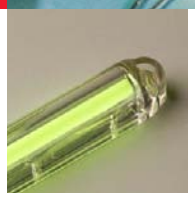
HOW NUCLEAR PRODUCTS KEEP US HEALTHY AND SAFE



ONTARIO POWER GENERATION

Millions of Ontarians benefit from electricity generated by Ontario Power Generation. Few people are aware that the company also brings benefits to people in many countries around the world as a supplier of isotopes such as heavy water, Cobalt-60 and tritium. These stable and radioactive isotopes are key components in applications in medicine, sterilization, food preservation, luminescent lighting, and fusion research.

Isotopes – what are they?

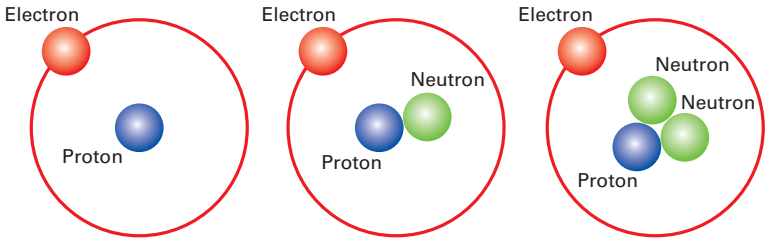
You may recall from your high school chemistry studies that every atom of every element is made up of protons, neutrons and electrons. Isotopes are atoms of the same element that have the same number of protons but different numbers of neutrons in their nuclei, and therefore, different atomic weights.

If, by peering into an imaginary microscope, we could see a cluster of hydrogen atoms, we'd notice that almost all hydrogen atoms consist of an electron orbiting a proton.

Of every million hydrogen atoms, 150 have a nucleus that contains a neutron as well as a proton. This isotope of hydrogen is called deuterium.

Isotopes have the same chemical properties because they have the same number of electrons. Deuterium bonds with oxygen to form heavy water (D_2O). Heavy water, or deuterium oxide, is 10 per cent heavier than regular water because of an extra neutron. Heavy water is used to cool the fuel in [1]CANDU and in nuclear research/isotope reactors.

A third isotope of hydrogen is called tritium (T). Tritium is produced in nuclear reactors and is radioactive.



The nucleus of ordinary hydrogen is a proton

The deuterium nucleus has one neutron and a proton

Tritium has two neutrons and a proton in its nucleus

Radioactive Isotopes

Radioactive isotopes have too many or too few neutrons in their nucleus, which creates excess energy. Release of this excess energy is known as radiation, or radioactive decay, and persists until the radioactive isotope becomes non-radioactive. Tritium, for example, releases beta radiation until it becomes helium, which is stable and non-radioactive.

Note: All three isotopes of hydrogen have a proton and an electron. Nuclei of deuterium (D) and tritium (T) also have neutrons.

[1] CANDU (Canada Deuterium Uranium) is a registered trademark of Atomic Energy of Canada Limited.

Gamma radiation is also being used in new applications including the development of cancer vaccines and new drugs, to tackle environmental pollutants and biohazards and to develop advanced materials for emerging technologies like the hydrogen economy.

Land-mine markers help save lives and reduce injuries caused by landmines.

Lighting a new way with tritium

Tritium is a radioactive hydrogen isotope that has been a part of our environment for millions of years. It is produced naturally by cosmic rays but is also a by-product of the daily operations of a CANDU nuclear reactor. When the deuterium in heavy water captures an additional neutron from the immense number of particles passing among the fuel elements, it changes to become tritium. Ontario Power Generation makes tritium commercially available for use in the production of self-powered lights, tritium-labeled chemicals for medical research, and research into future power sources.

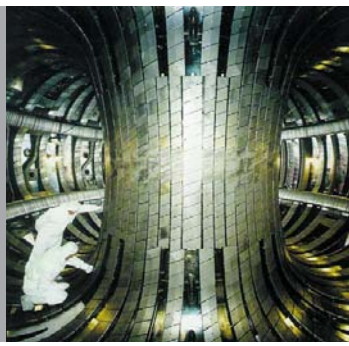
Tritium — The power source behind emergency lighting; the quest for a new energy source; and a valuable medical research tool.

Minute amounts of tritium combined with phosphor create luminescence. This energy-efficient light source does not require electricity and provides essential emergency lighting particularly for areas where electrical sparks can be dangerous and where minimal or no electrical wiring exists. Tritium lights are used in the manufacture of safety and security products like land-mine markers and emergency exit signs in commercial buildings and airplanes.

Power for future generations

Nuclear fusion has been hailed as the energy source of the future, the successor to coal, oil, and gas as underground reserves of these fuels are depleted. Fusion power offers the potential of an almost limitless source of clean energy for future generations. It is called 'fusion' because the nuclei of lightweight atoms, such as hydrogen, fuse to make heavier atoms while releasing tremendous amounts of energy. The process is similar to that which powers the sun and other stars. Ontario Power Generation has supplied tritium to fusion research projects around the world.

The interior of the Joint European Torus, a major nuclear fusion experiment.



Recently work has started on International Thermonuclear Experimental Reactor (ITER), the world's largest fusion research reactor being built by an international team of researchers, governments and businesses in Cadarache, France. ITER hopes to unlock the secrets of fusion and harness fusion power to generate clean and abundant energy. The ITER research project will require tritium and Ontario Power Generation hopes to be a potential supplier.

Other uses of tritium

Tritium is used as a "tracer" in biomedical research in the study and diagnoses of heart disease, cancer and AIDS. Because it emits beta radiation and has a favorable combination of chemical properties, tritium is a preferred isotope as a medical tracer for diagnostic pharmaceuticals. As a tracer, tritium can be used to follow a complex sequence of biochemical reactions, such as in the human body, to locate diseased cells and tissues. Small amounts of tritium are added to drugs or other substances to allow researchers to "trace" or follow their movement through a test subject, to learn more about diseases, and to test and improve the manufacture and efficacy of medicines.

