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1994 July 28

The Honourable C.J. Wildman
Minister of Environment and Energy
Government of Ontario
135 St. Clair Ave. West
Toronto, Ontario
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Dear Mr. Wildman,

A standard for tritium
A recommendation to the Minister of the Environment and Energy
ACES Report 94-01, 1994 May

We would like to submit our observations and remarks (enclosed). They are based on extensive experience in nuclear science research and the application of nuclear engineering technology. Our conclusion is that the risk from present and potential levels of tritium in Lake Ontario are <u>in</u>significant.

At issue is the improper application of a mathematical model outside its range of experimental verification to conclude that low-level radiation causes fatal cancers. There is no conclusive evidence to prove the validity of this linear extrapolation, and there is evidence of beneficial effects from low-level radiation. According to The Scientific Method, this model should not be used in the range of low-level radiation to draw any valid conclusions.

The misapplication of this model has resulted in a stated hazard of low-level radiation in the ACES Report which is understandably causing public concern. Such unfounded fears will affect the use of nuclear energy in Ontario for the generation of electricity, and could also prevent our use of nuclear technology in other industries and in medicine. This would result in the residents of Ontario being eventually deprived of the immense benefits of nuclear technology, including jobs and a plentiful and environmentally-friendly supply of electricity.

Yours truly,

J.M. Cuttler

Dr. J.M. Cuttler P.Eng
Vice President

Comments on recent recommendations for a new standard for tritium in water in Ontario
1994 July

Why only tritium?

The earth consists of material composed of naturally-occurring chemical elements ranging in atomic number from 1 (hydrogen) to 92 (uranium). Approximately thirty of these elements have naturally radioactive isotopes which emit nuclear radiation in our environment. (Nuclear radiation also enters from outer space.) In this regard, it is appropriate to consider naturally-occurring potassium-40, which has a half-life of 1.3 billion years and is present in most living species. Potassium is essential for human life, and it also gives each person an annual radiation dose of approximately 20 millirem[1]. This low-level dose is not hazardous, so there is no regulation against mining potash and spreading it as a fertilizer on farmland. Coal is another substance that contains trace amounts of radioactivity. Since the discharge of this low-level contamination is not hazardous, there are no regulations governing the mining and burning of coal, pertaining to its radioactivity. Present levels of tritium contribute much less of a dose than potassium-40 and many other sources.

Ambient radiation

The reality is that we are immersed in a sea of nuclear radiation. The average dose to a person is ~280 millirem per year, in Canada, or ~20 rem in a 70 year lifetime. This can range within a factor of two or so, depending on the geographic location. All living species have evolved and developed in this environment. Organisms can cope with the cell damage caused by this ambient radiation by repairing or replacing cells. There is even evidence that higher doses enhance tolerance to radiation.[2]

When is radiation dangerous?

There is considerable evidence to show that organisms can tolerate short-term exposures to comparatively high dose rates, but a point can be reached where the rate of damage exceeds an organism's ability to cope. It is known that a dose to a human of ~600 rem within a day causes death, within a month, to 50% of the cases. The 50% who survive can expect adverse health effects and a reduced life expectancy. The actual effects and reduction in lifespan depend on the physical condition (and mental attitude?) of the particular person exposed.

Linear extrapolation to very low dose rates

There is a scientific basis for a linear relationship for the likelihood of fatality down to a dose of about 50 rem.[1] However, extrapolating in a linear manner down to "zero" dose is only a convenient and very pessimistic assumption, used in safety analyses. It is not based on reality.[1] Nevertheless, the existence of this extrapolation has led to the misuse of this gross assumption for predicting the incidence of fatal cancer at very small doses.

Risk of cancer from low-level radiation

Scientists have been trying to fit this linear model to cancer data in the range of low doses. The data have not shown that low-level radiation causes cancer.[2] On the contrary, there is data which indicate that low radiation doses even reduce the likelihood of cancer.[2] This has led many scientists to the realization that cancer cannot be attributed to low doses of radiation and that there exists a threshold level below which we need not worry about radiation.

