SRB Technologies (Canada) Inc.
Presentation

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SRB TECHNOLOGIES (CANADA) INC.

Point Form Presentation
To
The City of Pembroke
In Support Of Application Seeking Authorization
To Resume Processing And Use Of Tritium

INTRODUCTION ("SECTION 1.0" IN SUBMISSION TO CNSC)

- SRB Technologies (Canada) Inc. has been in Pembroke since late 1990.
- SRB currently employs 15 people and use to employ as many as 40 employees.
- Located in the industrial park at 320 Boundary Road.
- The company leases a 12,000 square foot portion of a building.
- Our company is the original developer of the tritium light source.
- The tritium light source is a glass capsule coated with luminescent powder and filled with tritium. For questions on tritium see document: ***Frequently Asked Questions on Tritium.***
- The products are crucial to ensure the safety and security of people all over the world.
- Used by NATO peace keeping forces.
- Other lighting technologies require wiring, power or batteries.
- Our lighting products do not use electricity.
- Aid the environment against Global Warming.

PURPOSE OF THE APPLICATION ("SECTION 2.0" IN SUBMISSION TO CNSC)

- To allow resumption of the processing of tritium, see document: ***Submission to CNSC.***
- We currently purchase some light sources from our competitors which reduces profitability.
- Competitors are not capable of supplying all the different types of light sources.
- SRB is therefore unable to honour some important contracts.
- Purchasing lights from our competitors also reduces employment.
- Processing tritium would provide ability to make further improvements to our operation.
- Processing tritium would provide ability to continue to monitor the environment and groundwater.
- Processing tritium would provide ability to continue to fund our decommissioning fund which currently covers 100% of the cost of the Safe Shutdown State of the facility.

CORRECTIVE ACTION PLAN ("SECTION 3.0" IN SUBMISSION TO CNSC)

- As a result of the Commission's Decision in January 2007 we developed a Corrective Action Plan.
- The Corrective Action Plan looked at a number of factors.

BUSINESS STRATEGY ("SECTION 3.1" IN SUBMISSION TO CNSC)

- We reviewed our business strategy going forward.
- We evaluated whether to stay at the existing location or move:
    - SRB has built strong relationships with many members of the public.
    - Significant investment in understanding the local environmental conditions.
    - The company enjoys the support of a skilled and motivated workforce.
    - The existing plant and equipment has been carefully tuned over the past 2 years.

BENCHMARKING ("SECTION 3.2" IN SUBMISSION TO CNSC)

- Initiated a research study of other CNSC Licensees that best match SRB.
- We met many of these licensees and reviewed a number of recent documents.
- Defined areas of improvement.

ORGANIZATION ("SECTION 3.3" IN SUBMISSION TO CNSC)

- Conducted an organizational study as directed by the Commission.
- Reviewed responsibilities of individuals to ensure that there are no omissions or overlaps.
- Developed a stringent internal audit plan with emphasis on safety.
- Developed new organizational structure that ensures emphasis on safety.
- SRB Senior Management has formally constituted a number of committees.
- Since January 2007, most programs and procedures were improved and complemented.
- SRB was criticized for performing little review of the work produced by consultants:
    - We have since recognize that the use of consultants can lead to declining safety.
    - In 2007, SRB ensured that work of consultants was carefully reviewed.
    - SRB now understands that the responsibility for safety rests with SRB.

PUBLIC RELATIONS EFFORTS ("SECTION 3.6" IN SUBMISSION TO CNSC)

- SRB has formally constituted a Public Information Program Committee.
- A Public Relations Material Designer function has been added.
- A Public Relations Coordinator function has been added.
- On July 27 and December 7, 2007 met members of the public and local interest groups.
- As a result of concerns expressed by some members of the public during these meetings SRB incorporated in its application:
    - No operation of the reclamation unit.
    - Continue third party analysis of the Environmental Monitoring Program samples.
- Plan to meet again before licence Hearings.
- Continue to address inquiries from the public and provide information.
- Regularly provide City of Pembroke officials information.
- Regularly provide our local Member of Parliament information.
- Held a number of meetings with landlord and neighbors to provide information.
- Held discussions with media to help ensure that future reporting is accurate.
- SRB developed a list of local media contacts who are provided press releases.
- Press releases and supporting information also provided to members of the public.
- A survey is being developed to determine if and how the public would like to be informed.
- Company's website is frequently updated to provide up to date information on the facility.

SOURCES OF EMISSIONS FROM THE FACILITY (SECTION 3.4 IN SUBMISSION TO CNSC)

- Completed a report to identify tritium sources from the facility.
- A number of sources have been reduced in the last 21 weeks of operation.
- Emissions are expected to be approximately 34% of what they were in 2006.
- Emissions are continuously monitored with equipment that was entirely upgraded in 2006.
- A number of environmental measurements are regularly performed by a third party.

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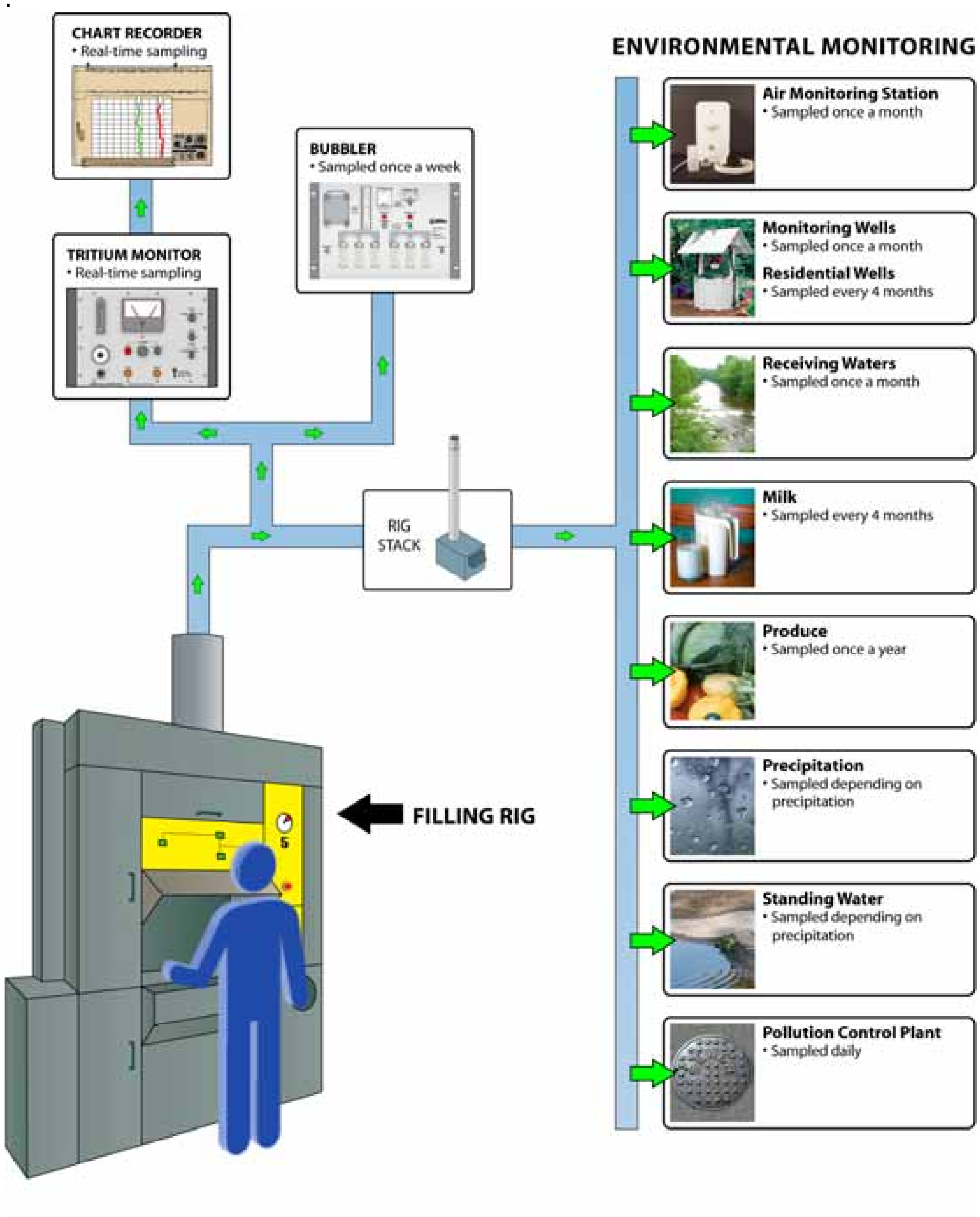


EFFECT ON THE ENVIRONMENT (SECTION 3.5.2 IN SUBMISSION TO CNSC)

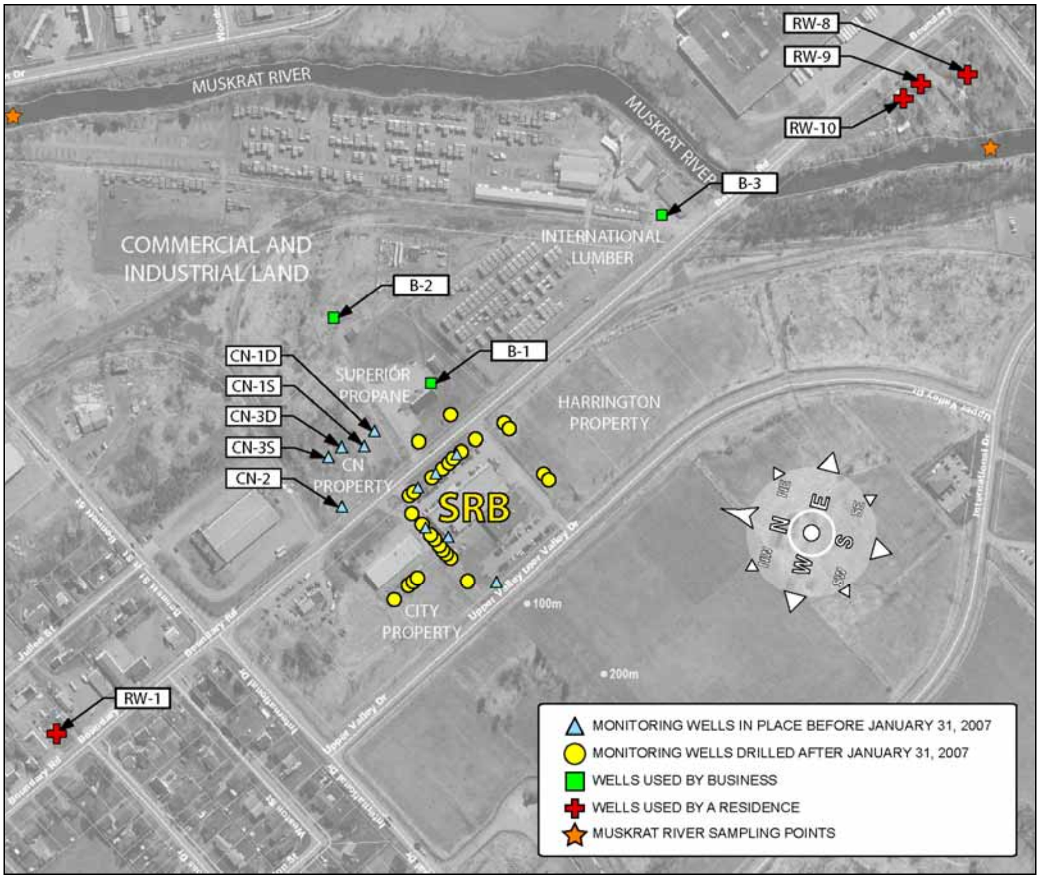
GROUNDWATER (SECTION 3.5.2.4 IN SUBMISSION TO CNSC)

- Commission has expressed the view that more wells were needed.
- SRB met CNSC Staff and Ontario Ministry of the Environment Staff.
- Based on meetings SRB developed a plan for additional groundwater work.
- Drilled 27 new monitoring wells on and around SRB at various depths.
- Groundwater study now include monitoring data from 55 wells.
- 38 wells are located within 150 meters of our stacks.

FIGURE 12: MONITORING WELLS DRILLED BEFORE AND AFTER JANUARY 31, 2007

• SRB identified all water supply wells in the vicinity of SRB
• Closest well is used by Superior Propane across the street from SRB (B-1)

FIGURE 13: WELLS IN THE VICINITY OF SRB



• SRB's consultant produced a Comprehensive Groundwater Report.
• Confirmed that well concentrations are due to deposition from air emissions.
• The highest tritium concentration of approximately 50,000 Bq/L is in a monitoring well located near the stack area on the SRB property.
• The planned decrease in emissions together with natural decay will eliminate tritium concentrations in groundwater in excess of the drinking water guideline over time.
• Wells used for drinking water ranged from 4 Bq/L to less than 1,500 Bq/L, less than 20% of the Ontario Drinking Water Guideline of 7,000 Bq/L
• International limits for drinking water range between 100 to 76,103 Bq/L, see document: ***Standards and Guidelines for Tritium in Drinking Water.***
• SRB will continue to monitor all wells.
• SRB will report results to CNSC and Ministry of the Environment Staff.

OCCUPATIONAL DOSE (SECTION 3.5.1.2 IN SUBMISSION TO CNSC)

• Limit of 50 mSv per year set by the CNSC for a worker in the nuclear industry:

TABLE 7: SRB OCCUPATIONAL DOSE REDUCTION

	2005 (mSv)	2006 (mSv)	DECREASE
AVERAGE	0.50	0.30	-40%
MAXIMUM	3.61	3.35	-7%

PUBLIC DOSE (SECTION 3.5.1.1 IN SUBMISSION TO CNSC)

• Limit of 1.0 mSv per year set by the CNSC for a member of the public.

TABLE 6: MAXIMUM DOSE TO A MEMBER OF THE PUBLIC FROM SRB

	2005 (mSv)	2006 (mSv)	DECREASE
PUBLIC DOSE	0.0337	0.0145	-57%

• For public dose in perspective, see document: ***Dr. Richard Osborne Presentation.***

CONCLUSION (SECTION 9.0 IN SUBMISSION TO CNSC)

• SRB has continued to operate the facility safely.
• SRB and its staff have demonstrated its commitment by the work it has performed.
• SRB and its staff have demonstrated and will continue to make improvements in the future.
• SRB has addressed all the issues expressed by the Commission.
• For these reasons we requested that the Commission approve the resumption of the operation of the facility, including the processing of tritium.

Frequently Asked Questions on Tritium

Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

Canada

FAQs and Fact Sheets

Frequently Asked Questions - Tritium Studies

Q1. What is tritium?

Tritium is a rare isotope (form) of hydrogen, the only radioactive form of this widespread natural element. In regular hydrogen, the atomic nucleus contains only one particle, while tritium nuclei have three particles.

Tritium starts to naturally decay as soon as it is formed, by emitting electrons (beta radiation from the nucleus). The half-life of tritium is 12.33 years: it takes just over 12 years for the disintegration (radioactivity) to be reduced by half, another 12 years to be reduced by one-quarter, and so on, until it eventually changes to helium (a stable, non-radioactive element).

Q2. Where does tritium come from?

Tritium is produced naturally from interactions of cosmic rays with the atmosphere.

It is also produced in nuclear reactors in several ways:

- from fission of uranium in reactor fuel;
- from neutron irradiation of heavy water (which, unlike regular water, is created from oxygen and deuterium – another naturally-occurring hydrogen isotope). Heavy water is used in some nuclear reactors such as the Canadian CANDU reactor;
- by irradiating lithium in a nuclear reactor (a procedure which is not being used in Canada).

Q3. How is tritium used?

- in sealed light sources, like emergency exit signs and airport runway lights;
- in medical and academic research;
- in some countries, as fuel for thermonuclear weapons;
- as fuel for some experimental nuclear fusion machines being developed to harness fusion energy for electrical power.

Q4. What are the levels of tritium typically found in the Canadian environment?

In atmospheric moisture, the concentration of natural tritium is about 0.2 – 1.0 Becquerels per litre (Bq/L). In the high Arctic, it is about 1.4 Bq/L.

Weapons-produced tritium (from weapon tests in the 1950s and 1960s) reached 120 Bq/L in Ottawa in the mid-1960s. Concentrations since then have steadily declined and are now from 2 to 3 Bq/L across Canada.

Slightly higher concentrations of tritium can be detected in air, water and food in areas near Canadian nuclear facilities.

Tritium has been measured routinely in public drinking water supplies in the vicinity of nuclear facilities discharging tritium to the environment. Concentrations are typically in the <1.9 - 115 Bq/L range.

For comparison, the Ontario drinking-water standard for tritium allows a maximum of 7,000 Bq/L. Health Canada's Guidelines for Drinking Water Quality established a similar benchmark.

Q5. What radiation dose do Canadians typically receive from tritium? What are the potential health effects of exposure to tritium?

In Canada, adult members of the public receive annual doses of radiation from tritium from about 0.1 microSieverts (µSv) up to 13 µSv (although very few members of the general public receive doses in the upper end of this range). Doses to children are about twice those of adults from the same exposure.

Near nuclear facilities, where tritium levels are slightly higher, the average annual dose to adults is about 1.5 µSv.

1,000 µSv (equal to 1 milliSievert, or 1 mSv) represent the recommended annual dose limit for the general public, according to the International Commission on Radiological Protection. This recommendation has been incorporated into the CNSC's Radiation Protection Regulations. Radiation doses greater than 1,000,000 µSv (1,000 mSv) can cause health effects such as sterility, nausea, reduced blood cell formation and malformation in embryos. There is no evidence of health effect at doses below about 100 mSv.

The worldwide average natural background radiation dose from all sources for a human being is about 2.4 milliSieverts (mSv) per year, according to United Nations experts.

The general population in Canada is not at risk from tritium intake. There is no convincing evidence – either from biological experiments, observations of humans following accidental intakes of tritium, or routine surveillance of radiation workers – that low doses of tritium cause adverse health effects.

Q6. In what chemical forms is tritium released from nuclear facilities? What happens to tritium in the environment?

Nuclear facilities may emit tritium in a variety of chemical forms. Canadian nuclear reactors emit tritium mostly in the form of tritiated water (only a very small fraction of the water molecules in the environment actually contain tritium). Some tritium may be emitted as tritiated hydrogen or in organic forms such as methane or pump oil.

In the environment, tritium may change from one chemical form to another. For example, tritiated hydrogen may convert to tritiated water, which can become part of the organic molecules in plants and animals. Tritium can be bound to carbon in organic compounds.

Tritium naturally occurs in the air, rivers, lakes or the sea.

Q7. How are people exposed to tritium? What happens when tritium enters the body?

Tritium can enter the body through inhalation, ingestion or absorption through the skin.

Most tritium leaves the body as tritiated water in urine, breath moisture and perspiration. Most inhaled tritiated hydrogen is exhaled immediately.

If tritium is taken in as tritiated water, a small amount becomes organically bound (bound to proteins, fat and carbohydrates) with an average 40-day half life. The remaining tritium in the body has a 10-day half-life.

Q8. How is tritium regulated?

In Canada, the Canadian Nuclear Safety Commission (CNSC) regulates nuclear facilities to protect health and the environment and specifies radiation dose limits for members of the public and workers.

For the general public, the Canadian radiation dose limit is 1 mSv per year over and above natural background levels.

The dose limit for nuclear energy workers is 100 mSv over 5 years or 50 mSv in 1 year. All doses must be as low as reasonably achievable. The average radiation dose received by Canadian workers in nuclear facility operations is less than 3 mSv/yr, with about 20% of that resulting from tritium.

Routine reactor operation and maintenance result in the release of small amounts of radioactivity from tritium, and the CNSC restricts the amount of radioactive material that may be released to the environment. The Commission imposes limits, called "Derived Release Limits (DRLs)" that state the maximum effluent releases permitted for a particular route (e.g. to the air or surface water) from a particular station. These limits represent an estimate of a release that could result in a dose of 1 mSv to an exposed member of the public. Releases must still be as low as reasonably achievable. Actual releases of tritium from nuclear facilities have typically been less than 10 % of the DRL.

The CNSC requires all domestic nuclear operators to provide quarterly reports of results of monitoring of routinely discharged radioactive effluents and annual reports of environmental monitoring programs. The CNSC also requires reporting of any release of a nuclear substance into the environment at a quantity not authorized by acts, regulations or licences, or any unmeasured release of a nuclear substance into the environment.

Most countries with similar technologies to those in Canada have the same radiation dose limits for workers and members of the public (as derived from guidelines of the International Commission on Radiation Protection).

Date Modified: 2008-11-02

Submission to CNSC

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SRB TECHNOLOGIES (CANADA) INC.

Written Submission
For
Hearing Day One

In Support Of Application Seeking Authorization
To Resume Processing And Use Of Tritium

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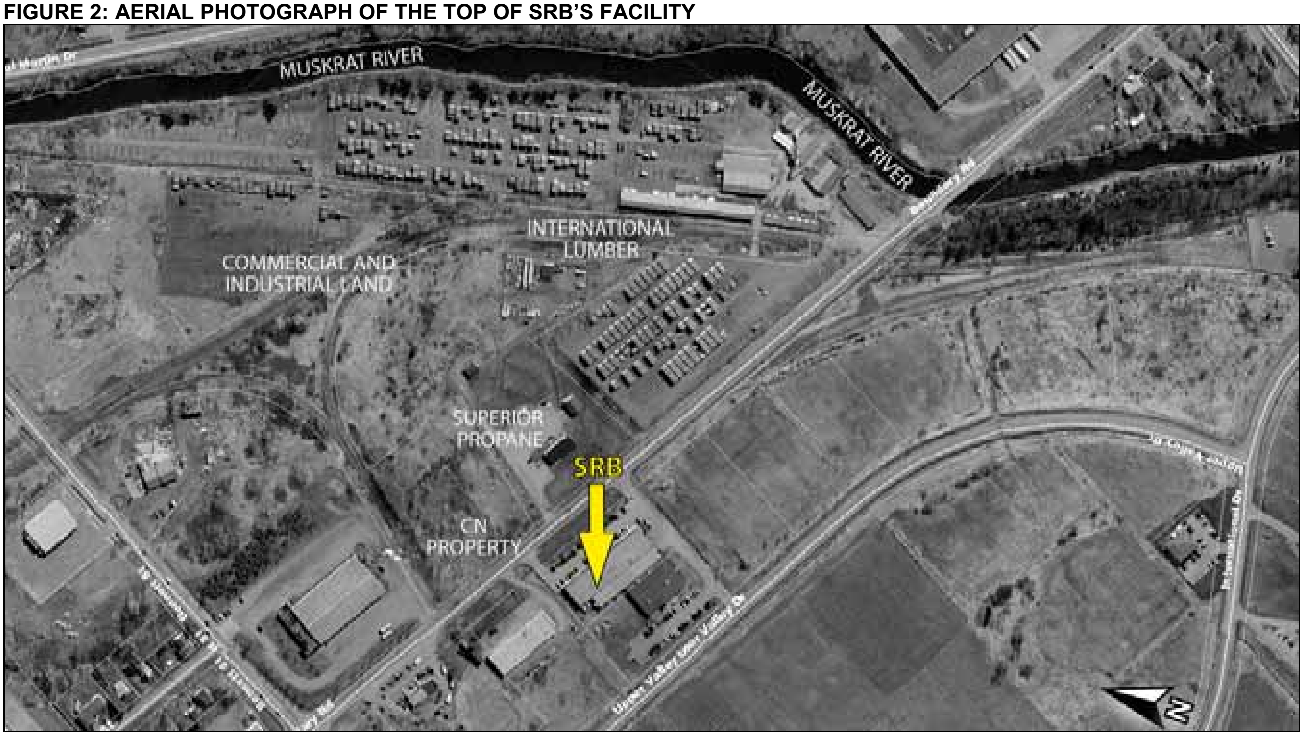
1.0 INTRODUCTION

SRB Technologies (Canada) Inc. is a small company that currently employs 15 people and is located in an industrial park on the outskirts of Pembroke, Ontario. The company leases 12,000 square feet of a building that houses a manufacturer of personal protective systems and a supplier of gases, welding equipment and safety products.

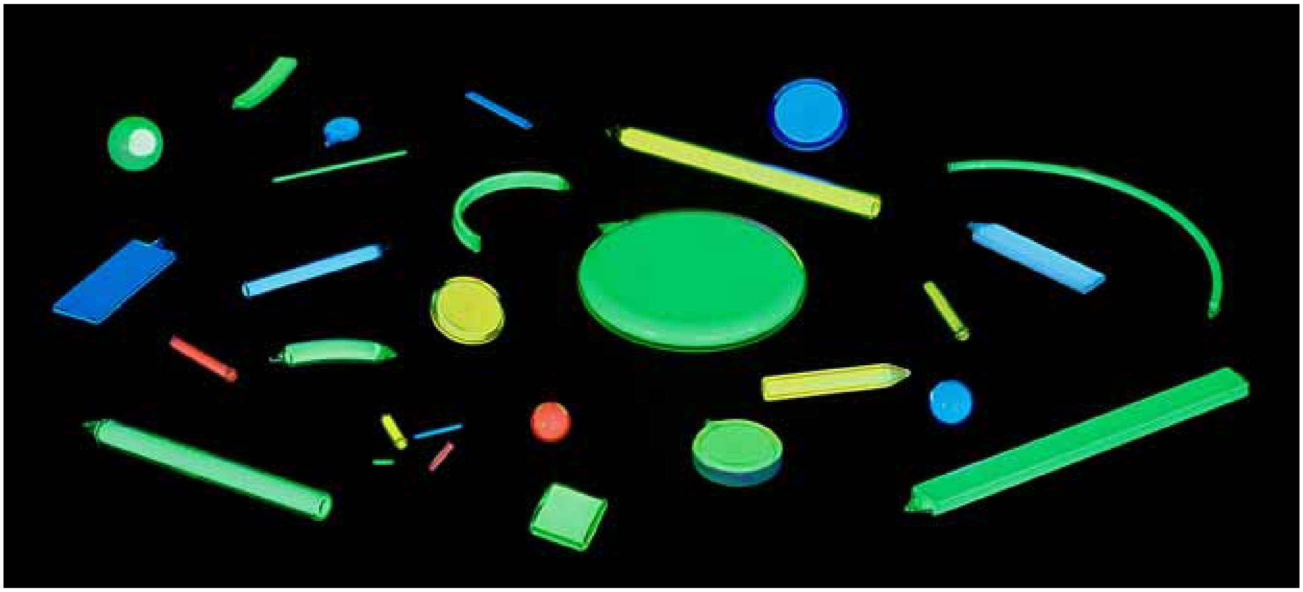
FIGURE 1: AERIAL PHOTOGRAPH OF THE FRONT OF SRB'S FACILITY

FIGURE 2: AERIAL PHOTOGRAPH OF THE TOP OF SRB'S FACILITY



Our company is the original developer of the tritium light source which is a glass capsule internally coated with luminescent powder and filled with tritium. The interaction between the particles emitted by the tritium and the luminescent coating produces light on a continuous basis.

