Canadian Radiation Protection Association

Statement on the proposal by the Ontario Drinking Water Advisory Council to lower the Ontario drinking water quality standard by a factor of 350

2010 April 12

Summary

The Ontario Drinking Water Advisory Council has recently recommended[1] to the Ontario Minister of the Environment that the Ontario drinking water quality standard for the radionuclide tritium be lowered by a factor of 350. The recommendation has not been prompted by a finding of an increase in the risk associated with the ionizing radiation from tritium but from the reliance on the methodology recommended by the US National Academy of Sciences (NAS) for the assessment of risks due to exposure to carcinogenic chemicals. The NAS risk assessment methodology is not generally applied to ionizing radiation nor is it generally applied to situations where exposure is dominated by naturally occurring sources, as is the case with ionizing radiation.

The Canadian Radiation Protection Association[2] opposes the recommended change for four reasons:

- there is no scientific basis for the proposed decrease,
- the methodology that led to the recommendation is not appropriate,
- adoption of the recommended value would not lead to any significant improvement in public safety because environmental levels of radionuclides from man-made sources are already managed through Canadian radiation protection regulations, and
- such a radical change and implementation of the new value would likely cause unwarranted public concern.

Accordingly, the position of the Canadian Radiation Protection Association is that there is no need for a reduction in the Ontario drinking water quality standard for the radionuclide tritium,

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[1] Report and Advice on the Ontario Drinking Water Quality Standard for Tritium. Prepared for the Honourable John Gerretsen, Ontario Minister of the Environment. Ontario Drinking Water Advisory Council; 2009.

[2] The Canadian Radiation Protection Association is a professional organization that supports the development and implementation of radiation safety programs in industry, medicine, research and the environment through scientific inquiry, public involvement and interaction with local, provincial, federal and international authorities.

and in particular for the reduction from its present value of 7000 becquerels per litre to the value of 20 becquerels per litre recommended by the Ontario Drinking Water Advisory Council.

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The nature of exposures of members of the public to ionizing radiation

Exposures to ionizing radiation are effectively and appropriately managed through an approach that focuses on the damaging agent—the amount of radiation being absorbed in a person's body (the radiation dose). This, the radiation dose, is what is important when possible effects of radiation on human health are of concern as it links directly to health risk. In the case of tritium, it is the radiation from the radioactive decay of tritium to helium, rather than the chemical nature of tritium or helium that is important.

The total radiation dose that we each absorb from all sources of ionizing radiation, day in, day out, mostly from natural sources (which include naturally-occurring tritium) and from medical exposures can be expressed in terms of microsieverts. This quantity reflects the different effectiveness of different types of radiation absorbed and is a practical and quantitative measure of risk to health, based on the results from epidemiological and laboratory studies over many decades.

The total radiation dose that each individual member of the public absorbs in a year ranges widely, depending on the natural radiation background where that person lives, on medical exposures undergone, and on how much the person travels, particularly by air. The value can range from about 1000 microsieverts to 5000 microsieverts or more. Hence, any radiation doses from human activities are added to the background radiation that varies from person to person by up to several thousand microsieverts per year.

The physical nature of ionizing radiation is such that at an annual dose of 1000 microsieverts any cell in the body experiences just less than one radiation "event" on average in the year. The distribution of interactions between ionizing radiation and the body tissues is therefore quite different from that between chemicals and tissues where, even at very low concentrations, the interactions are spread throughout tissues and are continuous.

The management of risks from exposures to ionizing radiation resulting from human activities therefore needs to be undertaken in a situation where the dominant radiation dose from ionizing radiation is from natural (and medical) sources, where the risks to be managed are from small increments in radiation doses above the background level, and where the spatial and temporal characteristics of the interaction that radiation has with body tissues are quite different from those of chemicals.

The current approach in Canada to managing risk from radiation

In epidemiological studies that have looked for the effects of radiation on health, the lowest radiation dose at which an increased incidence of radiation-induced cancer in a large population can be significantly detected is 100,000 microsieverts. Estimates of the likelihood of effects on health at lower doses and, in particular, when doses are extended over time (as with the public doses of interest here) must rely on laboratory studies. The evidence from these studies is clear that for such doses the likelihood of any detrimental effects on health is either small, or may be zero. Laboratory studies have even shown that small radiation doses may, in some circumstances, have a beneficial protective effect.

