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16 May 2002

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

Re : Emission of Radon from Slag (scories)

Dear Mr. Faucher,

In our meeting in Montréal on 13 May 2002 with the BAPE, one of the issues discussed concerned the potential emission of radon from slag containing above-background concentrations of uranium and thorium. This letter addresses that issue.

First, it should be noted that the slag to be produced by Niocan, as well as the historical slag on the Saint Lawrence Columbium (SLC) site, will be buried underground in the future Niocan mine near Oka. Therefore, any potential radon emissions from the slag will have no environmental impacts. Second, as discussed below, based on the nature of the slag and experience with radioactive slag resulting from the production of elemental phosphorus (phosphate ore also contains above-background concentrations of uranium), the radon emissions from the slag will likely be very low relative to the radioactivity in the slag.

There are a number of publications that discuss radon emissions from phosphate slag. Attached are extracts from three documents, including two produced by the United States Environmental Protection Agency (U.S. EPA). The first EPA document ("Idaho Radionuclide Study", EPA/520/8-90/008, April 1990 – cover and first page only) addresses the potential radiological impacts of slag that had been used widely as aggregate in road and house construction in Idaho. (This is the same type of slag that is disposed on surface (10^6 tonnes) at the decommissioned phosphorus refinery at Varennes, Québec, and also in Long Harbour, Newfoundland.) As stated at the bottom of page 1 of the report, "*Conspicuously absent were the elevated radon concentrations expected to originate from phosphogypsum [a by-product of phosphate fertilizer production]; radon levels were found to be indistinguishable from background.*"

The second EPA document ("EPA Fact Sheet – Questions & Answers on the Health Risks of Radioactive Slag", August 1990) states at the bottom of the second page that "*Radon does not come from slag*".

The third attachment is from Appendix F ("Radiation Survey of Long Harbour, Newfoundland") of a report by the Canadian Public Health Association ("Final Report - Task Force on Fluoride – Long Harbour, Newfoundland", 1978). Slag had been used as fill around homes in Long Harbour. The report states: *"Measurements of radon daughters [decay products of radon] in 80 dwellings in the community of Long Harbour showed no raised levels at all"* (p. 134) and *"A small but completely negligible increase in radon daughter levels was found to be associated with the use of slag in and around the dwellings"* (p. 135).

This experience relates to radon-222 ("radon") produced from the radioactive decay of radium-226 in the natural uranium (uranium-238) decay series. Another radon gas (radon-220 or "thoron") is produced in the natural thorium (Th-232) decay series. However, thoron has a very short half-life (55 s) compared to radon (3.8 days) and therefore has even less environmental impacts.

The phosphate slag (and the future Niocan slag) is produced in a high temperature process and thereby develops the material characteristics of ceramic or glass. It is very impervious to the flow of liquids (not leachable) or gasses. The radon produced in the slag is transformed by radioactive decay to solid (non-gaseous) radionuclides before it can escape from the slag. It is for these characteristics that various international authorities recommend that high-level radioactive wastes be vitrified (glass-like material) before they are permanently disposed.

Based on the analysis of the SLC slag, the future Niocan slag will contain more radium-226 than phosphate slag (10-13 Bq/g SLC slag versus about 2 Bq/g in phosphate slag). However, the principle of low radon emissions remains because of the nature of the slag.

In summary, because the Niocan and SLC slag will be disposed underground, there will be no environmental impacts of any radon emissions from the slag. In any case, the ceramic-like nature of the slag will result in very low radon emissions relative to the radioactivity of the slag.