FIGURE 3: VARIOUS TYPES OF TRITIUM LIGHT SOURCES PRODUCED BY SRB



The products that SRB manufactures which use these light sources are crucial to ensure the safety and security of people all over the world, including most NATO peace keeping forces. Other lighting technologies require wiring, power or batteries which result in a lack of reliability, portability and in some cases safety. Our lighting products do not use electricity thereby reducing energy consumption and aid the environment against Global Warming.

FIGURE 4: VARIOUS TYPES OF PRODUCTS PRODUCED BY SRB

After the decision of the Commission in January 2007, not to allow SRB to process tritium, SRB developed a Corrective Action Plan to restore the Commission's faith in our company, to further ensure protection of the public, our workers and of the environment, while allowing a return to a viable business operation.

Our plan has been diligently followed and significant improvements to the way the plant was operated up to January 2007 have been implemented. These improvements have been introduced to increase the safety and environmental performance of the facility, and to raise the level of public acceptance.

Improvements include:

- A proposal to operate under a new lower gaseous release limit, which will increase protection of the environment and the public and is considerably below the regulatory limit and the current licence limit.
- No tritium processing will take place while any type of precipitation occurs.
- Enhanced monitoring by drilling of 27 additional wells at various depths. Monitoring now includes data from a total of 55 wells.
- No operation of the reclamation unit will take place which addresses concerns expressed by some members of the public.
- Continuing the current Environmental Monitoring Program, with monitoring of 40 air stations, groundwater, local milk and garden produce as well as continued analysis by a third party as requested by members of the public.
- An Organizational Study[1] conducted to ensure sufficient management capacity is in place to manage the safety programs, the workers and contractors.
- A systematic and quantitative analysis of sources and their potential contribution to groundwater contamination has been conducted.
- An enhanced public information program which includes more interaction with the public and with special interest groups in particular.

SRB processed tritium in Pembroke from 1990 until January 2007 gathering over 16 years of operational experience. Successful mitigation measures introduced into the equipment in May, July and August 2006 were effective at drastically reducing emissions for the last 21 weeks that SRB processed tritium. We have developed a plan in anticipation of resumption of operation that will ensure continued protection of the public, our workers and of the environment. We have also continued to perform all other procedures and activities specified by our existing safety programs. We have met all the conditions of the existing licence and reporting requirements.

As part of our Application[2] filed on December 12, 2007 we have requested that the Commission extend the expiry of the licence by a period of 24 months from July 31, 2008 to July 31, 2010. This additional twenty four month period would provide SRB time to assess changes in groundwater conditions over all four seasons and during two years of operation, to analyze the data, to implement any additional mitigation measures as deemed necessary and to report to CNSC Staff in ample time before initiation of re-licensing activities prior to the expiry of the licence. SRB currently has in place the funds necessary for the safe state of closure of the facility which was approved by the Commission. The proposed licence expiry date also falls seven months after the date of the last milestone of the tritium study being performed by CNSC Staff for the Commission, which will provide both CNSC Staff and the Commission time to evaluate the Canadian regulatory regime for tritium, relative to regulatory practices in other jurisdictions.

SRB is one of only four manufacturers of tritium light sources in the world. The approval of the amendment will allow the company to maintain its reputation in the marketplace and maintain its status as a valid supplier. The processing of tritium is also key to our ability to continue to provide local employment, to make further improvements to our operation, to continue to monitor the environment and groundwater conditions, and to support the ongoing provision of decommissioning funds.

2.0 PURPOSE OF THE APPLICATION

The purpose of our application is to allow resumption of the operation of the facility, including the processing of tritium. Operations would also include functions previously performed at the facility, described as filling, bulk splitting and laser cutting. However, we are not requesting resumption of operation of the reclamation unit as part of the amendment.

We have determined by analyzing historical sales data that allowing the requested processes to be resumed would enable us to maintain a profitable and viable business. Our competitors are not capable of manufacturing all the different type of lights sources required to supply a number of our customers. SRB is therefore unable to honour some important contracts which, in turn, substantially limits our financial resources. Purchasing lights from our competitors also reduces profitability. Without the approval of this amendment, SRB will not have the financial resources to survive. Although we have every intention of doing so, we would not be able to continue to make improvements, further fund the facility’s financial guarantee, monitor groundwater conditions, or properly maintain the facility.

In order to reduce tritium concentrations in run-off from the facility, we do not propose to operate while any form of precipitation is occurring. Accordingly, a precipitation diversion system is not required or proposed.

Tritium concentrations on site in this operating mode would provide an acceptable level of environmental protection as it would allow for the sustainable use of groundwater resources. This is because any tritium released to atmosphere would not be washed into the ground by precipitation.

3.0 CORRECTIVE ACTION PLAN

Under Section 24(4), subsection (b) of the Nuclear Safety and Control Act, SRB is required to make adequate provisions for the protection of the environment and the health and safety of persons in carrying on the activity for which it has applied for. In order to ensure that this requirement was met SRB developed a Corrective Action Plan to address any possible areas of improvement in detail.

We have carefully reviewed the Record of Proceedings[3] issued on January 31, 2007 by the Commission to develop our Corrective Action Plan and our root cause analysis.

As part of the Corrective Action Plan, the following factors were addressed:

- Business strategy
- Benchmarking
- Organization
- Sources of emissions from the facility
- Effect of amended operations on groundwater, the environment and public
- Public relations

3.1 BUSINESS STRATEGY

We reviewed our business strategy going forward in order to determine what type of operations, in the existing or another location would best protect the environment and the public, still allowing for a profitable and viable business.

3.1.1 LOCATION

At the suggestion of the Commission, we evaluated whether to stay at the existing location or to seek a processing licence at another location. In considering whether or not to move premises, SRB took account of the following issues;

3.1.2 PUBLIC RELATIONS

The company has realized that, based on the number of intervenors from the local community who voiced their concern at the previous licensing hearings, there was a disconnect between ourselves and some members of the public. We have made a major effort to address this matter. An example is our decision to cease operation of the reclamation unit, since this was a major point of local concern.

We also acknowledge that as a result of our history, there is, and will continue to be, public scrutiny of SRB. However, SRB has made great strides in recent years to put in place a Public Information Program (PIP) that provides the public with information. The effectiveness of the program through the evaluation of concerns raised by the public is performed and the program is adapted accordingly.

During this period, SRB has built strong relationships with many members of the public in the local community, has provided briefings to City council, the local Member of Parliament and met with local special interest groups on a number of occasions.

To build these relationships in a new community and to develop a plan to address concerns from local special interest groups would take time to develop and refine to the level that is currently in place for the existing facility. Furthermore, a recent local newspaper survey[4] found that over 90% of survey respondents, a significant proportion of the population, were not concerned at the presence of the facility in their community.

3.1.3 ENVIRONMENTAL MONITORING

We have made significant investment in understanding the local environmental conditions. A move to another location would involve a new investigative program and render useless the work done on our present site.

3.1.4 WORKFORCE

The company enjoys the support of a skilled and motivated workforce, which is a vital contributor to the safe and efficient operation of the facility. Any move away from the area, would likely cause the loss of at least a proportion of these trained staff. To find replacement staff could be difficult and time consuming.

3.1.5 PLANT REFINEMENT

The existing plant, particularly the ventilation system, has been carefully tuned over the past 2 years. We feel that significant development and testing would be required at a new site to achieve the standard currently in place at the existing facility.

3.1.6 THE PATH FORWARD

As a result of this review, for the reasons discussed SRB decided to request to resume operation in the current location. Once it was decided to continue at the same location, we then reviewed our business in order to determine what type of operations would allow for a safe, profitable and viable business. Working under the current possession licence for a number of months has confirmed that, in order to have a financially viable business, tritium processing is a necessary component of our operation.

Senior Management performed a thorough analysis of all company activities and processes that result in emissions of tritium to the environment and produced a document which identified all sources of tritium emission from the facility, Systematic And Quantitative Analysis Of Tritium Sources[5], dated March 29, 2007. Each process was reviewed against historical sales data for 2004, 2005 and 2006 to find its relative importance in maintaining a profitable and viable business. The analysis allowed us to determine that maintaining the filling process alone allows us to generate over 90% of our revenue.

The operation of the bulk splitting process does not generate revenue but is required for the transfer of tritium from a container received from our suppliers (which contain up to 925,000 GBq) into smaller pyrophoric units (which contain up to 111,000 GBq). The use of these pyrophoric units is vital to lower emissions, as these allow for better reabsorption. SRB looked at having this process performed at another location by a licensed third party, but it was not possible.

Historical sales data showed that the laser cutting process represents approximately 10% of our revenue. As a result of working under the current licence, we have reached a mutually beneficial agreement with one of our competitors to supply the majority of the tritium light sources that were historically produced at our plant by this process and intend to continue to do so in the future, thereby reducing emissions. We do however need the ability to perform laser cutting for those tritium light sources that cannot be technically produced by our competitor.

The reclamation process was never performed to generate revenue but rather to provide a disposal route for expired devices and the recycling of the tritium gas within these expired devices. We do, however, have the option to dispose of expired product to a licensed waste facility thereby eliminating emissions from the plant. In addition, during discussions with the Concerned Citizens of Renfrew County and other members of the community , it was explained by the public that for many years their most important concern was the operation of the reclamation process, related emissions and overall recycling, involving product from all over the world. The public urged SRB to dispose of expired product to a licensed waste facility. This message was clearly received by SRB, and, recognizing that it is the main concern of the public, we are not including the operation of the reclamation unit in the requested amendment.

A finding of the document Systematic And Quantitative Analysis Of Tritium Sources[5] dated March 29, 2007, was that eliminating the reclamation process and reducing emissions from the laser cutting process eliminates some of the highest sources of tritium releases from the facility while still allowing a profitable and viable business.

Senior management sought the views of a majority of shareholders regarding this proposed reduced operation and has been given their full support.

3.2 BENCHMARKING

Since it was decided to remain at the existing location in Canada, Senior Management initiated a research study of other CNSC Licensees that best match the requirements that our company is subjected to. The intent of performing this study was to benchmark the performance of other licensees against the performance of SRB to help define where improvements could be made. Eighteen other CNSC licensees were selected for review. These other eighteen CNSC licensees follow the same Act and Regulations. A number of them also handle and release tritium.

We have held a number of meetings with a few CNSC Licensees to discuss their interpretation of the requirements for having a licence issued by the Commission and to get their opinion on where SRB should improve. In addition, a number of documents issued between 2004 and 2007 were reviewed in close detail to define specific areas of improvement for SRB.

Documents reviewed were as follows:

- Commission Member Documents
- Proceedings, Including Reasons for Decision
- Licensee documents acquired from licensees or through Access to Information requests
- CNSC Staff technical briefing on tritium

Particular attention was placed on environmental protection matters, groundwater issues and results and public perception as those were perceived to be the greatest areas needing improvement from SRB's point of view. Attention was given to actions taken by the Commission, CNSC Staff and the licensees.

A chart was developed to compare the grades allocated by CNSC Staff to other licensees for five safety areas (definition of safety area varies for some licensees) against the grades allocated to SRB in 2006:

- Environmental Protection
- Radiation Protection
- Quality Management
- Fire Protection
- Operations

Other than comments of the Commission and CNSC Staff, performance indicators were also reviewed for all licenses. Some of these comparisons are difficult to make as Licensees individually operate to ALARA, but it was decided that the following indicators should be analyzed to indicate possible areas of improvement:

- Occupational dose
- Public dose
- Emissions of tritium where applicable
- Emissions of isotopes other than tritium where applicable
- Number of reportable events and incidents
- Public concerns

A meeting was then held between Senior and Middle Management to discuss the results and to define areas of improvement for SRB. These findings were shared with all staff and considered as part of any action going forward. It was also decided that benchmarking proved to be a effective tool that should continue to be used in the future. An overview of the results were as follows:

3.2.1 GRADING SYSTEM

- Grades issued to SRB for Environmental Protection are below those of other licensees.
- Grade issued to SRB for Fire Protection "Program" is a "C" as other licensees. A number of licensees however have been issued a "B". It is important to note that SRB's latest Fire Protection Program has not yet been rated by CNSC Staff.
- Grades issued to SRB for Radiation Protection, Quality Management and Operations equal the highest issued by CNSC Staff.

TABLE 1: GRADES OF OTHER LICENSEES COMPARED TO GRADES ISSUED TO SRB IN 2006

	SRB		OTHER LICENSEES			
	PROGRAM	IMPLEMENTATION	PROGRAM		IMPLEMENTATION	
SAFETY AREA			BEST	WORST	BEST	WORST
ENVIRONMENTAL PROTECTION	E	E	B	C	B	C
RADIATION PROTECTION	B	B	B	B	B	B
QUALITY MANAGEMENT	B	B	B	C	B	C
FIRE PROTECTION	C	B	B	C	B	C
OPERATIONS	B	B	B	B	B	C

3.2.2 OTHER PERFORMANCE INDICATORS

- Average and maximum occupational doses at SRB in recent years are well below the average of other licensees.
- Public dose from SRB in 2006 was third highest amongst other CNSC Licensees that release tritium, but is far lower when all isotopes released by each licensee are considered. Comparisons are difficult as Derived Release Limit (DRL) calculations may vary in conservatism from licensee to licensee.
- Compared with emissions from all nuclear power stations, tritium light manufacturers and research facilities, for 2006, gaseous emissions of tritium oxide from SRB are third lowest, gaseous emissions of tritium are the highest and liquid effluent of tritium oxide is the second lowest.
- As in the case of SRB, in its existing and previous licence period, a number of licensees did not have any reportable events and incidents.
- As in the case of SRB a number of other licensees have a number of public concerns.
- As in the case of SRB a select number of licensees have groundwater issues, although specific circumstances vary; some with much higher concentrations in groundwater some with less.

3.2.3 AREAS OF IMPROVEMENT

- From the documents that we have reviewed on environmental protection we have concluded that other licensees appear to be less satisfied than SRB was in the past if they operated below their set administrative levels. Other licensees appear to have striven for continuous reduction of emissions. Also, from the documents on environmental protection reviewed, we have concluded that other licensees appear to have taken more time than SRB to address issues, by more carefully analyzing data in order not to reach premature conclusions.
- Other licensees appear to have addressed issues and problems more systematically through their Quality System and with the use of formal corrective action plans.
- A number of other licensees appear to have worked more closely with the public, more specifically with special interest groups, by having face-to-face discussions.
- Continue to use benchmarking in the future.

3.3 ORGANIZATION

As directed by the Commission we have conducted an organizational study, documented as Organizational Study[1], dated July 31, 2007, which defines the management capacity needed at the facility to manage the safety programs, the workers and contractors.

In the study we focused on the requirements, conditions, and activities associated with the current possession licence, however the study also addressed the requirements, conditions and activities associated with the resumption of operations.

The study identified a number of deficiencies and outlined a number of recommendations to address these deficiencies which have all been implemented in the last few months and reported to CNSC Staff in a document titled Supplemental To Organizational Study[6], dated December 31, 2007. This further ensures that as required under Section 24(4), subsection (a) of the Nuclear Safety and Control Act, that SRB is qualified to carry on the activities for which it has applied in the amendment.

Every employee and the majority of the shareholders were instructed to thoroughly read the study. Discussions ensued with Senior Management to discuss any questions and to define a path forward to address the recommendations in the study.

CNSC Staff provided their review of the Organizational Study[1] and Supplemental To Organizational Study[6] in a letter[7] dated February 19, 2008. CNSC Staff concluded that SRB has committed to continuous improvement, with the goals of improving and maintaining a healthy safety culture which will ensure the protection of the workers, the environment, and the public.

3.3.1 VISION, MISSION, GOALS, VALUES AND POLICY

Historically the company policies, goals and objectives were developed by Senior and Middle Management only. As a result of the institution of ISO 9001 in 1997, Management developed a quality policy, integrating goals which the Management adopted as the main driving focus for the company. The policy and goals were developed with greater emphasis on cost and customer satisfaction parameters and less on adopting a proactive approach to safety.

To ensure that the company adopts a pro-active approach to safety, with the involvement of all staff and the majority of the shareholders we have developed a new set of vision, mission, goals, values and policy and have set frequent intervals for future reviews, as documented in internal memo[8] dated October 14, 2007.

The vision was defined, not only for where the organization would like to be today, but also for where the organization would like to be in the future, with this future direction being understood and shared by all staff. It was also recognized that the company vision, mission, goals, values and policy needed to be fully communicated and understood by all contractors to ensure that their activities are geared to meet the requirements of the Nuclear Safety and Control Act, Regulations and conditions of the Licence. We have also declared our vision, mission, goals, values and policy publicly, notably on our web site, to demonstrate to the public that the overriding corporate objective is the company's commitment to nuclear and environmental safety.

Most importantly, the key is to define how the vision, mission, goals, values and policy are followed by staff. Historically SRB was satisfied if it operated below its set administrative levels. Little effort was put to analyzing performance data or to strive for continuous reduction of effects on the public and the environment.

Over the course of the last several months SRB has defined a number of quantifiable and qualifiable performance indicators that are used to identify shortcomings in terms of meeting the Nuclear Safety and Control Act, Regulations, and conditions of the Licence. Data and information are assessed and analyzed against historical data and relevance to our vision, mission, goals, values and policy.

FIGURE 5: COMPANY'S GOVERNING PRINCIPLES

SRBT

Our Vision

Strive to maintain or exceed the standing required to allow our company to process tritium and manufacture life safety devices to fulfill the needs of our customers.

Our Mission

Continuously improve company programs in order to meet or exceed the requirements of the Nuclear Safety and Control Act, Regulations and conditions of the licence in order to strive to achieve higher grades in all safety areas.

Our Goals

1. To promote a strong safety culture throughout the organization by having all employees continuously assess and analyze any impact the operations may have on the public and the environment.
2. To reduce any risk to the public and the environment due to the operations to ensure that requirements of the Nuclear Safety and Control Act, Regulations, conditions of the licence and ISO 9001 requirements are met or exceeded.
3. To be transparent, visible and open with our community, our regulators, and our staff.
4. To ensure that the products are supplied to customer requirements and specifications and to the requirements of the Nuclear Safety and Control Act, Regulations, conditions of the licence and ISO 9001 requirements.
5. To continue to lower emissions and improve the effectiveness of our programs and processes.

Our Values

We will achieve our goals by acting with integrity with the regulators, the members of the public and our employees, and by respecting their input and contribution by making improvements based on this input.

Our Policy

It is the policy of the company and its employees to learn from our operational experience and research, to consider the input of all stakeholders and be conservative in our decision making to ensure the protection of the public and the environment to achieve the goals that we have set to meet our ultimate vision.

3.3.2 ROLES AND RESPONSIBILITIES

We have reviewed decision making responsibilities of individuals to ensure that there are no omissions or overlaps and no problems of shared responsibilities. Changes have been made to better ensure the protection of workers, the public and environment, the most notable change was to appoint a single individual dedicated to each of “human protection” and another to “environment protection”, thereby putting more focus on environmental protection, since both roles were previously performed by a single individual.

A meeting then took place during the week of October 1, 2007 between each employee and Senior Management to discuss the employee’s job description in relation to the job description of others and the tasks expected specifically of them and others as they apply to meeting the requirements of the Canadian Nuclear And Safety Control Act, Regulations and conditions of the Licence. All employees were provided the opportunity to ask questions, recommend changes and confirm their agreement to the job description provided. This is documented in an internal memo[9] dated October 4, 2007. To complete this exercise, staff were then asked to review an organizational chart and the job descriptions of all their co-workers to ensure that they were clear as to what was expected of them and others.

3.3.3 QUALITY MANAGEMENT

As part of the review of all job descriptions, Senior Management explained to all employees that Senior Management had recognized that Quality Staff seemed to be viewed in a negative light by the rest of the staff. Quality findings were often not addressed in a timely manner.

Senior Management openly supported Quality Staff with other employees, and explained that their role was crucial to the success of the company and to the improvement of the safety culture. As a result of the processing Licence not being renewed, Senior Management prepared staff for coming change by making the Record of Proceedings known to all employees, and presenting and discussing the results in an understandable way. The motivation for making the changes necessary to improve and maintain the safety culture was the resumption of operation sometime in the future, and our desire to become a safety leader rather than a follower. It was explained that the key in using performance indicators is not only to identify areas needing improvement but to define the means of achieving it. In 2007 a system was developed to achieve this goal. The results of assessments are raised in a corrective or preventive action and subjected to a root cause analysis controlled by the Quality Department. The corrective actions are led by company Senior Management.

As part of the corrective action program, a stringent audit plan[10] as been developed by the Quality Manager and supported by Senior Management to audit all activities associated with developing, managing and implementing all company safety programs. Four audits have been performed to date. The Quality Department must be supported by staff when addressing the root cause analysis and employees are now consulted in performing root cause analysis. We recognize that a learning organization is able to use the ideas of those at all levels in the organization and that employees are more likely to be committed to the implementation of improvements if they have been intimately involved in generating ideas for that improvement.

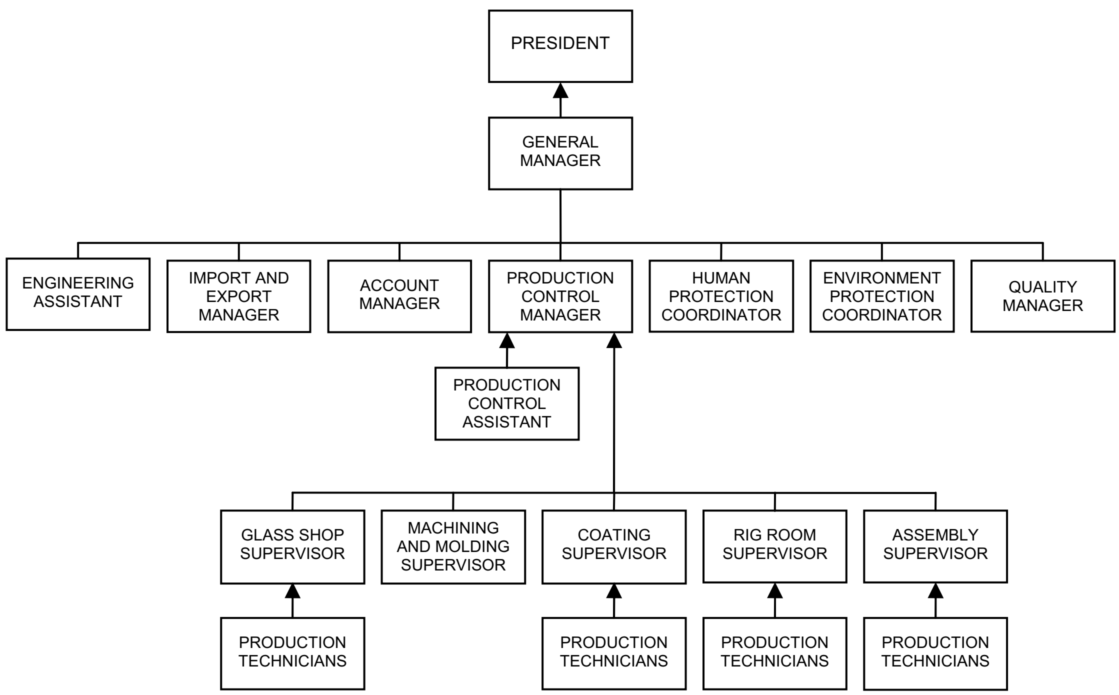
3.3.4 ORGANIZATIONAL CHART

The following organizational chart represents the current structure at the company as a result of addressing the recommendations of the organizational study[1].

Each position is held by a single individual who possesses the qualifications and experience requirements of the position. It is important to note that our review was not only based on the requirements for the current licence but those of a licence that would allow tritium processing to resume.

The activities proposed in the amendment would simply allow a few production technicians associated with production processes to be employed and would not negatively affect the current management capacity to manage the safety programs, the workers and contractors.

FIGURE 6: ORGANIZATIONAL CHART



3.3.5 COMMITTEES

Historically a number of informal committees met on a regular basis to discuss various items that ensure compliance with the Nuclear Safety Control Act, Regulations and conditions of the Licence.

The information attained during these informal committee meetings has been extremely valuable in providing the responsible individual information that can help in improving various safety programs and procedures and in ensuring the improvement in the provisions taken for the protection of the environment, the health and safety of persons and the maintenance of national security. Meetings have also been a useful mechanism for problem identification and resolution. For these reasons SRB Senior Management has formally constituted these committees and a number of others in the organizational structure, as documented in an internal memo[11] dated October 22, 2007:

- Health physics Committee
- Occupational health and safety Committee
- Executive Committee
- Fire Protection Committee
- Mitigation Committee
- Public information Committee
- Waste management Committee

Senior Management has formally and clearly defined the responsibilities of these committees including those of the Health Physics Team. Senior Management has also formally instituted minimum requirements for each committee or team, including listing the employees who hold positions requiring them to be part of the committee.