Nevertheless, the basic model applied in radiological protection is that the likelihood of a detrimental effect on health is proportional to the magnitude of the dose. This conservative model is the basis for methodology proposed by the International Commission on Radiological Protection (ICRP) for the assessment and management of risks from exposure to ionizing radiation[3]. The methodology has been widely accepted and adopted by regulatory and public safety agencies around the world. The key features of the methodology are that industrial and commercial facilities that use or process radioactive materials or that produce radiation have to be managed such that no member of the public may receive a radiation dose above a limit of 1000 microsieverts in any year from the totality of all such facilities and, moreover, that doses to the public should be as low as reasonably achievable (ALARA) below this limit, economic and societal factors being taken into account. This is the approach that is used by the Canadian Nuclear Safety Commission, the federal agency responsible for the regulation of nuclear energy in Canada, including environmental releases of radionuclides such as tritium.

The practical way of implementing these requirements is to apply emission limits to each particular industrial or commercial facility, taking into account all activities in any particular area. A limit is set taking into account all the routes by air, by water, by food, and by direct radiation by which any member of the public can be exposed to, and hence receive a radiation dose from, the totality of all radionuclides and all radiation. In practice, the actual permitted totality of values of emissions derived on this basis corresponds to a maximum radiation dose to any member of the public that is well below the annual dose limit, by how much depending on the circumstances of the facility.

This approach to regulation is practical because of the extensive and quantitative knowledge base that has been built up on how radionuclides are dispersed in the biosphere, on the radiation doses to members of the public that result from direct irradiation from the dispersed radionuclides (*external radiation*), on the biokinetic behavior of radionuclides in water, air and foodstuffs that might be taken in by members of the public (*internal radiation*), and on the relative biological impact of the different types of ionizing radiation. The radiation emitted when most radionuclides decay can reach body tissues whether the radionuclide is inside or outside the

[3] This model and the key features of the protection methodology have been recommended by the ICRP for many decades. The most recent recommendations from the ICRP are: International Commission on Radiological Protection. The 2007 recommendations of the International Commission on Radiological Protection. Oxford: Pergamon Press; ICRP Publication 103; Ann ICRP 37(2–4); 2008.

body, just as can radiation from sources such as X-ray devices. Hence, both external and internal radiations are always assessed. For some radionuclides, the radiation emitted when the radionuclide decays is sufficiently weak that the radiation only reaches body tissues if the decay occurs in the body.

The radionuclide tritium is an example of the latter so that radiation from the decay of tritium is only absorbed in the body when tritium is taken into the body from food, from water, or from air. The relationships between the radiation doses from tritium and the amounts of tritium in air, in water and in foods are well known and there is no new information that indicates significant underestimation of the radiation doses. The physical nature of the radiation from the radioactive decay of tritium is similar to that from X-rays and gamma radiation. Though there is a range in relative biological effectiveness across these radiations from weak X-rays to higher energy gamma radiation, with the radiation from the tritium decay being within this range, the range is sufficiently small that the ICRP and regulatory agencies do not distinguish between the relative effectiveness of these different radiations.

Accordingly, radiation dose from the radioactive decay of tritium that is taken by a member of the public is just one component of any assessment of radiation dose attributable to any facility. There is nothing that points to a need for the radiation doses from the radioactive decay of tritium that may be emitted by industrial or commercial facilities to be singled out and regulated any differently from radiation doses absorbed from all other radionuclides and radiation sources.

As a result of this kind of comprehensive radiation regulation, the maximum annual dose that any member of the public receives from radiation added by industrial and commercial facilities is only a fraction of the annual dose limit for all those activities and, hence, is an even smaller fraction of any individual’s total annual radiation dose.

Operators of such facilities have regulator-imposed triggers on emission levels that draw both their and the regulators’ attention to any unusual increase in emissions prompting remedial action well before any limit is approached.

The role of the drinking water guide

In contrast to the facility-related management of radiation risks by way of monitoring emissions, a drinking water quality standard (often referred to as the drinking water guide, or DWG) for any one particular radionuclide refers to a concentration of that radionuclide in just one of the pathways by which a member of the public can be exposed to that particular radionuclide. The DWG is not related to any particular source of emission of radioactivity, nor is any distinction made between natural or man-made sources of that particular radionuclide. In practice, concentrations of tritium in drinking water from the combination of natural and man-made sources are very small compared with the value of the current DWG so that, although the DWG is not useful in regulating industrial and commercial activities that have tritium in their emissions, by and large, it does provide some reassurance to members of the public.

