



WRITTEN SUBMISSION FOR NOVEMBER 17
COMMISSION HEARING ON BEAVERLODGE
DECOMMISSIONING SUSPENSION

1. INTRODUCTION:

Thirty percent of the lake chub in Beaverlodge Lake have serious eye defects (mostly, cataracts and other eye problems as well as some other abnormalities (Golder Associates, 2002) (the exact % is 29.4%). However, Cameco does not consider this to be an ecological risk (CMD 04- H23.1). That cataracts have been found in Fookes Lake since 1978 has been public knowledge. The Beaverlodge mine had been operating for twenty five years, since 1953.

The recent reassessment by SENES has given strong evidence to suggest that from a chemical standpoint, Ra-226 is not a concern because of its strong bind to the sediments. However, Ra- 226 is decaying into radon, polonium and bismuth and lead. How well do these four chemicals bind to the sediments? They may be free to settle in the sediments. Further, during certain seasons, the Ra-226 re-dissolves into the pore-water. The reassessment by (SENES, 2003) states "*Results of the aquatic species assessment indicated that the reproductive viability of both benthic and pelagic fish and benthic organisms (snails) are not expected to be affected by ionizing radiation.*" I

am skeptical that this statement would hold true for alpha particles. The "ionization of an alpha particle creates 160,000 ion pairs (average 4,000 ion pairs per micron on a 40 micron track). In a genetic organ, this may cause a large amount of damage that may only show up many years later (e.g. lung cancers in uranium miners).

Section 3.5 (SENES 2003) discusses the lake chub population in Beaverlodge Lake and Fulton Creek.. No cataracts have been found in the fish in either of the Reference lakes (Fulton Lake and Keddy Bay). The SENES study compares the eye defects reported in 1978, 1995 and 2002 with the Reference lakes in terms of percentages of population with eye defects and in terms of general health. The major difference between those lake chub in the contaminated lakes and those in Fulton Lake or Keddy Bay is found to be that those in the contaminated lakes have a lower condition factor. SENES attributes this partly to the (low quality of the foraging habitat). The habitat for lake chub could include the benthic invertebrates and/or aquatic plants. Could the lake chub be affected by such sustenance?

The Ra-226 concentrations in the sediments are recorded in Table 3.2.2 and 3.2.3; the porewater in Table 3.2.5; and the Sv/day in the snails in Table 5.4-2. Examining these results leads me to speculate that when the aquatic plants (Figure 5.4.3) and benthic invertebrates are measured, these benthic organisms may be found to be the cause of the cataracts. According to (CCNR, 1998) "cataracts are considered to be a 'delayed effect' of radiation".

2. ALPHA RADIATION MAY AFFECT REPRODUCTIVE VIABILITY;

Th-230 and Ra-226 and their four alpha-emitting progeny (two thirds of which are assumed will escape to the atmosphere) leaving one-third to continue decaying into four alpha and four beta emitting particulates within the benthic organisms and in the sediments. These could be the likely cause of the long-term risk of somatic cell damage

from the alpha emitting Polonium isotopes, Po-218, Po-214 and Po-210.

The ionizing radiation of gamma being a photon, is fast moving and therefore fails to create many ion-pairs when in a small animal (Gofman, 1980); beta-emitting particles vary in their energy and in their capability to cause health effects; while the alpha particles being (heavy, comprised of two protons and two neutrons) travel on a 40 micron track (the length of four human cells) when in tissue. This high energy, heavy alpha-particle travelling along this small space and at a slower rate than the beta particle or gamma photon, can create, on average 4000 ion-pairs per micron. The Bragg approach (Friedlander, 1981) shows that in fact travelling across these cells, the energy gradually increases to 10,000 ion-pairs per micron and starts at about 2,000 ion-pairs. The Beaverlodge decommissioned mine where the tailings mine effluent flows down Fulton Creek into Beaverlodge Lake contains a lot of alpha emitting ionizing radionuclides. So I believe it would be beneficial if Ra-226 and its progeny were further examined as being the possible cause of the eye defects in Fulton Creek and Fulton Bay in Beaverlodge Lake.

