



APR 27 2016

Dr. Gordon Edwards
Canadian Coalition for Nuclear Responsibility
53 Dufferin Street
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Dear Dr. Edwards,

Thank you for your letter dated April 11, 2016 (enclosed). Your comments and questions provide us with another opportunity to explain the scientific basis on which the Canadian Nuclear Safety Commission's (CNSC) position rests. This letter will provide clarity and closure regarding the risks to uranium miners from exposure to radon decay products (RDP).

For many years, radon has indeed been recognized as a hazard to underground miners. Radon was identified as a human lung carcinogen in 1988 by the International Agency for Research on Cancer, which is part of the World Health Organization. Epidemiological studies of historic uranium mine workers showing increased risk of lung cancer are the scientific basis for the current requirements for strong radiation protection measures in modern uranium mines. The CNSC's strict enforcement of radiation protection requirements is the reason the levels of RDP exposure of modern miners are so low. For example, RDP levels were 0.1 working level months (WLM) (equivalent to 0.5 millisieverts (mSv)) or lower for every year between 2001 and 2013. Current doses are almost 1,000 times lower than they were in the 1940s and 1950s.

As mentioned in your letter, the recent Cancer Care Ontario (CCO) report titled *Ontario Uranium Miners Cohort Study* stated that the cohort of uranium miners as a whole had a significantly increased risk of lung cancer mortality and incidence when compared to the general Canadian population. Taken in isolation, this finding does not tell the complete story. The report goes on to state that a subset of modern miners (starting employment after 1970) had similar risks to the entire cohort for the same dose categories. In other words, lower doses yielded lower risks, which were generally not statistically significant. The CNSC staff presentation in question correctly concluded that the true risk to modern miners is in line with what is expected for the general Canadian population. We stand behind our conclusions.

70 years of nuclear safety in Canada / 70 ans de sûreté nucléaire au Canada

The CNSC could have elaborated on the scientific evidence supporting our conclusions regarding the CCO report with the following:

- The statistically significant increased risk conclusions were based on external comparisons (section 5.1) of the entire cohort with the general Canadian population, with no consideration of the worker doses. After a critical review of the report, CNSC staff found the internal analyses (section 5.2) of radon exposure and lung cancer mortality and incidence diminished the statistical significance when the dose-response relationship was taken into account.
- In reference to table 56 (section 5.5), modern miners have similar risk levels as that of the entire cohort for the same dose categories. In the lower dose region, the risks are low. The confidence intervals for every relative risk value in table 56 spans 1; this means that these modern miners could have lower, the same or slightly higher risks than the unexposed workers (those who received 0 WLM).
- The limitations of this study should be considered when interpreting the results. The study did not include data on potential cofounders and co-exposures of radon decay products including: smoking status or exposures to crystalline silica, diesel exhaust, arsenic, and nickel. The lack of data on lung carcinogens warrants further investigation to determine their contribution to risk.

There are several issues regarding the challenging comments (a-d) made on page 2 of your letter:

- a) Excess relative risk (ERR) is an epidemiological risk measure that quantifies the additional risk of exposed persons, over and above the risk level of non-exposed persons that can be attributed directly to a given exposure, such as radiation. As stated in the CCO report [10]: the ERR for lung cancer mortality per 100 WLM was 0.66 (95% CI: 0.44-0.87) and the excess relative risk for lung cancer incidence per 100 WLM was 0.64 (95% CI: 0.43-0.85). ERR values are not, and should not, be called mortality factors; that is a grossly inappropriate representation of risk.
 - b) In Canada, nuclear energy workers are limited to 50 mSv in a one-year dosimetry period and 100 mSv over a five-year dosimetry period. Regulatory dose limits apply to a worker's total effective dose and are not limited to radon progeny. By law, as required by the *Radiation Protection Regulations*, the application of the ALARA principle keeps doses as low as reasonably achievable, with social and economic factors taken into account. Strict controls (both engineered and administrative) are in place in uranium mines and mills which ensure that those uranium miners' exposures to RDP are very low and in line with the ALARA principle. For this reason, discussing continuously elevated exposure situations which do not occur under CNSC regulatory oversight is of little value.
 - c) It is not appropriate to multiply small dose values by large groups of people to obtain a number of deaths or cancer cases. This is not grounded in science; it is in fact discouraged by all international scientific bodies.
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- d) Given the inappropriateness of statement (c), CNSC staff conclude that the manipulation of the values in statement (d) are incorrect and misleading. Your math is incorrect. The CNSC regulatory framework establishes appropriate dose limits and ALARA requirements to maintain the health and safety of workers and members of the public. We do not regulate based on inflated risk projections grounded in overestimated doses.

