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6 June 2002 **Via e-mail ; original signed copy via post.**

M. Richard Faucher
Président
Niocan Inc.
2000 Peel, suite 560
Montréal, Québec H3A 2W5

Re : Response to Request from the BAPE for Additional Information

Dear Mr. Faucher,

In our meeting in Montréal on 13 May 2002 with the BAPE (Bureau d'audiences publiques sur l'environnement), a number of issues were discussed for which the BAPE required further information. One of these concerned the potential emission of radon from slag containing above-background concentrations of uranium and thorium. A letter response to this issue was provided to you on 16 May 2002.

This letter addresses three other issues that required clarification, namely: the cumulative impact of U and Th emissions from your proposed facility; dust emissions during transfer of materials from the SLC site to the Niocan mine; and the emission of radon during flooding of the mine after shut-down (termed the "piston effect").

1. Emissions of Radioactivity from the Niocan Project and The Cumulative Impact of Dust Deposition

There will be airborne emissions resulting from normal operations at the proposed Niocan facility. These emissions will include uranium (U) and thorium (Th), and their radioactive decay products. The potential impacts of these emissions relative to background concentrations were estimated as follows.

The emission sources at the proposed facility are the pyrochlore concentrate dryer, the material mixer/hopper and the ferroniobium plant (Roche 2002 - letter of 8 May 2002 from Roche to M. Yves Dansereau, Ministère de l'Environnement). Relative to radioactivity emissions in the dust, the estimated annual releases of U and Th are 0.58 kg/y and 12.1 kg/y of U and Th respectively during the 17 years of Niocan site operations (Roche 2002).

The dust emissions will also contain the radioactive decay products of U and Th in approximate radioactive equilibrium, with the exception of the emissions from the ferroniobium plant (which will emit about 6-7% of the total uranium and thorium emitted). The ferroniobium plant is a high temperature process (1700°C), and quantities of the relatively volatile Po-210 above equilibrium amounts will be released. For this analysis, it was conservatively assumed that all (100%) of the incoming Po-210 radioactivity in the pyrochlore concentrate would be volatilized (based on 8400 tonnes/y at 800 ppm U). However, the exhaust air will cool prior to passing through dust emission controls (a baghouse), and thus the Po-210 will be removed in the baghouse as particulate. The baghouse on the emission stack will a have typical removal efficiency greater than 99% (Roche 2002). For this analysis, it was conservatively assumed that 2% of the total Po-210 radioactivity would be released from the ferroniobium plant emission stack; that is, a removal efficiency of only 98% was assumed. Because Pb-210 is also relatively volatile (although less than Po-210), it was also conservatively assumed that Pb-210 would be released at a rate equal to that of Po-210.

Similar to the analyses done by Dr. Chambers for emissions of radon from the Niocan mine (Letter and submission of Dr. D. Chambers to R. Faucher, Niocan, 30 April 2002 , Appendix B), the ISC3 atmospheric dispersion model of the U.S. EPA, along with the estimated emission rates of radionuclides, were used to predict annual average air concentrations around the facility (*User's Guide for the Industrial Source Complex (ISC3) Dispersion Models – Volume I – User Instructions*, EPA-454/B-95-003a). The stack dimensions (height and diameter), the emission rates and temperatures (Roche 2002), and the wind patterns obtained from the Dorval Airport were used in the ISC3 dispersion calculations.

The maximum air concentration of Po-210 (and Pb-210) at ground level was estimated to be 11 $\mu Bq/m^3$. For perspective on this concentration, background concentrations of naturally occurring radionuclides are highly variable, but worldwide reference values are 50 $\mu Bq/m^3$ for Po-210 and 500 $\mu Bq/m^3$ for Pb-210 (*Sources and Effects of Ionizing Radiation. Volume I: Sources*, United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), 2000). On this basis, the concentrations of Po-210 and Pb-210 due to emissions from the Niocan facility are expected to be small fractions of typical background levels.