The dose being allowed is 10 mGy/day (UNSCEAR, 1996 & IAEA, 1992). The 10 mGy/day appears to be for gamma radiation and for the survival of the organisms. UNSCEAR suggests a RBE=5 for alpha radiation. This international body also recommends in (para 265) that the 10 mGy/day modified by RBE=5 will protect the living organisms in the case of *survival*. But for **reproductive effects**, this dose should be lowered to 1-2.5 mGy-day (UNSCEAR,1996, para. 265) and it should be lowered again to 0.2 to 0.5 mGy/day when the RBE=5 is applied. For reproductive effects (1-2.5 mGy/day) at an RBE=10 would mean a limit from 0.1-0.25 mGy/day. At an RBE=40 0.025 to 0.0625 mGy/day. This may not be achieved at Beaverlodge Fulton Bay or in Beaverlodge Lake East. (Table 5.4.2 shows snails (benthic invertebrates) to have 1.82 mSv/day at RBE=10 in Fulton Bay and 1.52 mSv/day in Beaverlodge Lake East. For RBE=40, this would be 7.28 mSv/day in Fulton Bay and 6.08

mSv/day in Beaverlodge Lake East.

3. IS IT SELENIUM, URANIUM OR Ra-226 THAT IS CAUSING THE EYE DEFECTS?

When reading (SENES 2003), CMD 04-23.1 and CMD 04-H23, I get the impression that either the Ra-226 is not considered the cause of the cataracts, and/or that the cataracts in the lake chub are not considered to be an ecological risk. And that Se and/or U-238 are probably the cause. But I have not seen any evidence that would suggest that the chemical components of either Se or U-238 cause eye defects.

There does appear to be more concern about the Se in large fish which have doses above the Guidelines in Beaverlodge Lake, Fulton Bay and Keddy Bay as well as and Verna Lake, where people at a camp use the fish or the water. Se may, indeed be a health problem as well as a problem for eco-tourism and to local fishermen. But this does **not** mean that Ra-226 is not a major cause for the lake chub cataracts in the Beaverlodge Lake nor that these defects will not be a significant long-term ecological risk. If Ra-226 is eventually found to be the major cause - in spite of "its heavy binding to the sediments" when it re-dissolves into the pore-water in certain seasons in Greer Lake, it will then at those seasonal times get into the aquatic plants and the benthic invertebrates, and this will continue for many years or centuries.

Although I have not seen any evidence that either Se or U-238 cause eye defects, I have seen evidence that suggests that alpha-emitting radionuclides causes eye defects:

a)[PSL-2, 2001,(Table 21)] cites a scientist named Brenner who did experiments on the eyes of mice with alpha radiation. Brenner's data on lens opacification gives three RBE findings after mice, receiving three different doses: 250 mGy the RBE was 4-8; after a dose of 50 mGy, the RBE was 10-40; and after a 10 mGy dose, the RBE was 50-100.

b)My second example is a conversation with a radiologist, the late Dr. James Klein, Regina University. In the late 1970s, when I heard about the fish in the creek below Fookes Lakes, I asked

Dr. Klein whether this could be caused by alpha, beta or gamma radiation? His immediate response was that he thought it could be beta radiation, but he would look it up. After looking it up, he came back and said that alpha radiation would more likely be the cause. c)(CCNR,1998), an internet essay (http://www.ccnr.org/ceac_B.html) in Section B.25 (p.22) says "**cataracts and genetic effects are included in the category of delayed (radioactive) effects.**"

Whether it is Se, U-238 or Ra-226 that are the likely cause, on the surface, it may not appear to be of much consequence. However, on second thought, it should be recognized that the chemical causes of Se will not be regenerated in the same way as the Ra-226 alpha emitting progeny will be for years or centuries. This should mean that if Ra-226 and its progeny is the cause of the 30% of the lake chub with cataracts in Beaverlodge Lake, these would become a significant long-term ecological risk. That may make any closure of the decommissioned mine an unsustainable problem. Although this decommissioned mine eventually should be allowed to be closed, the consequences of licensing that mine need to be seen as a warning - a disastrous lesson for the long-term (1000 of years) ecology for our children when looking at new developments.