Yours truly,

SENES Consultants Limited

Leo M. Lowe, Ph.D.
Principal, Senior Health and
Environmental Physicist

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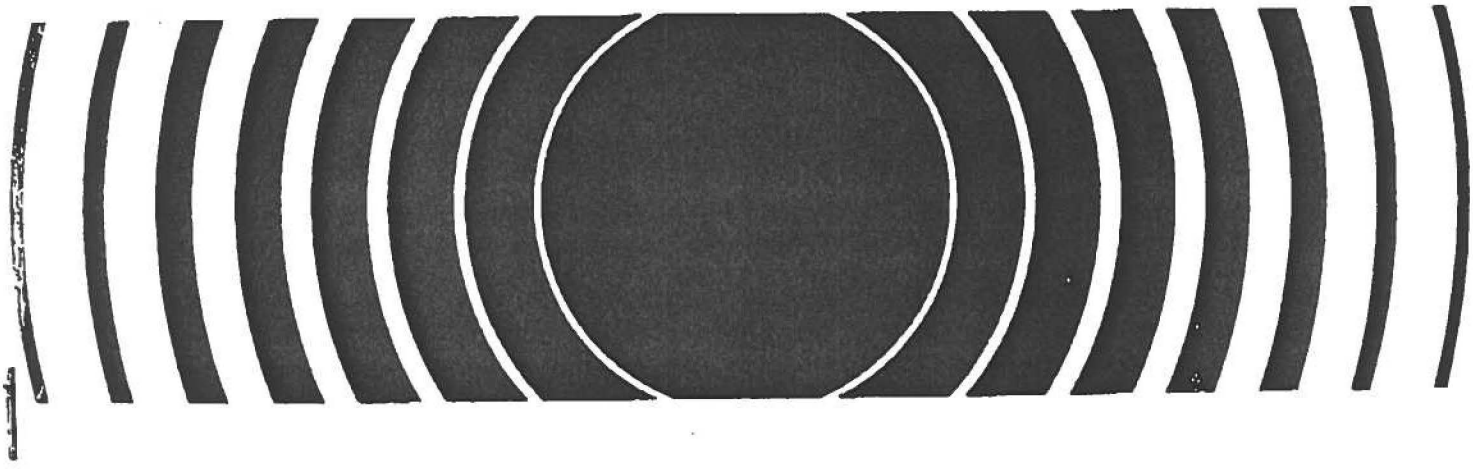
EPA/520/6-90/008
April 1990

EPA

Radiation

Idaho Radionuclide Study



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INTRODUCTION

In 1979, the U.S. Environmental Protection Agency (EPA) listed radionuclides as hazardous air pollutants and was required by the Clean Air Act to issue emission standards for radionuclides. In October 1984, EPA was ordered by the U.S. District Court, Northern District of California, to issue standards for elemental phosphorus plants and other source categories under Section 112 of the Clean Air Act.

Phosphorus ores contain approximately 60 times the levels of natural radioactivity normally found in the Earth's crust. Some of the radioactivity is released to air and water during processing of the ores, and some is distributed in the environment through the use of solid byproduct wastes. The EPA has established a radionuclide standard limiting polonium-210 (Po-210) air emissions per elemental phosphorus plant to 2 curies per year (Ci/y).

At the issuance of the standard in 1985, EPA stated:

> "The areas surrounding two plants, the FMC plant in Pocatello, Idaho and the Monsanto plant in Soda Springs, Idaho are characterized by high total levels of radiation from a variety of sources. The storage and widespread use of slag, and possibly other waste products from these plants, have significantly increased the natural background radiation levels in parts of the communities. In particular, phosphate slag from these plants has been widely used in aggregate in road and house construction in these areas. EPA and the State of Idaho will initiate a total assessment of the various sources and will investigate ways to reduce or prevent risks from growing."

In 1987, the U.S. Environmental Protection Agency's (EPA) Office of Radiation Programs' Las Vegas Facility (ORP/LVF) contracted with Battelle's Pacific Northwest Laboratory (PNL) to conduct a study to determine the radiation exposure to Pocatello and Soda Springs residents from the local phosphorus industry that had been operating for several decades.

The objective of the study was to determine the magnitude and relative importance of the various industrial sources of radiation and to estimate the dose to the affected populations. Following a review of pertinent literature, two components were considered to be most significant: gamma dose and risk estimates from using elemental phosphorus wastes, and the dose and risk estimates due to air emissions from the phosphorus plants. Conspicuously absent were the elevated radon concentrations expected to originate from phosphogypsum; radon levels were found to be indistinguishable from background.