Senior Management held individual meetings with mandatory members of each committee. During these meetings we discussed the responsibilities and requirements of each committee, the tasks expected specifically of them and others as they apply to meeting the requirements of the Canadian Nuclear And Safety Control Act, Regulations and conditions of the Licence. Each committee member was provided the opportunity to ask questions, recommend changes and confirm their verbal agreement of the committee requirements. During our meetings Senior Management also provided direction in carrying on the activities of a committee and its meetings.

All employees were also encouraged by Senior Management to, at their own discretion, propose to Senior Management the institution of any new committee to better ensure that the company is in compliance with the Nuclear Safety Control Act, Regulations and conditions of the Licence.

Through their experience Committees have been instrumental in the development of a new Radiation Safety Program and Waste Management program that are detailed in capturing activities and procedures that are currently in place. Committees have helped established sound and experience based “Emission Reduction Targets” and “Occupational Dose Targets” for the operations. Committee have ensured the involvement of a much greater proportion of staff which has increased the emphasis on safety.

3.3.6 PROGRAMS, PROCEDURES AND ASSOCIATED DOCUMENTS

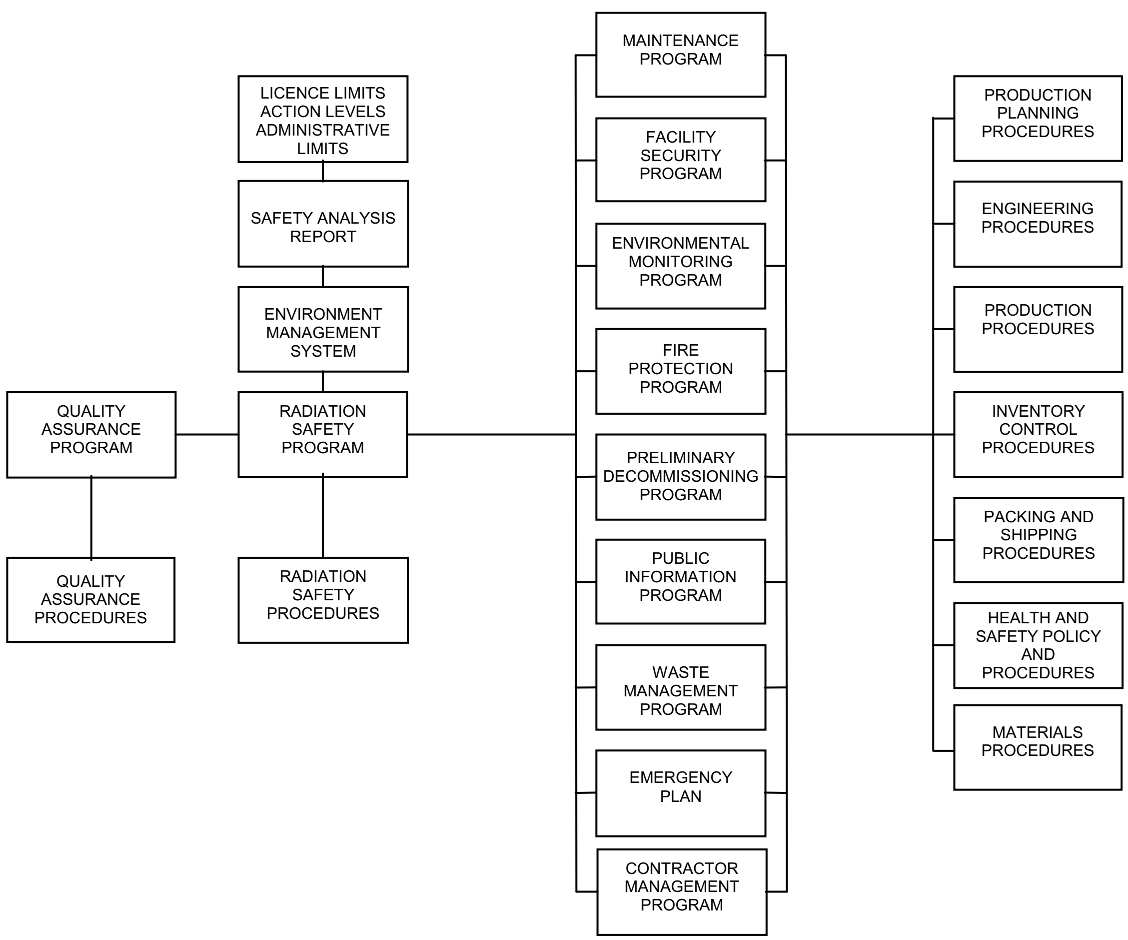
The procedures that will be used to implement the requested amendment are already in place.

Over the years SRB has put in place processes specific to the development, application and use of programs, procedures and associated documents as they pertain to meeting the Nuclear Safety and Control Act, Regulations and conditions of the Licence. These documents are those necessary to ensure that SRB is qualified to carry on the activity licensed and to ensure that, in carrying on that activity, SRB would make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security.

The activities of different individuals involved in a single process are planned, controlled and managed in a manner that ensures effective communication and the clear assignment of responsibilities. For each process designated individuals are given the authority and responsibility for developing the process, for ensuring that there is effective interaction between interfacing processes, for monitoring and reporting on the performance of the process, for improving the process and for ensuring that the process is aligned with the goals of the company.

Company procedures can be found directly in the following programs and documents:

FIGURE 7: SRB DOCUMENTS



3.3.6.1 PROGRAM AND PROCEDURE IMPROVEMENTS

Since January 2007, most of these programs and procedures were improved and complemented by other programs and procedures to further ensure protection of the public, the workers and the environment. Improvements were made as a result of SRB staff's research and study of International Atomic Energy Agency documents, CNSC Regulatory Guides, recommendations from the International Commission on Radiological Protection and various industry standards and documents of other CNSC licensees.

Most notable changes include a new revision of the Radiation Safety Program[12] reviewed and deemed acceptable by CNSC Staff in a letter[13] dated January 23, 2008 and a new revision of the Waste Management Program[14] which has been reviewed and deemed acceptable by CNSC Staff in a letter[15] dated February 22, 2008.

A new Health and Safety Policy and Procedures document[16] was also developed as a result of a change in jurisdiction from Provincial to Federal. The document ensures compliance with the Canada Labour Code, Part II and the Occupational Health and Safety Regulations and other associated regulations.

We recently submitted to CNSC Staff a document titled Review Of Hypothetical Incident Scenarios[17]. The purpose of this document was to review the existing incident scenarios for the facility and to determine if these were still applicable considering the improvements made to the safety programs and procedures and the equipment and system upgrades that have been implemented over the years. The review also ensured that the hypothetical incidents identified were credible and reflected worse case conditions.

We recently received CNSC Staff comments on our Quality Manual[18] in a letter[19] dated February 14, 2008 and comments on our Emergency Plan[20] in a letter[21] dated February 21, 2008. We will provide new revisions of these documents shortly after Hearing Day One, revisions will include more detail to further describe activities, procedures and controls that are currently in place at the facility which we expect will address all CNSC Staff comments.

As our own initiative we are currently incorporating all the organizational controls, changes and improvements that have been implemented at the facility into a new “Environmental Management System” which we expect to provide to CNSC Staff for comment before Hearing Day One.

3.3.6.2 CONTRACTOR MANAGEMENT PROGRAM

Concerns were raised during the licence hearings in 2006 over SRB's ability to effectively manage contractors. Historically, when additional skills were required the company used contractors who were licensees of the CNSC or performed work for other CNSC licensees. It was therefore believed by SRB that the work performed by the contractors was being performed properly, based on their expertise and reputation. As a result, SRB staff performed little review of the work, calculations and results produced by the contractors.

We have recognized that due to their lack of ownership, the use of contractors can lead to declining safety.

In 2007, SRB ensured that the roles and responsibilities of contractors were clearly defined and understood, whilst understanding that the responsibility for safety rested with SRB. We made changes to programs and procedures to ensure that the work, calculations and results produced by contractors are now carefully reviewed. We have sought to have multiple members of the Health Physics Team carefully review the work produced by all contractors. Staff has also developed a questioning attitude to ensure that all results and conclusions are justifiable. SRB's staff worked on developing their own expertise when needed by performing their own independent research. SRB have also sought training or independent opinions of other contractors to verify results where additional expertise was deemed necessary. This has allowed SRB to ensure that the work produced by the contractor was appropriate. SRB has also performed its own calculations where possible and developed its own independent conclusions which were discussed with the applicable contractor. Any difference in opinion is further investigated and resolved.

A Contractor Management Program[22] was instituted to formalize these activities. This program formally ensures that contractors selected can perform all necessary tasks required in a timely professional manner. All contractors are also required to hold all necessary approvals and certifications required to perform the services required.

CNSC Staff have reviewed SRB's Contractor Management Program[22] and stated that the program needed a bit more formalization and development in certain areas. SRB is committed to address CNSC Staff's comments and to provide another revision of the document before Hearing Day One.

It is important to note that SRB, where possible, will develop its own expertise to address issues but when additional skills, qualifications and resources are required to supplement company activities, contractors will continue to be used, but with much more oversight from SRB.

Although we believe that we have the necessary capacity to conduct our own environmental monitoring, we have elected to continue to utilize a qualified third party contractor to perform this function in recognition of the strongly expressed public opinion that results from a third party are much more credible. Despite the additional cost that this entails, we are attempting to accommodate local views wherever possible.

3.3.6.3 CONTINUOUS IMPROVEMENT

Over the proposed licence term, we will continue the improvement process already achieved and reported in this document. Line Managers will review the effectiveness of each program and procedure on a yearly basis with the Quality Manager. The result of these reviews will be reported and discussed with the President. An action plan will be developed to promptly make the required changes documents to address any opportunity for improvement.

3.3.7 COMMUNICATION

SRB Senior Management, supported by the Shareholders of the company, realized that SRB had been experiencing a pattern of declining safety culture. As a result Senior Management made nuclear safety the main focus of the operations and verbally communicated to all staff this new focus.

3.3.7.1 PUBLIC

Communication with the public is encouraged as a communication tool used by staff to further understand the expectations placed upon them in meeting the requirements of the Nuclear Safety and Control Act, Regulations, and conditions of the Licence.

Communication with the public and especially local interest groups can bring to light a different interpretation of the Act, Regulations and conditions of the Licence. This interpretation can be very useful in staff becoming more vigilant and cautious. Communication with the public is also recognized as providing the public more trust and confidence in the company's ability to protect the health of the public and environment.

3.3.7.2 CONTRACTORS

Communication with contractors is formally implemented through the Contractor Management Program[22] which ensures that contractors further understand the expectations placed upon them to meet the requirements of the Nuclear Safety and Control Act, Regulations, and conditions of the Licence.

3.3.7.3 STAFF

Senior Management realizes that to achieve a strong safety culture throughout the company, it is necessary that information be communicated and understood by staff at all levels and that the development of any plan or action geared to meeting the Act, Regulations and conditions of the Licence needs to include input from all staff.

As a result of the findings of the Organizational Study[1], in 2007, a number of communication channels were better defined with input from staff to ensure that staff clearly understands the expectations placed upon them necessary to meet the requirements of the Act, Regulations, and conditions of the Licence.

Our training methods have been updated to provide more emphasis on the concept of ALARA and to stress the importance in communication in order to have an effective ALARA program and on the benefits of procedure adherence.

Staff at all levels are encouraged to hold meetings with the affected parties when developing changes in procedures. Staff are encouraged to consider the input of all stakeholders and be conservative in their decision making to ensure the protection of workers, the public and the environment to achieve the goals that we have set to meet our ultimate vision.

Based on input from staff, Senior Management now makes use of two information boards in a well traveled area of the facility where all staff can review other employee’s job descriptions, committee’s job descriptions, the organizational chart and all committee and management meeting minutes and performance indicator data.

FIGURE 8: INFORMATION BOARDS

3.4 SOURCES OF EMISSIONS FROM THE FACILITY

To address a requirement of the Commission, we have completed a report that systematically and quantitatively analyzed tritium sources and their potential contribution to groundwater contamination, in document Systematic And Quantitative Analysis Of Tritium Sources And Their Potential Contribution To Groundwater Contamination[5], dated March 29, 2007.

The report[5] confirms that all sources of groundwater contamination that would result from resumption of operations are clearly identified and quantified.

In order to complete this report[5], a thorough review of the land, facility, equipment and storage areas was performed to determine how tritium could escape the facility. An analysis of tritium movement through the entire facility and each individual process was also performed. All data was gathered by performing a review of historical records held by SRB and the CNSC that may provide insight on an historical event or work practice which could have had an effect on groundwater contamination. Other information was acquired by performing interviews of staff who may have had insight into historical events or work practices which could have had an effect on groundwater contamination.

The report[5] identified and discussed thirty-five potential and known tritium sources of groundwater contamination. The report also quantified or qualified these sources, where possible, and their potential impact on or contribution to groundwater contamination.

Finally, the report[5] contains an analysis of historical tritium measurements of emissions, wells, precipitation and standing water was performed and discussion was provided to rationalize transport mechanisms of each source to groundwater. The analysis demonstrates that the observed tritium in groundwater is consistent with the evaluation of tritium releases in the report. This provided confidence that the assessment of tritium sources is comprehensive and that no significant source has been overlooked. CNSC Staff visited SRB on April 30, 2007 to discuss each source further and to review additional supporting information. CNSC Staff later reported in a letter dated June 8, 2007[23] that it was satisfied that the atmospheric modeling provided by SRB provided a reasonable basis for concluding that aerial releases through the stack are the most plausible source term for the levels of groundwater contamination now found near the facility. The data analysis has shown that the current situation several meters below the ground surface is likely a function of high aerial stack releases peaking in 2000.

Of the 35 potential and known tritium sources of groundwater contamination identified by the report, a total of 23 would remain should the amendment be approved. Two of the sources eliminated are associated with the reclamation process and others are from discontinued practices or incidents. A number of sources have been reduced through mitigation measures implemented in the last 21 weeks of operation of the facility prior to the issuance of the existing licence.

3.4.1 REDUCTION IN EMISSIONS FROM THE FACILITY

SRB has reported that the emission reduction initiatives show a significant continuous reduction in emissions over the last licensing period. The total quantity of tritium processed was analyzed and compared for 2005, 2006 and the last 21 weeks of operation since the most effective mitigation measures were introduced.

From this data it can be clearly concluded that the reductions in emissions were largely due to mitigation initiatives introduced by SRB rather than operational constraints and restrictions imposed under our former licence:

TABLE 2: TOTAL AIR EMISSIONS REDUCTION

	2005	2006	LAST 21 WEEKS OF OPERATION AFTER MOST EFFECTIVE MITIGATION MEASURES
TRITIUM PROCESSED (GBq)	23,186,724	17,311,153	6,989,138
TRITIUM RELEASED (GBq)	1,224,412	284,645	54,204
TRITIUM RELEASED / PROCESSED	5.28%	1.64%	0.78%

3.4.2 REDUCTION IN EMISSIONS FROM THE RIG STACK

We have analyzed the data and segregated the emissions from the tritium filling process from other tritium processing. This could be done as one of the two stacks serves the tritium filling process and the other stack serves all the other tritium processes which include the laser cutting, bulk splitter and the reclamation.

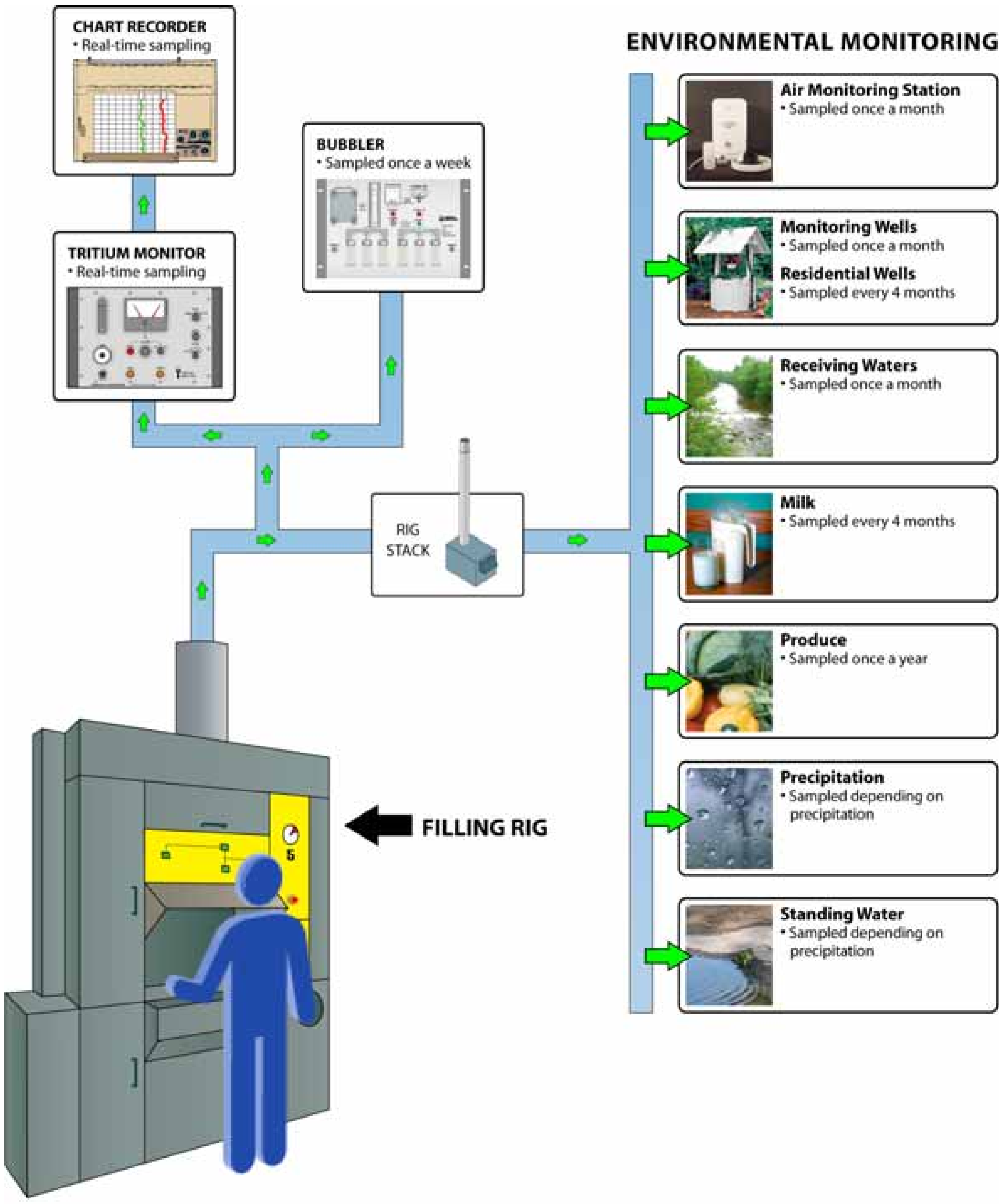
Each stack is independently monitored by its own bubbler system, tritium monitor and chart recorder and the resulting data is combined to determine the total stack emissions from the facility.

3.4.3 FILLING RIG OPERATION

When a cycle on a filling rig is performed a number of tubes are loaded and filled. The system which is approximately 100 cubic centimeters in volume is then evacuated using a vacuum pump. Once the system is fully evacuated a series of valves isolate the system from the atmosphere and the system is leak tested before initiating a cycle. A uranium bed is then heated to release tritium within this closed system to fill the tubes. The tubes are then sealed and removed. The system remains isolated from the atmosphere during this process. The tritium in the closed system is then reabsorbed onto the uranium bed as its temperature drops. A small amount of tritium gas remaining in the system is incapable of being reabsorbed by the uranium bed, and is subsequently released in a controlled manner by the operator.

These controlled releases are individually monitored by a tritium monitor connected to a real-time chart recorder and measured by the bubbler system sampling the stack providing ventilation to the filling rig, the vacuum pump and its exhaust system. Emissions are also measured in the environment at various sampling frequencies as depicted in Figure 9.

FIGURE 9: EMISSIONS MONITORING



3.4.4 MITIGATION MEASURES

In the past licence period we primarily focused our attention to developing emission reduction initiatives specifically related to the filling process as these formerly constituted the majority of the emissions. Our staff has been intimately involved in the improvements made with the filling process.

3.4.4.1 REDUCTION IN URANIUM BED HEATING CYCLES

In order to increase the ability of a uranium bed to reabsorb tritium during the filling process, SRB first implemented a reduction in the number of uranium bed heating cycles by approximately 30%. In **May 2006,** based on successful results, SRB then implemented a further reduction in the number of heating cycles of 25%.

3.4.4.2 REDUCTION IN VOLUME OF RELEASE

In late **July 2006** changes were made to allow the reduction of the volume of all our lights which our research determined would contribute to the reduction of emissions from the filling process.

3.4.4.3 PURGING WITH INERT GAS

In early **July 2006** a purging system was installed on the exhaust of the filling rigs in order to avoid stagnant tritium gas from converting to tritium oxide. In early **August 2006**, the system was modified to allow the flushing of the entire system to prohibit impurities from impeding the ability of a uranium bed to absorb tritium.

3.4.5 RESULTS

Results were presented to the Commission by SRB in a short presentation[35] during a Canadian Nuclear Safety Commission Meeting held on June 21, 2007.

The tritium processed in the filling process was analyzed and compared for 2005, 2006 and the last 21 weeks of operation since the most effective mitigation measures were introduced. From this data it can be clearly concluded that the reductions in emissions were largely due to mitigation initiatives introduced by SRB, rather than to operational constraints and restrictions imposed under our former licence:

TABLE 3: FILLING RIG AIR EMISSIONS REDUCTION

	2005	2006	LAST 21 WEEKS OF OPERATION AFTER MOST EFFECTIVE MITIGATION MEASURES
TRITIUM PROCESSED (GBq)	17,049,247	15,636,668	6,642,116
TRITIUM RELEASED (GBq)	670,949	196,964	2,787
TRITIUM RELEASED / PROCESSED	3.94%	1.26%	0.042%

As a further confirmation we have also analyzed the number of filling cycles performed against tritium released in 2005, 2006 and the last 21 weeks of operation, since the most effective mitigation measures were introduced. This confirmed a significant continuous reduction in emissions:

TABLE 4: TRITIUM RELEASED PER FILLING CYCLE REDUCTION

	2005	2006	LAST 21 WEEKS OF OPERATION AFTER MOST EFFECTIVE MITIGATION MEASURES
FILLING CYCLES	6,298	5,436	2,254
TRITIUM RELEASED (GBq)	670,949	196,964	2,787
TRITIUM RELEASED PER CYCLE (GBq)	107	36	1.24

3.4.6 MITIGATION COMMITTEE

SRB Senior Management has formally constituted a “Mitigation Committee” in the organizational structure, as documented in an internal memo[11] dated October 22, 2007.

Members of this Committee must be familiar with production equipment and processes for the facility that contribute to emissions from the facility. The Committee holds frequent meetings and discussions with Production Supervisors and Production Technicians in order to review equipment performance, adherence to production and engineering procedures and emission data. The information gathered during these meetings and discussions on equipment performance, adherence to production and engineering procedures and emission data is used to develop possible mitigation initiatives to reduce the emissions from the facility.

The Committee is also responsible for continuously seeking input from other staff, contractors or other individuals who may have recommendations to mitigate emissions from the facility.

Through research, expertise exchange with our competitors and operational experience our “Mitigation Committee” will continue to work on identifying and implementing additional mitigation measures in the future.

3.4.7 EMISSION REDUCTION TARGET

Based on operational experience and emissions during the last 21 weeks of operation, members of the “Mitigation Committee” and Production Supervisors have developed a realistic but optimistic “Emission Reduction Target” for the first year of operation should tritium processing resume.

It was decided that reducing the average weekly emissions by 10% for the first year of operation from the average weekly emissions for the last 21 weeks of operation would be an appropriate target.

Based on results achieved new targets will also be established for the second year of operation.

3.4.8 PROJECTION BASED ON TARGET

Therefore, based on the "Emission Reduction Target", emission for resumption of operations are expected to be approximately 34% of what they were in 2006.

TABLE 5: TOTAL YEARLY EMISSIONS IN 2006, PROJECTED BASED ON LAST 21 WEEKS

	2006 TOTAL YEARLY EMMISSIONS (FROM TABLE 2)	TOTAL YEARLY EMMISSIONS BASED ON LAST 21 WEEKS OF OPERATION	PROJECTED YEARLY BASED ON TARGET OF 10% REDUCTION
TRITIUM RELEASED (GBq)	284,645	108,957	98,061

3.5 EFFECT OF AMENDED OPERATIONS ON THE ENVIRONMENT AND THE PUBLIC

We have determined the anticipated effects that the proposed amendment (i.e. tritium processing only when there is no precipitation and no operation of the reclamation unit) would have on concentrations of tritium in groundwater, in other environmental media, and on the radiation doses to the public and to SRB staff. Anticipated values from operations are estimated to be even lower than those in 2006, since emissions are expected 34% of those reported in 2006 based on the drastic reductions in the last 21 weeks of operation and the "Emission Reduction Target" that we have established. We processed tritium for only a few weeks in 2007 and therefore do not to show data for 2007 as data would not provide any indication of anticipated effects from resumption of operation.

