NUCLEAR *facts*

What about radiation? Is it harmful?

SOME PEOPLE ARE AGAINST THE USE OF NUCLEAR ENERGY BECAUSE OF FEAR OF RADIATION.

However, radiation is a fact of life – we are all exposed to radiation from natural sources every day – and the various uses of nuclear energy contribute only a small addition to that natural radiation.

What is radiation?

In the broadest sense radiation is energy that is transmitted in the form of waves or particles. There are many types of radiation. Visible light is the most obvious. Microwaves, radio waves, television signals, are other forms of radiation that are common in our daily lives. These are all "non-ionizing" radiation.

The various types of radiation associated with the use of nuclear energy are categorized as "ionizing" radiation. That means the radiation has sufficient energy to produce ions when it interacts with matter, i.e. can eject an electron from an atom.

A simplified picture of an atom has a nucleus composed of *protons* and *neutrons*, surrounded by *electrons* orbiting like the planets around the sun. The number of protons in the nucleus determines the *atomic number*, which gives the atom or element its characteristics, while the total of the protons and neutrons determines the *atomic weight*. Many elements have different *isotopes*, which, because they have the same number of protons, are identical, physically and chemically, but have different numbers of neutrons and therefore differ in atomic weight.

Most elements or *nuclides* found in nature are stable but a few are *radioactive*, that is they emit radiation as they *decay* to a stable form. Examples are uranium, radium and a nuclide we all have in our bodies, potassium-40, one of the isotopes of naturally occurring potassium.

These *radioactive* nuclides emit forms of radiation often referred to as *nuclear radiation*. There are three basic types of nuclear radiation:

- alpha particles;
- beta particles;
- gamma rays.

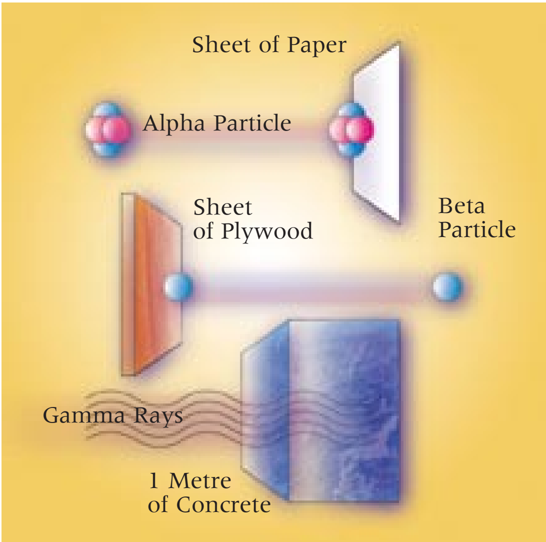
Alpha particles are produced from the radioactive decay of heavy elements such as uranium. They are composed of two neutrons and two protons identical to the nucleus of a helium atom. Because of their relative size and electrical charge from the two protons, alpha particles can travel only a very short distance in any material. For example a normal sheet of paper can stop alpha particles.

Beta particles are electrons that come from transformation of a neutron in the nucleus of an atom to a proton. They can travel up to about five metres in air and one centimetre in tissue.

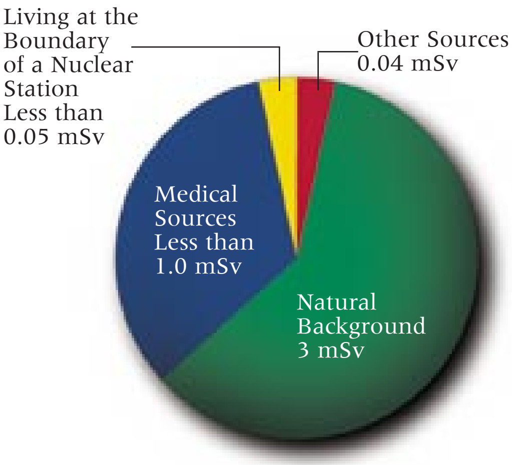
Gamma rays are electromagnetic radiation similar to X-rays. Unlike the latter, which are produced by machines, gamma rays are emitted from the nucleus of a radioactive atom that is in an excited state. Gamma rays travel at the speed of light and can penetrate long distances in air and tissue. Several centimetres of lead or metres of water are needed to stop typical gamma rays such as those from cobalt-60, which are used for cancer therapy.