EPA
Region 10
1200 Sixth Avenue
Seattle WA 98101
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Idaho
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(1)

August, 1990

EPA Fact Sheet

Questions & Answers on the Health Risks of Radioactive Slag

In May 1990, EPA officially released the Idaho Radiounclide Study. The study revealed that some citizens in Pocatello and Soda Springs may be at elevated risks of contracting cancer due to long-term exposure to radioactive slag in foundations, streets and sidewalks. In June, almost 200 citizens from the Pocatello and Soda Springs area responded to an EPA questionnaire and many more attended public meetings on the issue.

This Fact Sheet was prepared to respond to the diverse range of questions and concerns raised by citizens. We wish to thank those of you who took the time to respond to the questionnaire and to attend the public meetings. Citizen involvement is essential both for the community and for EPA. It is EPA's hope that, by involving the community early in the process, decisions can be made which will protect the health and well-being of the affected communities.

Questions and Answers:

We have chosen questions and concerns which are most representative of the many received. The questions and concerns fall into four main categories:

- Information about health risks
- The scientific validity of the report
- Possible economic impacts
- Plans for the future

Information about health risks

I live in Pocatello. After all the concerns raised about Pocatello, why has Soda Springs been singled out for additional study?

The Radionuclide Study has documented the use of slag in the foundations of a number of homes in Soda Springs, however, the study did not reveal slag foundations in any of the residential foundations tested in Pocatello. People living in slag-containing homes have the highest potential risk for exposure to radioactive slag because of the large amount of time spent in the home as opposed to on the street. For this reason, EPA will first be focusing on voluntary home testing for radiation in Soda Springs.

EPA will conduct follow-up investigations in Pocatello to verify whether or not slag was used in residential foundations there. Similar investigations may be undertaken in other communities as well.

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During what years was slag used in foundations for homes?

Slag was used in some residential foundations from the 1950's to 1977. In 1977, because of concerns about radiation exposure in homes, the State of Idaho issued a memorandum recommending a voluntary ban on the use of slag in residential foundations. EPA has reason to believe that this ban was observed for the construction of new homes. It is possible, however, that some slag may have been used in houses built before the 1960's or after 1977 as a part of remodels or do-it-yourself additions.

My house was built in the early sixties and has a slag foundation. What are my and my family's risks?

Until your home is tested and we know the actual, if any, levels of radiation, it is not possible to estimate the risks to you or your family. For this reason, EPA encourages you to participate in the voluntary testing program.

The risk to individuals from slag is directly related to the time spent in close proximity to radioactive slag. People who spend most of their time in a slag-containing basement, for example, are likely to have greater radiation exposures than people living primarily on the second floor of the same house. You can decrease the risk levels to members of your family by decreasing their exposure to slag.

Are children at greater risk because of their small size and developing bodies?

There is some evidence that children may be at greater risk from radiation exposure than adults. This is because a child's cells divide more rapidly than an adults and radiation damage to a cell is most likely to occur while the cell is dividing. Exposures late in life are less likely to result in cancer than those earlier in life because cancer can take many years to develop. An older individual may die from some other cause before the cancer develops. This "latency period" can be 20 years or more.

Isn't the slag pile at the plant the biggest danger? How far away do you have to be to be safe?

Once slag is several inches thick, radiation emitted from deep within the pile is absorbed or shielded before it can be released into the environment. For this reason, the huge slag piles emit little more radiation than a slag paved road or parking lot. In addition, once people get several yards away from the source of slag, their radiation exposure decreases rapidly. For example, if a person walks off a slag containing road onto an open field, the radiation exposure will decrease dramatically within a few yards.

What is being done to clean up the air pollution due to the plants?

EPA regulates these emissions. The main source of radiation exposure from air emissions from elemental phosphorus processing is Polonium 210 (a radioactive isotope) which is released into the air as a stack emission. In Soda Springs, Monsanto has already installed stack emission controls which meet the Federal standards. In Pocatello, FMC has committed to meet the standards within two years.

