Peterborough County-City
HEALTH UNIT
...because health matters!

April 2, 2012

Canadian Nuclear Safety Commission
280 Slater St., P.O. Box 1046
Ottawa, ON K1P 5S9

Re: Shield Source Inc.'s application to renew its Nuclear Substance Processing Facility Operating Licence

Dear Members of the Commission:

The Peterborough County-City Health Unit (PCCHU) is concerned about exposure of the public to tritium from Shield Source Incorporated (SSI), located at the City of Peterborough Airport. Tritium is the most common point source radionuclide found in drinking water in Ontario (ODWAC, 2009). It poses a potential human health hazard because of its ionizing radiation potential. The main health related concern is the potential direct and indirect effects on DNA and the damage that could result in cancer, teratogenic, reproductive and hereditary effects (ATSDR, 1999; Federal-Provincial-Territorial Committee on Drinking Water, 2006; OEHHA, 2006).

Shield Source Incorporated

The geographical and operational situation of SSI places local residents at risk of tritium exposure greater than background levels. Of primary concern to us is the accidental spill of 147.25 TBq of tritium gas which occurred on February 1, 2010, and the ongoing contributions of tritium to groundwater and vegetative sources. In addition, the annual exposure to tritium from SSI is the highest man-made source of tritium in Ontario at 0.067 m/sv per year (CNSC, 2009).

Conclusions

It is clear from SSI's *Environmental Monitoring Program Annual Compliance Report For 2010* that the local environment and human population is being exposed to more than background levels of tritium.

Previous models of organically-bound tritium (OBT) relative to tritiated water have been higher than expected. When measurements of OBT were taken around a similar site, SRB Technologies near Pembroke, they revealed higher than expected ratios of OBT relative to tritiated water. The area around SSI is largely agricultural, increasing the potential for contamination of local food sources either through vegetation or water sources.

SSI emits higher levels of tritium than nuclear power plants and in 2010 had an accidental spill of a large amount of tritium gas which impacted the exposure levels of local residents and the environment. The PCCHU is gravely concerned about the potential impact of tritium on the health of local residents due to SSI's continued emissions and the impact on groundwater. There is also increased risk for OBT in local food sources unless corrective action is taken.

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Recommendations

The PCCHU proposes that additional efforts be made to reach as low as reasonably achievable (ALARA) emissions of tritium for the benefits of the health of the local community and the environment. **As a result the PCCHU recommends that the CNSC grant SSI a three year license renewal under the following conditions**:

- Corrective action, including rigorous engineering controls, be taken by SSI to reduce the contribution of tritium to groundwater, air and local food sources to levels consistent with the nuclear power industry;
- Enhanced routine, monitoring of tritium concentrations in water, air and fruits in all directions of the site including the residential area east of the airport be established;
- SSI agrees to provide the Medical Officer of Health of the Peterborough County-City Health Unit with reports of routine and unexpected release of tritium; and
- A mid-term report of actions taken to reduce emissions be provided to the CNSC and the Medical Officer of Health of the PCCHU.

Yours sincerely,

Original signed by

Rosana Pellizzari, MD, MSc, CCFP, FRCPC
Medical Officer of Health, Peterborough County-City Health Unit

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Public Health Ontario
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Tritium Exposures

MARCH 28, 2012

TO: **Rosana Pellizari, Medical Officer of Health, Peterborough County-City Health Unit**

FROM: **Rena Chung, Environmental Science Specialist, Public Health Ontario**
Ray Copes, Director of Environmental and Occupational Health, Public Health Ontario

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The following summary has been prepared in response to your request for assistance in reviewing tritium exposures related to Shield Source Incorporated (SSI), a tritium handling facility located in Peterborough. SSI is currently requesting a renewal to their Nuclear Substance Processing Facility Operating Licence (expiration date July 31, 2012) from the Canadian Nuclear Safety Commission (CNSC) which will extend their licence period from three years to 10 years. According to SSI (2012), the request for an extended licence period is to accommodate planning and construction of a new building to house their operations that are currently separated into two facilities approximately 12km apart.

It is our understanding that public comments regarding the licence renewal are due to CNSC by April 2, 2012. We have prepared this summary to assist in the interpretation of SSI's operations and potential public exposures to tritium. Please note that the following summary is based on the materials provided to us via email and given the timeline a complete literature search was not conducted nor could dose estimates or risk limit calculations provided in CNSC and SSI's reports be verified.

1.0 Tritium Background

Tritium (^3H) is a radioactive isotope of hydrogen and is produced naturally via cosmic radiation and atoms in the atmosphere which then reaches the earth through precipitation. Tritium is also produced artificially as a by-product of nuclear and research reactor operation or industries which use tritium to produce gaseous light sources. Tritium is most familiar to Canadians in association with CANDU (Canadian deuterium uranium) reactors.

Tritium gas (T^2) is a radioactive form of hydrogen gas that is used inside processing equipment. Once exposed to ambient air, it rapidly transforms and becomes the more stable form of tritium gas (HT). Once released in the atmosphere, HT can form tritiated water (HTO) over a period of hours or days. HTO is the main contributor to public dose in the environment (CNSC, 2009a).