3.5.1 RADIATION DOSE

3.5.1.1 PUBLIC DOSE

As reported in the Annual Compliance Report for 2006[25], the maximum calculated annual dose to a member of the public due to the emissions from SRB in 2006 was 0.0145 mSv (millisieverts), less than 1.5% of the public dose limit of 1.0 mSv per year set by the CNSC. Anticipated doses to the public from the operations are estimated to be even lower than those in 2006, since emissions are expected 34% of those reported in 2006. The dose is conservatively calculated for a resident living closest to SRB and working in a business adjacent to SRB taking into account inhalation and skin absorption of tritium and consumption of local groundwater and produce:

TABLE 6: MAXIMUM DOSE TO A MEMBER OF THE PUBLIC FROM SRB

	2005 (mSv)	2006 (mSv)	DECREASE
PUBLIC DOSE	0.0337	0.0145	-57%

3.5.1.2 OCCUPATIONAL DOSE

As report in the Annual Compliance Reports for 2005[24] and 2006[25] (the last full year of operation), occupational doses are well below the maximum annual dose of 50 mSv (millisieverts) set by the CNSC for a Nuclear Energy Worker:

TABLE 7: SRB OCCUPATIONAL DOSE REDUCTION

	2005 (mSv)	2006 (mSv)	DECREASE
AVERAGE	0.50	0.30	-40%
MAXIMUM	3.61	3.35	-7%
COLLECTIVE	23.50	11.34	-52%

Based on operational experience and occupational doses associated with specific activities performed operation, the Human Protection Coordinator and Production Supervisors have developed a challenging but realistic "Occupational Dose Target" for the first year of operation should tritium processing resume. A reduction of 15% of the average overall dose for the first year of operation would be an appropriate target. Based on results achieved, new targets will also be established for the second year of operation.

3.5.2 ENVIRONMENT

We have tabulated monitoring results reported in the Annual Compliance Reports for 2005[24] and 2006[25]. These results show a good and direct correlation between the reduction in emissions and concurrent reductions in the environment. Data also shows a clear reduction in emissions in 2006 from those in 2005.

3.5.2.1 PASSIVE AIR SAMPLERS

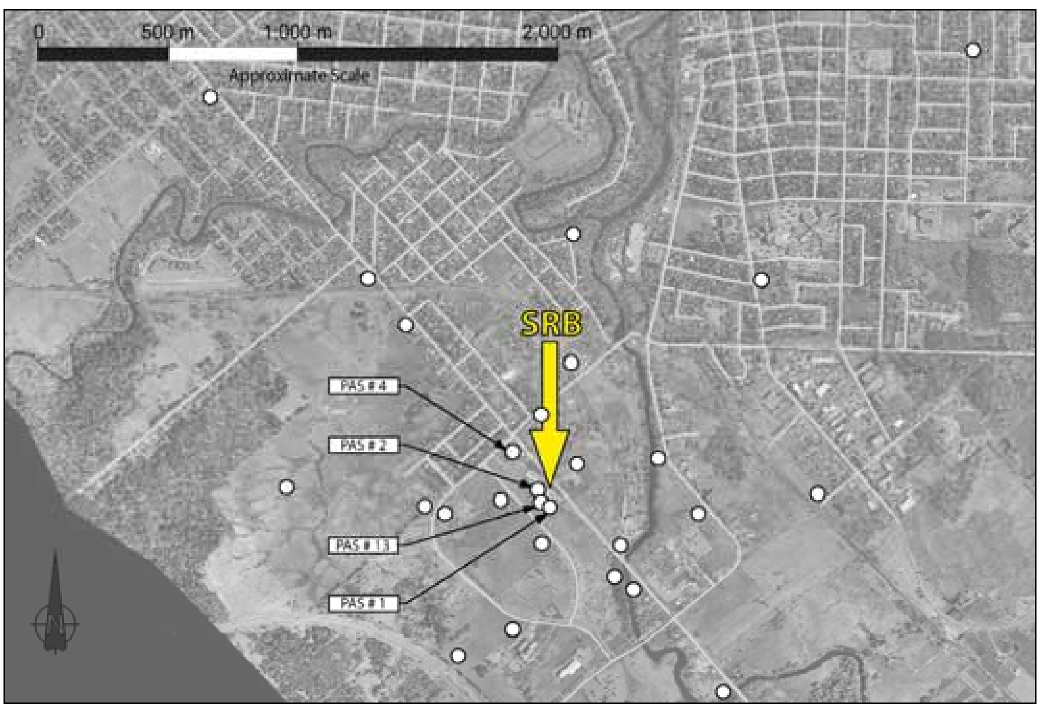
Our environmental monitoring program consists of the monthly sampling of 40 air monitoring stations. Results show that concentrations dropped significantly during 2006:

TABLE 8: PASSIVE AIR SAMPLER TRITIUM CONCENTRATION REDUCTION

SAMPLERS CLOSEST TO SRB	DISTANCE FROM SRB (m)	2005 (Bq/m^3)	2006 (Bq/m^3)	DECREASE
PAS # 1	94	142.00	24.21	-83%
PAS # 2	53	128.60	33.24	-74%
PAS # 4	222	84.30	19.05	-77%
PAS # 13	62	175.30	35.66	-80%

*Passive air sampler used to calculate maximum possible dose to a member of the public:

FIGURE 10: PASSIVE AIR SAMPLER LOCATION MAP



SRB plans on installing additional passive air samplers to the east of the facility to provide improved coverage in this high frequency wind sector.

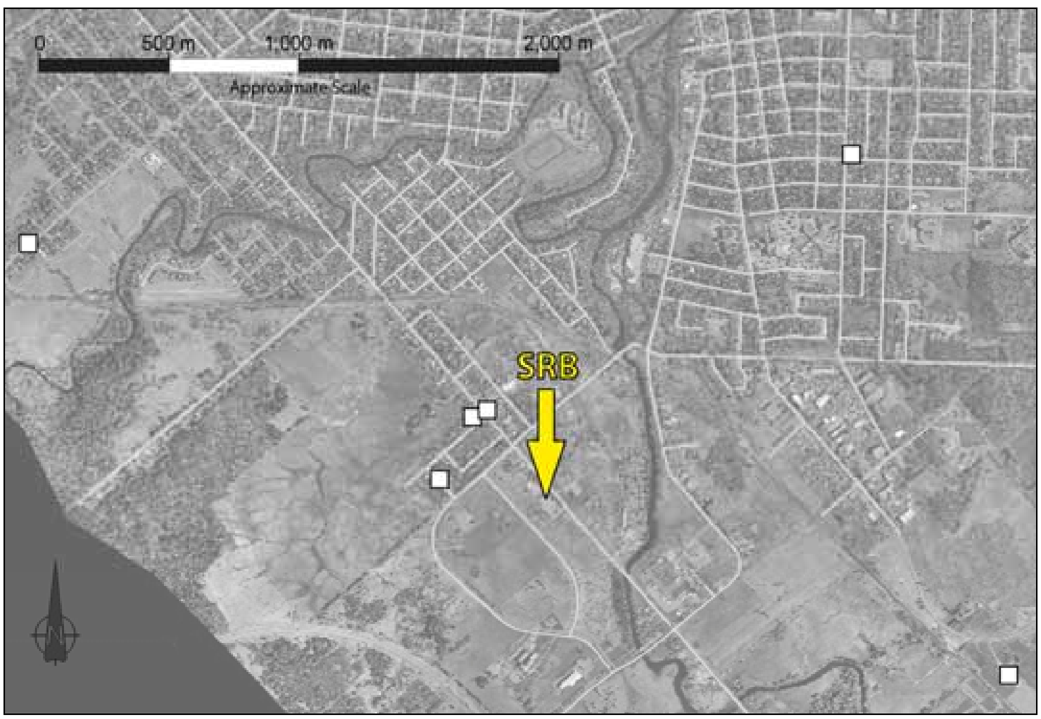
3.5.2.2 PRODUCE RESULTS

As part of our environmental monitoring program we also sample produce from at least six local gardens. The three local gardens located approximately 400 meters from the facility yield the highest concentrations measured. Results show that concentrations significantly dropped in 2006:

TABLE 9: PRODUCE TRITIUM CONCENTRATION REDUCTION

PRODUCE CLOSEST TO SRB	APPROXIMATE DISTANCE FROM SRB (m)	2005 (Bq/L)	2006 (Bq/L)	DECREASE
CUCUMBER	400	4,400	312	-92%
ONION	400	7,000	692	-90%
TOMATO	400	4,800	598	-87%
POTATO	400	4,900	500	-89%
APPLES	400	5,500	1,257	-73%

FIGURE 11: PRODUCE SAMPLING LOCATION MAP



3.5.2.3 SOIL MOISTURE

Soil moisture or standing water on and around the facility are the sole direct contributor to elevated tritium concentrations in groundwater and result from air emissions. The tritium concentrations in soil and groundwater are consistent with emission levels.

Prior to the issuance of the Designated Order on August 15, 2006 the facility processed tritium during normal business hours including periods of precipitation. The Commission amended the Designated Order[26] on September 5, 2006 to allow SRB to process tritium but not during the occurrence of any type of precipitation, including rain, drizzle, freezing rain, hail and snow.

As part of this amendment SRB proposes to process tritium but not during the occurrence of any type of precipitation, including rain, drizzle, freezing rain, hail and snow. All measures, methods and procedures required to do so are already in place.

Average tritium levels in standing water taken on site while SRB processed tritium during periods of precipitation were compared against measured levels while processing during periods of no precipitation. Results were presented to the Commission by SRB in a short presentation[35] during a Canadian Nuclear Safety Commission Meeting held on June 21, 2007.

The results during periods of no precipitation show a significant reduction in average standing water measurements taken around the property. The observed reductions were considered to be due to both the reduction in emissions achieved by SRB below the licensed values as well as the cessation of operations during precipitation events:

TABLE 10: SOIL MOISTURE TRITIUM CONCENTRATIONS WITH AND WITHOUT PRECIPITATION

	PROCESSING DURING PRECIPITATION	NOT PROCESSING DURING PRECIPITATION	
DESCRIPTION	APRIL 3, 2006 TO AUGUST 2, 2006 AVERAGE	OCTOBER 11, 2006 TO DECEMBER 5, 2006 AVERAGE	REDUCTION
WATER DRIPPING FROM STACKS	2,300,000 Bq/L	3,010 Bq/L	-99%
STANDING WATER NEAR STACK	19,300 Bq/L	670 Bq/L	-97%
DOWNSPOUTS	15,300 Bq/L	540 Bq/L	-96%
DITCHES PROPERTY LINE	760 Bq/L	430 Bq/L	-43%
AVERAGE WEEKLY EMISSIONS[1]	2,267 GBq	349 GBq	-85%

1 – Emissions include total reported HTO and 2% of total reported HT (to account for HT oxidation to HTO).

3.5.2.4 GROUNDWATER

The Commission has expressed the view that more wells were needed to be drilled through the stratigraphy to get a better understanding of the tritium levels in groundwater and tritium releases to the environment.

Since the Commission published its decision[3] on January 31, 2007, SRB has analyzed data from existing groundwater wells, met with CNSC Staff and Ontario Ministry of the Environment (MOE) Staff and developed a plan[27] with the full knowledge and cooperation from adjacent property owners that has resulted in two additional phases of groundwater investigations. These investigations included the installation of an additional 27 new monitoring wells located on and around the property where SRB is located. The additional 27 wells were drilled to the top of bedrock and at various depths into bedrock to confirm the depth of bedrock surface, to measure the hydraulic conductivity values in those zones, and to identify concentrations of tritium in the groundwater below and adjacent to the site. The information was used to verify that groundwater with elevated concentrations of tritium is moving, as predicted, to the Muskrat River. Our groundwater studies now include monitoring data from 55 wells, including 38 wells located within 150 meters of our stacks. The locations of the wells in close proximity of our facility are depicted in Figure 12:

FIGURE 12: MONITORING WELLS DRILLED BEFORE AND AFTER JANUARY 31, 2007

FIGURE 13: WELLS IN THE VICINITY OF SRB

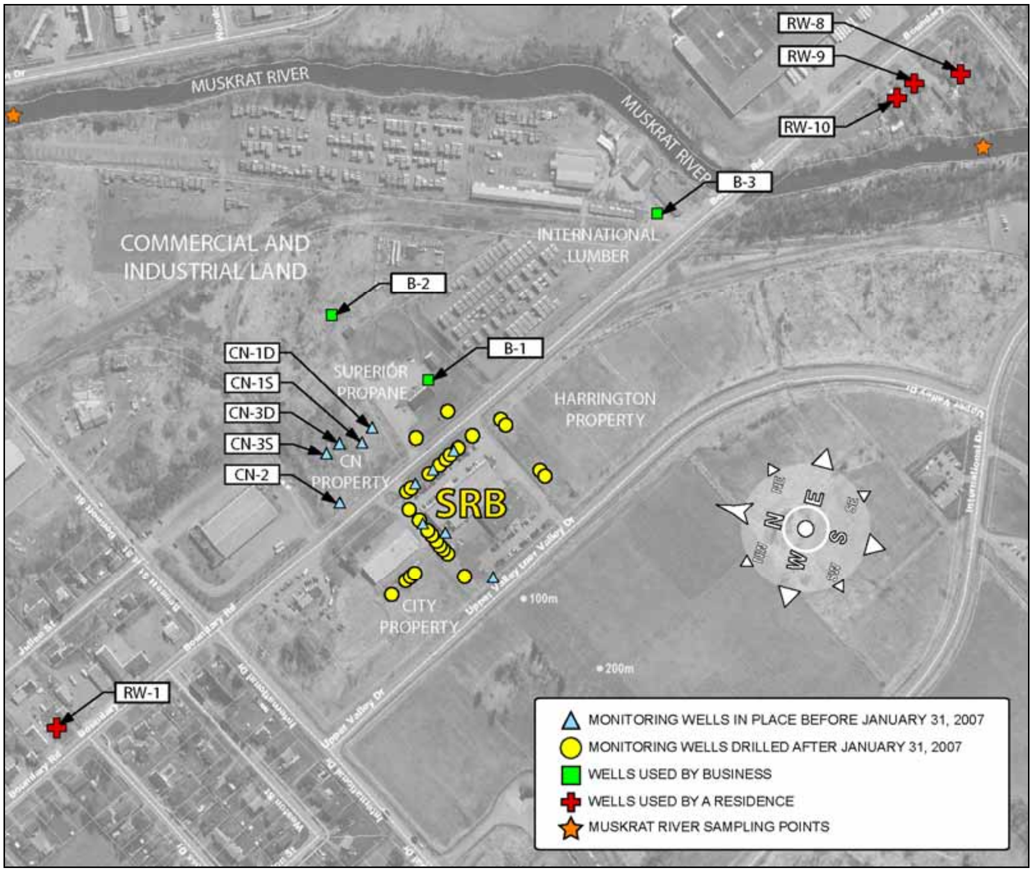
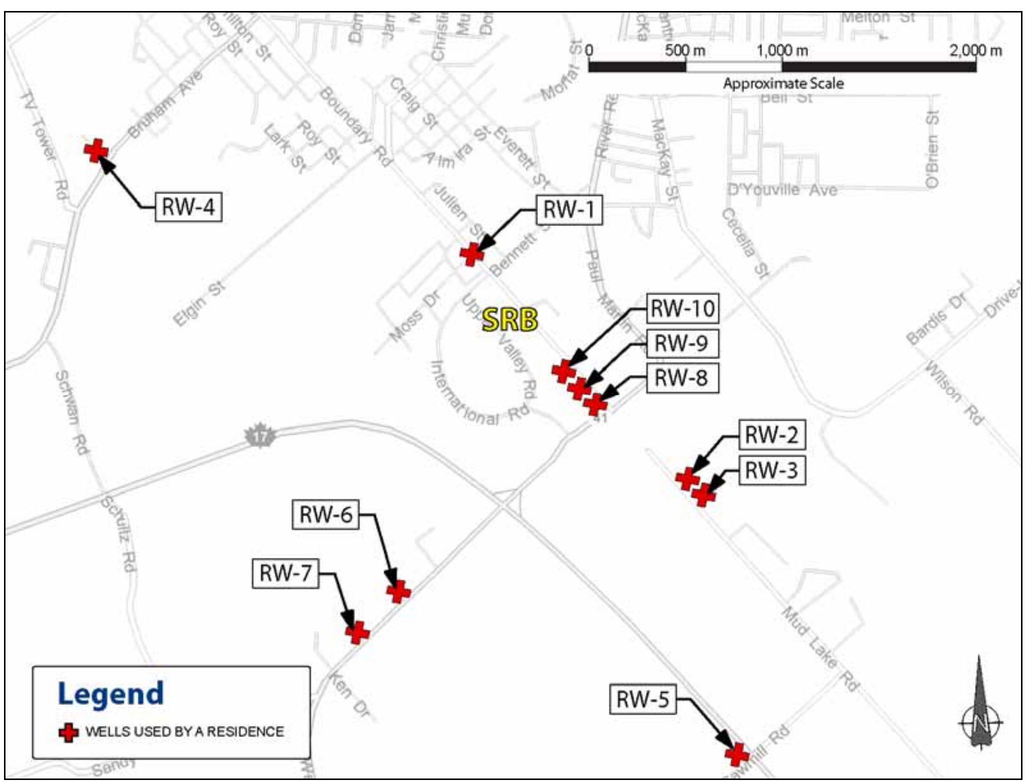


FIGURE 14: LOCATION OF ALL RESIDENTIAL WELLS



Efforts were also taken to further ensure that no other wells used for drinking water were located near SRB. A By-Law exists for the City of Pembroke prohibiting the installation of drinking water wells in the City of Pembroke including the SRB site. SRB reviewed well records from the MOE for 1 kilometer radius around SRB to help identify possible additional wells that might have been put in place before the existence of the By-Law. In addition, a door-to-door survey was also completed by SRB to identify any additional groundwater wells within 400 m of the SRB facility not in the MOE database. In total we have identified seven wells, six that are used for drinking water (two by businesses and four by residences), and one well that is used by one of these businesses for washing vehicles.

A Comprehensive Groundwater Report and Complete Analysis[28] was then provided to CNSC and MOE Staff in January 2008. This report included:

- All groundwater and soil data that have been collected.
- All results of monitoring data with concentrations and water levels.
- Interpretation of the data in the context of tritium concentrations in groundwater at and around the SRB facility. The interpretation includes analysis of:
    - Depths to bedrock.
    - Distributions of hydraulic conductivity in bedrock and overburden.
    - Horizontal and vertical hydraulic gradients.
    - Available MOE water well logs from the surrounding area.
    - Groundwater velocities and travel times.
    - Tritium distributions in soil and groundwater.
    - Potential future impacts and other potential monitoring locations.

The report[28] confirmed that the observed concentrations of tritium in groundwater fall within the ranges expected for air dispersion of tritium emissions to the borehole locations and equilibrium exchange with soil water at those locations. The results in the overburden clearly show that the source of tritium in soil and groundwater is from atmospheric emissions and therefore not from any release of liquid containing elevated tritium concentrations.

Originally all but 2 of 55 groundwater samples had tritium concentrations that were consistent with values expected from the emissions history and air concentrations at the well locations. The two groundwater samples (MW06-1 and MW07-18) were greater than those expected from air dispersion were affected by water draining from roof downspouts or from snow storage areas in which water or snow would have developed higher tritium levels in closer proximity to the stacks. MW07-18 now reflects the levels predicted and for the first few samplings might have been affected by dragdown during drilling.

Soil samples taken over time have clearly shown decreases in tritium concentrations that are directly correlated with decreases in emissions of tritium from the facility. The planned decrease in emissions together with natural decay will eliminate all tritium concentrations in groundwater in excess of the drinking water guideline within a few decades, and there is no indication of residual risk while this natural mitigation occurs.

Horizontal flow along the top of bedrock and within the shallow bedrock below the site occurs toward the east where Superior Propane is located also representing the closest direction to the Muskrat River. The largest groundwater velocity based on the geometric mean hydraulic conductivity of the bedrock (most permeable unit) and measured gradients is about 4 m/a.

The highest elevated tritium concentrations of approximately 50,000 Bq/L remains in a monitoring well located near the stack area on the SRB property. Only two water supply wells are located down gradient of the SRB site. Those supply wells (B1 and B2 on Figure 13) are located on the Superior Propane property. The one well that is used to supply water to the office has been monitored regularly and exhibits tritium concentrations less than 1,500 Bq/L. The other well is used to supply water for truck washing and is not used for drinking purposes and has not exceeded 5,000 Bq/L. As a precautionary measure SRB has been supplying Superior Propane with bottled drinking water since October 2006 and has been sampling concentrations in the well monthly.

SRB has been monitoring all residential wells used for drinking water for more than one year and concentrations have ranged from 4 Bq/L to less than 1,500 Bq/L (depending on their location in relation to the facility), or less than 20% of the Ontario Drinking Water Standard of 7,000 Bq/L.

If an individual was to use the water from a well with a concentration of 1,500 Bq/L as a sole source of drinking water for the entire year, their dose from consuming that water would be approximately 0.025 mSv (millisieverts) for the entire year, or approximately 2.5% of the annual public dose limit set by the Canadian Nuclear Safety Commission of 1 mSV (millisieverts).

A groundwater divide occurs off-site, adjacent to the southwest corner of the building. Flow at this location heads in a north to northwest direction, but does not involve groundwater originating on the SRB property. All groundwater originating on site migrates in an easterly direction toward the industrial areas adjacent to the Muskrat River.

The Muskrat River likely represents the main discharge area for shallow groundwater in the area and is about 420 meters from the SRB property along the shortest pathway. Assessment of groundwater velocities in conjunction with natural decay of tritium indicates that any discharge of groundwater, at the river, that originated at the SRB site will have tritium levels well below the Drinking Water Standard. SRB has been measuring concentrations of tritium for over one year upstream and downstream of the SRB site in the Muskrat River and all measurements are near background levels.

Groundwater with elevated tritium levels will migrate at an average horizontal velocity of 4 m/a in the shallow bedrock. At this rate, tritium concentrations will decline by natural decay to 10% of their initial values after about 160 m of travel, and will decline to 1% of initial values in 340 m of travel. Because the highest concentrations of tritium on site are about 50,000 Bq/L, the maximum concentrations at a distance of about 100 m down gradient, after about 3 half-lives (one half life for tritium is approximately 12.3 years) of travel, will be less than the drinking water guideline of 7,000 Bq/L.

3.5.2.5 FUTURE GROUNDWATER WORK

3.5.2.5.1 MONITORING

The Groundwater Report[28] has confirmed that the concentrations in soil and boreholes are directly related to those in soil moisture resulting from atmospheric emissions and air dispersion. Therefore lower emissions and the cessation of operations during the occurrence of precipitation will continue to result in lower soil moisture concentrations.

Over the proposed licence term, SRB will therefore continue to monitor tritium concentrations in the facility's downspouts and in precipitation. SRB will report and analyze measurements as part of the Environment Monitoring Program quarterly report.

The Report[28] indicates that the average lateral groundwater velocity indicates that any changes that might occur in groundwater quality would take place relatively slowly, and could be readily observed with the sampling frequency of the current monitoring program.

Although not required to do so in its existing licence, SRB currently conducts monthly monitoring of the newly installed wells located just off site and of the water supply well nearest SRB, B-1. Under the amended licence SRB proposes to continue monthly monitoring of those wells. SRB also proposes to continue to monitor tritium concentrations in the wells as per Appendix F, item 1 of existing licence and is proposing to report the results as part of the Environment Monitoring Program quarterly report rather than reporting monthly as required in Condition 6.6 of existing licence:

TABLE 11: PROPOSED WELL SAMPLING FREQUENCY

LOCATION	WELL I.D.	PROPOSED FREQUENCY
MONITORING WELLS ON SRB SITE	MW06-1-2-3-8-9-10 AND MW07-11 -12-13-14-15-16-17-18-19-22-23-26 -29-31-34-37	MONTHLY
MONITORING WELLS LOCATED NEAR SRB SITE	MW07-20-21-24-25-27-28-32-33-35 -36	MONTHLY
SUPERIOR PROPANE	B-1	MONTHLY
RESIDENTIAL AND BUSINESS WELLS	RW-1-2-3-4-5-6-7-8-9-10 AND B-2-3	MARCH, JULY AND NOVEMBER
CN WELLS	CN-1S-1D-2-3S-3D	MARCH, JULY AND NOVEMBER

NOTE: Wells MW06-4-4S and MW07-30 no longer exist and MW06-5 and MW06-6 are located too far away to provide any meaningful result and will therefore continue not to be monitored.

All data indicates that any water with elevated concentration of tritium will eventually migrate toward the Muskrat river but will have concentrations much lower than the Drinking Water Standard. As a precaution, SRB also proposes to continue to monitor the Muskrat River sampling points upstream and downstream from the SRB site on a monthly basis.

3.5.2.5.2 CONNECTION BETWEEN WELLS

As indicated in the Groundwater Report[28], a hydraulic connection may exist between monitoring wells MW07-22 (top of bedrock) and MW07-37 (shallow bedrock), based on water level measurements.

This is likely due to caving of rock fragments at the bedrock surface into the borehole and widening of the hole diameter during drilling. However, the observed vertical gradient between MW07-31 (deeper bedrock) and MW07-22 (top of bedrock) indicates that an effective seal is present within MW07-31. Current tritium concentrations in MW07-22 are low, and therefore there is little risk for migration of elevated tritium into the shallow or deeper bedrock at this location.

However, as recommended in the Groundwater Report[28], MW07-37 will be carefully monitored and abandoned during future activities at the site if levels of tritium in that well increase to values near the drinking water standard.

3.5.2.5.3 GROUNDWATER FLOW

Concentrations of tritium in samples from wells MW07-20 and MW07-21, located between SRB and Superior Propane, are low (< 700 Bq/L) and decreasing, and suggest tritium has not arrived at groundwater supply well B-1 as a result of lateral transport of groundwater.

However, as recommended in the Groundwater Report[28], if continued monitoring indicates increase in concentrations in these wells, additional actions, including possible completion of additional monitoring wells into shallow bedrock near B-1, will be considered.

As indicated in the Groundwater Report[28], a groundwater divide exists adjacent to the southwest corner of the building. Tritium within the groundwater migrating to the west originates just off-site and is a result of air emissions not from groundwater on SRB's site. Concentrations of tritium in groundwater in three of the monitoring wells to the west of the site are currently close to the Drinking Water Standard, but are exhibiting a decreasing trend with time. Although there is not enough data to determine the exact flow direction for the groundwater to the west, it is recommended that the groundwater concentrations in the current off-site wells (MW07-27, -28, -35 and -36) continue to be monitored.