I thought that the main problem in this area was radon. Is EPA going to be doing something about radon?

Radon is a naturally occurring radioactive gas which is known to cause lung cancer. Radon does not come from slag. Anyone having their homes tested for slag radiation by EPA can also have their home tested for radon at no charge, as a courtesy for the participants. (EPA will be issuing a fact sheet on radon and gamma rays in the near future.)

(3)

Isn't it true that you get more radiation from the sun than from slag?

For the most part, the sun exposes people to light, which is a different form of energy than the radiation from slag. It generally does not penetrate deep into the body like the ionizing gamma radiation from slag. Over-exposure to the sun is most often associated with skin cancer. For many people in southeast Idaho, slag causes a larger exposure to radiation than does the sun and this exposure can cause a wide variety of cancers.

How do the risks you describe compare to other risks like smoking?

Smoking, drinking, hang-gliding and the like are voluntary activities and each can lead to a substantial increase in a persons overall health risk. We all know that smoking greatly increases one's chances of getting lung cancer and hang-gliding involves the substantial risk of an accident, but these are risks some people are willing to accept because they receive enjoyment from the activities.

Slag, however, is an involuntary risk. Exposure to slag is something that we would all be wise to avoid if we could, but many have no choice. In much the same way that air pollution poses an involuntary risk to the general populations of large industrial cities, slag poses an involuntary risk to many people in southeast Idaho. Such health risks should be minimized or avoided. These risks can be reduced by society through the cooperation of industry, federal, state, and local governments.

The Radionuclide Study makes many assumptions about exposure to slag, including a 70 year lifetime of exposure. Most people will never be exposed for that long. How would a ten year exposure effect me?

Risk due to radiation is believed to be roughly proportional to the duration and amount of the exposure. For consistency of technique and comparison, EPA and other health agencies base their studies on a 70 year lifetime of exposure to the hazard that is being studied. In terms of risk numbers, a person with only 10 years exposure would have 1/7th the risk of a 70 year exposure. As noted earlier, however, exposures late in life are less likely to result in cancer than those earlier in life due to the "latency period" for cancer development which can be as much as 20 years.

I've been reading about the people who were exposed to radiation because they lived downwind from Hanford, Washington where plutonium was produced for the atomic bomb during the war. How does our exposure to radiation compare to the "downwinders"?

The problem at Hanford was much more serious than the problem in Pocatello or Soda Springs. The people exposed to the most radiation near Hanford had many times the maximum exposure of anyone from slag in southeast Idaho. In addition, many more people were exposed to radiation from Hanford. The major health risk to the "downwinders" was and is thyroid cancer due to milk contaminated with radioactive iodine.

Why is there so much uncertainty about the effects of low-level radiation?

Much of our knowledge about radiation health risks is based on studies of large populations of humans who received large one-time doses of radiation, like the Hiroshima survivors. Based upon these studies and the growing body of scientific evidence on lower level exposures (often associated with medical procedures), risk estimates for long-term, low-level radiation exposure have been developed. Because the low-level risk calculations are based on assumptions which are difficult to scientifically prove or disprove, some members of the scientific community are apparently willing to contend that radioactive slag does not pose a significant health risk. However, the National Academy of Sciences recently concluded that there is at most a 5% chance that there is no health risk at radiation levels such as those observed in Pocatello and Soda Springs due to slag.

The scientific validity of the report

Did anyone besides EPA evaluate this study?

The Idaho Radionuclide Study was reviewed at several stages. The study design was reviewed by the independent EPA Science Advisory Board (SAB), the EPA Office of Radiation Programs reviewed the final draft of the study, and the independent Agency for Toxics and Disease Registry (ATSDR) of the Public Health Service reviewed the final report prior to its release.

A number of elected officials have indicated their desire to have the SAB review the final study. EPA has sent copies of the final report to members of the SAB Radiation Advisory Committee. We will be providing them with a briefing on the study at their next meeting on October 23, 1990. The SAB will hear how EPA carried out the sampling protocol, what data was obtained and how EPA applied this data to develop estimates of risk to the community.