There is sound and current evidence that the risk of lung cancer to uranium miners is no higher than for the general Canadian population. While the CCO study does assign an excess relative risk to RDP exposure, the impact of that risk on health outcomes is small. Given the low exposure levels of modern miners, their risk of lung cancer is indistinguishable from the risks to the general Canadian population. The CNSC will continue to ensure that doses and therefore risks to all workers and members of the public remain low.

As always, we encourage you to visit our website at nuclearsafety.gc.ca to get the facts about uranium mining, and to access the vast amount of health-related research published in peer-reviewed scientific journals.

Yours sincerely,



Michael Binder

Enclosure: (1)

c.c.: The Right Honourable Justin Trudeau, Prime Minister of Canada
The Honourable Catherine McKenna, Minister of Environment and Climate Change (Canada)
The Honourable Jim Carr, Minister of Natural Resources (Canada)
The Honourable Philippe Couillard, Premier of Quebec
The Honourable Pierre Arcand, Minister of Energy and Natural Resources
The Honourable David Heurtel, Minister of Sustainable Development, the Environment and the Fight Against Climate Change



PAR COURRIEL

Michael Binder, President,
Canadian Nuclear Safety Commission.

April 11 2016.

Dear Dr. Binder:

I have received your e-mail of March 29, 2016, replying to my recent critique of the January CNSC presentation to the Quebec Interministerial Committee. You say in your response, "*Our presentation is based on solid science, research and decades of regulatory experience.*"

But you fail to retract a false assertion in the CNSC presentation concerning the findings of a 2015 scientific report on lung cancers in Ontario's uranium miners. The report in question, "Ontario Uranium Miners Cohort Study Report", was funded by CNSC and carried out by the Occupational Cancer Research Centre. [www.nuclearsafety.gc.ca/eng/pdfs/RSP-0308.pdf].

The CNSC presentation states "a recent epidemiological study of the Ontario uranium miners cohort (1965–2007) *showed that their risk for lung cancer was no higher than for the Canadian population*". [CNSC, p.20] This statement is completely false. The OCRC report *found that the mortality rate from lung cancer among the cohort of Ontario uranium miners is 34 percent greater than for the Canadian population, and the incidence of lung cancer in the same cohort is 30 percent higher than for the Canadian population.* [OCRC, p.iii]

The OCRC report also states that "*miners who started employment after 1970 had similar risks of lung cancer mortality to the full cohort for the same categories,*" [OCRC, p.75] and that "*lung cancer mortality and incidence rates were persistently elevated overall and across sub-cohorts*" [OCRC, p.84]. How does the phrase "persistently elevated" become translated by CNSC staff into the phrase "no higher than for the Canadian population" ?

The OCRC report concludes: "*This study confirms what is known about underground uranium miners, which is that they have an increased risk of lung cancer.*" [OCRC, p.82]

That concluding statement is not subject to any qualifications or reservations of any kind. It is strikingly different from the statement made to the committee by the CNSC, which implies that the study reached the exact opposite conclusion. In the view of CCNR, this misrepresentation of the results of a scientific study is inconsistent with the CNSC's obligation to disseminate objective scientific information (Nuclear Safety and Control Act, Article 9b).

To say OCRC found no increase in lung cancer in uranium miners could not be farther from the truth. The OCRC web site states: "*Over 30,000 men were employed to extract uranium from deep underground mines in Ontario from 1954 through 1996. Despite economic benefits, mining uranium is a dangerous occupation with potentially fatal long-term consequences. One example is the excess of lung cancer mortality associated with radon decay products that has been well demonstrated in uranium miners worldwide.*" [<http://tinyurl.com/z6b5gpc>]

Nevertheless, CNSC staff argues that less than one lung cancer death would occur in a population of 24,000 miners, based on risk factors in the OCRC Report, and concludes :

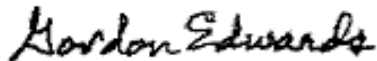
"while the [OCRC] study does assign an excess relative risk to [radon] exposure, the impact of that risk on health outcomes is so small, given the low exposure levels of modern miners, that lung cancer risks to current uranium miners are indistinguishable from the risks to the general Canadian population." [E-mail from M Binder, March 29 2016]

CCNR challenges this conclusion, and the appropriateness of your endorsing such a conclusion.

