UPDATE ON COMMENT RE BEAVERLODGE CLOSURE

20 JANUARY 2005

Since October I have done more study about the Cameco Beaverlodge application and the Consultant's studies. I therefore intend to update section by section of my October submission.

1. UPDATED INTRODUCTION

I note that CNSC staff is on record (in the Cigar Lake Day 2 Transcripts, page 92) as concluding that "selenium is the cause of the cataracts" and, further, "in no way are the cataracts and other effects caused by radiation damage." If this CNSC conclusion is correct that selenium is the sole cause of the cataracts in the lake chub, the long-term problem of Ra-226 would diminish somewhat. However, (Ruggles 1978), on September 13, 1977, found that lake chub in the creek below Fookes Lake had a Ra-226 concentration of 5.9 and 7 Bq/gram (Table 10). In Beaverlodge Lake the trouts' kidneys had 60 ug/gram selenium, but the radium in trout kidneys was not measured, nor were the Ra-226 progeny. When comparing these statistics, it can be misleading. The sediments in Fookes Lake had a Ra-226 concentration of 70 and 94 Bq/gram in September 1976 (Ruggles Table 21). No selenium measurements were published in that study. I

remain sceptical regarding the totality of the correctness of that CNSC staff answer to the Commissioners' question (please see a further explanation of this in my updated conclusion).

Cameco employed (Golder 2002) and (SENES 2003) to study this situation. SENES 3.5, working with the Golder results, found that lake chub assessment to be consistent with (TAEM 1994 and 1995), and similar to the 1978 study. However, I do concede that the health of the lake chub appears to be sustainable although Golder found that their "condition" is lower than the lake chub in the reference lakes. The availability of their suitable diet may be diminishing.

SENES Table 3.4-4 compares the Pb-210 and Ra-226 in the bone and flesh of white sucker in Fulton Bay with selenium. The concentrations of the radionuclides appear to be negligible in such a comparison. The selenium is two times higher than its threshold of 8 for skeletal muscle (Golder Table 2.4-1). There is no threshold set for radionuclides for fish bone and flesh. Comparing the results of the radiological energy with the microgram weight of selenium is somewhat misleading, and like comparing apples and oranges. Furthermore, the kidney and liver were also tested for the selenium and other chemicals but they were not tested for the radionuclides. Perhaps because of the Ônegligible' doses in flesh and bone, this might mean there has been an incorrect interpretation of information, tables and figures. (See explanation below in conclusion) In this case, I find such a quantitative comparison somewhat misleading. A qualitative explanation would have helped this to be more meaningful.

2. ALPHA RADIATION MAY AFFECT REPRODUCTIVE VIABILITY

In the last paragraph of Section 2 of my October comment, I looked at the possible results, if an RBE=40 were to be adopted, as was recommended by the regulators in (PSL-2 2001); also, if para 265 in (UNSCEAR 1996) were to be followed, the Ra-226 result could be considerably higher than

shown in these studies. Such changes could bring the doses of Ra-226 to far above any safe average. The uncertainty of the value of the RBE, together with the lower safe value for reproductive effects (40 ug/hr., down from 400 ug/hr. for survival), makes it very difficult, or maybe impossible, to compare, or to make decisions on a comparison between, these radionuclides and non- radionuclide chemicals.

Until more studies are done on the effects of alpha radiation that could help to determine the value of the RBE, one cannot have a great deal of confidence in the SENES predictions in Appendix E. I am concerned about the potential genetic effects of these radionuclides in the long term.

3. RA-226 OR SELENIUM CAUSING CATARACTS

My study has led me to conclude that trying to compare the biological effects of a radionuclide such as Ra-226, with a non- radionuclide chemical such as selenium, may not be possible because of the difference in the units by which each is measured. Radionuclides are measured by energy, the unit becquerel/gram meaning one disintegration of energy (in MeV) per second; the selenium is measured by the amount or weight in ug/gram.

There are further complications when measuring the biological effectiveness of radionuclides:

a) the type of radiation (alpha, beta or gamma), and the amount of energy produced;
b) the half-life of the radionuclide;
c) the type of radiation and half-life of each of the progeny.

