Tritium Primer:

An overview of the serious problems posed by tritium in Canada

Tritium is a dangerous radioactive substance produced in very large quantities during normal operations by Canadian (CANDU) nuclear reactors. Canada's nuclear regulator (the Canadian Nuclear Safety Commission or CNSC) takes a cavalier attitude toward tritium that is out of step with guidance from the International Atomic Energy Agency and the approach of regulators in other countries. As a result, millions of Canadians are exposed to tritium at higher concentrations than would be permitted elsewhere.

What exactly is tritium?

Tritium is a form of the element hydrogen. It has all of the special properties that hydrogen has, and in addition is radioactive, meaning that each atom is unstable and will at some point suddenly transform and shoot off a high-speed particle akin to a "subatomic bullet". This transformation is called a "radioactive decay event"

Hydrogen's special properties include the fact that it is the smallest, lightest most abundant element in the universe. As such it can pass through all types of containment. Hydrogen is also a key building block of all life and the most common element in all organic molecules. About half of the atoms in our bodies are hydrogen atoms.

Hydrogen combines with oxygen to make water. Water covers 70 per cent of the Earth' s surface, moves continually around the world and is essential for the survival of all known forms of life. Human beings are comprised of 60 - 70 per cent water by weight.

Tritium is radioactive hydrogen. As such, it goes everywhere hydrogen does and combines readily with oxygen to make **radioactive water** (also called tritiated water) that travels rapidly and easily through the environment and into all forms of life.

Where does tritium come from?

Small amounts of tritium are produced naturally in the Earth's upper atmosphere. Large amounts of tritium are produced by atomic bombs and nuclear reactors. CANDU nuclear reactors produce 20-50 times more tritium than most other types of nuclear reactors around the world.

During normal operations, CANDU nuclear reactors release very large quantities of tritium into the environment. Tritium is released in water vapor and as gas through roof vents and stacks. Tritium is also released in liquid form (as radioactive water) into rivers and lakes. Large quantities of tritium are also released by manufacturers of glow-in-the-dark, tritium-filled signs.

Once released, much of the tritium becomes part of the water cycle. Falling to earth as radioactive rain and snow, it accumulates in the environment. Freezing, melting, evaporating, and raining down again, it seeps into groundwater and flows into streams, lakes, rivers, aquifers, and oceans. It is also taken up by all living organisms.

What does tritium do inside the human body?

Tritium enters the human body as gas, water vapour or water. It can be inhaled, imbibed or absorbed through the skin. It can also enter the body when we eat tritium-contaminated food. Much of the tritium that enters the body passes through fairly quickly.

Some tritium gets incorporated into organic molecules in the body such as cellular components, hormones and enzymes; this is referred to as "organically bound tritium" and can occur anywhere in the body since tritium passes unimpeded through all membranes and barriers, even into the nucleus or "control centre" of the cell where the genetic material such as DNA is stored. Tritium can be incorporated into DNA molecules where it can do great harm.

Once incorporated, tritium is like a tiny ticking time bomb.

Sooner or later it undergoes radioactive decay, during which it emits a high speed particle or "subatomic bullet" which can break molecular bonds and damage the coded information in DNA molecules. Much, but not all, of the molecular damage is repaired. If not repaired, the result is a crippled cell that may later develop into a cancerous growth or result in a genetically damaged child.

Tritium can cause many different types of health problems.

It is classified as a carcinogen (causes cancer), a mutagen (causes genetic mutations) and a teratogen (causes problems in the developing fetus resulting in birth defects). It is also possible that tritium causes other untoward health effects like heart disease, autoimmune disorders, allergies and hormonal dysfunctions.

Pregnant women, children and developing fetuses are particularly vulnerable to the adverse effects of tritium exposure. Women, overall, are more sensitive than men. Canadian authorities ignore these differences.

How do you know if there is tritium in your drinking water?

Since tritium occurs naturally in the upper atmosphere, drinking water everywhere contains one-half a Becquerel of tritium per litre from natural cosmic radiation. A Becquerel (Bq) is a unit of radiation that refers to a level of radioactivity where one nuclear disintegration event is taking place, on average, per second.

In addition to the one-half Bq/ l of tritium from cosmic radiation, there is tritium in our drinking water from the over 2000 atomic bomb tests that took place worldwide in the 1950's and 60's. What remains of the the tritium added to the global environment by these tests raises the level of tritium in most water in the Northern Hemisphere to 2 Bq/l/, or four times what would be there naturally from cosmic radiation. Two Bq/ l level is frequently referred to as the "background level" of tritium in drinking water.

Additional large quantities of tritium are released into drinking water from nuclear reactors.