The Radionuclide Study concludes that we are at an increased risk of cancer due to slag. How, then, can our area have one of the lowest cancer rates in the country if slag is such a health problem? I have worked with slag for over 30 years, and I don't know of a single person who has gotten cancer from slag. What kinds of cancer are associated with radiation?

Approximately 25% of Americans will die of cancer. Cancer is caused by many competing factors. Exposure to low-level radiation from slag is associated with a wide range of cancers. Because people are typically exposed to many different cancer causing agents during their lifetimes, it is almost impossible to know the exact cause of an individual cancer.

The total number of observed cancers in southeast Idaho is low by national standards. Healthy lifestyles, rural living, a low incidence of smoking and drinking could all contribute to the lower overall incidence of cancer in this area, thus masking any increase cancer rate due to slag. Exposure to slag is expected to account for only a small percentage increase in the total number of cancer deaths. It is virtually impossible to detect small increases in the incidence of cancer in small populations like in southeast Idaho. We can say that reducing exposure to radioactive slag is likely to reduce an individual's chance of contracting a fatal cancer.

EPA has wasted taxpayer's money on a study that is based on too many assumptions and poor science.

The Radiounclide Study is based on the best information currently available both regarding slag and the possible health effects of long-term, low-level radiation exposure associated with slag. We recognize that some people have been frustrated about the uncertainty inherent in the study. This is why the voluntary radiation testing of homes in Soda Springs is so important. It will give us a much better understanding of the extent of the problem and it will give us the information we need to identify precisely which homes are contaminated and help us decide what should be done to best protect public health.

Economic Impacts

This report was presented to intentionally alarm the residents unnecessarily. This will hurt our economy.

EPA has no desire to alarm the community. However, we have learned from experience that it is best to candidly and honestly inform the public of potential health risks as soon as they are known. Otherwise, EPA would be guilty of withholding information from the public.

Some have suggested that we should not have come to the public until we had all the questions answered and all the solutions in place. This would have made it impossible for EPA to involve the community in developing solutions. By discussing the report with the community from the outset, EPA can involve you in making decisions which will affect your own community.

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What are the consequences of banning slag? What are the other sources of aggregate for use on roads and highways? How do the costs compare?

In terms of roads and highways, the cost of natural aggregate (gravel, etc.) is more than for slag. Therefore the cost of road repair and construction would go up. In addition, the companies that sell slag would lose this source of revenue. This could impact some jobs.

I understand that both Eastern Michaud Flats (including FMC and Simplot) and Monsanto could be listed as Superfund sites by EPA. Is this because of the slag problem?

No. Eastern Michaud Flats and Monsanto are under consideration as Superfund sites mainly because of groundwater contamination due to heavy metals. EPA should know if these sites will be listed as Superfund sites by the end of August. If listed, it is possible that slag in addition to other contaminants could be investigated and added to the list of problems needing attention.

Is it true that EPA has immediate plans to tear up our streets and sidewalks?

No. This would be both disruptive and impractical. EPA plans to involve the communities in determining a long term course of action for dealing with streets and sidewalks. Currently, a specific decision on the need for road or sidewalk remediation has not been made. However, if remedial action is deemed necessary, we anticipate that it can be achieved over a period of 15 to 20 years as a part of State and Local road maintenance programs.

Plans for the future

How am I going to have an impact on what happens to me and my home? Isn't it up to each citizen to decide whether or not to take the risk, just like we decide to smoke or drink?

Yes. It will be up to each homeowner to decide whether or not to have their home tested. If a problem is found, the homeowner will decide whether not or they want corrective action to be taken. The two decisions are separate. A decision to have one's home tested does not commit one to home remediation.

What if I have a slag problem in my home and I want to do something about it?

EPA is currently exploring the most cost-effective options for reducing or eliminating the exposure to radiation from slag in homes. In cooperation with the homeowners, EPA will develop a plan for reducing radiation levels on a house by house basis for those homes exceeding the "action levels".

