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Oral Presentation

Submission from the Northern Ontario School of Medicine

Exposé oral

Mémoire de l'École de médecine du Nord de l'Ontario

In the Matter of

Bruce Power Inc. – Bruce A and B Nuclear Generating Station

Request for a ten-year renewal of its Nuclear Power Reactor Operating Licence for the Bruce A and B Nuclear Generating Station

Commission Public Hearing – Part 2

May 28-31, 2018

À l'égard de

Bruce Power Inc. - Centrale nucléaire de Bruce A et Bruce B

Demande de renouvellement, pour une période de dix ans, de son permis d'exploitation d'un réacteur nucléaire de puissance à la centrale nucléaire de Bruce A et Bruce B

Audience publique de la Commission – Partie 2

28-31 mai 2018

Canada

Lakehead · Laurentian · Medicine

Northern Ontario School of Medicine

École de médecine du Nord de l'Ontario

April 13, 2018

Commission Secretariat
Canadian Nuclear Safety Commission
280 Slater Street, P.O. Box 1046
Ottawa, Ontario, K1P 5S9

To: Commission Secretariat and CNSC

From: T.C.Tai, Christopher Thome

RE: Intervention 2018-H-02: Bruce Power license renewal for Bruce A and B Nuclear Generating Stations.

Overview

The following intervention is in support of a 10-year license renewal for Bruce Power for continued operations of their Bruce A and B Nuclear Generating Stations.

Bruce Power has made a significant long-term financial commitment to support university research programs across Canada. This began in 2010 at McMaster University with funding for research on lake whitefish. The program expanded in 2015 to support multiple research streams at the Northern Ontario School of Medicine (NOSM) and other institutions, all encompassed under the Bruce Power Centre for Health, Environment and Radiation (BP-CHER). Bruce Power has directly provided $6,068,129 to university scientists to conduct high quality research related to human health and environmental impacts. The program is structured to ensure that this research is conducted independently of Bruce Power operations and is non-biased. This is achieved by leveraging Bruce Power support through peer-reviewed federal and provincial granting agencies such as the Natural Sciences and Engineering Research Council of Canada and Mitacs, which have provided us with an additional $2,230,000 for research. In addition, all

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of the data we collect is published in reputable peer-reviewed scientific journals.

In total, through the BP-CHER program we have obtained over $8,000,000 through the direct support from Bruce Power and government leveraged funds. To date, the BP-CHER research program has supported the training of 28 HQP (4 PhD students, 14 MSc students, and 10 post-doctoral fellows) and has resulted in numerous scientific publications and presentations at international conferences. In additional to research funding, Bruce Power has provided additional financial support to the program by donating an electric car and charging station to NOSM and sponsoring scientific conferences where our students can present their findings.

Research Projects

Multiple different research projects are currently underway, encompassed under the BP-CHER program, that are focused on understanding the biological effects of low-dose radiation exposure. So far, the results we have obtained from these projects do not support the current models of radiation risk. The linear-no-threshold (LNT) model used in radiation protection assumes that all exposure is harmful, regardless of how small, and that risk increases linearly with dose. However, our findings indicate that exposure in the low dose region (< 100 mGy) does not increase risk and in some cases can have a positive biological effect.

1) Fetal Programming

The fetal programming research explores the effects of radiation exposure during pregnancy (fetal programming) in mice on cardiovascular and metabolic disease endpoints and potential changes in brain and behaviour outcomes. This research is important for the medical community to help characterize risks associated with radiation

exposure during pregnancy. Sources of radiation exposure include both diagnostic imaging exposure and occupational exposure. This research will have broad implications as there is currently a lack of knowledge and understanding of the long term cellular effects due to low dose radiation exposure during late gestation. Our preliminary findings suggest that exposure to low dose radiation (<1000 mGy) during late gestation had little effect on adult cardiovascular and behavioural outcomes.

2) SNOLAB - Sub-background Radiation

One of the larger projects we are running is investigating the impacts of sub-natural background radiation exposure. All living systems have evolved in the presence of natural background ionizing radiation, originating from cosmic and terrestrial sources. Many studies have looked at what happens to organisms when they are exposed to radiation levels above background. However, very little work has looked at what happens when natural background radiation is removed. The limited available data suggests that sub-background exposure is detrimental to biological growth and can increase levels of genetic damage. The issue with conducting these studies is that high energy cosmic radiation is difficult to shield from. The best way to shield from background radiation is to conduct experiments in underground laboratories, where the overhead rock can eliminate cosmic rays. Only a handful of such laboratories exist around the world. The only one in Canada is SNOLAB located in Sudbury. We have recently established the first functional biological laboratory within SNOLAB. Experiments are being conduced using both cell culture models and whole organism systems to study the effects of exposure to a sub-background environment on growth and development, as well as genomic damage, DNA repair capacity and oxidative stress. The results of this research will provide further insight into the biological effects of low-dose radiation and mechanisms of carcinogenesis.