Tritium is highly mobile and can become incorporated in many components of the environment. Tritium releases are measured in becquerels (Bq) which represents the number of disintegrations and doses are reported in Sieverts (Sv).

2.0 Health Hazards Associated with Tritium

Tritium emits low energy beta radiation which does not pose an external radiation hazard (CNSC, 2009a; OEHHA, 2006). Individuals can be exposed to tritium most commonly via ingestion of tritiated water, inhalation of tritiated vapour and ingestion of produce or animal products impacted by tritium. Overall, tritium poses a potential human health hazard because of its ionizing radiation potential. The main concern is the potential direct and indirect effects on DNA and the damage that could result in cancer, teratogenic, reproductive and hereditary effects (ATSDR, 1999; Federal-Provincial-Territorial Committee on Drinking Water, 2006; OEHHA, 2006).

Human health effects can be described as deterministic or stochastic. Deterministic effects (such as nausea, vomiting, diarrhoea, hair loss, haemorrhage, immune function loss, nervous system damage, and death) do not occur until the dose reaches a certain threshold after which the severity of harm will increase with the dose (Federal-Provincial-Territorial Committee on Drinking Water, 2006). The threshold is considered to be 500 mSv delivered over a short period of time (hours to days).

A stochastic effect includes cancers and potential teratogenic or hereditary effects. The most common cancers associated with radiation exposure are leukemia and solid tumours of the lung, breast, thyroid, bone, digestive organs and skin (Federal-Provincial-Territorial Committee on Drinking Water, 2006). Cancers associated with radiation exposure, are histopathologically and clinically indistinguishable from naturally occurring cancers in non-exposed populations (BRER, 2005). Epidemiological correlation has been demonstrated through populations exposed to high doses such as the atomic bomb survivors of Hiroshima and Nagasaki, Japan, patients who received high radiation doses for diagnostic or therapeutic purposes, and occupationally exposed workers (Federal-Provincial-Territorial Committee on Drinking Water, 2006).

3.0 Shield Source Incorporated

SSI manufactures gaseous tritium light sources (GTLS) used in self-luminous safety signs and devices. In June 2009, SSI's request for a 5-year licence period was approved as a 3-year licence with a mid-term report based on issues raised by the CNSC. These issues included the need for a groundwater monitoring plan, stack improvement initiative and the need for SSI to "broaden its public information programs to a wider audience" (CNSC, 2009b). CNSC also proposed to lower atmospheric release limits to below the derived release limit (DRL) in keeping with the as low as reasonably achievable (ALARA) principle.

3.1 Releases to the Environment

SSI currently operates under weekly action levels, release limits and derived release limits (DRL) as summarized in Table 1. The DRLs are applied at the point of discharge to limit rates of radioactivity release. The derivation of the DRLs accounts for all possible exposure pathways following airborne releases to the public. An action level is a facility-specific concentration (or any other parameter) that, if reached, indicates a loss of control over normal operations of a facility. When the action level is reached, the licensee must conduct an investigation and determine the cause, identify and restore the radiation protection program after contacting the CNSC.

Table 1: SSI's Limits and Action Levels

Limits and Levels	Tritium Oxide (HTO)	Tritium Gas (HT)	Total Tritium (Tritium Oxide and Gas)
Derived Release Limit	100TBq/year	34 Million Tbq/year	
Release Limits	70 TBq/year		500 TBq/year
Action Levels	5.0 TBq/week	17 TBq/week	
	50 TBq/year	170 TBq/year	

Note: TBq = Terabecquerels
Reference: CNSC, 2010a

Currently, SSI primarily releases tritium to the atmosphere through stack emissions (released as HT) with a small quantity of tritiated liquid waste to the sewer.

During their current licence period, SSI has operated under these limits with the exception of an exceedance the week of January 26th to February 2nd, 2010 when they released 150.30 TBq of HT (SSI, 2012). SSI responded to this exceedance by implementing a safety gate valve on the tritium fill machines. All other releases since the exceedance have been within their licence limit and action level. Other operational changes, in keeping with CNSC's conditions, included the extension of the ventilation stack from 30 to 60 feet and an increased exit velocity in an effort to reduce the wake effect and further dissipate the tritium.

Previously in 2009, the CNSC requested SSI to characterize and investigate groundwater contamination resulting from washout by natural precipitation from the stack (prior to the stack height increase following the release exceedance). The groundwater levels measured between July 2009 and September 2010 ranged from below the detection limit (reported as 50 Bq/L) to 21,500 Bq/L. There is one residential drinking water well located across the road from the airport. This well continues to be monitored and measurements have been below the detection limit. The CNSC (2010a) expects the groundwater tritium concentrations to diminish since the installation of the new stack and that the drinking water well will not be affected since the groundwater flow direction moves away from the residence.

