

## Tritium: its production and uses

- Tritium is a radioactive, heavy isotope of hydrogen, with a half-life of 12.3 years. The nucleus of a tritium atom has one proton and two neutrons, making it three times heavier than a normal hydrogen atom, which has only one proton in its nucleus.
- Each tritium atom eventually disintegrates by giving off a beta particle, becoming a non-radioactive helium atom. In living tissue, the beta particle causes cellular damage which may result in cancer, malformed fetuses, or genetic damage. Hence human exposure to tritium oxide (HTO, also known as “tritiated water”) poses health risks.
- Tritium is largely a man-made substance produced by nuclear reactors (especially CANDU reactors) and by the explosion of nuclear weapons (especially H-bombs). Some tritium is created naturally as a result of cosmic radiation from outer space.
- The natural background of tritium from cosmic radiation is around 3 kilograms spread around the globe. The total global inventory of man-made tritium in the atmosphere peaked in the mid-1970s at several hundred kilograms as a result of H-bomb testing.
- Nuclear reactors are now the major source of tritium in the environment. CANDU reactors create much more tritium than other reactor types – about 3 kg [or 1 billion billion becquerels] per year. To limit radiation doses to CANDU workers a tritium removal facility was opened at Darlington, Ontario, in 1990.
- At the Darlington Tritium Removal Facility tritium oxide (HTO) is extracted and converted into elemental tritium (HT). It is stored in stainless steel containers in a concrete vault. Most of the annual production of about 2.5 kg [or 900 million billion becquerels] (Drake 1996) is in storage. Some is sold for use in “glow-in-the-dark” devices such as exit signs or military equipment, or for conversion to biomedical tracers. The cost of Darlington tritium is around \$25,000 US per gram. Total annual demand is about 150 grams.
- Tritium is inserted into glass tubes to make glow-in-the-dark devices. Tritium’s beta particles strike a phosphorescent coating on the inside of the tube, making it glow. One exit sign contains about 12 tubes -- 2.5 milligrams [or 900 billion becquerels] of tritium in total.
- Elemental tritium is also used in nuclear weapons - about 2-4 grams per weapon. Tritium reservoirs in warheads must be replenished roughly every eight years.
- The U.S. closed its last weapons tritium production reactor in 1988. It operates a tritium recycling facility in South Carolina for the military. Tritium reservoirs from warheads are shipped to the facility, emptied of old tritium, and recharged with recycled tritium. Tritium from a new U.S. production facility would cost about \$100,000 per gram.
- The U.K.’s weapons tritium production facility (the Chapelcross Processing Plant), which operated from 1980 until 2005, is also now closed.
- Although published information is scarce, the Darlington tritium inventory is likely to be several dozen kg, roughly equal to the total tritium inventory in U.S. nuclear weapons.
- Very large amounts of tritium would be required if fusion reactors were ever developed – roughly 50 kg for every 1000 MW of energy produced.