As recommended in the Groundwater Report[28], if results suggest an increase in tritium concentrations, additional groundwater monitoring wells may be required to the west of the site to determine the extent and degree of tritium migration in that direction.

3.5.2.5.4 FUTURE DEVELOPMENT

The City of Pembroke Zoning By-Law 97-38 requires all buildings within the city, including residential dwellings, to be connected to the municipal piped water services, and prohibits the installation of water supply wells within the city limits. Therefore, no new groundwater supply wells are expected to be installed in the vicinity of the SRB facility. SRB has agreed with the owner of the land where SRB is located to restrict excavation or modification of the land until an assessment is performed by SRB to ensure that the work undertaken will not result in a risk to a worker performing such work.

Vacant lands in the vicinity of SRB are primarily zoned as Industrial. SRB has agreed with the City of Pembroke to perform surface soil sampling at all new developments within the vicinity of the SRB Facility. To date, two developments have been initiated near the site, including the construction on the vacant lands immediately to the east of SRB. The second development of a motel is approximately 500 m to the southeast of the site. Soil samples were collected for both sites by SRB with tritium concentrations in surface soil water of less than 340 Bq/L, levels that do not represent a risk to workers or the environment. The sampling of soils prior to construction activities will ensure that new developments will not be at risk from elevated tritium concentrations.

3.5.2.5.5 REMEDIATION

The Commission directed SRB to evaluate the need for remediation.

The average lateral groundwater velocity indicates that any changes that might occur in groundwater quality would take place relatively slowly, and could be readily observed with the sampling frequency of the current monitoring program. Natural decay of tritium, together with the reduction of emissions, and source concentrations in soil water will ensure that tritium concentrations in groundwater on the SRB property, and off-site will naturally decline to levels well below the drinking water guideline of 7,000 Bq/L within a few half-lives and within travel distances of only about one hundred meters. While this natural mitigation occurs, the system can be readily monitored to ensure that there are no risks to nearby water supply wells from tritium concentrations that exceed the drinking water guideline.

At this time, there is no indication of current or future risk related to groundwater with elevated tritium levels in the vicinity of the SRB facility.

Based on the information collected to date passive remediation of tritium, allowing natural decay and dispersion of the groundwater below the stacks and elsewhere on site is adequate and it would appear that no other measures need to be implemented now or in the future other than maintaining a monitoring program of wells and the mitigation of emissions as SRB has proposed.

3.5.3 RELEASE LIMIT FOR THE PROPOSED OPERATION

Based on all the information gathered on groundwater to date, we have developed a conservative release limit for air emissions specifically designed to protect groundwater and in doing so will also be protective of the environment and the public in the vicinity of the SRB facility. The Release Limit Rationale[29] is found in Appendix A of licence Application dated December 12, 2007.

The release limit is primarily based on environmental protection and ensures the sustainable use of groundwater resources. We are confident that the release limit has been developed with sufficient data and conservatism. The release limit to atmosphere is based upon a number of conservative assumptions. These newly calculated values are more restrictive than the release limit in the current licence NSPFPL-13.01/2008 and are consistent with the ALARA principle:

TABLE 12: PROPOSED AIR RELEASE LIMIT VS CURRENT LICENCE RELEASE LIMIT

NUCLEAR SUBSTANCE AND FORM	CURRENT LICENCE RELEASE LIMIT TO AIR (GBq/YEAR)	PROPOSED RELEASE LIMIT FOR AMENDMENT (GBq/YEAR)	% BELOW CURRENT LICENCE RELEASE LIMIT
TRITIUM AS TRITIUM OXIDE (HTO)	135,000	67,200	50%
TOTAL TRITIUM AS TRITIUM OXIDE (HTO) AND TRITIUM GAS (HT)	521,000	448,000	14%

3.5.4 ACTION LEVELS FOR THE PROPOSED OPERATION

Using Regulatory Guide G-228 on developing and using action levels we have also developed, in accordance with Subsection 6(1) of the Radiation Protection Regulations action levels for the proposed resumption of operation.

SRB assessed both the average and maximum weekly emissions during the last 21 weeks of operation and deducted the estimated emission contribution from the reclamation process which will not be operated under this amendment and identified an appropriate action level that would meet the requirements of section 6 of the Radiation Protection Regulations.

TABLE 13: PROPOSED WEEKLY ACTION LEVELS FOR THE PROPOSED AMENDMENT

NUCLEAR SUBSTANCE AND FORM	PROPOSED ACTION LEVELS FOR AIR EMISSIONS FOR THE AMENDMENT (GBq/WEEK)
TRITIUM AS TRITIUM OXIDE (HTO)	840
TOTAL TRITIUM AS TRITIUM OXIDE (HTO) AND TRITIUM GAS (HT)	7,753

The selected weekly action levels if reached every week of the year are 35% below the licence limit for HTO and 10% below the licence limit for HT + HTO. Reaching the action level on a weekly basis for the entire year for both HT and HTO would yield a dose to a nursing infant of 0.011 mSv per year, 1.1% of the public dose limit of 1 mSv per year based on the most recent DRL produced in 2006.

3.5.5 EXISTING MEASURES, METHODS AND PROCEDURES

Although we will continue to implement mitigation measures to reduce emissions the issuance of this amendment would not require that any new methods or procedures be implemented. Previous operation of the facility necessitated the implementation of a number of new procedures which ensured that certain operational limitations were observed. We will continue to work to these procedures and consequently observe these conditions as follows:

- No tritium processing shall take place during the occurrence of any type of precipitation, including rain, drizzle, freezing rain, hail and snow (procedure number ENG-016). This will further reduce soil moisture concentrations near the stack and on site.
- Processing of tritium shall only occur if the effective stack heights are at least 27.8 m for optimum dispersion conditions (procedure number ENG-014).
- Monthly maintenance of pitot tubes installed in the exhaust stacks will be carried out (Maintenance Program). This ensures ventilation performance is measurable which in turn allows the determination of the effective stack height.
- Bulk splitting rig shall only be operated if the operator is in the presence of a qualified supervisor (procedure number 450-001). This practically eliminates the possibility of an unplanned release.
- At any one time SRB will only use a filling rig or the bulk splitting rig to process Tritium (procedure numbers 400-001 and 450-001). This ensures that emissions can be individually monitored on the chart recorder and attributed to a specific activity.
- Pyrophoric uranium tritium traps excluding the bulk tritium cylinders shall be loaded with no more than 111,000 GBq of tritium at anytime (procedure number 450-001). This mitigates an accidental release.
- The processing of tritium shall only occur between the hours of 0700 and 1900 (procedure numbers 400-001 and 450-001). This further mitigates dose to the public and concentration in soil moisture near the stack as the air is generally more stagnant at night therefore less dispersion occurs.

3.6 PUBLIC RELATIONS EFFORTS

SRB has made great strides in the last few years to put in place a Public Information Program that provides the public living in the vicinity of SRB with information about our operations. Despite these improvements, SRB realizes that, based on the number of intervenors from the local community who voiced their concern at the last licensing hearing, there has been a disconnect between SRB and some members of the public.

SRB very much appreciates the Workshop held by the CNSC in January 2008 on the Assessment and control of Tritium's health Risk. After attending the Workshop, our local Member of Parliament issued a Press Release which resulted in positive coverage stating that "From what I have heard today, there is a clear absence of evidence to suggest that tritium exposure to workers in the industry or local residents is linked to any disease. That in and of itself is good news for the people of the upper Ottawa Valley". After attending the workshop, the Mayor of Pembroke also issued a statement to the Press following the workshop which resulted in positive coverage stating that "residents have nothing to fear" and that "tritium levels safe in City".

We recognized that SRB needed to make drastic changes to regain the confidence and trust of the public, and especially of local interest groups, in order to facilitate future licensing. Some of our efforts were reported in a document tiled Public Relations Efforts[30], dated February 16, 2008. CNSC Staff reported in a letter[31] dated February 29, 2008 that they were satisfied that SRBT's enhanced Public Information Program met the criteria found in CNSC regulatory Guide G-217.

Senior Management felt it was important to incorporate this need in our revised company vision and goals (see Figure 5: Company's Governing Principles on page 14). Our new vision requires that SRB remain in good standing with the Commission by maintaining or exceeding the standards required. Such standing is partly achieved by acceptance by the public. In turn, one of our company's new goals is to be transparent, visible and open with our community. One of the values set by Senior Management is to act with integrity with members of the public by respecting their input and contribution. The new company vision, mission, goals, values and policy were made publicly known on our website shortly after their institution.

3.6.1 COMMITTEES

SRB Senior Management has formally constituted a Public Information Program Committee in the organizational structure, as documented in an internal memo[11] dated October 22, 2007. Senior Management has formally and clearly defined the responsibilities, composition and requirements of this committee. This committee has since met on 4 occasions to discuss various Public Information Program matters as documented in the meeting minutes.

3.6.2 NEW APPOINTMENTS

3.6.2.1 PUBLIC RELATIONS MATERIAL DESIGNER

A Public Relations Material Designer function has been added to our organization, SRB has created this function in order to design and produce public relations material specifically aimed at meeting the needs of local special interest groups, members of the public with concerns and the public at large.

This function was incorporated in the responsibilities of the Engineering Assistant as documented in the Engineering Assistant job description. This individual has formal training in designing and producing advertising and public relations material coupled with a number of years of work experience in graphic design and printing. This individual's workload allows this function to be performed and no changes are expected as a result in the future.

3.6.2.2 PUBLIC RELATIONS COORDINATOR

A Public Relations Coordinator function has been added to our organization, SRB has created this new role to support the President in coordinating and focusing all public relations efforts to implement the company vision. This individual is responsible for providing information to the public. In the first Public Information Program Committee meeting held on October 22, this individual also holds the position of Environment Protection Coordinator was appointed this role as she possesses intimate knowledge of public information concerns. This is also a good fit as the Environmental Protection Coordinator has also been responsible for communicating and explaining environmental monitoring results to the public.

The workload of this individual will continuously be assessed to ensure that all her duties can be performed effectively. A possibility exists that the Public Relations Coordinator function will be delegated to another employee or to a new employee should it be necessary in the future.

3.6.3 COMMUNICATION

We have proactively initiated an increased number of meetings and discussions to familiarize various stakeholders with our operations.

3.6.3.1 PUBLIC

On July 27, 2007 we met with members of the public and local interest groups who were most concerned regarding our operations. The purpose of this meeting was to define areas of concern for the public to help SRB develop a path forward that would address these concerns. Following this meeting we have incorporated methods to address these concerns as part of our plan for resumption of operation.

For example the public have clearly stated during their meeting in July that "the Concerned Citizens of Renfrew County's main and most important concern was over the operation of the reclaim". As a result in their request for licence amendment SRB proposes "No operation of the reclamation unit due to concerns expressed by some members of the public". In addition during the meeting in July the public requested "that the environmental monitoring continue to be done by a third party". As a direct result we have incorporated the continued analysis of the environmental monitoring program by a third party in our request for licence amendment.

We met members of the public and of a local interest group again on December 7, 2007 to discuss some of the details of this amendment application. We informed the public that, based on their comments from previous meetings, the company had made the decision not to include the operation of the reclamation rig and to continue to use third parties for conducting environmental monitoring activities. We have offered to hold another meeting before the licence amendment hearing.

As part of the current licence we sample the water in a number of wells belonging to the public every 4 months for tritium concentration. On a yearly basis we also sample produce from gardens belonging to members of the public for tritium concentration. We promptly provide each member of the public with a report of the sample results along with the anticipated radioactive exposure due to tritium from consuming either the water or produce. We provide members of the public a comparison of this exposure against the CNSC limit and against radioactive exposure from other known sources, such as cosmic radiation, x-rays, etc.

We also continue to address inquiries from members of the public and provide information accordingly.

3.6.3.2 CITY OF PEMBROKE

On August 10, 2007 we met with members of Pembroke City Council and other City Officials operations. The purpose of this meeting was to provide an annual update to the City and to define areas of concern for the City to help SRB develop a path forward that would address these concerns. Following this meeting we have incorporated methods to address these concerns as part of our plan for resumption of operation. During the meeting with the City, two Councillors stated that they were pleased that SRB was maintaining an open dialogue with the concerned members of the public and that they wished for that to continue in the future. We confirmed that we would continue these efforts in the future. SRB invited members of Council for a tour of the facility but no one to date has requested a tour. It is important to note however that the Mayor, the Deputy Mayor and four of the six Councilors have already visited our facility in the past. Another meeting has been scheduled with the City of Pembroke on March 4, 2008 to further discuss SRB's licence amendment application to resume tritium processing.

We continue to regularly provide the Mayor and City of Pembroke officials information on licensing actions or other issues regarding SRB, tritium, relevant media coverage, groundwater study results and sewage measurements. All information is followed by a phone call to ensure clear understanding.

3.6.3.3 FEDERAL MEMBER OF PARLIAMENT

We regularly provide our local Member of Parliament and staff with information on licensing actions or other issues regarding SRB, tritium and relevant media coverage. All information is followed up by a phone call to ensure that all information supplied was clearly understood.

3.6.3.4 NEIGHBOURS

We have initiated a number of meetings and discussions with our landlord and neighbours to provide them information on our operation. Information was mostly focused on groundwater results and resumption of operation. Again, all information is followed up by a phone call.

3.6.3.5 MEDIA

SRB has held meetings and discussions with members of the local media to help ensure that future reporting is accurate and balanced and that SRB is given the opportunity to comment, clarify and explain any issue at hand.

Discussions take place after any article or letter to the editor that contains information that does not accurately reflect facts about tritium or radiation or SRB's position.

3.6.3.6 PRESS RELEASES

As the media have proven to be the most effective way of communicating with the public, we realized that SRB had previously not proactively informed the media of licensing actions or other issues regarding the facility.

As a result SRB developed a list of local media contacts who are provided press releases regarding licensing actions or other issues regarding the facility.

Press releases and detailed supporting information is also provided to the City of Pembroke, the Federal Member of Parliament and to members of the public who have expressed concerns regarding our operations at past CNSC licence hearings.

To date three such press releases have been issued to the media. The press releases have resulted in much more balanced and positive media coverage and have served well in informing the public.

Press releases provide a contact person to provide media the opportunity to ask questions or seek clarification. SRB addresses inquiries more promptly than in the past while ensuring that all information supplied is clearly understood.

3.6.3.7 LITERATURE

Under direction of the President, in December 2007, the Public Relations Material Designer has updated the company brochure and pamphlet to include 2006 dose data which more closely reflects anticipated effects from SRB as a result of possible resumption of operation.

The pamphlet and brochure are available on the website and widely distributed to any individual who voices interest or concerns regarding the operations of the company. A plan is in place to mass distribute the pamphlet around day one of the hearing.

With input from the Public Information Program Committee the Public Relations Material Designer is currently designing literature dedicated to the groundwater studies performed by SRB. We expect this to be available by May 5, 2008.

3.6.3.8 SURVEYS

A recent local newspaper survey[4] found that of 2,311 respondents, over 90% of survey respondents and a significant proportion of the population, were not concerned at the presence of the facility in their community.

SRB also intends to perform community surveys to get a better understanding of the community's concerns. A survey is currently being developed specifically to determine if the public would like to be informed of various SRB related matters, and if so, in what manner and how often.

3.6.3.9 WEBSITE

The website is frequently updated to provide up to date information on the facility.

The main page provides a number of possible information sources:

FIGURE 15: WEB SITE MAIN PAGE

FIGURE 16: WEB SITE REPORTS AND RESULTS PAGE

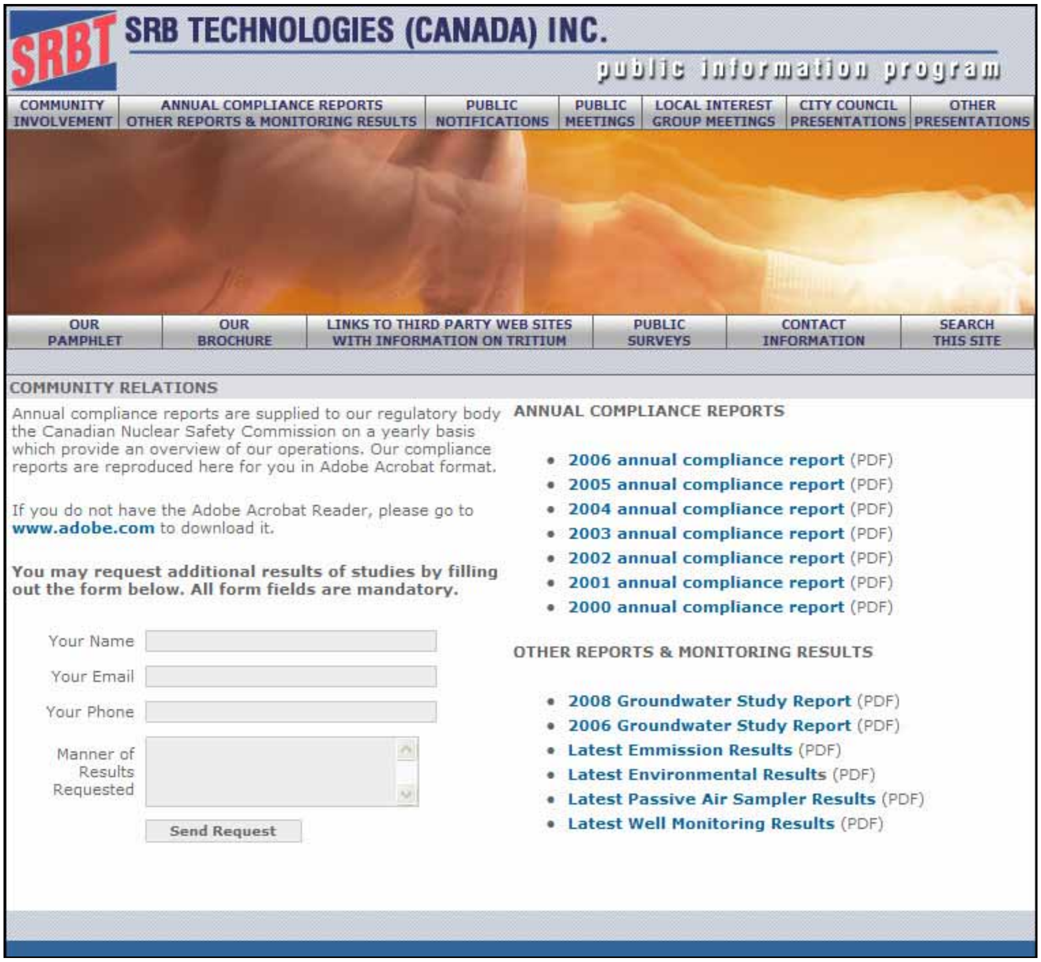


FIGURE 17: LINK TO THIRD PARTY SITES WITH INFORMATION ON TRITIUM


SRB TECHNOLOGIES (CANADA) INC.

public information program

COMMUNITY INVOLVEMENT | ANNUAL COMPLIANCE REPORTS OTHER REPORTS & MONITORING RESULTS | PUBLIC NOTIFICATIONS | PUBLIC MEETINGS | LOCAL INTEREST GROUP MEETINGS | CITY COUNCIL PRESENTATIONS | OTHER PRESENTATIONS

OUR PAMPHLET | OUR BROCHURE | LINKS TO THIRD PARTY WEB SITES WITH INFORMATION ON TRITIUM | PUBLIC SURVEYS | CONTACT INFORMATION | SEARCH THIS SITE

For further information on Tritium, please visit the third party sites listed below

CNSC: http://www.nuclearsafety.gc.ca/eng/newsroom/issues/tritium.cfm

The Canadian Nuclear Safety Commission (CNSC) is an independent quasi- judicial agency that reports to Parliament through the Minister of Natural Resources. The CNSC regulates the use of nuclear energy and materials to protect health, safety, security and the environment, and to respect Canada's international commitments on the peaceful use of nuclear energy.

United States Environmental Protection Agency - http://www.epa.gov

The US EPA has done extensive research on Tritium and its properties. This government site will provide you with endless information about tritium. Simply do a search on tritium from their main page.

International Atomic Energy Agency: http://www.iaea.org

THE major international regulatory body. Search tritium from their main page to find info

International Commission on Radiological Protection: http://www.icrp.org

In preparing its recommendations, ICRP considers the fundamental principles and quantitative bases upon which appropriate radiation protection measures can be established, while leaving to the various national protection bodies the responsibility of formulating the specific advice, codes of practice, or regulations that are best suited to the needs of their individual countries

Health Physics Society: http://www.hps.org

A nonprofit scientific professional organization whose mission is to promote the practice of radiation safety

International Agency for Research on Cancer: http://www.iarc.fr

IARC's mission is to coordinate and conduct research on the causes of human cancer, the mechanisms of carcinogenesis, and to develop scientific strategies for cancer control.

FIGURE 18: PUBLIC NOTIFICATIONS AND PRESS RELEASES

4.0 PLAN FOR RESUMPTION

A number of measures will be taken before resumption of operations should the amendment be approved. A document tilted Plan for Resumption[32], dated December 31, 2007 was provided to CNSC Staff for review.

The measures are based on all the information gathered while processing tritium was taking place at the facility prior to January 31, 2007. Measures that will be implemented for resumption of the operation will therefore be based on:

- Over 16 years of operational experience
- Operating the same equipment last used on January 31, 2007
- Operation and Supervision by the same trained staff employed on January 31, 2007
- Operation under the same procedures last in use on January 31, 2007

4.1 OPERATIONAL EXPERIENCE

SRB processed tritium in Pembroke from 1990 until January 2007. SRB and its staff have gathered over 16 years of operational experience with the filling and bulk splitting process and 14 years with the laser cutting process. The equipment has been operated in essentially the same manner over 16 years.

4.2 PROCEDURES

All procedures that would resume are as follows:

TABLE 14: FROM PROCEDURE MATRIX – SUBMITTED BY E-MAIL DECEMBER 17, 2007

PROCEDURE	DESCRIPTION	REVISION
400-001	TRITIUM FILLING OF BETALIGHTS	H
400-002	PRE-BAKE OF COATED PREFORMS	C
400-003	HOLDING CHAMBER FOR COATED PREFORMS	B
400-004	STUB GLUING	A
450-001	BULK SPLITTER OPERATION	F
500-001	CULHAM LASER CUTTING	D
500-002	L.M.I. LASER CUTTING	C
500-003	PROCESS WORKING PRESSURES	B
ENG-016	NO TRITIUM PROCESSING DURING PRECIPITATION	A

4.3 STAFF AND TRAINING

The activities proposed in the amendment are performed in the Rig Room, this department used to employ two to three people.

Before resumption, staff that will be involved in supervising, performing or assisting in any of these procedures will be provided refresher training as they have all operated the equipment in the past. The President will personally authorize any individual performing training and any individual being given the training.

Initially, only one existing staff member will be re-assigned to the Rig Room on a full time basis, and therefore will not negatively affect management capacity already in place at the facility to manage the safety programs, the workers and contractors.

This specific individual has been employed at our company for over 16 years and was supervising and performing these processes over the past 6 years.

Of the 15 employees that remain employed at the company, 6 have direct experience in the rig room directly performing the processes that will resume with approval of the amendment. These individuals have been intimately involved in the improvements made with the filling process which have resulted in a significant continuous reduction in emissions over the last 21 weeks of operation. These 6 individuals have also been involved in the improvements made by the company in 2007.

For a period of time, processing will resume incrementally under the control of the Rig Room Supervisor, in the presence of one of the other 5 individuals.

After the training on a new procedure has been completed, spot checks of the trainee will be performed to ensure that all tasks are being performed to procedure. These spot checks will be performed by the Rig Room Supervisor or a qualified individual at a higher level of authority. During these spot checks the new trainee will be asked to explain the procedure being performed. This is to confirm that the trainee has not lost understanding of the principle rather than just memorization of the words of the concept. During the spot checks the trainee will also be asked to discuss instances where the procedure can result in problems and describe to the trainer measures that should be taken in the eventuality of these problems occurring. Records and sign off of each step of the training performed will be maintained.

4.4 EQUIPMENT

All equipment on site continues to be maintained in accordance with our maintenance program and procedures under the requirements of our existing licence.

As it is required under our existing procedures, before any cycle is performed on the filling rig, bulk splitting rig and laser cutting systems, these systems are powered and tested before initiating a cycle. Only after these steps are completed are tritium filled sources processed.

5.0 DECOMMISSIONING

In March 2006, SRB created a decommissioning fund to which it has been making monthly contributions. Despite financial constraints brought on by the loss of our processing licence, SRB has demonstrated its commitment and complemented the funds in this account to cover 100% of the cost of the Safe Shutdown State of the facility.

The financial guarantee was submitted in the form of an Escrow Agreement and a Financial Security and Access Agreement[33].

Based on a hearing held on September 12, 2007 and the information submitted by SRB and CNSC Staff, in a decision[34] released on October 23, 2007, the Commission, pursuant to section 24 of the Nuclear Safety and Control Act, accepted the Escrow Agreement for $79,368.10 and the Financial Security and Access Agreement as the financial guarantee provided by SRB for safe state of closure.

The acceptance of the Safe Shutdown State for the facility is an initial risk reduction measure that further ensures the safety of public, the workers and the environment.

6.0 FIRE PROTECTION

The building where SRB is located is classified as a Group F, Division 3 “Low Hazard Industrial Occupancy”. In the last couple of years SRB has implemented a number of changes that reduce or eliminate the probability and risk of unplanned incidents as a result of a fire.