Analogy with taking aspirins

The following illustration of the misuse of a linear model is simplistic but instructive. It is generally known that a very large dose of aspirins, taken all at once, will cause illness and death. Extrapolating the fatal effect of a dose of say 100 aspirins by two decades, in a linear manner, would lead to the ridiculous statement that exposure to one aspirin represents 10,000 excess fatalities per million people. In fact a small dose causes no harm; it relieves pain. (Some doctors even recommend one aspirin each day to reduce the likelihood of strokes and heart attacks).

Potential and actual dose from tritium in water

The assumption made, in the ACES Report, in calculating the hypothetical exposure is that the concentration of tritium in lake water remains constant at the value of the standard, presently 40,000 becquerels per litre (Bq/L). In reality, the concentration at water plant intakes is typically four or more decades lower. In the rare case when the tritium concentration could rise, it would soon subside due to constant lake currents and inflow of fresh water.

Still, if this pessimistic assumption is made, and it is also assumed that each person drinks ten glasses of this water each day, then an annual dose of only ~60 millirem would result for 40,000 Bq/L. This hypothetical dose (which is a fraction of the ~280 millirem dose from natural radiation) would not be considered hazardous by many scientists. The actual exposure of Ontario residents to the effects of tritium is many decades lower than this value. When the risk from current tritium exposures is so insignificant, even from a hypothetical exposure at the current standard, it is not a responsible action to impose a tighter standard.

Reported hazard of tritium in water

The ACES report[3] recommends that the current standard of 40,000 Bq/L of tritium be tightened, not to the WHO recommended level of 7000 Bq/L, but to 100 Bq/L, giving the reason that "exposure to 7000 Bq/L represents 340 excess fatal cancers per million people."

First of all, the consequences expressed by this statement do not correspond to reality. They are hypothetical only, and result from the application of an inappropriate model. This methodology has extrapolated in a linear manner over many decades, from a single exposure of 50 rem to a hypothetical exposure of ~30 microrem/day, corresponding to 7000 Bq/L of tritium in water. Such a methodology cannot be used to predict the effect of this low-level radiation on the probability of cancer fatalities.

Secondly, if the proposed standard of 100 Bq/L is based on a further linear extrapolation, does the ACES report imply that 5 excess fatal cancers per million people (340 x 100/7000) are acceptable?

Conclusions

The current (and upset) tritium levels in Lake Ontario are not a cause for worry by local residents.

The WHO recommendation to change from the current standard to a new limit of 7000 Bq/L should not frighten people into regarding a dose of 60 millirem per year as hazardous.

References

1 **Low-level radiation risk: a scientific perspective**, Ontario Medical Review, **49**, 10, October 1982.

2 R.S. Yalow, **Radiation and society**, presented at the northeastern regional symposium on the BEIR V report and its implications, Health Physics Society, 1991 April 17.

3 **A standard for tritium: a recommendation to the Minister of the Environment and Energy**, ACES Report 94-01, 1994 May, Advisory Committee on Environmental Standards, 40 St. Clair Ave. W., Toronto, M4V 1M2.

North Renfrew Times
NRT 940727

Letter to the editor

No evidence of harm if waste left in Port Hope area

Re: "No desire to become a future statistic" – Deborah Greeley, NRT, July 20

Ms. Greeley says that she is frightened by (I guess) the tritium level in Perch Lake. She says it's 1000 times normal without specifying the level. I seem to remember that the article in the *Citizen* said that the level was in the 10,000-14,000 Becquerels (tritium disintegrations per second) per litre (Bq/L) range. As stated in the article, this is not dangerous to drink. The current drinking water standard in Ontario is 40,000 (Bq/L).

Last January, in answer to a newspaper advertisement from ACES, (Advisory Committee on Environmental Standards) requesting comments on the Ontario environment ministry's proposal to reduce the tritium standard to 7000 Bq/L, I made the following comments.

My major comment was that I did not feel that the balance between benefit and cost had been studied adequately. It should not be 'beyond the scope' as stated. It is the critical issue.