Because of concerns raised by the BAPE regarding the potential build-up of uranium and thorium on soil over time, the total accumulation of uranium and thorium during the 17 years of Niocan operations was also estimated. The accumulation of U and Th in soil was based on the annual deposition rates of dust calculated by ISC3, and the conservative assumption that all of the deposited U and Th would remain in the top 1 cm of soil (assumed to have a density of 1.6 $tonnes/m^3$) during the 17 years of Niocan operations.

The estimated maximum soil concentrations are shown in the following table in comparison to background U and Th concentrations over the carbonatite (based on data reported for an airborne survey of the Oka area by the Geological Survey of Canada (GSC) and described in the latter and submission of Dr. Chambers to R. Faucher, Niocan, 30 April 2002, Appendix B). Also shown for comparison are estimated worldwide values for U and Th in soil (UNSCEAR 2000).

Estimated Maximum Soil Concentrations of U and Th
Due to Deposited Dust and Comparison to Background

Element	Maximum Deposition Rate ($g\ m^{-2}\ y^{-1}$)	Maximum Incremental Soil Conc. [a] (ppm)	Background Soil Conc. Over Carbonatite [b] average (range) (ppm)	Background Soil Conc. Worldwide [c] median (ppm)
uranium	1.2E-04	0.1	5.3 (<2 to 89.4)	2.9
thorium	2.4E-03	2.6	23.8 (<7 to 157.6)	7.4

a. In top 1 cm of soil; concentrations averaged over greater depths would be lower.
b Estimated from GSC airborne survey.
c UNSCEAR (2000) estimate based on U-238 and Th-232 concentrations.

Despite the conservative assumptions, the table shows that the maximum accumulations of U and Th over the 17 years of Niocan operations will be small fractions of background concentrations, in comparison to both the carbonatite and to typical worldwide values. It should be noted that the maximum deposition rates will occur on the Niocan site. Average deposition rates off-site will be much lower.

In summary, the air concentrations of Po-210 and Pb-210 due to emissions from Niocan operations and the accumulated deposition of U and Th on soil are expected to be small fractions of background concentrations.

2. Dust Emissions During Transfer of Slag and Drummed Material from the SLC Site to the Niocan Mine

Approximately 6000 tonnes (6000 Mg) of slag (chunk size) and associated rocky material, along with about 2000 tonnes of sand-like material in drums are to removed from the SLC site and transported to the Niocan site over a three- to five-year period. The slag will be handled with a front-end loader and dumped into trucks (33 tonnes/truck). Since many of the drums are corroded, any loose material will be watered to reduce emissions, and will be placed in bags on smaller trucks and hauled directly underground via the mine ramp (Personal communication, Niocan, May 2002).

On this basis, the only dust emissions to the environment from these materials will be during the loading of the slag and drummed material at the SLC site, and the dumping of the slag into a shaft at the mine site. Emissions during these operations were estimated using standard emission factors (empirically-based) provided by the U.S. EPA (1995) (*Compilation of Air Pollutant Emission Factors AP-42, Fifth Edition, Volume 1: Stationary Point and Area Sources*, Section 13.2.4 Aggregate Handling and Storage Piles). The quantity of dust emissions per tonne (Mg) of material moved is dependent on windspeed, moisture content of the material, and the particle size of the emitted dust.

Based on an average windspeed of 4.2 m/s (*Climate Normals*, Dorval International Airport, 1961-1990), and a moisture content of 1% for the slag (AP-42 gives a mean of 0.92% (range of 0.25% – 2.0%) for slag from iron and steel production), the total dust (all particle sizes) emitted during loading and dumping the 6000 tonnes of slag would be 86 kg. Assuming that this material is moved in three years, the annual emission rate would be about 29 kg/y of slag. (This is probably an overestimate considering the chunk-like nature of the slag.)

