to Tritium file

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The Hon. B. Wildman
Minister of Environment and Energy
135 St. Clair Avenue West
Suite 100
Toronto, Ontario
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RE: The Advisory Committee for Environmental Standards Recommendation for a Standard for Tritium in Drinking Water

Dear Mr. Wildman:

SENES Consultants Limited (SENES) has considerable experience in the assessment of health risk associated with environmental issues, including both radiological and conventional pollutants, in Canada and many countries around the world. With this background of expertise, we feel it necessary to comment on the recommendations contained in the Advisory Committee for Environmental Standards (ACES) report - "A Standard for Tritium" (May 1994). We believe that the values recommended in this report for the Ontario Drinking Water Objective (ODWO), and especially the rationale used in developing these values, raise fundamental issues concerning the appropriate use of risk concepts. Adopting this rationale could have far-reaching and potentially adverse impacts on developing standards for pollutants and other risk factors, on the setting of priorities for environmental issues, and on the most effective allocation of funding.

ACES recommends as a basis for this standard an acceptable lifetime risk for excess cancers due to exposure to tritium of 5 per million people at risk. Using the latest risk of fatal cancer estimates for radiation exposure and radiation dose conversion factors for tritium intake to humans, this level of risk corresponds to a life-long average tritium concentration in drinking water of 100 Bq/L. This is the proposed interim ODWO for tritium. A further reduction to 20 Bq/L is recommended within 5 years (corresponding to a lifetime risk of 1 in one million), on the basis of current uncertainty in radiation risk estimates and provided tritium emissions can be sufficiently reduced to meet this level. ACES further recommends that the ODWO for tritium shall be applied as a health-based Maximum Acceptable Concentration so that when the drinking water standard is exceeded, an alternative water supply should be made available.

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Problems

1. Consider the toss of a coin as in the first example but now allow for the event E that the coin stands on edge. Record the class $\mathcal{B}_3$ of events generated from H, T, E; it has 8. Record the class $\mathcal{B}_3$ of events generated from H, T, E; it has 8 events; the operations $\vee, \wedge, c$ can be used to form convenient designations for some of the events.

2. Consider the second example involving a first coin (copper) and a second coin (silver). Shake and toss a pair of coins 50 times in succession.

(a) Use a full table as indicated in Section 1 but for economy of effort record the indicator values 0, 1 only in the 4 elementary event columns H_1H_2, H_1T_2, T_1H_2, T_1T_2.

(b) At the bottom of the table record the apparent or estimated probabilities $\hat{P}_A$ for the elementary events.

(c) Record $\hat{P}_A$ for the remaining events.

3. Another use for binary labelling. For Problem 1 the label (1, 1, 0) can be used for the event H, the label (1, 0, 0) for the event $H \vee T$ and 00 or where the three positions correspond to the three elementary events and 1 (0) indicates the presence (absence) of the elementary event as a "component."

(a) With this labelling check that $\mathcal{B}_3 = \{(i_1, i_2, i_3) : i_j = 0, 1\}$.

(b) Verify that $(i_1, i_2, i_3) \vee (i_1', i_2', i_3') = (\max(i_1, i_1'), \max(i_2, i_2'), \max(i_3, i_3'))$,
$(i_1, i_2, i_3) \wedge (i_1', i_2', i_3') = (\min(i_1, i_1'), \min(i_2, i_2'), \min(i_3, i_3'))$,
$(i_1, i_2, i_3)^c = (1 - i_1, 1 - i_2, 1 - i_3)$.

4. The binary labelling for Problem 2.

(a) With the elementary events in the order $H_1H_2, H_1T_2, T_1H_2, T_1T_2$, say, record the binary label (i_1, i_2, i_3, i_4) for each of the 16 events in $\mathcal{B}_3$.

(b) Record the operations $\vee, \wedge, c$ in terms of the binary labels.

We provide the following specific comments on the ACES report:

1. An incremental lifetime risk of 5 per million (reducing to 1 per million after 5 years) for a carcinogenic environmental pollutant may be a laudable ultimate goal, but such a risk level must be placed in context with the risk from other controllable and non-controllable factors. Also, risks should be compared with benefits and costs in reducing such risks. A standard based on risk considerations only without consideration of practicality and economics may impose large cost burdens on society to achieve such a standard with little corresponding benefit. Such expenditures may achieve far greater benefits to public health if allocated elsewhere.

2. An incremental lifetime risk of 1 per million is a factor of 50 to 70 below a risk level considered to be *de minimis*, trivial or completely insignificant by many authorities. For example, the AECB's Advisory Committee on Radiological Protection (ACRP), the U.S. National Council on Radiation Protection and Measurements (U.S. NCRP) and other organizations have suggested that a risk level of 1 per million per year may be considered as *de minimis*.