What is going to happen next?

Throughout the process of addressing the phosphorous slag problem, community involvement will be critical. We are now developing a Community Relations Plan based on the input we are receiving. While our immediate focus is on Soda Springs, it is important that other communities be kept well informed and that they be involved in the decision making process as it effects them.

Later this year, EPA will distribute a proposed sampling plan for home testing and options for "action levels" for homes. (The action level which is finally selected will represent a radiation level above which EPA recommends that corrective action be taken.) Following the release of the proposed sampling plans and action levels, there will be a 30 day public comment period. EPA representatives will be available in the communities during the comment period to answer questions and to solicit verbal and written testimony.

After the public comment period, EPA will address community comments, questions and concerns in writing. Community input will be important in helping EPA make the final decision concerning testing methods and action levels. A final sampling plan and action level should be released about one month after the public comment period is over.

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FINAL REPORT

CANADIAN PUBLIC HEALTH ASSOCIATION

TASK FORCE ON FLUORIDE

Long Harbour, Newfoundland

(1978)

during the full shift and heavy equipment would act as a shield.

In the pellet plant, the radiation levels were much lower, primarily due to the presence of much less phosphate and to greater separation from the radiation source. The highest level observed was only twice the normal background.

The only other area with increased radiation levels within the plant itself was the slag discharge chute and the slag pit area. This reflects the fact, confirmed by laboratory analyses, that the slag contains all the radioactive materials which were present in the phosphate feed. The general radiation level observed was 40 μR/h, with values up to 80 μR/h at the edge of the slag pit. The radiation exposure received by workers in these areas will, therefore, be lower than the permitted level.

The slag dump was found to have a gamma radiation level of 110 μR/h. This value is identical to that shown by the phosphate ore stock pile. It is calculated that the radiation exposure of workers operating yard equipment and trucks would be less than one-half of the amount considered permissible for members of the public.

All areas of the plant in which radon and radon daughters could accumulate were measured. The only area showing a positive result was the ore storage shed. Because of the large amount of phosphate ore and pellets present, a small but detectable increase of radon daughters to 0.003 WL occurred. This is a negligible level, comparable to normal background levels. Apart from a barely detectable level of 0.001 WL in the laboratory building, radon daughter levels were zero at all other locations tested within the plant.

With only very low levels of radioactivity in the phosphate ore, dust arising from its handling, grinding, pelleting, drying, and conveying to the furnaces would also have only low concentrations of radioactive materials. The radiological hazards would be insignificant compared to any hazard which may be caused by the minerals in the dust. As this area of occupational health was being studied by the Task Force on Fluoride, measurements were not undertaken in this study.

b) Long Harbour and Neighbouring Communities

Measurements of radon daughters in 80 dwellings in the community of Long Harbour showed no raised levels at all. The highest level was 0.016 WL. As these observations were made under winter conditions with doors and windows closed, the survey results reflect the highest values to be expected. The annual average, on which any evaluation of health effects should be based, will be much lower.

A total of 64 homes was surveyed in the neighbouring communities of Blaketown, Chapel Arm, Dunville, Long Cove, Mount Arlington Heights, Norman's Cove, and Whitbourne. Although crushed slag was known to have been used in all these communities except Mount Arlington Heights, the radon

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daughter levels were not high. The highest level measured in a home associated with slag was 0.016 WL, the same maximum as the homes in Long Harbour.

A small but completely negligible increase in radon daughter levels was found to be associated with the use of slag in and around the dwellings. The effect was discernible only by a graphical comparison of a large number of homes.

The presence of slag was found to cause a small increase in the gamma radiation levels in homes. The increase was less than the variation seen in moving from place to place in areas not having slag present.

In two houses in which crushed slag had been spread over the basement excavation to form an unfinished floor, the gamma radiation level was found to be 40 μR/h and 65 μR/h, respectively. These levels are considered to be undesirably high for continuous exposure of the residents, more particularly since it should not be too difficult to remove the slag.