For the 2000 tonnes of drummed sand-like material (assuming a nominal moisture content of 5% - AP-42 gives a moisture content of 7% for sand), if it is conservatively assumed that 100% of the drums collapse and all the material is loose during loading, the total emissions during loading would be 1.5 kg, or an annual rate of about 0.5 kg/y. The emission rate is dependent on the assumed moisture content of the sandy material (5% versus the 1% for the slag), but this calculation assumes no reduction in dust emissions by watering the material during loading.

On a mass basis, these dust emissions are extremely small and insignificant relative to the annual emissions from other sources on the site, such as the pyrochlore concentrate dryer (750 kg/y), the material mixer (125 kg/y), or the ferroniobium plant (395 kg/y) (Roche 2002 - letter of 8 May 2002 from Roche to M. Yves Dansereau, Ministère de l'Environnement).

Considering releases of uranium and thorium, based on concentrations of 800 and 15,000 mg/kg of U and Th respectively in the slag, there would be 0.02 and 0.44 kg/y of U and Th released with the slag over the three-year period the slag is moved. These are small fractions (less than 4%) of the estimated annual releases of 0.58 kg/y and 12.1 kg/y of U and Th respectively during the 17 years of Niocan site operations (Roche 2002). For the drummed material, based on average concentrations of 44 and 72 mg/kg of U and Th respectively (Personal communication, Roche, June 2002), the emissions of U and Th will each be less than 10^{-4} kg/y when the material is moved. The results are summarized in the following table.

Comparison of Dust Emission Sources

Sources	Annual Emissions (kg/y)		
	Total Dust	Uranium	Thorium
Dryer (CP01), mixer (CP02) and ferroniobium plant (CP03) [a]	1270	0.58	12.1
SLC slag [b]	29	0.02	0.44
SLC material in drums [b]	0.5	$< 10^{-4}$	$< 10^{-4}$

a. During 17 years of operation.
b. During 3 years of moving SLC material.

In summary, the dust emissions during the transfer of slag and other material from the SLC site to the Niocan mine will be insignificant relative to total dust emissions.

3. Emission of Radon During the Flooding of the Mine Openings – The "Piston Effect"

After Niocan mining operations have ceased, pumping of the groundwater will also cease. The groundwater will then revert to previous levels over a period of one year or more that it will take to fill the mine openings (Personal communication, Niocan, May 2002). Some concern has been expressed to the BAPE that the flooding of any mine openings at the end of operations will cause large amounts of radon to be released to the atmosphere. The rate of radon release due to this "piston effect" can be conservatively estimated as follows.

The maximum volume of underground mine openings at the end of mining operations will be 300,000 m^3 (Personal communication, Niocan, May 2002). If it is conservatively assumed that these openings contain radon at the same concentrations as the pore or void spaces of the ore in the mine (at 20 ppm uranium and a density of 3 tonnes/m^3), and that the average void fraction of the ore is 5%, the maximum concentration of radon in the pore spaces, and hence the underground openings, is estimated to be 3×10^6 Bq/m^3. (It should be noted that much of the mine would be backfilled by this time, with the result that the average uranium concentration around the mine openings would be less (by about a factor of 4) than the 20 ppm assumed here.)

If all this radon in the mine openings is emitted over a one year period as the mine is flooded, the emission rate of radon during that year would be about 3×10^4 Bq/s. For perspective, this is 30% of the estimated emission rate of radon of 1×10^5 Bq/s that would occur during the 17 years of mining operations (Letter and submission of Dr. D. Chambers to R. Faucher, Niocan, 30 April 2002 , Appendix B).

In summary, the emissions of radon during the flooding of the mine openings will be smaller and of much shorter duration than the emissions during mine operations. Since emissions during mining will result in radon concentrations within the normal variations of background radon (Submission of Dr. D. Chambers, Appendix B), the potential impacts of emissions of radon during flooding of the mine openings (the "piston effect") will be even smaller and inconsequential.

In closing, I trust that this letter provides appropriate responses to the issues raised by the BAPE. I would be pleased further information or answer any questions you may have.

Yours truly,

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Leo M. Lowe, Ph.D.
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