6.1.1 CNSC STAFF INSPECTIONS

CNSC staff performed inspection of the facility in 2000, 2004 and 2005. These inspections have resulted in 13 directives, 2 recommendations and 1 action notice. All have since been addressed through many building, equipment and procedure modifications requiring the erection of fire barriers and the installation of fire doors, dampers providing adequate fire separation. All modifications were performed to licence requirements and reviewed to the satisfaction of a third party against the requirements of the National Fire and Building Codes and the National Fire Protection Association, NFPA-801.

6.1.2 FIRE PROTECTION PROGRAM

Our Fire Protection Program was revised in April 2006 to ensure the company’s compliance with the National Fire and Building Codes and the National Fire Protection Association, NFPA-801. The new Fire Protection Program was also complemented by a new Site Plan, a Fire Hazards Analysis, a Fire Systems Inspection Audit, a Pre-Incident Plan and a Fire Safety Plan.

6.1.3 YEARLY INSPECTIONS FROM THE PEMBROKE FIRE DEPARTMENT

Since 2005 yearly inspection are performed by the Pembroke Fire Department to ensure compliance against applicable fire codes and standards. Initially inspections were performed against Ontario Building and Fire Codes but in 2006 inspections were also performed against the National Fire and Building Codes and the National Fire Protection Association, NFPA-801.

The last site inspection was performed by the Pembroke Fire Department in May 2007 resulted in one recommendation and no violations. The recommendation which pertained to identification of the sprinkler shut off valve has since been addressed.

6.1.4 YEARLY THIRD PART INSPECTIONS

In 2005 SRB contracted Nadine International Inc. to perform yearly site visits to ensure SRB’s compliance with the requirements of the National Fire and Building Codes, and of the National Fire Protection Association, NFPA-801. The last site inspection was performed by Nadine International Inc. in November 2007 resulted in no recommendation or violations.

6.1.5 FIRE RESPONDER TRAINING

In April 2006 SRB funded the majority of a training program for NFPA and EMS course titles for the Officers of the Pembroke Fire Department. Course titles include: Respiratory Protection, Personal Protective equipment, Advanced Hazardous Waste Operations, Emergency Response Awareness, Spill Prevention and Control, Combustible and Flammable Liquids, Compressed Gas Safety and Radiation Safety. On site training and familiarization is regularly provided to members of the Pembroke Fire Department.

6.1.6 YEARLY STAFF TRAINING

Yearly fire extinguisher training is performed for all staff. Training was last performed in September 2007.

6.1.7 YEARLY FIRE ALARM DRILLS

In conjunction with the Pembroke Fire Department SRB performs yearly fire alarm drills the last one of which was in September 2007. Any finding is promptly addressed.

6.1.8 SPRINKLER SYSTEM

In order to improve the life safety conditions at our facility, an automatic sprinkler system was installed in the SRB facility in 2006 which is monitored by a newly installed fire alarm control panel.

The sprinkler system design was reviewed and approved by both the Pembroke Fire Department in July 2006 and by Nadine International Inc. in September 2006 against applicable requirements prior to installation. All recommendations were implemented.

Site inspections were performed by the Pembroke Fire Department and by Nadine International Inc. in October 2006 to verify sprinkler system installation against applicable requirements. All recommendations were implemented.

The fire alarm control panel was also verified in August 2006 against applicable ULC requirements by a member of the Canadian Fire Alarm Association.

6.1.9 COMBUSTIBLE LOADINGS

Good housekeeping practices are maintained to reduce the possibility of clutter which could accelerate the spread of fire. Efforts have been made to reduce combustible loading in the facility, especially in the areas of the facility where tritium is handled. The 2007 Fire Hazards Analysis form Nadine International Inc. reports that zones 2 and 3, the areas where tritium is stored on containers and in light sources have “minimal fire load” and represent a “low fire hazard”.

6.1.10 FIRE PROTECTION EQUIPMENT INSPECTIONS

Inspections of the emergency lighting and fire extinguishers, to the requirements of the National Fire Code have been performed since March 2003. In addition monthly inspections of the sprinkler system and of the fire alarm control panel, to the requirements of the National Fire Code are being performed since January 2007.

6.1.11 VENTILATION PERFORMANCE

Visual and audible alarms have also been installed that would be triggered in the event of ventilation malfunction. Ventilation equipment operation and effectiveness is important in mitigating the dose to a receptor resulting from a fire. In March 2006, SRB developed its first Maintenance Program which incorporates monthly preventive maintenance rather than corrective that ensures continued operation and effectiveness of ventilation equipment.

7.0 EQUIPMENT

Since 2005 SRB made several capital expenditures that will further protect the public, the workers and the environment and will serve in the years to come.

7.1 ADDITION OF NEW EMISSION MONITORING EQUIPMENT

In 2006 the majority of equipment used in emissions monitoring has been upgraded to more modern standards in order to provide better assurance of accuracy.

SRB installed an entirely new bubbler monitoring system as the primary means of measuring tritium emissions as well as a power backup system. As part of the monitoring system SRB also installed pitot tubes on the stacks and digital flow meters. We also contracted a third party to install an independent bubbler monitoring system to allow the validation of the new bubbler system. Results showed that the new system was accurate and conservative, which further protects the public and the environment. At least every two years SRB will repeat this calibration exercise.

7.2 TRITIUM PROCESSING EQUIPMENT UPGRADE

In recent years, we have replaced a number of components on a number of the pieces of equipment used to process tritium, this ensures equipment reliability eliminating any backlog in corrective maintenance.

The “reduction in uranium bed heating cycles”, the “reduction in volume of release” and the system used for “purging of inert gas” are emission reduction initiatives that have permanently been implemented in our equipment and procedures and as discussed in section 3.4.4, these have been successful in significantly reducing emissions from the facility.

As part of SRB’s mitigations efforts, all oil pumps were replaced with scroll pumps to reduce dose to all staff.

SRB also installed and tested a tritium oxide trap to attempt to further reduce emissions, the trap however proved not to be effective.

Through its “Mitigation Committee” SRB will study the further reduction in “volume of release” of the filling and of the bulk splitter.

8.0 COST RECOVERY

Each of the last three quarterly invoices in 2007 were paid in full by making regular multiple payments over the course of each quarter.

SRB continues to make regular multiple payments towards the latest invoice for the fee period between January 1, 2008 to March 31, 2008 and we expect to also have it paid in full by the end of the quarter on March 28, 2008. SRB very much regrets this delay, which is caused solely by our current economic circumstances following the loss of our processing licence.

We also have some disagreement with the fee adjustment for the Period between April 1, 2006 and March 31, 2007. From the limited information available to date, we strongly suspect that some of the hours charged, may not qualify as Recoverable Activities as spelled out in the CNSC Cost Recovery Program. We feel that some of the hours charged were in support of the Designated Order and were "Development" in nature. We believe the results of this "Development" were also used, and will continue to be used, to assess and regulate other licensees and should not be solely charged to SRB. We are in communication with CNSC Staff regarding the matter, my goal is to personally make every effort to resolve this matter prior to the April 2008 hearing.

To date SRB Technologies (Canada) Inc. has paid and met all its cost recovery obligations. We continue to be committed to the payment of any cost provided that the costs are justified and reasonable.

9.0 CONCLUSION

Throughout the term of the current Licence, SRB has continued to operate the Facility safely and in accordance with the provisions of the Licence and the Nuclear Safety Control Act and Regulations.

SRB and its staff has demonstrated its commitment and integrity by the work described in this submission.

SRB and its staff has demonstrated that it will continue to make improvements in the future by the various initiatives, goals and targets described in this submission and based on future input and concerns raised by the CNSC, members of the public and our employees. For example, for the first year of resumption of operation SRB has set an “Emission Reduction Target” and an “Occupational dose reduction target”. In addition SRB has committed to perform a yearly review of the effectiveness of each program and to use results from these reviews to make improvements.

SRB has demonstrated that it has addressed all the issues expressed by the Commission in the Record of Proceedings issued on January 31, 2007 through a Corrective Action Plan described in this submission.

SRB has demonstrated that it has met all the conditions of the existing licence and reporting requirements.

We therefore believe that:

- Under Section 24(4), subsection (a) of the Nuclear Safety and Control Act, SRB is qualified to carry on the activity that for which it has applied for.

- Under Section 24(4), subsection (b) of the Nuclear Safety and Control Act, SRB will, in carrying on that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

For these reasons we respectfully request that the Commission approve the resumption of the operation of the facility, including the processing of tritium.

The processing of tritium is key to our ability to continue to provide local employment, to make further improvements to our operation, to continue to monitor the environment and groundwater conditions, and to support the ongoing provision of decommissioning funds.

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Standards and Guidelines for Tritium in Drinking Water

Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

Standards and Guidelines for Tritium in Drinking Water

INFO-0766

January 2008

Canada

Standards and Guidelines for Tritium in Drinking Water

January 2008

DISCLAIMER

The information contained in this document is not exhaustive, however it can be considered to be reasonably complete in regards to the major emitters of tritium in the world. The information is current as of September 2007.

This factual document does not attempt to analyze the information or draw conclusions.

Standards and Guidelines for Tritium in Drinking Water

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TABLES

ACRONYMS

ACES	Advisory Committee on Environmental Standards
ACNS	Advisory Committee on Nuclear Safety
ACRP	Advisory Committee on Radiological Protection
AECB	Atomic Energy Control Board
ALARA	as low as reasonably achievable
BEIR I	Biological Effects of Ionizing Radiation
CDW	Federal-Provincial-Territorial Committee on Drinking Water
CNSC	Canadian Nuclear Safety Commission
DCF	dose conversion factor
DRL	derived release limit
EU	European Union
FAO	Food and Agriculture Organization (of the United Nations)
GL	guideline reference level
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
JWG-6	Joint Working Group 6
MAC	maximum acceptable concentration
MCL	maximum contaminant level
MOE	Ministry of the Environment (of Ontario)
NSC Act	Nuclear Safety and Control Act
OECD	Organization for Economic Cooperation and Development
OEHHA	Office of Environmental Health Hazard Assessment
PHG	public health goal
RDL	reference dose level
TID	total indicative dose
USEPA	United States Environmental Protection Agency
WHO	World Health Organisation

GLOSSARY

ALARA	Principle for radiation protection, according to which exposures are kept as low as reasonably achievable, while the social and economic factors being taken into account.
Becquerel	Unit of activity, the rate at which transformations occur in a radioactive substance. 1 Bq = 1 transformation or disintegration per second. See Table 1.
committed effective dose	Effective dose that will be accumulated over a period of time, following a single intake of radioactive material into the body. Standard periods of integration are 50 years for adults and 70 years for a lifetime exposure. Unit: Sievert, symbol Sv. See Table 1.
dose conversion factor	Converts an intake of a given radionuclide, in Becquerels, to effective dose, in Sieverts
drinking water	Water intended for human consumption.
effective dose	Measure of dose designed to reflect the amount of radiation detriment likely to result from the dose. Unit: Sievert, symbol Sv. See Table 1.
guideline reference level	Highest recommended concentration of a contaminant in drinking water guidelines. Synonyms: maximum acceptable concentration, maximum contaminant level.
maximum acceptable concentration	Highest acceptable concentration of a contaminant in the *Guidelines for Canadian Drinking Water Quality*. Synonyms: guideline reference level, maximum contaminant level.
maximum contaminant level	Highest acceptable concentration of a contaminant in the United States' National Primary Drinking Water Regulations. Synonyms: guideline reference level, maximum acceptable concentration.
radionuclide	Unstable nuclide that emits ionising radiation.

Table 1. Radiation Units

Quantity	Old unit	Symbol	SI unit	Symbol	Relationship
Activity	Curie	Ci	Becquerel	Bq	1 Ci = 3.7×10^{10} Bq
(Committed) Effective dose	rem	rem	Sievert	Sv	1 rem = 0.01 Sv

EXECUTIVE SUMMARY

- Natural background levels of tritium can be found everywhere in the environment.
- In Canada, the control of tritium releases to the environment is important, since this element is a by-product of CANDU nuclear reactors and is used to produce gaseous tritium light sources.
- The guidelines for radionuclides in drinking water adopted by the majority of the international community are based on international radiation protection methodologies and recommendations of the International Commission on Radiological Protection (ICRP) and the World Health Organization (WHO).
- The European Union, the United States, Australia and Finland use variations of the WHO approach to arrive at differing guideline reference levels.
- In Canada, current tritium levels in drinking water are several orders of magnitude lower than the guideline reference level (GL) of 7,000 Bq/L near nuclear facilities, and similarly well below the European Union's GL of 100 Bq/L.

1. INTRODUCTION

1.1 Tritium in the Environment

Tritium is a radioactive form of hydrogen with a physical decay half-life of 12.3 years. It emits very low-energy beta radiation, which is completely absorbed by common materials such as sheets of plastic, glass or metal, and cannot penetrate the top dead layer of skin in humans. Exposure can nevertheless pose a risk if the element is ingested in drinking water or food, or inhaled or absorbed through the skin. In Canada, the control of tritium releases to the environment is particularly important, since CANDU reactors produce significantly more tritium than most other types of reactors due to the use of heavy water (deuterium) in the moderator and heat transport system. Tritium is also used by a few industries to produce gaseous tritium light sources. Much smaller quantities are used in research applications, and as a tracer in oil and gas exploration. Tritium also forms naturally in the upper atmosphere due to the continuous bombardment of atmospheric gases by high energy cosmic rays. When it is present either naturally or artificially, tritium may be incorporated into water, thus entering the natural hydrological cycle. Hence, natural background levels of tritium can be found everywhere in the environment, including water, soil, and vegetation. Additional information on the presence and use of tritium in Canada can be found in a recent document produced by the Canadian Nuclear Safety Commission [CNSC, 2007a].

1.2 Regulation of Tritium Releases in Canada

Under the *Nuclear Safety and Control Act* (NSCA), the mandate of the Canadian Nuclear Safety Commission (CNSC) includes the dissemination of scientific, technical and regulatory information concerning the activities of the CNSC, and the effects on the environment and the health and safety of persons, of the development, production, possession, transport and use of nuclear substances. Under the *NSC Act*, the CNSC regulates facilities that possess more than 1 GBq (1×10^9 Bq) of tritium. The CNSC regulates potential releases of tritium to the environment through several licensing requirements, including absolute limits on how much tritium can be released on a license-specific basis. This is typically accomplished by imposing quantitative Derived Release Limits (DRL) on tritium entering air or water. These quantities are based on limiting releases to levels less or equal to the prescribed public dose limit of 1 mSv. Current tritium DRLs and amounts actually released relative to these absolute limits are summarized in [CNSC, 2007b].

General requirements for major nuclear facilities licensed by the CNSC include environmental protection policies, programs, and procedures that make adequate provision for protection of the environment. These are typically referred to collectively as an environmental management system, and include two key provisions for the control of releases of radioactivity to the environment: ALARA and Action Levels. ALARA is the paramount requirement for all licensed activities under the *Radiation Protection Regulations*; according to it, releases must be kept "As Low As Reasonably Achievable", social and economic factors being taken into account. Action Levels are also required, and are set such that an exceedence may indicate a loss of control. Action levels are typically set for gaseous or liquid effluent concentrations or for activity levels in the environment. Response to an action level includes a thorough investigation of the cause, remedial actions and reporting to the CNSC. In addition, licensees usually establish administrative controls set well below action levels to trigger investigations into potentially unusual operating conditions and their root causes.

The CNSC requires regular reporting of the results of monitoring of routinely-discharged radioactive effluents (including the total activity or total amount released), and, at a minimum, annual reports of environmental monitoring results. Lastly, the CNSC also requires the reporting of any release of a nuclear substance into the environment at a quantity not authorized by the *NSC Act*, regulations or the license, or any unmeasured release.

1.3 Scope of this Document

In January 2007, the Commission tribunal directed CNSC staff to initiate research studies on tritium releases in Canada, and to study and evaluate tritium processing facilities in the world exercising best practices. In response, CNSC staff initiated a "*Tritium Studies*" project with several planned information gathering and research activities extending to 2010 (a fact sheet is available at www.nuclearsafety.gc.ca). The objective of this project is to enhance the information available to guide regulatory oversight of tritium processing and tritium releases in Canada.
This present report of drinking water standards and guidelines is a factual report, one of a series of public information documents being produced through the auspices of the *Tritium Studies* project. Its purpose is threefold:

- to summarize criteria on a national and international basis from readily-available public sources of information, along with the scientific and policy basis underlying these criteria;
- to discuss the Canadian federal drinking water guideline of 7,000 Bq/L relative to criteria or guidance from other jurisdictions; and
- to provide a perspective on the need for any revisions to the existing regulatory approach for tritium by providing representative data on the current levels of tritium in drinking water sources near major facilities releasing this radionuclide in Canada.

This compilation is reasonably comprehensive, but no attempt was made to document every possible criterion in every jurisdiction. A substantive effort was nevertheless made to obtain authoritative criteria directly from all relevant developed countries, through detailed searches of public sources of information, and through correspondence with key regulators when this information was not directly available. The focus of our effort was on countries that operate CANDU and other power reactors, countries of the European Union, and other developed countries with significant releases of tritium.

2. RADIATION PROTECTION BASIS OF DRINKING WATER GUIDELINES

In most countries, including Canada, the guidelines for radionuclides in drinking water are based on international radiation protection methodologies, including recommendations of the International Commission on Radiological Protection (ICRP) and the World Health Organization (WHO) [ICRP, 1991a; WHO, 2004]. A summary table is provided in the Appendix, along with detailed information on guidelines and standards for individual countries.

2.1 International Commission on Radiological Protection (ICRP)

Radiation protection methodologies and principles have been developed by the International Commission on Radiological Protection (ICRP). This body of international experts was established to advance the science of radiological protection for the public benefit. It examines the scientific evidence available and provides recommendations and guidance on all aspects of protection against ionising radiation. These recommendations have been followed closely in establishing the Radiation Protection Regulations under the Canadian *Nuclear Safety and Control Act*. The ICRP approach is also endorsed and used in most other countries and by international organizations, such as the World Health Organization (WHO), the International Atomic Energy Agency (IAEA) and the Nuclear Energy Agency of the Organization for Economic Cooperation and Development (OECD).

The dose limits recommended by the ICRP for occupational and public exposures are generally adopted by regulators (including the CNSC and Health Canada) for legal purposes, and must not be exceeded under normal circumstances. For members of the public, the ICRP recommends an effective dose limit of 1 mSv for any combination of external and internal doses, received or committed in one year, excluding natural background radiation and medical or therapeutic exposures. The excess lifetime risk from a single exposure to 1 mSv has been estimated to be 7.3×10^{-5} [ICRP, 1991a], or 1 in 14,000. This level of risk includes outcomes such as fatal cancer, severe hereditary effects, and non-fatal cancers weighted for severity and ease of curing. For a lifetime exposure of 1 mSv per year over 70 years, the total risk would be about 5×10^{-3} or 1 in 200 [ICRP, 1991b].

2.2 World Health Organisation (WHO)

The WHO is the directing and coordinating authority for health within the United Nations system. It is responsible for providing leadership on global health matters, shaping the health research agenda, setting norms and standards, articulating evidence-based policy options, providing technical support to countries and monitoring and assessing health trends.

In setting derived guidelines for radionuclides in drinking water, the WHO recognised that water consumption contributes only a portion of the total radiation dose, and that some radionuclides present are natural in origin and therefore cannot be excluded from consideration. Consequently, the WHO guidelines for radionuclides in drinking water have been derived based on a reference dose level (RDL) or effective dose of 0.1 mSv from one year's consumption of drinking water. This represents 10% of the dose limit for members of the public, as recommended by the ICRP [ICRP, 1991a] and as adopted in the Basic Safety Standards of the International Atomic Energy Agency [IAEA, 1996] and the CNSC's Radiation Protection Regulations. These principles have been accepted by the WHO and many of its member states, the European Commission, and the Food and Agriculture Organization of the United Nations (FAO). The RDL of 0.1 mSv represents less than 5% of the average annual dose attributable to natural background radiation (i.e., 2.4 mSv). The risk of fatal and weighted non-fatal conditions at a lifetime exposure (i.e. 70 years) of 0.1 mSv per year ($1/10^{th}$ of 1 mSv) is between 10^{-5} and 10^{-6} per year, or about 6×10^{-4} over a lifetime or 1 in 1,667 [Health Canada, 1995a].

For each radionuclide, the guideline reference level (GL, also known as the maximum acceptable concentration, MAC, or maximum contaminant level, MCL) for radionuclides in drinking water has generally been calculated using the following equation:

$$\mathbf{GL = \frac{RDL}{DCF \times q}}$$

where:

GL = guideline reference level of radionuclide in drinking water (Bq/L),
RDL = reference dose level, equal to 0.1mSv per year,
DCF = dose conversion factor for ingestion by adults (Sv/Bq),
q = annual ingested volume of drinking-water.

Most national and international guidelines assume a daily water intake of 2 L, or 730 L/year, and are based on an adult dose conversion factor (DCF) provided by the ICRP [ICRP, 1996]. The DCF provides an estimate of the 50-year committed effective dose resulting from a single intake of 1 Bq of a given radionuclide.
The calculation for the GL for tritium would therefore be as follows:

$$\mathbf{GL = \frac{1 \times 10^{-4}\ Sv\ per\ year}{730\ L/year \times 1.8 \times 10^{-11}\ Sv/Bq} = 7{,}610\ Bq/L}$$

Higher DCFs for younger age groups (accounting for the higher uptake and/or metabolic rates) do not lead to significantly higher dose criteria, due to the smaller amounts of water consumed. Consequently, the GL based on adult parameters and an RDL of 0.1 mSv per year for one year's consumption of drinking water can be used for all age groups as a conservative assumption [WHO, 2004].

The guideline reference level (GL) is based on the total activity in a water sample, whether radionuclides appear singly or in combination, and includes the dose due to both natural and artificial radionuclides. Individual GLs therefore apply only in the event that a single radionuclide is found in the water supply. Where two or more radionuclides that affect the same organ or tissue are found to be present in drinking water, the total dose received from all radionuclides should not exceed the guideline reference level of 0.1 mSv per year.

In Canada and elsewhere, actual concentrations of radionuclides, particularly in surface drinking waters, are usually orders of magnitude (e.g. 100-fold) below the GL from the WHO (2004). Water supplies with levels of radioactivity up to the reference level are considered acceptable for consumption. However, the adoption of these guidelines does not imply "lack of action" until concentrations reach the GL. The treatment of water supplies for radionuclides is typically governed by the ALARA principle, i.e. keeping exposures "As Low As Reasonably Achievable", with economic and social factors taken into consideration. Levels may be further reduced if justified. In cases where a single sample does not meet the guideline, the reference dose would be exceeded only if exposure to the same measured concentration were continued for a full year. Hence, such a sample does not in itself imply that the water is unsuitable for consumption, and should be regarded only as a level at which further investigation, including additional sampling, is needed. [WHO, 2004; Health Canada, 1995b]

3. REGULATORY APPROACHES

3.1 Application in Canada

In Canada, the quality of drinking water is primarily the responsibility of the provinces and municipalities. The Canadian *Guidelines for Canadian Drinking Water Quality* [Health Canada, 2007] combine radiological, chemical, and microbiological risk assessment and management practices within a flexible risk control strategy. The *Guidelines* have been established through the Federal-Provincial-Territorial Committee on Drinking Water (CDW), and are intended to facilitate consistency in drinking water quality across the country.

The *Guidelines* have been designed to accommodate the diverse needs of the various jurisdictions involved. Although not mandatory, the *Guidelines* may be used by the provinces and territories as a basis for setting maximum permissible levels for radionuclide, chemical, and microbiological hazards. Since water quality is essentially a provincial responsibility in Canada, the provinces may adopt the *Guidelines* in whole or in part, or may establish their own criteria.

The *Guidelines* set the GL of tritium in drinking water at 7,000 Bq/L.

3.2 Application in Canadian Provinces

Several provinces have incorporated the tritium guideline from Health Canada's *Guidelines for Canadian Drinking Water Quality* into a provincial drinking water standard; all other provinces do not have prescribed limits for tritium. Information for the provinces that have adopted this value as a standard (Alberta, Manitoba, Ontario and Quebec) is provided in the Appendix.

The Ontario Drinking Water Advisory Council is currently examining the Ontario Drinking Water Quality Standard for tritium at the request of the Ontario Minister of the Environment. In 1994, the Ontario Advisory Committee on Environmental Standards

(ACES) submitted the report "*A Standard for Tritium. A Recommendation to the Minister of Environment and Energy [of Ontario]*", which recommended an interim guideline of 100 Bq/L for tritium in drinking water. Shortly thereafter, the Ontario Ministry of the Environment (MOE) issued an Interim Ontario Drinking Water Objective for tritium of 7,000 Bq/L based on internationally-recommended radiological protection approaches [MOE, 1994]. The Minister of the Environment then requested guidance from Health Canada in regards to the different approaches used within these two documents.

In response, the Joint Working Group 6 (JWG-6) was formed in January 1995, composed of representatives from the Atomic Energy Control Board's (AECB, replaced by the CNSC in 2000) Advisory Committees on Nuclear Safety (ACNS) and Radiological Protection (ACRP), the Group of Medical Advisors, and Health Canada.

The JWG-6 found that the proposed limits in the ACES report approaching the value of zero risk may not be achievable in any human endeavour. The experts further concluded that the interim risk limit of 100 Bq/L for tritium in drinking water proposed by the ACES study was inconsistent with international regulatory philosophy, which instead supported the MOE's limit of 7,000 Bq/L. The JWG-6 also studied the estimated lifetime cancer risk from continuous exposure (in drinking water) to maximum acceptable concentrations (MAC) of selected carcinogens, as derived from the Canadian Drinking Water Quality Guidelines. They noted that the risk associated with exposure to carcinogens in drinking water ranged from less than 1 to more than 800 per million, whereas the risk associated with exposure to all radioactive materials combined was 400 per million. The JWG-6 concluded that the risk-management strategy behind the 1995 guidelines provided a high degree of health protection, and the 7,000 Bq/L interim guideline for tritium was formalized as a standard in Ontario Regulation 242/07 [MOE, 2007].