All of these are relevant, and indeed critical to an understanding of the biological effectiveness of a radionuclide, eg., the Pb-210 is a beta- emitter with only a 0.15 MeV energy in comparison to alpha-emitting Po-210[5.5 MeV (138 days)] that it decays into. Even though the half- life of Pb-210 is 22 years, my concern is the Polonium-210 for 200 years. The effects of radiation can best be found in

scientific experimental work. Delayed doses make it difficult to detect, eg., cancer 10 - 30 years, and therefore it is difficult to observe the effects of irradiation in populations of plants and animals until a long period of time has elapsed. (IAEA 1992, page 4) Po-210, which is a progeny of Ra-226, is often used in the experiments, some of which do indicate the effectiveness of this species of radiation. (eg., Samuels 1966)

The biological effectiveness of Ra-226 can be examined from its physical and chemical aspects, as well as from the radiological aspect. (Golder 2002) and (SENES 2003) have both relied heavily on the chemical aspect and on a theory called "sequential abstraction", i.e., how well a contaminant combines chemically to other chemicals in the sediments, in their assessment of the biological effectiveness of Ra-226, selenium and other chemicals. They find that Ra-226 binds tightly to other chemicals in the earth. However, both Golder and SENES scientists admit that in the Greer Lake sediment where the pore water is found to be very high (12 Bq/l), this theory does not appear to be upheld. It is said that this could be due to the 15% of the radium that is bound to the organic material. In Greer Lake, over 89% of the lake chub population has deformities, mainly cataracts, and Greer Lake is only a short distance from Beaverlodge Lake. In the Golder Associates study photo of a lake chub caught in the Greer Lake, the chub looks healthy and is 12 cm. long, but the caption below reads "lake chub with cataract eye." But, in photos of two lake chub caught in Fookes Lake (the tailings source) in 2000, one of them is missing an eye but is 10 cm. long and looks fairly healthy. However, the other looks unhealthy and is only 6 cm. long. The sediment in Fookes Lake in 2000 ranged from 48 - 59 Bq/gram Ra-226. The selenium in the 0 - 2 cm. is 44 ug/g, and for the next 6 cm. dropped to 0.5 ug/g.

For selenium information, I went to the internet. At EnvironmentalChemistry.com I found out that selenium is a non-metal; has a hexagonal crystal structure; an atomic number of 34 and in its most common form has 45 neutrons; incompatible to it

are acids and strong oxidizers; it is a combustible solid; the routes of exposure are: eye contact, inhalation, ingestion; and skin. The target organs are eyes, skin, respiratory system, liver, kidney, blood or spleen. This is useful information and confirms that eyes can be infected by selenium. The selenium threshold are given in Golder, Table 2.4-1. In the sediments the selenium goes up to 19 ug/gram.

However, when examining radium from the same internet source, no targets are given. "Uses" are said to be "treating cancer" and, under "Special Hazard", "Radioactive" is given as a direction or warning. Golder indicates in a number of the tables that selenium is a flesh- seeker, whereas Ra-226 is a bone-seeker. But the Ra-226 is decaying into Po-210, which is also a flesh-seeker (Thomas 1994). In Dr. Thomas' study on Po-210 in caribou, she says in 2.4.1, "The behaviour of Po-210 may parallel Cs-137. Like Cs and K, Po-210 is metabolically similar to selenium and sulphur with an affinity to protein." This may refer to the fact that these radionuclide and non-radionuclides (Po-210, CS, K, Se and S) are **flesh-seekers**. This will make them more biologically dangerous.

The 7Bq/g and 5.9 Bq/g in lake chub in the creek below Fookes Lake (Ruggles 1978) found that four out of eight of these lake chub tested either had a very small pupil in the left eye, or very small pupils in both eyes. That such eye problems do not seem to being found in Ace Creek where the Ra-226 in the sediments is up to 13 Bq/gram (Appendix Table II-4) may be puzzling, but that radium in the Creek has probably been there only since the tailings spill of 1976; Fulton Creek has been flowing down into Fulton Bay since the 1950s.

When examining the potential biological effects from the 4.73 Bq/g Pb-210 and Po-210 in Beaverlodge Lake (Appendix Table II-4) and Ra-226 (2.66 Bq/g), I have tried to visualize the possible radiation damage from alpha particles to the aquatic plants and benthic invertebrates. The Pb-210 (4.73 Bq/g) decays into Po-210 at the same rate as Po-210 (i.e., 4 -5 disintegrations/gram per

second).