CANDU reactors produce so much tritium that they raise the level of tritium in drinking water, several times beyond the 2 bq/l "background" level. For example, due in large part to tritium emissions from the 12 CANDU reactors operated by Ontario Power Generation on the north shore of the Lake Ontario, water from the lake is contaminated at the level of 8 Bq/l (1). The tritium in one litre of this water will "decay" eight times per second, 480 per minute, 28800 per hour, 691,2oo per day, and so forth. Even after 12.3 years, the "half life" of tritium, this liter of water will still be giving off 4 "subatomic bullets" per second - more than twice the "background level".

If you live near a nuclear generating station or other nuclear facility, chances are there will be tritium in your drinking water well above the "background level".

Drinking water in Ottawa, 170 km downstream from Atomic Energy of Canada's Chalk River Labs, contains 6 Bq/l of tritium, with occasional spikes of up to 30 Bq/l. Drinking water in Oshawa near the Darlington Nuclear Generating Plant contains 8 Bq/l of tritium. Drinking water in New Brunswick near the Point Lepreau Nuclear Generating station contains nearly 40 Bq/l of tritium (2).

In Pembroke, Ontario, the Canadian Nuclear Safety Commission allowed a tritium sign factory, SRB Technologies Inc., to release immense quantities of tritium into the environment, very close to residential neighbourhoods. Wells near SRB still contain over 1000 Bq/l tritium. Gardens were severly contaminated: at one point, 12,000 Bq/l of tritium was measured in locally grown potatoes. Groundwater at the base of SRB's stacks had in excess of 130,000 Bq/L of tritium (3).

Tritium cannot be filtered out of drinking water

Municipal water treatment facilities and commercially available water filters cannot remove tritium from drinking water. For this reason, it is very important to keep tritium out of drinking water supplies. Unfortunately Canadian nuclear facilities are currently permitted to release large quantities of tritium into drinking water supplies such as Lake Huron, Lake Ontario, and the Ottawa and St. Lawrence Rivers.

Is there any evidence of adverse health effects from tritium?

There are studies which indicate associations between Canadian nuclear reactors and increased rates of fatal birth defects, childhood leukemia, and Down's Syndrome in nearby populations (4). A recent comprehensive study of nuclear workers from around the world found that Canadian nuclear workers have far greater risks of contracting solid cancers and leukaemias than nuclear workers from other countries exposed to equivalent amounts of external radiation. Independent scientists have suggested that the higher exposures of Canadian workers to tritium could be the cause (4). The Canadian Nuclear Safety Commission seems uninterested in exploring high cancer rates in CANDU reactor workers, and it refuses to conduct health studies on members of the public exposed to high tritium levels as in Pembroke.

Why doesn't the Canadian Nuclear Safety Commission protect Canadians from this tritium hazard?

The CNSC seems unable to shake its former mandate as a promoter of the nuclear industry. Despite a primary mandate to protect Canadians and the environment, the CNSC repeatedly puts the interests of the industry first. Since CANDU technology produces so much tritium, the CNSC must turn a blind eye to the risks of tritium exposure or the industry would not be able to function very well, if at all.

Far from protecting Canadians, the CNSC and Health Canada repeatedly try to defend a ludicrous 7,000 bq/l voluntary Canadian guideline for tritium in drinking water. Their defense relies on outdated and highly flawed models of how radiation from tritium damages the human body. They have seriously underestimated tritium's potential to do damage based on its smallness and low energy of decay.

Most jurisdictions that have thoroughly examined the question of how much tritium to allow in drinking water have opted for standards of 100 Bq/ l or lower. Many independent scientists and NGO's such as the the International Institute of Concern for Public Health and the Canadian Environmental Law Association advocate far tighter standards in the range of from 2 - 10 Bq/l.

What can we do about this problem?

Canadian legislators need to recognize that Canada's nuclear regulatory system is not protecting the public and is in dire need of reform. Canada needs a health protective standard for tritium in drinking water. Ideally this would be no more than the background level of 2 Bq/l. Emissions of tritium from nuclear facilities need to be reduced and deliberate dumping of tritium into drinking water sources must be stopped. The marketing of radioactive waste tritium must also be stopped and the use of tritium EXIT signs should be phased out. Canadians need to put pressure on their legislators to make these changes happen.

References:

1) Bob Drimmie, Manager University of Waterloo Environmental Isotope Laboratory, Personal Communication, 2009.

2) Canadian Nuclear Safety Commission. Standards and Guidelines for Tritium in Drinking Water (INFO-0766). 2008.

3) Canadian Nuclear Safety Commission. SRB Technologies (Canada) Inc. - Transcript - Application for the renewal of Class IB Nuclear Substance Processing Facility Operating Licence in Pembroke Nov 30, 2005

4) Health effects of tritium. Rosalie Bertell. 2006. Written intervention submitted to the Canadian Nuclear Safety Commission for the November 27, 2006 public hearing for SRB Technologies license renewal application.