3. There is an inconsistency in the ACES report in that the ODWO is based on lifetime risk, whereas it is stated that the standard shall be applied as a health-based Maximum Acceptable Concentration (so that when the drinking water standard is exceeded, an alternative water supply should be made available). No averaging time for the ODWO is proposed in the report, but actions to provide an alternative water source implies this averaging to be relatively short-term.

   Examination of published data for tritium in drinking water produced at the Ajax, Oshawa, Scarborough (Horgan), Toronto (Harris) and Port Elgin water supply plants over the period 1984 to 1993, shows all these plants have experienced short-term tritium concentrations above 100 Bq/L. Despite this, the average tritium concentrations over this entire time period were 31 Bq/L at Ajax, 20 Bq/L at Oshawa, 14 Bq/L at Scarborough, 13 Bq/L at Toronto and 47 Bq/L at Port Elgin. Thus, the lifetime risk accumulated over this period would have been well within the 5 per million ACES risk basis without resort to alternative water supplies during periods when the tritium concentration exceeded 100 Bq/L. The present incremental level of lifetime risk from tritium in drinking water is therefore already below a level considered *de minimis* by many authorities.

4. As demonstrated above, the additional lifetime risk to members of the public from tritium in drinking water is already less than 5 per million. Thus, imposition of a standard of 100 Bq/L would not result in any significant benefit to public health. It should be noted that the current level of public risk has been achieved under a 40,000 Bq/L standard. This is indicative of the impact of the ALARA (as low as reasonably achievable) principle of radiation protection

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searchers for hire to private companies. At UCLA, there were two components to the assignment: to produce the harvester itself and to come up with a tomato tough enough to be picked at 13 miles per hour.

The breakthrough ushered in a whole new age of agricultural efficiency. Since the new harvesters each cost $200,000 and worked best in volume, larger operators inevitably took over their smaller neighbors. Within a few years in California, 4,000 tomato farms were amalgamated into 600, an estimated 18,000 farm laborers lost their jobs, the price of tomatoes began to climb twice as fast as that of other vegetables and consumers were introduced to the concept of square tomatoes. The benefits of the breakthrough (in the form of maximized profits) were accrued exclusively by large farmowners and equipment manufacturers.

The same kind of phenomenon is taking place in Canadian universities, writes Savan. Among other unfortunate episodes, she describes the response of two McGill scientists, Irving DeVoe and Bruce Holbein, both with the microbiology department, to a federal policy that encourages universities to transfer technology whenever possible to the private sector. DeVoe and Holbein had developed a technique for removing metals from liquids and set up their own companies, operating out of university labs with funding borrowed from departmental and grant funds.

The presence of a privately owned, profit-oriented company working on campus behind locked doors caused so much stress that the two researchers were "persuaded to take unpaid leaves of absence" and eventually resigned. The unauthorized loans were repaid, but the affair raised issues of academic ethics and corporate responsibility that have never been resolved. The unwritten code of upright academic behavior, Savan observes, had been tested and found wanting.

Savan is not exactly withering in her denunciation of scientific corruption -- she is too much the reasoned, practical scientist herself -- and she falls short in delineating the often cited "vested interests" that are driving scientific research. But her work is impressively thorough in its exploration of the effect of biased research. Anyone who still cherished the notion of scientists as social heroes or as Isaac Newtons absentmindedly waiting for the apple to fall should be edified by Savan's portrait of scientists driven by vanity and greed like the rest of us. More important, she clearly demonstrates that the scientific profession is no longer dedicated (if it ever was) to the enhancement of a universal living standard.

Many of the studies in the book, which is based on a four-part series Savan produced for the CBC Radio program Ideas, document the corruption of scientific method by corporations. Researchers working for Ethyl Corp. and E.I. Du Pont de Nemours & Co. Inc., for example, consistently produced data to prove that there is no link between the levels of lead in gasoline and in the blood of children. Savan cites the lead debate to illustrate the bias of scientific protagonists; looking at comparable data, corporate scientists concluded that there is no connection between lead-gas and lead-blood levels, while government scientists decided that the link between the two is absolute. In the United States, government scientists won out, leading to the introduction of regulations that cut lead in gas by 91 per cent. In Canada, unfortunately, corporate scientists were more persuasive, and the permissible lead level in gasoline is still high.

"Scientific evidence has become fundamental to public policy decisions," Savan writes. "Political, corporate and academic vested interests require data to support their positions. As a result it has become difficult, if not impossible, to distinguish a researcher's preferences from the ideology surrounding the research endeavor. The administration of science -- the system of training, advancement, publication and funding -- is itself slanted toward certain fields, hypotheses and individuals."

Savan proposes an extensive reevaluation of our attitude toward scientists and calls for the full disclosure by research academies of all corporate, commercial, governmental and advocacy-group affiliations for the development of strict conflict-of-interest guidelines at universities, scientific research institutions, journals and funding agencies, and for an extensive reform of the peer-review process. By demystifying science and its motives, Savan has clarified issues that must now be addressed.

David Lees writes a column on environmental issues for Toronto Life Magazine.