4. THE POSSIBILITY THAT ALPHA-EMITTERS IN BENTHIC INVERTEBRATES AND AQUATIC PLANTS MAY BE CAUSING EYE DEFECTS IN LAKE CHUB

The mean concentration of Pb-210 in the sediments in Fulton Bay is 4.73 Bq/g. This means that **alpha-emitting Po-210 is producing 4 or 5 alpha particles per second** in Beaverlodge Lake sediment and that this will continue as long as Ra-226, which is decaying at a rate of 2.66 Bq/g, is decaying into the Pb-210 (i.e., for many centuries). Some of these alpha particles will be getting into the roots of the aquatic plants, and into the benthic invertebrates, by either consumption, inhalation and/or contact. Alpha particles appear to have a propensity to go to the genetic organs [PSL-2 2001 (3.4.1); Samuels 1966]. However, as Dr. Whicker wrote: " (scientists) are very ignorant when it comes to estimating the dose rates to the germ cells and tissues, and (they) are also ignorant about how to interpret the effects from a given dose rate produced by alphas." (Whicker 2001)

The (Samuels 1966) experiment appears to show that by injecting the Po-210 at a rate of 0.03 Bq/g (of body weight) into the peritoneum of a mouse **the Po-210 localized in the ovary follicles**. At this low dose rate (0.03 Bq/g) Samuels found that 79% of the oocytes survived. But, as the dose was increased, the percentages of the oocyte survival decreased. In four tests at 0.15 Bq/g the survival of oocytes was only on average 47.5%; calculating the average of three tests at 0.3 Bq/g, 36% of the oocytes survived. This experiment appears to indicate that Po-210 at a very low dose rate (0.03Bq/g) can create a greater biological effectiveness than it appears to create at 3.7 Bq/g (on an average of two tests 25% of oocytes survived) and at the equivalent of 0.03 Bq/g, gamma radiation, 4 oocytes survived. If the plants and benthic invertebrates were to take up the 4.73Bq/g Po-210 in Fulton Bay, one could deduce that the biological effectiveness might be considerably lower than it will eventually be when the parent

radionuclides subside.

However, in a study by Dr. Patricia Thomas, Toxicology College, University of Saskatchewan, entitled "An estimation of radiation doses to benthic invertebrates from sediments near a Canadian uranium mine", she calculated that only a very small fraction of the alpha-emitting radionuclides that were consumed by a worm would be absorbed into the bloodstream. (Thomas submitted in 2001) However, I am still concerned that the Pb-210 (which is a beta-emitter)may be absorbed and may emit the Po-210.

My concern is that in the long term, the people living in the centuries ahead, and their environment, may be seriously affected. According to [Thomas and McNeill, page 12, 1982 (AECB 0081)] only 60% of the cells were killed in these experiments; **30% of the cells were damaged**. It is these damaged cells, in the long term, affecting these benthic biota, which form the basis of the food web, that could cause deformities of some sort such as blindness. (UNSCEAR 2001 Scientific Annex entitled "Hereditary effects of radiation, tables 5 and 11) lists a number of genes that can lead to blindness when damaged. But because we do not understand well enough for Dr. Whicker to be able to have an opinion on the effects of alpha radiation because there is not enough experimental data, I believe it is very important for both the closure of an older mine and for the development of new high-grade mines, that we make a concerted effort to obtain more experimental data of the kind recommended by Dr. Whicker.

5. CONCLUSION

According to CMD 04-M39, "**The possibility of long-term consequences of genetic damage caused by alpha radiation** continues to be studied by the scientific and regulatory community." I believe taking the risk of this possibility is unacceptably unethical, at least until such studies are made available to the public and more is known about the effects of alpha radiation. Thus, when I expressed scepticism regarding the

totality of the correctness of the CNSC staff's answer to the Commission re my comments submitted to the (Cigar Lake, Day 2 Hearing), above (#1), I was expressing my scepticism of what is being allowed and tolerated for the sake of economic gain to our present generation at these uranium mines. Risks to ourselves, or even to those who are given an opportunity to object, is somewhat different than when the risks are taken for people who are not yet born and thus have no opportunity to try to protect themselves.

[IAEA-1091 1999](1.1) said: "There is a growing need to examine methods to explicitly address the protection of the environment from radiation. The concept of sustainable development places environmental protection on an equal footing with human protection, on the basis that it is necessary first to protect the environment in order to protect human populations."

The closure of the Beaverlodge Lake mine will affect people (whose welfare is dependent on their environment) for centuries to come. We need to understand more about the long-term genetic effects of alpha radiation. These alpha-emitting radionuclides are likely to spread far and wide through the food web during the many centuries the radionuclides will be decaying.

In 1987, the Bruntland World Commission on Environment and Development, page 8, warned how future generations may feel about our present unsustainable developments; "They may show profits on the balance sheets of our generation, but our children will inherit the losses. . . They may damn us for our spendthrift ways but they can never collect on our debt to them."

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