What are the sources of nuclear radiation?

Most of the radiation we receive comes from natural sources. These include cosmic rays from space and naturally occurring radioactive elements. The largest source is from radon, a gaseous radioactive daughter product from the decay of radium. Radon decays to solid radioactive particles which, if inhaled, can remain in our lungs or respiratory tracts. Since radium is present in many rocks radon is very pervasive. Outside, radon is dispersed, but, in buildings, the radon that comes from building materials or from the surrounding earth can accumulate to significant levels.



Sources of Radiation



The next significant source of ionizing radiation is from medical diagnosis and treatment. X-rays are common for many medical examinations and various radioisotopes are used in a wide number of diagnostic procedures. High energy X-rays, accelerator beams and gamma radiation from cobalt-60 are used for the treatment of cancer. In this case, large doses of radiation are given deliberately to the cancerous tissue while avoiding, as much as possible, the surrounding healthy tissue.

Finally, X-rays and radioactive elements are used in various industrial processes such as radiography, for measurement, and in research. Irradiation facilities using large quantities of cobalt-60 are used for the sterilization of medical equipment and, in many countries, for the irradiation of food to kill dangerous organisms. Nuclear reactors produce radiation and radioactive elements through the fission process but these are confined by shielding and containment.

How is radiation measured?

Because of its ionizing properties, nuclear radiation is relatively easy to measure. The basic unit of radiation dose is the *gray*. However, since various forms of ionizing radiation have different effects on the human body a special unit of measurement for radiation dose to humans is used, the *sievert (Sv)*, which takes into account these differences. Since the sievert is a relatively large value, typical levels of dose are expressed in *millisieverts (mSv)*, one-thousandth of a sievert.

How much radiation do we get?

Tables 1 and 2 give typical values of radiation dose as determined by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR).

What are the effects of radiation?

Like many other things, the effect of radiation depends on the dose. Very large doses, in the order of 5,000 millisieverts or more, can be lethal. Smaller doses can produce cancer after many years. There is still uncertainty about the effect of very small doses such as we receive from man-made sources. In many locations in the world the dose of radiation from natural sources is many times that of the average given above; yet there is no evidence that the people living in those areas have any increased rate of cancer or other undesirable effects. Recent research in Japan and France has shown that small doses of radiation can be beneficial in the treatment of disease.

The effect of radiation on humans has been studied extensively, both at the biological level and through epidemiology. Among the epidemiological studies, the largest has been that of the Japanese survivors of the atomic bombs dropped on Hiroshima and Nagasaki. This has provided the basis for regulatory standards around the world. In addition, there have been studies of uranium miners, of workers who used radioactive paint in the 1920s, of those exposed to the fall out from the Chernobyl accident of 1986, and many others.

Table 1.

Typical radiation doses from natural sources (mSv/yr)

Source	Average	Range
Cosmic radiation	0.40	0.3 to 1.0
External terrestrial	0.48	0.3 to 0.6
Inhalation (radon)	1.2	0.2 to 10.0
Ingestion	0.3	0.2 to 0.8
Total	2.4	1 to 10

Table 2.

Typical average radiation doses from man-made sources (mSv/yr)

Source	Average	Range
Medical diagnosis*	0.4	0.04 to 1.0
Nuclear bomb testing	0.005	0.004 to 0.006
Nuclear power	0.0002	0.0001 to 0.02

* The dose from various medical diagnostic procedures varies considerably. A chest X-ray will give about 0.14 mSv while a lower GI tract examination gives about 6.4 mSv.

Regulations in all developed nations ensure that the radiation dose received by the public or workers from man-made sources is very small. In Canada, the maximum allowable dose to members of the public from any nuclear activity is 1 mSv per year. In practice, the actual dose is less than one-hundredth of that.

See also the Web site of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) at www.unscear.org and that of the International Commission on Radiological Protection (ICRP) at www.icrp.org

Canadian Nuclear Association

130 Albert Street, Suite 1610
Ottawa, Ontario K1P 5G4
Tel. (613) 237-4262
Fax (613) 237-0989
www.cna.ca