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3) Prostate Cancer Research - Half-Body Irradiation

A clinical trial is currently underway at McMaster University to study the effectiveness of using low-dose half body radiation to treat patients with recurrent prostate cancer. The doses used in the trial are much lower (10 – 100 x) compared to conventional high dose targeted radiation therapy. Whereas the goal of high dose therapy is to directly target and kill cancerous cells, the aim of low-dose therapy is to stimulate the patient's immune system. There is data to suggest that low dose radiation exposure can increase the immune response thereby indirectly killing cancerous cells. A total of 10 fractions of 150 mGy will be delivered over the course of 5 weeks. Seven patients have been enrolled in the study so far and another 14 will be recruited. Patient blood samples are being analyzed pre, during and post treatment for markers of prostate cancer progression. In addition, various cells and molecules associated with the patient's immune system are being measured.

4) Radiation-Induced Cataracts

A project has recently been initiated to study radiation-induced cataracts. The International Commission on Radiological Protection (ICRP) has lowered their recommendations for dose limits to the lens of the eye and is now suggesting an annual limit of 20 mSv. However, this reduction has been challenged due to a lack of conclusive evidence for an increased risk at lower doses. We are currently conducting a retrospective study on patient health care data in Ontario to determine if there is any correlation between cataract rates and diagnostic computed tomography (CT) scans. In addition, several laboratory studies are planned to help understand the exact mechanism by which radiation exposure can lead to lens opacities, which still remains unknown.

Published Results

The success of the BP-CHER research program has resulted in numerous scientific publications in high impact peer-reviewed journals. One of the most significant accomplishments was the release of an entire focus issue of the Radiation Research journal devoted to the BP-CHER program (*Radiat Res* 2017, 188:4.2*)*. Radiation Research is one of the top journals in the field of radiation biology. The focus issue contained 8 papers (4 original articles, 3 review articles and 1 commentary) prepared by researchers at NOSM and McMaster University all related to low-dose radiobiology. Two of the publications examined the effects of radiation from CT scans in cancer prone mice and demonstrated that a single CT scan (*1*) or multiple CT scans (*2*) can extend cancer latency and prolong lifespan. Another two of the publications studied radiation effects on development in lake whitefish and found that low-dose chronic (*3*) or fractionated (*4*) exposure can stimulate growth. Comprehensive reviews were prepared summarizing the current literature on ionizing radiation effects on the cardiovascular system (*5*), radiation effects on oxidative stress and epigenetic programming (*6*) and a unique cell culture system that is ideal for studying the mechanisms of carcinogenesis (*7*). Lastly, a commentary paper outlined the sub-natural background research that is being conducted within SNOLAB (*8*).

In addition to the focus issue, a collection of other scientific publications have been produced. A review article was recently published summarizing the human epidemiological data on radiation-induced cataracts, the same data that was used by ICRP in support of reducing the dose limit to the lens of the eye (*9*). The review provided a critical evaluation of the cited studies, highlighting issues with their relevance to occupational exposures due to dose, dose rate, radiation type and cohort age. Two papers have examined the influence of radiation dose rate on cancer (*10, 11*). Dose rates were calculated for 4

internally deposited radionuclides and compared to lung cancer frequency using historic data from beagle dog experiments. Threshold dose rates were identified, between 0.1 - 0.8 Gy/day, below which there was no significant increase in cancer, which challenges the LNT model. A review article was published in 2017 summarizing the literature on the effects of radiation exposure during prenatal development (*12*). A series of papers have also been published relating to the lake whitefish research program (discussed in the intervention submitted by Drs. Joanna Wilson, Christopher Somers and Richard Manzon).

Outreach

Bruce Power has also contributed significantly to youth science outreach in the community. For the past three years, students and researchers from NOSM have directed weeklong March Break and Summer STEM camps that Bruce Power has supported financially. The camps were aimed at educating children in grades 3 - 7 about science, technology, engineering and mathematics through fun hands on activities and experiments. The camps were located at Bruce Power as well as in the Northern Ontario communities of Blind River, Elliot Lake, Spanish and on the Missassauga First Nations Reserve. Over 200 kids have attended these camps. We have received extremely positive feedback on the program from parents and members of the local community.

Summary

Overall, Bruce Power has made a significant commitment to university research projects at the Northern Ontario School of Medicine and other institutions across Canada. Their financial contributions have allowed us to pursue multiple different research streams focused on the biological impacts of low-dose radiation exposure. Research is

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currently being conducted on fetal programming, sub-natural background radiation exposure, low-dose radiation therapy and radiation induced cataracts. The data we have generates thus far does not support the current LNT model of radiation risk. The BP-CHER program has furthered the training of numerous students and post-doctoral fellows and has led to publications in high impact scientific journals. For these reasons, we support a 10-year license renewal for Bruce Power.

Sincerely,

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