3.3 Application in Other Countries

As mentioned earlier, the guidelines for radionuclides in drinking water of most of the international community are based on a single calculation incorporating international radiation protection recommendations from the ICRP and WHO:

$$\mathbf{GL = \frac{RDL}{DCF \times q}}$$

RDL = 0.1 mSv per year
DCF = 1.8 x 10^{-11} Sv/Bq
q = 730 L/year ingested water

Different guideline values among most jurisdictions (see Table 2) result from four sources of variation, described in sections 3.3.1 to 3.3.4.

Table 2. International Limits for Tritium in Drinking Water

	Power reactors		Tritium Limit
	CANDU	Total	(Bq/L)
Canada	18	18	7,000
EU	2	126	100
Finland	0	4	30,000
Australia	0	0	76,103
Russia	0	31	7,700
Switzerland	0	5	10,000
United States	0	103	740
WHO	n/a	n/a	10,000

3.3.1 Variation in RDL (or committed effective dose)

Whereas most countries implement the RDL or committed effective dose of 0.1 mSv recommended by the WHO, a few countries have chosen a different RDL, resulting in a different guideline level when used in the GL equation:

Australia: 1 mSv per year = 76,103 Bq/L [NHMRC, 2004]
Finland: 0.5 mSv per year = 30,000 Bq/L [STUK, 1993]
United States: 0.04 mSv per year = 740 Bq/L (or 2,253 Bq/L, see variation 3.3.4)

3.3.2 Variation in Rounding Out of the Final Criterion

The GL calculation above results in a value of 7,610 Bq/L. However, this value was rounded in three different ways: the WHO and Switzerland rounded the value up to 10,000 Bq/L, whereas Russia and Canada rounded it out to 7,700 and 7,000 Bq/L, respectively. [WHO, 2004; DFI, 2006; NRB-99; Health Canada, 2007]. ISTISAN (2000) reported a value 7,600 Bq/L using only two significant digits.

3.3.3 European Union Special Case

The derivation of a drinking water total indicative dose (TID) criterion (0.1 mSv/year) in the European Union's (EU) *Council Directive on the quality of water intended for human consumption 98/83/EC* [EU, 1998] is not explained in the directive or in primary documents prior to the publication of the directive. However, it follows the basic logic of the WHO as outlined in section 2.2. Derived activity concentrations were subsequently calculated after the directive was published, using parameters from the 96/29 EURATOM Directive. The corresponding criterion for an adult is 7,600 Bq/L, with a critical concentration of 6,000 Bq/L for a 1-2 year old [ISTISAN, 2000]. The inclusion of criteria for radioactivity in the directive was not part of the initial proposal of the EU Commission [EU, 1995]; these criteria were incorporated during the development of the legislation at the request of the European Parliament.
Following the *Opinion of the European Parliament* of 12 December 1996, the *Council Common Position* of 19 December 1997, and the *Decision of the European Parliament* of 13 May 1998, the EU Commission did not make the requirements for radioactivity

mandatory, but only indicative. Tritium was cited as an indicator parametric value at 100 Bq/L, and the total indicative dose was cited as an indicator parametric value of 0.1 mSv/year [ISTISAN, 2000].

The 100 Bq/L parameter is effectively a screening value, providing an indication of the possible presence of other, potentially more harmful, artificial radionuclides discharged into the environment. Both the tritium concentration and the total indicative dose have a similar status, indicating a potential radiological problem when exceeded, and should not be regarded as limit values [ISTISAN, 2000].

For example, in the implementation of these principles in the United Kingdom, if the level of tritium is above 100 Bq/L, further investigation is triggered and action *may be* required [DWI, 2005]. The relevant guidance states:

"Tritium can also be an indication of contamination from artificial sources and water companies should take actions to investigate the source of any exceedence of the indicator value. If the indicator value is exceeded additional analysis should be undertaken to establish which isotopes are present and the total indicative dose calculated from the individual isotope concentrations. If the total indicative dose exceeds the indicator value of 0.10 mSv/year, appropriate medical advice should be sought. The specification for total indicative dose is expressed in terms of the dose over a year. In interpreting the results of radioactivity monitoring it is necessary to take account of the variability in activity levels over time. Some water sources are likely to show seasonal variation due to natural processes. In addition, any short term increase in radionuclides that may result from radiological incidents should be assessed against guidance for food and liquids, within guidance published by the former Department of the Environment (Civil Emergencies involving radioactive substances)."

Most EU member states have transposed the 1998 EU directive into a national law, regulation or standard, and most have followed the logic of using the 100 Bq/L value for tritium only as a screening value (see forms in Appendix).

3.3.4 United States Special Case

The United States (US) did not adopt ICRP risk coefficients and dose limit recommendations in deriving its original – and still current - drinking water standard for tritium. Instead, the United States Environmental Protection Agency (USEPA) used information from 1967 U.S. Vital Statistics, and the Biological Effects of Ionizing Radiation I report [BEIR, 1972], to set the national standard (referred to as a Maximum Contaminant Level or MCL) at 20,000 pCi/L (740 Bq/L) based on a 4 mrem (0.04 mSv) per year dose limit.

Considering the sum of the deposited fallout radioactivity and the additional amounts due to releases from other sources existing in 1967, the USEPA believed that the total dose equivalent from man-made radioactivity was not likely to result in a total body or organ dose to any individual that exceeded 4 mrem/year. Consequently, the USEPA believed that the adoption of the standard would not affect many public water systems, if any. At the same time, the Agency believed that a MCL set at this level would provide adequate public health protection.

In setting the MCLs for man-made beta and photon emitters in 1976 [USEPA, 1976], the USEPA used cancer risk estimates for the U.S. population in 1967 [see USEPA, 2000a and 2000b for a discussion of the 1991 proposed rule]. The BEIR I report indicated that the individual risk of fatal cancer from a lifetime total body dose rate of 0.04 mSv per year ranged from about 0.4 to 2 x 10^{-6} per year (1 in 2,500,000 to 1 in 500,000) depending on whether an absolute or relative risk model was used. Using best estimates from both models for fatal cancer, the USEPA believed that an individual risk of 0.8 x 10^{6} per year (1 in 1,250,000) resulting from a 0.04 mSv annual total body dose was a reasonable estimate of the annual risk from a lifetime ingestion of drinking water. Over a 70-year period, the corresponding lifetime fatal cancer risk would be 5.6 x 10^{-5} (1 in 17,857), with the risk from the ingestion of water containing less amounts of radioactivity being proportionately smaller [USEPA, 2000b].

Since the time the USEPA developed the 1976 standard, scientists have improved the calculation methods to equate concentrations of tritium in drinking water (pCi/L) to radiation doses in people (mrem). In 1991, the USEPA re-calculated the tritium concentration equal to a dose of 4 mrem from weighted organ-specific dose equivalent values, using weighting factors as specified by the ICRP in 1977/1979, and using metabolically-based dose calculations. With this updated method of calculation, the USEPA found that a dose of 4 mrem (0.04 mSv) per year would equal a tritium concentration of 60,900 pCi/L (2,253 Bq/L) — a threefold increase from the maximum contaminant level of 20,000 pCi/L (740 Bq/L) established in 1976. However, since the older criterion met overall risk management objectives, the USEPA kept the 1976 value of 20,000 pCi/L for tritium in its latest regulations in the final rule [USEPA, 2000a].

A search by CNSC staff of the most populated individual States indicated that most (if not all) States have adopted the USEPA MCLs for drinking water quality. However, in 2006, the Office of Environmental Health Hazard Assessment (OEHHA) in the California Environmental Protection Agency adopted a public health goal (PHG) of 400 pCi/L (14.8 Bq/L) for tritium in drinking water [OEHHA, 2006]. PHGs established by OEHHA are not regulatory, and represent only non-mandatory goals. By state and federal law, MCLs established by DHS must be at least as stringent as the federal MCL. PHGs are based solely on scientific and public health considerations, without regard to economic cost considerations or technical feasibility. While the current California maximum contaminant level (MCL) for tritium in drinking water is 20,000 pCi/L (740 Bq/L), the ongoing revision of the California drinking water standards (MCLs) will consider the above-mentioned PHG for tritium in drinking water along with economic factors and technical feasibility.

4. DIFFERENCES BETWEEN CANADIAN AND INTERNATIONAL APPROACHES

In Canada, the guideline reference level (GL), or maximum acceptable concentration (MAC), for tritium in drinking water is 7,000 Bq/L, as described in the *Guidelines for Canadian Drinking Water Quality* [Health Canada, 2007]. Of the many countries researched for the purposes of this compilation, most have based their national standard, regulation or guideline on internationally-accepted radiation protection concepts, including the ICRP's dose-risk estimations and dose conversion factors, as well as the reference dose level of 0.1 mSv per year adopted by the WHO. Together, these concepts suggest a rounded GL of 7,600 Bq/L.

There are four main exceptions or variations to this approach.

1) Rather than a mandatory parameter, the EU has elected to use a tritium guideline value of 100 Bq/L as a screening parameter for the presence of other, potentially more harmful, artificial radionuclides.
2) Whereas Australia accepts the ICRP concepts mentioned above, it differs from the WHO by adopting a reference dose level of 1 mSv per year rather than 0.1 mSv per year. The result is an Australian national guideline of 76,103 Bq/L.
3) Whereas Finland also accepts the ICRP concepts mentioned above, it differs from the WHO by adopting a reference dose level of 0.5 mSv per year rather than 0.1 mSv per year, and a drinking water intake rate of 2.2 L per day rather than 2 L. Therefore, Finland's standard for tritium in drinking water is 30,000 Bq/L.
4) The United States calculated its national MCL for tritium in drinking water in 1976 based on former radiological concepts that now differ from current ICRP and WHO opinion, and continues to retain this older criterion on a risk management basis (see section 3.3.4).

5. CURRENT TRITIUM LEVELS IN DRINKING WATER

In Canada, current tritium levels in drinking water are orders of magnitude less than the GL of 7,000 Bq/L near nuclear facilities, and similarly well below the European Union's GL of 100 Bq/L. To provide a perspective on the data available, representative data are provided in Tables 3 and 4, illustrating recent levels of tritium in drinking water near major nuclear facilities releasing this radionuclide in Canada.

Although no exhaustive search was conducted for all available international information, in developed countries with power reactors such as Belgium [AFCN, 2006], France [IRSN, 2007], Germany [BMU, 2006], and Spain [CSN, 2005], tritium levels in drinking water are also well below each country's GL of 100 Bq/L.

Table 3. Drinking Water Tritium Concentration near Nuclear Sites

Water Source	Province	Source	Distance from Site	Tritium level (Bq/L)
Kincardine	Ontario	Bruce Power[1]	15 km SSW of Bruce B	6.4
Port Elgin	Ontario	Bruce Power[1]	17 km NE of Bruce A	17.4
Southampton	Ontario	Bruce Power[1]	22 km NE of Bruce A	12.0
Local deep wells	Ontario	Bruce Power[1]	Local to Bruce	<5.9 – 19.1
Local shallow wells	Ontario	Bruce Power[1]	Local to Bruce	12.3 – 58.2
Rolphton	Ontario	Chalk River Laboratories[2]	28 km upstream of CRL	3.0
Deep River	Ontario	Chalk River Laboratories[2]	9 km upstream of CRL	3.0
Chalk River Laboratories	Ontario	Chalk River Laboratories[2]	CRL intake well	11.0
Highview	Ontario	Chalk River Laboratories[2]	8 km downstream of CRL	<15.0
Harrington Bay	Ontario	Chalk River Laboratories[2]	9 km downstream of CRL	8.0
Fort William	Ontario	Chalk River Laboratories[2]	14 km downstream of CRL	7.0
Petawawa	Ontario	Chalk River Laboratories[2]	18 km downstream of CRL	7.0
Pembroke	Ontario	Chalk River Laboratories[2]	28 km downstream of CRL	7.0
Champlain	Quebec	Hydro-Québec (Gentilly)[3]		< 18
Gentilly	Quebec	Hydro-Québec (Gentilly)[3]		< 18
Trois-Rivières	Quebec	Hydro-Québec (Gentilly)[3]		< 18
Dipper Harbour	New Brunswick	NB Power[4]	28 Ridge Rd, Dipper Harbour	15.0
Dipper Harbour	New Brunswick	NB Power[4]	22 Ridge Rd, Dipper Harbour	24.5
Dipper Harbour	New Brunswick	NB Power[4]	16 Ridge Rd, Dipper Harbour	20.0
Dipper Harbour	New Brunswick	NB Power[4]	10 Ridge Rd, Dipper Harbour	19.0
Dipper Harbour	New Brunswick	NB Power[4]	4 Ridge Rd, Dipper Harbour	18.0
Maces Bay	New Brunswick	NB Power[4]	190 Welch Cove Rd, Maces Bay	39.0
Maces Bay	New Brunswick	NB Power[4]	181 Ridge Rd, Maces Bay	32.5
Maces Bay	New Brunswick	NB Power[4]	132 Ridge Rd, Maces Bay	22.5
Maces Bay	New Brunswick	NB Power[4]	68 Ridge Rd, Maces Bay	14.0

[1] *Annual Summary and Assessment of Environmental and Radiological Data for 2006.* Bruce Power. 2007.
[2] *Annual Report of Radiological Environmental Monitoring in 2005 at Chalk River Laboratories.* AECL. 2006.
[3] *Centrale nucléaire Gentilly-2. Résultats du programme de surveillance de l'environnement du site de Gentilly. Rapport annuel 2006*. Hydro-Québec. 2007.
[4] *Point Lepreau Generating Station. Environmental Monitoring Radiation Data.* NB Power. 2007.

Water Source	Province	Source	Distance from Site	Tritium level (Bq/L)
Bowmanville	Ontario	Ontario Power Generation[5]	7 km ENE of Darlington	6.0
Newcastle	Ontario	Ontario Power Generation[5]	13 km E of Darlington	5.8
Oshawa	Ontario	Ontario Power Generation[5]	8 km W of Darlington	7.1
Local water wells	Ontario	Ontario Power Generation[5]	Local to Darlington	<1.9 – 21.6
Ajax	Ontario	Ontario Power Generation[5]	5 km ENE of Pickering	6.1
Scarborough Horgan	Ontario	Ontario Power Generation[5]	11 km SW of Pickering	5.1
Toronto Harris	Ontario	Ontario Power Generation[5]	22 km WSW of Pickering	5.1
Whitby	Ontario	Ontario Power Generation[5]	12 km ENE of Pickering	6.4
Local water wells (range)	Ontario	Ontario Power Generation[5]	Local to Pickering	<1.9 – 114.7

[5] *2006 Results of Radiological Environmental Monitoring Programs*. Ontario Power Generation Inc. 2007.

Table 4. Drinking Water Tritium Concentration in Background Locations

Water Source	Province	Source	Tritium level (Bq/L)
Bancroft	Ontario	Bruce Power[1]	<3.7
Bancroft	Ontario	Ontario Power Generation[5]	<1.9
Belleville	Ontario	Bruce Power[1]	4.2
Belleville	Ontario	Ontario Power Generation[5]	2.6
Brockville	Ontario	Bruce Power[1]	4.6
Brockville	Ontario	Ontario Power Generation[5]	3.9
Burlington	Ontario	Bruce Power[1]	6.0
Burlington	Ontario	Ontario Power Generation[5]	3.3
Coburg	Ontario	Bruce Power[1]	5.3
Coburg	Ontario	Ontario Power Generation[5]	4.8
Drummondville	Quebec	Hydro-Québec (Gentilly)[3]	< 18
Goderich	Ontario	Bruce Power[1]	5.2
Goderich	Ontario	Ontario Power Generation[5]	4.5
Kingston	Ontario	Bruce Power[1]	4.6
Kingston	Ontario	Ontario Power Generation[5]	3.6
London	Ontario	Bruce Power[1]	3.7
London	Ontario	Ontario Power Generation[5]	2.5
Niagara Falls	Ontario	Bruce Power[1]	4.1
Niagara Falls	Ontario	Ontario Power Generation[5]	2.7
North Bay	Ontario	Bruce Power[1]	<3.7
North Bay	Ontario	Ontario Power Generation[5]	<1.9
Orangeville	Ontario	Bruce Power[1]	<3.7
Orangeville	Ontario	Ontario Power Generation[5]	<1.9
Parry Sound	Ontario	Bruce Power[1]	<3.7
Parry Sound	Ontario	Ontario Power Generation[5]	2.0
Sarnia	Ontario	Bruce Power[1]	4.0
Sarnia	Ontario	Ontario Power Generation[5]	4.0
St. Catharines	Ontario	Bruce Power[1]	3.7
St. Catharines	Ontario	Ontario Power Generation[5]	2.9
Sudbury	Ontario	Bruce Power[1]	5.8
Sudbury	Ontario	Ontario Power Generation[5]	2.9
Thunder Bay	Ontario	Bruce Power[1]	<3.7
Thunder Bay	Ontario	Ontario Power Generation[5]	<1.9
Windsor	Ontario	Bruce Power[1]	5.2
Windsor	Ontario	Ontario Power Generation[5]	4.6

[1] *Annual Summary and Assessment of Environmental and Radiological Data for 2006.* Bruce Power. 2007.
[3] *Centrale nucléaire Gentilly-2. Résultats du programme de surveillance de l'environnement du site de Gentilly. Rapport annuel 2006*. Hydro-Québec. 2007.
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APPENDIX

COMPILATION OF TRITIUM GUIDELINES AND STANDARDS

Introduction

The following appendix includes a summary table along with forms containing information on the standards or guidelines for tritium in drinking water currently observed by a number of countries (including CANDU owner countries, the members of the G8, representative State members of the EU, and other significant countries) international organisations and Canadian provinces (in alphabetical order). All government and organisation websites were thoroughly searched for relevant legal and regulatory documents. Some information was supplemented by personal communication with relevant officials, where it was feasible. Additional information may be available, but was not obtainable within reasonable effort.

This database is not exhaustive, however it can be considered to be reasonably complete in regards to the major emitters of tritium in the world. The occasional blank spaces in the forms indicate that the relevant information was not accessible.

TABLE A1.
SUMMARY TABLE OF INTERNATIONAL LIMITS FOR TRITIUM IN DRINKING WATER

		Power reactors*		Information Obtained	Tritium Limit (Bq/L)
		CANDU	Total		
CANDU OWNERS	**Canada**	18	18	yes	7,000
	- Alberta	0	0	yes	7,000
	- Manitoba	0	0	yes	7,000
	- N. Brunswick	1	1	yes	none
	- Ontario	16	16	yes	7,000
	- Quebec	1	1	yes	7,000
	India	15	17	no	n/a
	Republic of Korea	4	20	partly	none
	Romania	2	2	yes	100
	China	2	10	yes	none
	Argentina	1	12	partly	none
	Pakistan	1	2	no	n/a
EU	Total	2	126	yes	100
	Belgium	0	7	yes	100
	Finland	0	4	yes	30,000
	France	0	59	yes	100
	Germany	0	17	yes	100
	Italy	0	0	yes	100
	Northern Ireland	0	0	yes	100
	Scotland	0	2	yes	100
	Spain	0	8	yes	100
	Sweden	0	10	yes	100
	United Kingdom	0	19	yes	100
OTHER	Australia	0	0	yes	76,103
	Japan	0	53	partly	none
	Norway	0	0	yes	100
	Russia	0	31	partly	7,700
	Switzerland	0	5	yes	10,000
	United States	0	103	yes	740
	- California	0	4	yes	740
	WHO	n/a	n/a	yes	10,000

* Sources:

World Nuclear Association reactor database
http://www.world-nuclear.org/reference/reactorsdb_index.php

CANDU Owners Group website
http://www.candu.org

Jurisdiction	**ALBERTA**
Tritium limit in drinking water	7,000 Bq/L
Committed effective dose	0.1 mSv/year
Additional considerations	The sum of the committed effective doses from all radionuclides is not to exceed 0.1 mSv/year.
Exact / Rounded	Rounded down to the nearest 1,000
Scope	Provincial
Policy point of origin	Guidelines for Canadian Drinking Water Quality
Legal standard / Guideline	☒standard ☐guideline
Year of adoption	2003
Technical / legal reference(s)	Potable Water Regulation, Alta. Reg. 277/2003 http://www.canlii.org/ab/laws/regu/2003r.277/20070717/whole.html Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems http://environment.gov.ab.ca/info/posting.asp?assetid=6979&categoryid=5
Enforcement	Alberta Environment is responsible for enforcement, as per the regulation and standards mentioned above
Consequences of exceeding limit	
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : adult dose conversion factor ☒ yes ☐ no ☒ yes ☐ no
Applicability	
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	 2 L/day (730 L/year) 1.8×10^{-11} Sv/Bq 0.1 mSv/year $\text{MAC (Bq/L)} = \frac{1 \times 10^{-4} \text{ (Sv/year)}}{730 \text{ (L/year)} \times \text{DCF } (1.8 \times 10^{-11} \text{ Sv/Bq})}$ Calculation = 7,610 Bq/L, rounded down to 7,000
Safety factor	A recommended reference dose level (RDL) of the committed effective dose, equal to 0.1 mSv from 1 year’s consumption of drinking water (from the possible total radioactive contamination of the annual drinking water consumption). This comprises 10% of the

	intervention exemption level recommended by the ICRP for dominant commodities (e.g., food and drinking-water) for prolonged exposure situations, which is most relevant to long-term consumption of drinking water by the public (ICRP, 2000). The RDL of 0.1 mSv is also equal to 10% of the dose limit for members of the population, recommended by both the ICRP (1991) and the International Basic Safety Standards (IAEA, 1996).
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 0 0 0 0
General comments	When two or more radionuclides are found in drinking water, the following relationship should be satisfied: $\frac{C1}{MAC1} + \frac{C2}{MAC2} + \ldots \frac{Ci}{MACi} \leq 1$ where Ci and MACi are the observed and maximum acceptable concentrations, respectively, for each contributing radionuclide.

Jurisdiction	**ARGENTINA**
Tritium limit in drinking water	No guideline or standard Reference value of 10,000 Bq/L from the WHO, used on a case-by-case basis
Committed effective dose	0.1 mSv/year
Additional considerations	
Exact / Rounded	
Scope	
Policy point of origin	
Legal standard / Guideline	Argentine Food Code (Law 18.284) http://www.anmat.gov.ar/codigoa/caa1.htm Standards do not include radioactivity
Year of adoption	
Technical / legal reference(s)	Personal communication with the Nuclear Regulatory Authority Argentina (July 31, 2007)
Enforcement	
Consequences of exceeding limit	
Target population : All ages and sexes Urban Rural	
Applicability	
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	 2 L/day (730 L/year) 1.8×10^{-11} Sv/Bq 0.1 mSv/year Level (Bq/L) = $\frac{1 \times 10^{-4} \text{ (Sv/year)}}{730 \text{ (L/year)} \times \text{DCF } (1.8 \times 10^{-11} \text{ Sv/Bq})}$ Calculation = 7,610 Bq/L, rounded up to 10,000
Safety factor	
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 1 2
General comments	

Jurisdiction	**AUSTRALIA**
Tritium limit in drinking water	1 mSv/year (76,103 Bq/L)
Committed effective dose	1 mSv/year
Additional considerations	
Exact / Rounded	Exact
Scope	National
Policy point of origin	ICRP 1991; 2000
Legal standard / Guideline	☐standard ☒guideline
Year of adoption	2003
Technical / legal reference(s)	Australian Drinking Water Guidelines 6 http://www.nhmrc.gov.au/publications/synopses/_files/adwg_11_06.pdf
Enforcement	Enforced at the State and Terrritorial level
Consequences of exceeding limit	*Summary of operational responses:* **Dose level Response (mSv per year)** < 0.5 1. Continue routine monitoring. 0.5-1 1. Consult with relevant health authority. 2. Review frequency of ongoing sampling. 3. Evaluate operational options to reduce exposure. >1-10 1. Consult with relevant health authorities. 2. Assess in detail possible remedial actions, taking into account potential health impacts and cost effectiveness of actions. 3. Implement appropriate remedial action on the basis of the cost-benefit evaluation. > 10 1. Water not suitable for consumption on the basis of radioactivity levels. 2. Consult with relevant health authorities. 3. Immediate intervention is expected and remedial action must be taken to reduce doses to below the guideline value of 1.0 mSv.
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : reference man = 70 kg ☒ yes ☐ no ☒ yes ☐ no
Applicability	Drinking water is defined as water intended primarily for human consumption, either directly, as supplied from the

	tap, or indirectly, in beverages, ice or foods prepared with water. Drinking water is also used for other domestic purposes such as bathing and showering. With the exception of bottled or packaged water, the ADWG apply to any water intended for drinking irrespective of the source (municipal supplies, rainwater tanks, bores etc) or where it is consumed (the home, restaurants, camping areas, shops etc). This Guideline deals only with situations where the radionuclide concentrations arise either from natural sources, or, more rarely, as the result of past practices (such as abandoned mining operations). It specifically does not apply to situations where the radionuclides arise from current practices under regulatory control, such as an operating uranium mine. Therefore, the guideline should not be used to support an increase in the radionuclide concentrations of drinking water as a result of an operation, on the grounds that the overall dose levels remain below 1 mSv per year.
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	 2 L/day (730 L/year) 1.8×10^{-11} Sv/Bq 1 mSv/year Annual dose (mSv/year) = DCF x water consumption x radionuclide concentration (mSv/Bq) x (litres/year) x (Bq/L)
Safety factor	The ICRP recommended that, for commodities that are essential for normal living and are amenable to intervention, an individual dose of approximately 1 mSv per year is an acceptable intervention exemption level (ICRP 2000). This is consistent with the recommendation of the NHMRC (1995) of a public exposure limit for practices of 1 mSv per year from all sources. Furthermore, Lokan (1998) concluded that a value of 1 mSv per year might be appropriate as a default action level above which some corrective action will be necessary. Based on the above, it is recommended that a guideline dose of 1 mSv per year should be applied for radioactivity in drinking water.
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 0 0 2 0
General comments	The total estimated dose per year from all radionuclides in drinking water, excluding the dose from potassium-40, should not exceed 1.0 mSv.