Unfortunately, the significance of any particular concentration of a radionuclide relative to the numerical value of the guide is often misunderstood. For example, the current value for tritium is 7,000 becquerels per litre of water. It is related to the annual dose limit for members of the public such that, if all the water consumed by an individual in a whole year has this concentration, then the radiation dose to that individual from all the tritium ingested would be about 100 microsieverts. This dose is 10% of the regulatory limit for radiation doses that can be added to background radiation by industrial and commercial activities. An observation of a concentration of tritium in one daily sample that is close to the value of the DWG is easily mistaken by members of the public as indicating an acutely dangerous situation, it not being realized that only if the total annual consumption of water was at this concentration would the radiation dose approach 10% of the regulatory limit for members of the public.

The proposed change to the drinking water guide

The Ontario Drinking Water Advisory Council has now recommended that the Ontario drinking water quality standard for the radionuclide tritium be lowered by a factor of 350. This recommendation was not prompted by any finding of an increase in the risk associated with the ionizing radiation from tritium but by reliance on the methodology recommended by the US National Academy of Sciences (NAS) for the assessment of risks arising from exposure to carcinogenic chemicals[4].

As noted above, the physical nature of exposures to ionizing radiation differs from that for chemicals, and the exposures of the public to ionizing radiation are dominated by naturally-occurring sources. The NAS risk assessment methodology has been applied when individual exposures include exposure to carcinogens from naturally occurring sources but the methodology is not appropriate for situations where exposure to a carcinogen is dominated by the naturally occurring sources[5]. We believe that application of the NAS methodology to this exposure scenario involving ionizing radiation is not justified and we consider that the value of the DWG for tritium should not be based on such novel applications of the NAS methodology, particularly when this methodology yields a result that is so dramatically different from that obtained from the more widely accepted ICRP methodology.

Implementation of the suggestion to lower the drinking water guide for tritium down by the factor of 350 to 20 becquerels per litre would result in measured concentrations from natural and man-made sources in many water bodies being more than 10% of the new guide value and more than 50% in parts of some water bodies. The annual radiation dose to an individual, for whom water with 20 becquerels per litre was their sole source of water for the year, would be about 0.3 microsieverts; equivalent to about 2–3 hours of natural background radiation, a few minutes of cosmic rays when flying at cruising altitude across Canada, and very small compared with the

[4] Risk Assessment in the Federal Government: Managing the Process. Commission on Life Sciences, US National Research Council, National Academy Press; 1983.

[5] See, for example, Review of the EPA's Draft Framework for Inorganic Metals Risk Assessment. U.S. Environmental Protection Agency Science Advisory Board. EPA-SAB-06-002; 2006.

differences in radiation doses experienced by individual members of the public in their everyday living.

With this lowered value for the drinking water guide there would be no improvement in public safety which is well handled through the radiation protection regulations. More importantly, since the magnitude of emissions from all regulated facilities fluctuate—though well within permitted values—the lowered value of the drinking water guide might well result in quite unwarranted public anxiety as well as unnecessary actions on the part of government agencies and facility in responding to an anxiety that had been prompted by radiation doses only a fraction of a microsievert.

Conclusion

The position of the Canadian Radiation Protection Association is that there is no need for a reduction in the Ontario drinking water quality standard for the radionuclide tritium from its present value of 7000 becquerels per litre to the value of 20 becquerels per litre recommended by the Ontario Drinking Water Advisory Council. The risk methodology adopted by the ODWAC is not generally applied to ionizing radiation, nor is it applied to situations where exposure is dominated by naturally-occurring sources, as is the case with ionizing radiation.

A large reduction such as that proposed by the ODWAC would not improve public safety and would put the standard at a level that corresponds to a tiny fraction of the range of radiation doses received by members of the public in their day-to-day living. The reduction would likely lead to unwarranted concern by the public and unnecessary actions by government agencies and facility operators. Exposures to ionizing radiation are effectively and appropriately managed through an approach that focuses on the damaging agent—the amount of radiation being absorbed in a person’s body. The present system of radiological protection in Canada is well developed and is supported by an extensive quantitative knowledge of the behavior of radionuclides in the biosphere and the effects of radiation on health and is consistent with practices internationally. The radioactive decay of tritium is but one source of radiation and there is no imperative that indicates it need be treated in any way other than as one contributor to the radiation doses that may be received by members of the public as a result of emissions from industrial and commercial facilities.