exposure.

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