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

Could it be that the alpha emitting radionuclides, which are getting into the aquatic plants and benthic invertebrates may be the cause, or a contributing factor, to be causing the eye defects in the lake chub in Beaverlodge Lake? Data for the radionuclides in the lake sediments in the Fulton Creek can be found in the (SENES, 2003) study. Another study by Canada North Environmental Services entitled "Dubyna Site Aquatic Investigations", 2003. This volume discusses in greater detail the results of their study of macro-invertebrates in Dubyna Lake and Creek, a

contaminated lake flowing into Beaverlodge Lake, and Schmoor Lake and Creek, a reference lake. As well as the quantitative effects of large fish, there is a section called "Qualitative sampling" of macro-invertebrates. I was disappointed to learn that this section does not include any qualitative effects of radionuclides. Only the energy of the radionuclides is included in any calculation. The RBE is supposed to account for the effects of the ionization. On the latter subject, the scientists cannot agree about the value of the effects of this dense ionization. There is very little data collected (Whicker, 2001). Thus, we do not know what the long-term effects of alpha radiation are from Ra-226. (SENES, 2003) Section 4.2.4.3, discussing the general conclusions of chronic radiation warns: "reproduction is likely the most limiting endpoint" and after discussing the UNSCEAR advise (40 uGy/hour) warns: the **uncertainty** in the selection of appropriate reference levels is acknowledged.

The mean abundance per square metre and the number of taxa were analyzed; also an equation which includes energy in its calculation when "measuring the structure within the biological community" in order to find the diversity; and another equation to indicate the dominant organisms. These four features are used to calculate the quality of the community.

I believe that the genetic and somatic quality of the effects of high-LET alpha emitting ionizing radionuclides, together with the potential biological effects from the long lived Ra-226 +/progeny should be considered from a qualitative and long-term aspect. It is possible to measure doses of alpha radiation in lower trophic levels than large fish. The researchers for (NCRP 109, 1999) measure the alpha-emitters in small fish and insects as well in Beaverlodge Lake. The (NCRP-109, 1991) study explained how it calculated the effects from gamma radiation, but said that for alpha radiation no such calculation was possible. Thus, in the Appendix it recommended using an RBE=20. (But my problem is that I am aware that the ionizing effects from alpha are quite different than that from gamma). Therefore, just to add a

"*qualitative*" RBE does not include these serious genetic effects from alpha. This difference, is a qualitative effect about which there needs to be some discussion. (Goodhead, 1993) as cited in (PSL-2, 2001) has pointed out this difference. [The very high RBEs found by (Samuels, 1966), 377 and by (Rao et al, 1991) 245 the two experiments reported in (PSL-2, 2001) to look for genetic effects from alpha-emitters also signifies the importance of a more realistic quality factor). For such a reason, presumably, (PSL-2, 2001) recommends a RBE=40.

CNSC staff members have told me that it is only necessary to consider populations and communities (correspondence, Jan. 29, 2003). The quality of the effect (ionization effects alpha radiation are only seen at individual levels). But the population is made up of individuals, and if these are diseased or suffering from some abnormalities in large enough numbers they will eventually show up in populations. Eye defects in nearly one third of the lake chub population are showing up in Beaverlodge Lake. Some may consider lake chub not important because humans do not consume them. However, ecologically they may have importance, and the Canadian Environmental Assessment Act, which I presume would be included in subsections 16 (1) and (2) needs to be complied with even if no CEAA examination is necessary.

There is also a possibility that these eye defects are caused by the synergistic chemical attributes of Se and/or U-238, and the alpha radiation may be adding the alpha-emitters from Ra-226. If Ra-226 is the cause of the problem, the effects become "significant" because of the long, long-term decay of Th-230 and Ra-226. Whereas, if the cause is confined to Se, the significance of the effect will be considerably lower. If U-238 is the cause, because of its chemical features, the effects would be less significant and the radiological effects are low because of its slow decay due to its 5 billion year half-life.