Tritium is also being used in the development of new devices that provide power for many years. Prototypes of long life batteries using tritium have been developed that can last for up to 20 years. These devices have many applications in hard-to-service, long-life systems such as medical implants (like pacemakers, cochlear implants and drug delivery systems); intelligence gathering sensors for safety systems (like structural sensors on bridges); climate monitoring equipment including weather satellites, anti-tamper devices and memory back-up.

Putting our weight into research

Ontario Power Generation makes heavy water available for commercial use. It supplies the majority of the world's non-nuclear heavy water demand to stable isotope manufacturers, chemical companies and research facilities, among others.

Solvents created with heavy water are used in Nuclear Magnetic Resonance (NMR) analyses to help researchers determine the structure of complex organic compounds and protein structures. The study of protein structures is important in cancer research such as the discovery of cancer biomarkers. NMR techniques are used in pharmacology to screen potential drug candidates. In addition, heavy water is used in the medical field to gain a better understanding of human metabolism, obesity and in diabetes research.

In industrial applications, heavy water is used as a tracer in oil exploration to estimate potential yield of an oil field. It is also used as a "custody tag" to trace the origin and ownership of liquids such as gasoline and perfume.

Heavy water is used to produce a variety of NMR solvents and labeled compounds. These products are widely used by scientists in agriculture, biology, chemistry, environmental studies, drug development, medical and health studies.

Cobalt-60 is used effectively to eliminate harmful bacteria in many food products and to sterilize medical equipment.

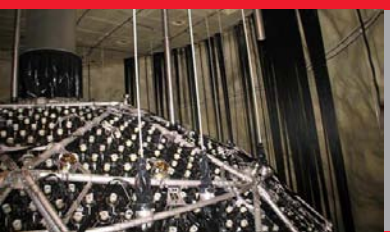
Isotopes can be naturally-occurring or produced, stable or unstable. Deuterium is a stable isotope. Unstable isotopes such as Cobalt-60 and tritium undergo radioactive decay. During radioactive decay, energy is emitted and the element turns into a more stable form.

By harnessing the energy released by these isotopes, the medical and industrial worlds are able to provide essential services such as cancer treatment, sterilization and self-powered luminescent emergency lighting.

Improving our health with Cobalt-60

Cobalt-60 is one of the radioisotopes whose energy adds to the well-being of millions of people. Cobalt-60 is produced in Ontario Power Generation's CANDU reactors by using adjuster rods that contain Cobalt-59 inserts. Over time, some of the Cobalt-59 inserts absorb a neutron and change at the atomic level to become Cobalt-60. About every 24 months, the Cobalt-60 adjuster rods are removed, processed and safely loaded for shipment. Licensed end users include, scientists, technicians, and academic researchers – for irradiation technology applications.

Cobalt-60 emits gamma radiation, making it an ideal isotope for use in a variety of medical and industrial applications. One such application is sterilization with Cobalt-60 irradiation – a Canadian technology used around the world to enhance the safety of perishable food and medical and consumer products. Favoured because of its efficiency and cost-effectiveness, Cobalt-60 can sterilize products after they have been packaged, thereby rendering them immediately safe to use. From syringes, gloves and surgical instruments to cotton balls and contact lens solution, Cobalt-60 irradiation ensures the safety of hundreds of products. Food irradiation using Cobalt-60 is increasingly viewed as the safest and most effective way to eliminate harmful insects and bacteria such as salmonella, E.coli and listeria from our food supply. One of the benefits of gamma radiation is that it can kill bacteria and microorganisms without affecting the quality of the foods' taste, colour, texture and nutritional value.



The SNO detector is located 2 kilometers underground at the Inco Creighton Mine near Sudbury Ontario.

Detecting ghosts from the heavens

Ontario Power Generation was a sponsor of a project which is helping to unlock secrets of our universe. Located deep underground in the Canadian Shield of Northeastern Ontario, the Sudbury Neutrino Observatory enabled an international team of scientists to obtain new information about the tiny, ghost-like neutrino particles - elementary building blocks of our universe - that are produced in huge numbers in the core of the sun.

As one of the most sophisticated detectors in the world, the Sudbury Neutrino Observatory allowed scientists to see neutrinos through three separate reactions, two of them never before observed. These neutrinos were detected as tiny bursts of blue-violet light by 9,500 light sensors mounted in a geodesic sphere that surrounded a tank of 1,100 tonnes of heavy water.

SNOLAB, an additional underground science laboratory constructed in 2003 will allow scientists to study dark matter and research a radioactive process called neutrino-less double beta decay to better understand the development of matter in the universe.

Safe and secure

Ontario Power Generation's overriding priority is always safety. Nuclear safety, employee safety and environmental safety are part of every operational and business decision and a key factor in achieving world-class performance. It is also a commitment we have made to our community, which has given us the privilege to operate here. Ontario Power Generation conducts the sale of isotope products and services with the highest regard for employee and public safety.

SNOLAB

Commercial Services
Ontario Power Generation Inc.
700 University Avenue
Toronto, Ontario
M5G 1X6

Telephone: (416) 592-2555
Toll Free: 1-877-592-2555

Visit our Web site at
www.opg.com
You can also visit our Information Centres located at the Pickering and Darlington Nuclear Generating Stations.

Recycled
Supporting responsible use of forest resources
www.fsc.org Cert no. SGS-COC-004789
© 1996 Forest Stewardship Council

100%

Design, print, distribution: OPG Office Services

ONTARIO POWER GENERATION