



Tritium: a universal health threat released by every nuclear reactor

“...as an isotope of hydrogen (the cell’s most ubiquitous element), tritium can be incorporated into essentially all portions of the living machinery; and it is not innocuous -- deaths have occurred in industry from occupational overexposure.”

-- R. Lowry Dobson MD, PhD: *The toxicity of tritium* 1979

Introduction

Tritium is a radioactive isotope of hydrogen. It is generated in nuclear power reactors and is released to the environment in water and air. It cannot be filtered. Releases have been occurring since the 1960s when power reactors began to come online. Releases continue as reactors age and components degrade, contaminating air, water and soil. The radiation emitted from nuclear power facilities is categorized as “ionizing radiation” because it can break the chemical bonds of its target that could be a human cell or protein or other biological substance basic to life.

What is Tritium?

- Tritium (^3H) releases ionizing radiation in the form of a beta particle.¹
- Tritium is a byproduct of nuclear power reactors, which can release thousands of curies or more of tritium every year.²
- Tritium has a half-life of 12.3 years. This means it will be dangerous for *at least* 120 years, since the hazardous life of a radioactive isotope is ten to twenty times its half-life.³
- No economically feasible technology exists that can remove tritium from a reactor’s waste water that is released to the river, lake, or ocean that provides the reactor’s cooling water. And no economically feasible technology exists to remove tritium from the reactor’s gaseous and steam releases to the air.
Therefore, every nuclear reactor releases tritium as a part of its routine operation and not just as the result of accidental leaks or spills.
- No monitor exists that can detect or record the true amounts of tritium in the continuous flow of waste cooling water released, or in the amounts vented to the atmosphere.
Therefore, no one really knows how much tritium is released every year.

Tritium Exposure Paths

- Because tritium is an isotope of hydrogen, it is found in water, and in plant and animal tissue, including human tissue.
- Tritium can be inhaled and ingested, and can be absorbed through the skin.
- Eating food contaminated with tritium can be even more damaging than drinking tritium in water, because organically bound tritium (tritium bound in animal or plant tissue) can stay in the body for 10 years or longer.^{4,5}
- Tritiated water *may* be cleared from the human body in about 10 days⁶. However, if a person lives in an area where tritium contamination is fairly constant (near a nuclear power reactor, for instance) this chronic exposure can pose *continuing* significant health hazards.⁷

Health Hazards

- Most studies indicate that tritium can produce typical radiogenic impacts including cancer, genetic effects, developmental abnormalities and reproductive effects.⁸ Tritium can cause mutations, tumors and cell death.⁹ Tritiated water is associated with significantly decreased weight of the brain and of genital tract organs in mice¹⁰ and can cause irreversible loss of female germ cells in both mice and monkeys even at low concentrations.¹¹
- Studies indicate that lower doses of tritium can cause more cell death,¹² mutations,¹³ and chromosome damage¹⁴ per dose than higher tritium doses. The beta decay of tritium can be more damaging than x-rays or gamma rays,¹⁵ imparting damage that is two or more times greater per dose than either x-rays or gamma rays.^{16,17}
- There is no evidence that a threshold exists for damage from tritium exposure; even the smallest amount of tritium can have negative health impacts.¹⁸
- Tritium from tritiated water can become incorporated into DNA, the molecular basis of heredity and life for organisms. DNA is especially sensitive to radiation,¹⁹ and tritium produces complex DNA double strand breaks that are difficult to repair²⁰, if not impossible.
- Tritium can cross the placental barrier and stay in fetal oocytes, meaning that if a pregnant woman's female fetus is exposed to tritium, the fetus's eggs can be exposed to the tritium's radiation for decades after this initial exposure.²¹ Additionally, radioactive isotopes incorporated within a woman's body pose an in-utero risk 4-5 times greater than an external exposure would pose to her developing fetus.²²

“Tritium is no big deal. All it can do is destroy a DNA molecule.”

-- a health physicist, Oak Ridge National Laboratory, 1977

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Citations

Please note: a number of these studies have older dates. This does not mean the information in them is invalid or “out-of-date.” The health effects imparted by radiation do not go “out-of-date” as the health effects themselves are not subject to scientific advances, only the ways in which we measure or understand them can change or advance.

¹ Tritium is not the only release of concern at nuclear power reactors. For example, radioactive noble gases are also harmful byproducts of every nuclear reactor and, as with tritium, cannot be filtered from a reactor's releases. Gases such as krypton and xenon give off radioactive beta particles and turn into strontium and cesium, respectively - two notoriously dangerous products of nuclear weapons testing. See Beyond Nuclear's fact sheet *Health Hazards of Radiation*.

² Dobson, R. Lowry. The Toxicity of Tritium. International Atomic Energy Agency (IAEA) symposium: *Biological Implications of Radionuclides Released from Nuclear Industries*. Vienna. vol.1: p. 203. 1979.

³ Tritium decays with a low-energy beta particle that emits an average of 5.7 kilo-electron volts (keV) and a maximum energy of 18.6 kilo-electron volts. Studies indicate that low-energy beta radiation can be more damaging than higher energy gamma- or x-rays.

⁴ Straume, T and Carsten, AL. Tritium Radiobiology and Relative Biological Effectiveness. *Health Physics*. vol. 65 (6) : 657-672; 1993. [This special December 1993 issue of *Health Physics* is entirely devoted to tritium.]

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- ¹⁸ Dobson, RL and Cooper, MF. Tritium Toxicity: Effect of Low-Level ³HOH (tritiated water) Exposure on Developing Female Germ Cells in the Mouse. *Radiation Research*. vol. 58:91-100. 1974.
- ¹⁹ Hori and Nakai. 1978.
- ²⁰ *Review of Risks from Tritium: Report of the Independent Advisory Group on Ionising Radiation*. Documents of the Health Protection Agency: Radiation, Chemical and Environmental Hazards section of the Radiation Protection Division. United Kingdom. November 2007.
- ²¹ Ibid.
- ²² Fairlie, I. Commentary: childhood cancer near nuclear power stations. *Environmental Health*. vol. 8:43. 2009.