I am wondering then whether Cameco is assuming

that these eye defects are caused by a chemical. Even though Se does have genetic and teratogenic effects and therefore once it gets into fish, useful for human consumption, then it becomes a serious concern. At present Cameco does not appear to consider these eye defects to be an ecological risk. (CMD 04-H 23.1)

5.CONCLUSION:

I question the validity of the statement quoted in both (SENES 2003 and Golder 2002):

"The results of the reproductive viability of both benthic and pelagic fish and benthic organisms (snails) are not expected to be affected by ionizing radiation"

when applied to alpha radiation.

For alpha radiation there is no threshold dose (Friedland, 1981). Furthermore, the (Samuels, 1966 and Brenner, 1991) appear to indicate in the reproductive effects that the lower the dose the higher (or greater) are the effects. Normally, experiments with chemicals or gamma radiation show the reverse result that the higher the dose the greater the effect. The Samuels and Brenner experiments are showing the effects of alpha radiation. Therefore, biologists, who may not understand such specific effects of alpha radiation, would assume the reverse (i.e. if the dose is low, don't worry). But, within CNSC there are radio-biologist experts, who have seen the results of these Samuels and Brenner experiments. Yet, the CNSC staff appear to have supported Cameco's apparent preference that the cause of the eye defects is the chemical toxicity of Se or U-238.

The *reproductive effects* of Po-210 have been shown by (Rao et al, 1991) to have an RBE of 245, whereas, Rao two years earlier (Rao et al, 1989) in another experiment showed for *survival* effects the RBE was only 6.7. [UNSCEAR, 1996, (para 265)] says that 10 mGy/day is not likely to affect the *survival* of organisms. But that only 1-2.5 mGy/day

should be allowed for *reproductive* effects. Taking into consideration the RBE factor for alpha radiation, the daily dose that would be safe becomes very much lower than 10 mGy/day for *reproductive* effects.

It is the long-term reproductive effects that would render the effects "*significant effects*" and furthermore, may cause the Commissioners to consider Paragraph 24 (4) (b) Nuclear Safety Commission Act which says that no licence be amended unless it will make adequate provision for the protection of the (long-term) environment.

These problems of past technology should provide lessons for today's technology which is allowing 25% ore to be developed, while almost no evidence exists on the reproductive effects of alpha radiation from the long lived Th-230 and Ra-226 (Whicker, 2001)

REFERENCES:

Brenner, D.J., D. Medvedorski, Y. Huang, G.R. Mooriau Jr. And B.V.Worgul, 1991 "Accelerated heavy particles and the lens. Vi.RBE studies at low doses. Radials Res. 128:73-81

(CCNR, 1998) Concerned Citizens for Nuclear Responsibility, 1998 "Health//Environment Issues Linked to Nuclear Fuel Chain-Section B"(http://www.org/ceac_B.html) Goffman, John, M.D., 1981 "Radiation and Human Health", Sierra Book Club, San Francisco

Friedlander, Gerhart, 1981 "Nuclear and Radio-chemistry" Third Edition, Wiley-interscience Publication, John Wiley and Sons, New York. A textbook that was recently used in a class at the Waterloo University.

Golder Associates, 2002, A consultant for Cameco who was employed to study the lake chub in Beaverlodge Lake.

PSL-2, July, 2001, Canadian Environmental Protection Act, 1999 for Environment Canada and Health Canada - "Priority Substances List Assessment Report - Releases of Radionuclides from Nuclear Facilities (Impact on Non-Human Biota), Revised Draft.

Rao et al, 1991 "Induction of Sperm Head Abnormalities by Incorporated Radio-nuclides: Dependence on Subcellular Distribution, Type of Radiation, Dose Rate and Presence of Radio Protectors" D.V. Rao, N. R. Venkateswara, R.W. Howell, V.K. Lanka and K.S.R. Sastry.

Rao et al, 1989 "In viva radio-toxicity of DNA incorporated 1-125 compared with that of densely ionizing alpha particles" Lancet 2, 650-653 (1989).

Samuels, L.D., Kresga Centre for Environmental Health, Harvard School of Public Health, 1966 "Effects of Polonium-210 on mouse ovaries".

SENES, 2003 A consultant for Cameco who was employed to write a reassessment regarding Beaverlodge Lake.

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