According to the CNSC (2010a), tritium in crabapples collected in 2009 was 2.5 times the expected concentration at 3,000 Bq/L but noted that the crabapples are not used for consumption. CNSC did not specify the sample location, however SSI's 2009 Environmental Monitoring Plan Compliance Report notes that sampled apples with the same concentration of 3,140 Bq/L were collected within 220 m northeast of the facility's stack. Clarification from SSI is required to confirm sample location.

3.2 Dose

According to SSI (2012), a third party calculated a dose for a "critical receptor". This is a hypothetical person who lives within 200 m of the facility and consumes their drinking water, produce and meat produced within the same 200 m radius. The calculated dose for the receptor has been no more than 4% of the allowable limit of 1 mSv/year. SSI (2012) reports the following estimated doses during the past licencing period:

Table 2: Potential Dose to the Public

Receptor	2009 (mSv/year)	2010 (mSv/year)	2011 (mSv/year)
Adult (16 – 70 years)	0.03	0.04	Not Available
Child (6 – 15 years)	0.02	0.03	Not Available
Infant (0 – 5 years)	0.03	0.04	Not Available

Reference: SSI, 2012

3.3 Comparisons to Other Doses

The average member of the public receives an annual dose of 2 to 3.4 mSv from background radiation (MOL, 2008) with a Canadian average of 2.7mSv (Health Canada, 2008). The International Commission on Radiological Protection (ICRP) allows for an annual dose of 1 mSv for the general public outside of natural sources. A comparison of the annual effect doses for 2010 (the year SSI had a release exceedance) and other sources of ionizing radiation are presented in Table 3.

Table 3: Comparable Doses for Ionizing Radiation (mSv/year)

Annual Dose (mSv/Year)		Reference
>5,000	Dose which will Likely result in death when received all at once	CNSC , 2011
1000	Dose which may cause symptoms of radiation sickness if received within 24 hours	CNSC , 2011
100	Lowest acute dose known to cause cancer	CNSC , 2011
50	Nuclear Energy Workers	
2.7	Annual Dose from Background Sources (average)	Health Canada, 2008
1.9	Annual Dose from Radon (variable)	
1	Annual Effective Dose Limit for the Public	
0.05	Chest X-Ray	UNSCEAR, 2012
0.04	**2010 SSI Estimated Annual Effective Dose of an Infant and Adult Receptor**	SSI, 2010b
0.03	10-hour plane ride **2010 SSI Estimated Annual Effective Dose of a Child Receptor**	UNSCEAR, 2012 SSI, 2010b

4.0 Key Considerations

Currently, risk from radionuclides is considered in relation to known background sources and held to a public limit of 1 mSv/year.

While concentrations at the nearest drinking water well do not exceed the current standard and the groundwater flow direction is away from the nearest residence's drinking water well, SSI's operations will continue to impact groundwater from stack washout. It is our understanding that OPG operates a tritium removal facility at Darlington which removes tritium from heavy water, however no other treatment technology is known to be available to remove tritium at a local drinking water treatment plant and therefore, removal of tritium from groundwater may not be achievable. Although groundwater concentrations are anticipated to decrease over time due to facility improvements, SSI will continue to contribute tritium to groundwater unless some corrective action is implemented.

The CNSC has conducted the Tritium Studies Project which included a review of health effects and an evaluation of all tritium handling facilities (CNSC, 2010b). In their report they concluded that doses to

the public living near nuclear facilities are exposed to 0.0001 to 0.1 mSv/year from tritium releases. Table 4 compares selected annual doses for the public surrounding tritium handling facilities and nuclear facilities in 2006.

Table 4: 2006 Annual Doses to Public Surrounding Tritium Handling Facilities

Facility	Facility Description	Annual Dose (mSv/year)
Bruce Power	Nuclear generating facility	0.00155
Darlington	Nuclear generating facility	0.00092
Pickering	Nuclear generating facility	0.00236
SRB Technologies	Tritium Handling Facility	0.0145
Shield Source Incorporated	Tritium Handling Facility	0.067

Reference: CNSC, 2009c

SSI operates under upper limits of releases called Derived Release Limits (DRLs) which typically correspond with compliance with the effective dose of 1 mSv/year and an action level which are a fraction of the DRL to control releases from the facility. In 2006, the annual dose for a critical receptor located within 220 m of SSI's facility was within the public limit of 1 mSv/year but was greater than other critical receptors surrounding other tritium handling facilities. In keeping with ALARA, additional improvements could be made to lower the annual dose.

Currently, SSI has a network of monitoring stations (air and groundwater) located within a 16 km radius of the ventilation stack that measure concentrations on a monthly basis. Produce samples are also sampled (apples and grapes), although inconsistently when looking at their records. Estimated doses for the public are currently based on modeled concentrations of organically bound tritium in meat and vegetation. Review of measured concentrations in fruits should be considered as this would be a more reliable way to verify what exposures are likely to be.

We hope the above comments are helpful. Please do not hesitate to contact us if we need to clarify or elaborate on any of the above material.

5.0 References

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