All our estimates of allowable radiation exposure have been based on the linear no-threshold theory giving the factor of 0.00005 fatal cancers per millisievert (mSv) quoted. This follows from exposures at high levels (atomic bombs) extrapolated to low levels on the assumption that cancers are proportional to ionization damage. It makes no allowance for biological factors.

WOW!

There is in fact no evidence that exposures below 250 mSv (100 years of exposure to natural background) is harmful to humans. And there are experimental results that indicate that exposures of this level may be beneficial.

One should also realize that our evolution has all been in times of higher radiation exposure than the current levels. Perhaps we are adapted to higher levels and actually now suffer from a radiation deficiency.

However, if we accept the linear theory as the best we have, setting the level at 0.10 mSv (the exposure from drinking water containing (7000 Bq/L) seems frivolous. If this level were dangerous, we would never fly in an airplane where the exposure could be ≈ 0.1 mSv/flight. We would not live inside our houses where the exposure could be ≈ 0.3 mSv/yr higher than outside. We would not live in the mountains where the exposure would be ≈ 1 mSv/yr higher than at sea level. We would not go to the Grand Central Station in New York where the exposure would be ≈ 5 mSv/yr. And we would never go to the Kerela region of India where the exposure would be ≈ 30 mSv/yr.

However, people living in Kerela live 10-15 years longer than the Indian national average so the danger cannot be so great. In fact we have here good experimental evidence that man can live with radiation levels at least ten times normal background.

Now considering the tritium level, we are concerned with relatively short term exposures caused by spills from a power plant or tritium processing installation. We may also have fusion power plants to contend with eventually. Continuous exposure to drinking water containing 40,000 Bq/L corresponds to about 0.5 mSv/yr. This is like going to the mountains for six months or visiting Kerela for a week. I believe that few people would consider either trip too risky.

As mentioned above, I believe the cost of any action to be critical. A crude estimate (assuming the linear theory) for the action of shutting down one Pickering unit to avoid exposing one million people to 0.5 mSv/yr would cost about $10 million per cancer saved. I have heard that a 50 cent immunization will save a life in some parts of the world.

Shutting the reactor down at 0.1 mSv/yr would cost $50 million per cancer saved. This is only the cost in lost power. There are other socio-economic effects that result in some increase in death rates that may well be larger than the reduction in cancers. There would be even more direct effects if the power supply were marginal – especially in the -30°C weather we have.

I hear that they are having brown-outs in the US right now. Will we be far behind if we continue to mismanage our system. And part of that management is getting our standards right.

To answer the questions i[n] the advertisement, I offere[d] the following:

1. Is the proposed standar[d] acceptable? No.
2. If not, what is the basis fo[r] finding the proposed leve[l] unacceptable See above.
3. Do you have an alternativ[e] level to propose and what i[s] your rationale for suggestin[g] this level? The current leve[l] (40,000 Bq/L) or higher de[-]pending on an economic anal[-]ysis.

I have not seen the ACE[S] recommendation but I sug[-]gest that you do not have t[o] be a scientist to understan[d] that a balance between cos[t] and benefit is required and i[t] is the same for the wastes a[t] Chalk River and at Por[t] Hope.

I agree with Ms. Greele[y] that we are "morally and eth[-]ically" bound to vote NO t[o] moving the Port Hope waste[s] here. However, my reason i[s] that there is, it seems, no ev[-]idence that those waste[s] have or will harm anyone i[f] they are left where they ar[e].

How can we "morally o[r] ethically" justify spendin[g] $200 million on moving th[is] stuff or even $17 million on [a] siting exercise? For this so[rt] of money, a Boston hospita[l] is now installing a proto[n] therapy facility for treatin[g] cancer. Protons can do [a] much better job than the x[-]rays from our linacs or fro[m] Co-60 made in NRU. Th[e] Boston facility will trea[t] thousands of patients an[d] save hundreds of lives ever[y] year. But we can't afford on[e] in Canada!

Bruce Bighan[m]
Deep Rive[r]