- (a) The OCRC study reported a 66 % increase in lung cancer mortality per 100 WLM of radon exposure, compared with those unexposed. *Note: the WLM (Working Level Month) is a unit of human exposure to radon.* CNSC staff chooses to use a lower mortality factor – 64% instead of 66%– taken from a different study. We will use CNSC’s chosen number.
- (b) The current regulatory limit for radon exposure of miners is 4 WLM per year, the same as it was 40 years ago. CNSC’s presentation to the Quebec Interministerial Committee [p.20] describes this limit as an "international safety standard". But a miner exposed at this level during a 45-year working lifetime would accumulate 180 WLM of radon exposure, and **according to the CNSC risk figures cited above, 180 WLM gives an increase in lung cancer mortality of $64 \times 1.8 = 115$ percent – more than double the expected number of lung cancer deaths.** Nevertheless, CNSC has kept this "safety standard" for 40 years.
- (c) Actual radon exposures are less than the regulatory limit. CNSC publication INFO-0813 shows that the average 2006 radon exposure for Canadian workers in underground uranium mines was 0.1854 WLM (per year). That rate of exposure gives an accumulated lifetime radon exposure of 8.343 WLM.* [see Technical Note] **Using CNSC’s mortality factor, this exposure would cause a 5.3% increase in lung cancer mortality.** Most oncologists would regard a 5 % increase in lung cancer mortality as a matter of concern. In a population of 24,000 miners it represents about **60 additional radiation-induced lung cancer deaths.**
- (d) CNSC says the excess relative risk for lung cancer mortality could range from 42% to 86% per 100 WLM ; 64 % is just the midpoint of the interval, and is of uncertain validity. Using the upper end-point of the interval, and repeating the same calculations as before, we get **a projected 7.1 percent increase of lung cancer mortality.** In a population of 24,000 underground miners, that would correspond to **about 80 extra lung cancer deaths**

As a federal agency charged with protecting the health and safety of workers and the public, we feel that CNSC should be overestimating rather than underestimating potential harm to workers – especially when that harm is a matter of life and death.

Yours very truly,



Gordon Edwards, Ph.D., President,
Canadian Coalition for Nuclear Responsibility.

- cc. The Right Honourable Justin Trudeau, Prime Minister of Canada
The Honourable Catherine McKenna, Minister of Environment and Climate Change (Canada)
The Honourable Jim Carr, Minister of Natural Resources (Canada)
L’Honorable Philippe Couillard, Premier Ministre du Québec
L’Honorable Pierre Arcand, Ministre de l’Énergie et des Ressources naturelles (Québec)
L’Honorable David Heurtel, Ministre du Développement durable, de l’Environnement, et de la Lutte contre les changements climatiques (Québec)

See Technical Note, next page →

*** Technical Note :**

According to CNSC publication INFO-0813, the average radiation exposure for Canadian workers in underground uranium mines in the year 2006 was 1.74 millisieverts (mSv) and 53.3 percent of that exposure was due to radon and its decay products ; thus $1.74 \times .533 = 0.927$ mSv radiation equivalent exposure from radon.

According to the Canadian Centre for Occupational Safety and Health (CCOSH), one WLM of radon exposure is equal to five millisieverts of radiation equivalent. [www.ccohs.ca/oshanswers/phys_agents/ionizing.html]

So the average 2006 radon exposure for underground uranium miners, as reported by CNSC, was about $0.927 / 5 = 0.1854$ WLM.

G. Edwards.

References :

Regulation des mines et usines de concentration d'uraniums, 22 janvier 2016, P. Thompson, powerpoint presentation to Quebec Interministerial Committee on Uranium in Quebec, www.ccnr.org/CNSC_BAPE_Jan22_2016.pdf

Truth and Consequences, Feb 22/16, G. Edwards, a critique of CNSC's presentation to the Quebec Interministerial Committee on Uranium in Quebec. www.ccnr.org/CCNR_CNSC_Feb22_2016.pdf

Reply from Michael Binder to Gordon Edwards, March 29, 2016. www.ccnr.org/Binder_reply_March29_2016.pdf

Ontario Uranium Miners Cohort Study Report, Feb 2015, OCRC. www.ccnr.org/OCRC.pdf