	The ICRP (1991) estimates the lifetime risk of a fatal cancer resulting from exposure to radiation to be 5×10^{-2} per Sv of radiation dose, that is, five additional fatal cancers for every 100 people exposed per year. Based on this estimate, a dose of 1 mSv per year gives an annual risk of 5×10^{-5}, that is, about five additional fatal cancers per 100,000 people exposed per year.

Jurisdiction	**BELGIUM**
Tritium limit in drinking water	100 Bq/L
Committed effective dose	0.1 mSv/year
Additional considerations	Total indicative dose from radionuclides not to exceed 0.1 mSv/year
Exact / Rounded	Exact
Scope	National
Policy point of origin	EU Directive 98/83/EC
Legal standard / Guideline	☐standard ☒guideline
Year of adoption	1998
Technical / legal reference(s)	« Surveillance radiologique de la Belgique – Rapport de synthèse 2005 » http://fanc.fgov.be/download/Rapport%20SRT%202005%20FR.pdf
Enforcement	None. EU Directive 98/83/EC not yet transposed into law.
Consequences of exceeding limit	n/a
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : Adult dose conversion factor, applies to adults and children over 10 years old ☒ yes ☐ no ☒ yes ☐ no
Applicability	As defined in the EU Directive 98/83/EC: ‘water intended for human consumption’ shall mean: (a) all water either in its original state or after treatment, intended for drinking, cooking, food preparation or other domestic purposes, regardless of its origin and whether it is supplied from a distribution network, from a tanker, or in bottles or containers; (b) all water used in any food-production undertaking for the manufacture, processing, preservation or marketing of products or substances intended for human consumption unless the competent national authorities are satisfied that the quality of the water cannot affect the wholesomeness of the foodstuff in its finished form; Exclusion: (a) natural mineral waters recognised as such by the

	competent national authorities, in accordance with Council Directive 80/777/EEC of 15 July 1980 on the approximation of the laws of the Member States relating to the exploitation and marketing of natural mineral waters (1); (b) waters which are medicinal products within the meaning of Council Directive 65/65/EEC of 26 January 1965 on the approximation of provisions laid down by law, regulation or administrative action relating to medicinal products (2).
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose	 2 L/day (730 L/year) 1.8×10^{-11} Sv/Bq 0.1 mSv/year Level (Bq/L) = $\frac{1 \times 10^{-4}\ \text{(Sv/year)}}{730\ \text{(L/year)} \times \text{DCF}\ (1.8 \times 10^{-11}\ \text{Sv/Bq})}$
Comment	Calculation = 7,610 Bq/L. Adoption of 100 Bq/L indicator parameter according to Council Directive 98/83/EC.
Safety factor	Maximum dose (0.1 mSv/y) is 10% of the dose limit for members of the population (see WHO form for details).
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 0 7 5 0
General comments	See WHO comments.

Jurisdiction	**CALIFORNIA**
Tritium limit in drinking water	740 Bq/L* (20,000 pCi/L)
Committed effective dose	4 mrem/year (0.04 mSv/year)
Additional considerations	If two or more radionuclides are present, the sum of their annual dose equivalent to the total body or to any organ shall not exceed 4 millirem/year.
Exact / Rounded	Exact
Scope	State
Policy point of origin	US National Primary Drinking Water Regulations
Legal standard / Guideline	☒standard ☐guideline
Year of adoption	2002 (updated 2007)
Technical / legal reference(s)	California Regulations Related to Drinking Water, CCR Title 22, Div. 4, Chap 15, Article 5 http://weblinks.westlaw.com/Find/Default.wl?DB=CA%2DADC%2DTOC%3BRVADCCATOC&DocName=22CAADCS64443&FindType=W&AP=&fn=_top&rs=WEBL7.07&vr=2.0&spa=CCR-1000&trailtype=26
Enforcement	
Consequences of exceeding limit	
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : adult ☒ yes ☐ no ☒ yes ☐ no
Applicability	
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	 2 L/day (730 L/year) 4 mrem/year (0.04 mSv/year)
Safety factor	
Context : CANDU reactors Total power reactors Research centres	 0 4

* Level currently under revision

Tritium light manufacturing	
General comments	The current California maximum contaminant level (MCL) for tritium in drinking water is 20,000 pCi/L (740 Bq/L). The Office of Environmental Health Hazard Assessment in the California Environmental Protection Agency adopted a public health goal (PHG) of 400 pCi/L (14.8 Bq/L) for tritium in drinking water. PHGs established by OEHHA are not regulatory in nature and represent only non-mandatory goals. By state and federal law, MCLs established by DHS must be at least as stringent as the federal MCL, if one exists. PHGs are based solely on scientific and public health considerations, without regard to economic cost considerations or technical feasibility. The ongoing revision of the California drinking water standards (MCLs) will consider the PHG for tritium in drinking water along with pertinent economic factors and technical feasibility.

Jurisdiction	**CANADA**
Tritium limit in drinking water	7,000 Bq/L *
Committed effective dose	0.1 mSv/year
Additional considerations	The sum of the committed effective doses from all radionuclides is not to exceed 0.1 mSv/year.
Exact / Rounded	Rounded down the the next 1,000
Scope	National
Policy point of origin	ICRP
Legal standard / Guideline	☐standard ☒guideline
Year of adoption	1995
Technical / legal reference(s)	Page 6 - Guidelines for Canadian Drinking Water Quality: - Summary Table
Enforcement	None (guideline only, except in Ontario)
Consequences of exceeding limit	None
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : adult dose conversion factor ☒ yes ☐ no ☒ yes ☐ no
Applicability	
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	 2 L/day (730 L/year) 1.8×10^{-11} Sv/Bq 0.1 mSv/year $\text{MAC (Bq/L)} = \frac{1 \times 10^{-4}\ \text{(Sv/year)}}{730\ \text{(L/year)} \times \text{DCF}\ (1.8 \times 10^{-11}\ \text{Sv/Bq})}$ Calculation = 7,610 Bq/L, rounded down to 7,000
Safety factor	A recommended reference dose level (RDL) of the committed effective dose, equal to 0.1 mSv from 1 year's consumption of drinking water (from the possible total radioactive contamination of the annual drinking water consumption). This comprises 10% of the intervention exemption level recommended by the ICRP for dominant commodities (e.g., food and drinking-water) for prolonged exposure situations, which is most relevant to long-term consumption of

* Level currently under revision

	drinking water by the public (ICRP, 2000). The RDL of 0.1 mSv is also equal to 10% of the dose limit for members of the population, recommended by both the ICRP (1991) and the International Basic Safety Standards (IAEA, 1996).
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing Tritium removal facility	 17 17 1 2* 1
General comments	When two or more radionuclides are found in drinking water, the following relationship should be satisfied: $\frac{C1}{MAC1} + \frac{C2}{MAC2} + \ldots \frac{Ci}{MACi} \leq 1$ where Ci and MACi are the observed and maximum acceptable concentrations, respectively, for each contributing radionuclide.

* 1 operating facility in September 2007

Jurisdiction	**CHINA**
Tritium limit in drinking water	No specific guideline or standard. WHO guidelines used in environmental samples.
Committed effective dose	
Additional considerations	
Exact / Rounded	
Scope	
Policy point of origin	
Legal standard / Guideline	Standards for drinking water quality (GB 5749-2006) Limited concentrations of radionuclides in foods (GB 14482-94) Standards do not include radioactivity
Year of adoption	
Technical / legal reference(s)	Personal communication with the National Institute for Radiological Protection (September 30, 2007)
Enforcement	
Consequences of exceeding limit	
Target population : All ages and sexes Urban Rural	
Applicability	
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	
Safety factor	
Context : Candu reactors Total power reactors Research centres Tritium light manufacturing	 2 10
General comments	

Jurisdiction	**EUROPEAN UNION (EU)**
Tritium limit in drinking water	100 Bq/L
Committed effective dose	0.1 mSv/year
Additional considerations	Total indicative dose from radionuclides not to exceed 0.1 mSv/year
Exact / Rounded	Exact
Scope	International
Policy point of origin	WHO 2004
Legal standard / Guideline	☐standard ☒guideline
Year of adoption	1998
Technical / legal reference(s)	Council Directive 98/83/EC http://eur-lex.europa.eu/LexUriServ/site/en/oj/1998/l_330/l_33019981205en00320054.pdf
Enforcement	Each Member State must transpose Directive 98/83/EC into national law. Each Member State is responsible for enforcement of its national water laws or guidelines. Monitoring for tritium is not required if justifiable.
Consequences of exceeding limit	None at EU level unless risk to public health in several EU Member States.
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : Adult dose conversion factor ☒ yes ☐ no ☒ yes ☐ no
Applicability	<u>'water intended for human consumption' shall mean</u>: (a) all water either in its original state or after treatment, intended for drinking, cooking, food preparation or other domestic purposes, regardless of its origin and whether it is supplied from a distribution network, from a tanker, or in bottles or containers; (b) all water used in any food-production undertaking for the manufacture, processing, preservation or marketing of products or substances intended for human consumption unless the competent national authorities are satisfied that the quality of the water cannot affect the wholesomeness of the foodstuff in its finished form;

	Exclusion: (a) natural mineral waters recognised as such by the competent national authorities, in accordance with Council Directive 80/777/EEC of 15 July 1980 on the approximation of the laws of the Member States relating to the exploitation and marketing of natural mineral waters (1); (b) waters which are medicinal products within the meaning of Council Directive 65/65/EEC of 26 January 1965 on the approximation of provisions laid down by law, regulation or administrative action relating to medicinal products (2). Possible exclusion (each member State must decide whether to exclude or not): “Water intended for human consumption from an individual supply providing less than 10 m³ a day as an average or serving fewer than 50 persons, unless the water is supplied as part of a commercial or public activity.”
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	 2 L/day (730 L/year) 1.8×10^{-11} Sv/Bq 0.1 mSv/year $\text{Level (Bq/L)} = \frac{1 \times 10^{-4}\ \text{(Sv/year)}}{730\ \text{(L/year)} \times \text{DCF}\ (1.8 \times 10^{-11}\ \text{Sv/Bq})}$ Calculation = 7,610 Bq/L. Adoption of 100 Bq/L indicator parameter according to Council Directive 98/83/EC. [see also ISTISAN, 2000]
Safety factor	Maximum dose (0.1 mSv/y) is 10% of the dose limit for members of the population (see WHO form for details)
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 2 133
General comments	See WHO/EU for detailed comments.

Jurisdiction	**FINLAND**
Tritium limit in drinking water	30,000 Bq/L
Committed effective dose	0.5 mSv/year
Additional considerations	Total indicative dose from radionuclides not to exceed 0.5 mSv/year
Exact / Rounded	Rounded to the nearest 1,000
Scope	National
Policy point of origin	National
Legal standard / Guideline	☒standard ☐guideline
Year of adoption	1993
Technical / legal reference(s)	Radioactivity of Household Water (ST 12.3), STUK
Enforcement	
Consequences of exceeding limit	
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : Adult dose conversion factor ☐ yes ☐ no ☐ yes ☐ no
Applicability	Household water comprises water used for drinking, water used in the production of beverages, and water used in preparing or producing foods industrially.
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	 2.2 L/day (803 L/year) 1.8×10^{-11} Sv/Bq 0.5 mSv/year $\text{Level (Bq/L)} = \frac{5 \times 10^{-4}\ \text{(Sv/year)}}{803\ \text{(L/year)} \times \text{DCF}\ (1.8 \times 10^{-11}\ \text{Sv/Bq})}$ Calculation = 34,592 Bq/L, rounded down to 30,000
Safety factor	
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 0 4 0 0
General comments	Although Finland is a member of the EU, it has not yet implemented Council Directive 98/83/EC

Jurisdiction	**FRANCE**
Tritium limit in drinking water	100 Bq/L
Committed effective dose	0.1 mSv/year
Additional considerations	Total indicative dose from radionuclides not to exceed 0.1 mSv/year
Exact / Rounded	Exact
Scope	National
Policy point of origin	EU Directive 98/83/EC
Legal standard / Guideline	☒standard ☐guideline
Year of adoption	2001
Technical / legal reference(s)	Decree No. 2001-1220 relative to water intended for human consumption, excluding mineral water http://www.car-analyse.com/hydro/d011220.htm
Enforcement	Transposition of EU Directive 98/83/EC into national law
Consequences of exceeding limit	Test for presence of other artificial radionuclides
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : Adult dose conversion factor ☒ yes ☐ no ☒ yes ☐ no
Applicability	Decree applies to: (a) all water either in its original state or after treatment, intended for drinking, cooking, food preparation or other domestic purposes, regardless of its origin and whether it is supplied from a distribution network, from a tanker, or in bottles or containers; (b) all water used in any food-production undertaking for the manufacture, processing, preservation or marketing of products or substances intended for human consumption unless the competent national authorities are satisfied that the quality of the water cannot affect the wholesomeness of the foodstuff in its finished form, including water-based food ice.

Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose	 2 L/day (730 L/year) 1.8×10^{-11} Sv/Bq 0.1 mSv/year Level (Bq/L) = $\dfrac{1 \times 10^{-4}\ \text{(Sv/year)}}{730\ \text{(L/year)} \times \text{DCF}\ (1.8 \times 10^{-11}\ \text{Sv/Bq})}$
Comment	Calculation = 7,610 Bq/L. Adoption of 100 Bq/L indicator parameter according to Council Directive 98/83/EC.
Safety factor	Maximum dose (0.1 mSv/y) is 10% of the dose limit for members of the population (see WHO form for details).
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 0 59 ITER fusion project 0
General comments	See WHO comments.

Jurisdiction	**GERMANY**
Tritium limit in drinking water	100 Bq/L
Committed effective dose	0.1 mSv/year
Additional considerations	Total indicative dose from radionuclides not to exceed 0.1 mSv/year
Exact / Rounded	Exact
Scope	National
Policy point of origin	EU Directive 98/83/EC
Legal standard / Guideline	☒standard ☐guideline
Year of adoption	2001
Technical / legal reference(s)	Drinking Water Regulation (TrinkwV-2001) [in German] http://bundesrecht.juris.de/trinkwv_2001/index.html
Enforcement	Transposition of EU Directive 98/83/EC into national law
Consequences of exceeding limit	Fines and penalties if contamination is high or low and not quickly remediated.
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : Adult dose conversion factor ☒ yes ☐ no ☒ yes ☐ no
Applicability	Applies to: (a) all water either in its original state or after treatment, intended for drinking, cooking, food preparation or other domestic purposes, including the cleaning of items that may come into contact with foodstuffs or the human body.
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	 2 L/day (730 L/year) 1.8 x 10-11 Sv/Bq 0.1 mSv/year $\text{Level (Bq/L)} = \frac{1 \times 10^{-4}\ \text{(Sv/year)}}{730\ \text{(L/year)} \times \text{DCF}\ (1.8 \times 10^{-11}\ \text{Sv/Bq})}$ Calculation = 7,610 Bq/L. Adoption of 100 Bq/L indicator parameter according to Council Directive 98/83/EC.

Safety factor	Maximum dose (0.1 mSv/y) is 10% of the dose limit for members of the population (see WHO form for details).
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 0 17 7 0
General comments	See WHO comments.

Jurisdiction	**ITALY**
Tritium limit in drinking water	100 Bq/L
Committed effective dose	0.1 mSv/year
Additional considerations	Total indicative dose from radionuclides not to exceed 0.1 mSv/year
Exact / Rounded	Exact
Scope	National
Policy point of origin	EU Directive 98/83/EC
Legal standard / Guideline	☒standard ☐guideline
Year of adoption	2001
Technical / legal reference(s)	Legislative Decree 2 February 2001, no. 31 “Application of Directive 98/83/EC Relative to the Quality of Water Destined for Human Consumption." [in Italian] http://www.parlamento.it/leggi/deleghe/01031dl.htm
Enforcement	Transposition of Directive 98/83/EC into national law
Consequences of exceeding limit	
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : Adult dose conversion factor ☒ yes ☐ no ☒ yes ☐ no
Applicability	As defined in the EU Directive 98/83/EC: <u>‘water intended for human consumption’ shall mean</u>: (a) all water either in its original state or after treatment, intended for drinking, cooking, food preparation or other domestic purposes, regardless of its origin and whether it is supplied from a distribution network, from a tanker, or in bottles or containers; (b) all water used in any food-production undertaking for the manufacture, processing, preservation or marketing of products or substances intended for human consumption unless the competent national authorities are satisfied that the quality of the water cannot affect the wholesomeness of the foodstuff in its finished form; <u>Exclusion</u>: (a) natural and medicinal mineral waters

Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose	 2 L/day (730 L/year) 1.8×10^{-11} Sv/Bq 0.1 mSv/year Level (Bq/L) = $\frac{1 \times 10^{-4} \text{ (Sv/year)}}{730 \text{ (L/year)} \times \text{DCF } (1.8 \times 10^{-11} \text{ Sv/Bq})}$
Comment	Calculation = 7,610 Bq/L. Adoption of 100 Bq/L indicator parameter according to Council Directive 98/83/EC.
Safety factor	Maximum dose (0.1 mSv/y) is 10% of the dose limit for members of the population (see WHO form for details).
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 0 0 0 0
General comments	See WHO comments.

Jurisdiction	**JAPAN**
Tritium limit in drinking water	No guideline or standard
Committed effective dose	
Additional considerations	
Exact / Rounded	
Scope	
Policy point of origin	
Legal standard / Guideline	Water quality standards do not include radioactivity. http://www.jwwa.or.jp/english/water_en/water-e07.html
Year of adoption	
Technical / legal reference(s)	Personal communication with the Office of Radiation Regulation, Science and Technology Policy Bureau; Ministry of Education, Culture, Sports, Science and Technology. (July 31, 2007)
Enforcement	
Consequences of exceeding limit	
Target population : All ages and sexes Urban Rural	
Applicability	
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	
Safety factor	
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 0 53
General comments	

Jurisdiction	**MANITOBA**
Tritium limit in drinking water	7,000 Bq/L
Committed effective dose	0.1 mSv/year
Additional considerations	The sum of the committed effective doses from all radionuclides is not to exceed 0.1 mSv/year.
Exact / Rounded	Rounded down the the next 1,000
Scope	Provincial
Policy point of origin	Guidelines for Canadian Drinking Water Quality
Legal standard / Guideline	☒standard ☐guideline
Year of adoption	2002
Technical / legal reference(s)	Drinking Water Safety Act Drinking Water Safety Regulation Drinking Water Quality Standards Regulation http://www.gov.mb.ca/waterstewardship/odw/reg-info/acts-regs/index.html
Enforcement	Manitoba Office of Drinking Water, as per the act, regulation and standards mentioned above
Consequences of exceeding limit	
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : adult dose conversion factor ☒ yes ☐ no ☒ yes ☐ no
Applicability	
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	 2 L/day (730 L/year) 1.8×10^{-11} Sv/Bq 0.1 mSv/year $\text{MAC (Bq/L)} = \frac{1 \times 10^{-4}\ \text{(Sv/year)}}{730\ \text{(L/year)} \times \text{DCF}\ (1.8 \times 10^{-11}\ \text{Sv/Bq})}$ Calculation = 7,610 Bq/L, rounded down to 7,000
Safety factor	A recommended reference dose level (RDL) of the committed effective dose, equal to 0.1 mSv from 1 year's consumption of drinking water (from the possible total radioactive contamination of the annual drinking water consumption). This comprises 10% of the intervention exemption level recommended by the ICRP for dominant commodities (e.g., food and

	drinking-water) for prolonged exposure situations, which is most relevant to long-term consumption of drinking water by the public (ICRP, 2000). The RDL of 0.1 mSv is also equal to 10% of the dose limit for members of the population, recommended by both the ICRP (1991) and the International Basic Safety Standards (IAEA, 1996).
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 0 0 0 0
General comments	When two or more radionuclides are found in drinking water, the following relationship should be satisfied: $\frac{C1}{MAC1} + \frac{C2}{MAC2} + \ldots \frac{Ci}{MACi} \leq 1$ where Ci and MACi are the observed and maximum acceptable concentrations, respectively, for each contributing radionuclide.

Jurisdiction	**NEW BRUNSWICK**
Tritium limit in drinking water	none
Committed effective dose	
Additional considerations	
Exact / Rounded	
Scope	provincial
Policy point of origin	
Legal standard / Guideline	☐standard ☒guideline
Year of adoption	1993
Technical / legal reference(s)	New Brunswick Potable Water Regulation 93-203 http://www.gnb.ca/0062/regs/93-203.htm
Enforcement	
Consequences of exceeding limit	
Target population : All ages and sexes Urban Rural	 ☐ yes ☐ no : ☐ yes ☐ no ☐ yes ☐ no
Applicability	
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	
Safety factor	
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 1 1 0 0
General comments	

Jurisdiction	**NORTHERN IRELAND**
Tritium limit in drinking water	100 Bq/L
Committed effective dose	0.1 mSv/year
Additional considerations	Total indicative dose from radionuclides not to exceed 0.1 mSv/year
Exact / Rounded	Exact
Scope	Regional
Policy point of origin	EU Directive 98/83/EC
Legal standard / Guideline	☒standard ☐guideline
Year of adoption	2001
Technical / legal reference(s)	Statutory Rule 2007 No. 147 "The Water Supply (Water Quality) Regulations (Northern Ireland) 2007" http://www.opsi.gov.uk/sr/sr2007/20070147.htm#sch2
Enforcement	
Consequences of exceeding limit	
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : Adult dose conversion factor ☒ yes ☐ no ☒ yes ☐ no
Applicability	Applies to water supplied: (a) for such domestic purposes as consist in or include, cooking, drinking, food preparation or washing; or (b) to premises in which food is produced, wholesomeness of the foodstuff in its finished form.
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	 2L/day (730 L/year) 1.8×10^{-11} Sv/Bq 0.1 mSv/year Level (Bq/L) = $\frac{1 \times 10^{-4} \text{ (Sv/year)}}{730 \text{ (L/year)} \times \text{DCF } (1.8 \times 10^{-11} \text{ Sv/Bq})}$ Calculation = 7,610 Bq/L. Adoption of 100 Bq/L indicator parameter according to Council Directive 98/83/EC.
Safety factor	Maximum dose (0.1 mSv/y) is 10% of the dose limit for members of the population (see WHO form for details).

Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 0 0 0 0
General comments	See WHO comments.

Jurisdiction	**NORWAY**
Tritium limit in drinking water	100 Bq/L
Committed effective dose	0.1 mSv/year
Additional considerations	Total indicative dose from radionuclides not to exceed 0.1 mSv/year
Exact / Rounded	Exact
Scope	National
Policy point of origin	EU Directive 98/83/EC
Legal standard / Guideline	☒standard ☐guideline
Year of adoption	2001
Technical / legal reference(s)	Drinking Water Regulations FOR 2001-12-04 nr 1372 [In Norwegian] http://www.lovdata.no/cgi-wift/ldles?doc=/sf/sf/sf-20011204-1372.html
Enforcement	Transposition of EU Directive 98/83/EC into national law
Consequences of exceeding limit	As per Food Law (LOV 2003-12-19-124); investigation required
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : Adult dose conversion factor ☒ yes ☐ no ☒ yes ☐ no
Applicability	<u>“drinking water” definition</u>: (a) all water either in its original state or after treatment, intended for drinking, cooking, food preparation or other domestic purposes, regardless of its origin and whether it is supplied from a distribution network, from a tanker, or in bottles or containers; (b) all water used in any food-production undertaking for the manufacture, processing, preservation or marketing of products or substances intended for human consumption unless the competent national authorities are satisfied that the quality of the water cannot affect the wholesomeness of the foodstuff in its finished form.

Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose	 2 L/day (730 L/year) 1.8×10^{-11} Sv/Bq 0.1 mSv/year $\text{Level (Bq/L)} = \frac{1 \times 10^{-4}\ \text{(Sv/year)}}{730\ \text{(L/year)} \times \text{DCF}\ (1.8 \times 10^{-11}\ \text{Sv/Bq})}$
Comment	Calculation = 7,610 Bq/L. Adoption of 100 Bq/L indicator parameter according to Council Directive 98/83/EC.
Safety factor	Maximum dose (0.1 mSv/y) is 10% of the dose limit for members of the population (see WHO form for details).
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 0 0 1 (Halden Reactor Project) 0
General comments	See WHO comments.

Jurisdiction	**ONTARIO**
Tritium limit in drinking water	7,000 Bq/L
Committed effective dose	0.1 mSv/year
Additional considerations	The sum of the committed effective doses from all radionuclides is not to exceed 0.1 mSv/year.
Exact / Rounded	Rounded down the the next 1,000
Scope	Provincial
Policy point of origin	Guidelines for Canadian Drinking Water Quality
Legal standard / Guideline	☒standard ☐guideline
Year of adoption	2002
Technical / legal reference(s)	Ontario Safe Drinking Water Act, 2002 http://www.search.e-laws.gov.on.ca/en/isysquery/84f3bc08-caf6-4104-8bc7-ca6d6bddd3eb/4/frame/?search=browseStatutes&context= Ontario Drinking water Quality Standards (O. Reg. 169/03 and 242/07) http://www.canlii.org/on/laws/regu/2003r.169/20070717/whole.html Ontario Drinking Water Systems Regulation (O. Reg. 170/03) http://www.canlii.org/on/laws/regu/2003r.170/20070717/whole.html
Enforcement	Ontario Ministry of the Environment, as per the regulation and standards mentioned above
Consequences of exceeding limit	
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : adult dose conversion factor ☒ yes ☐ no ☒ yes ☐ no
Applicability	
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose	 2 L/day (730 L/year) 1.8×10^{-11} Sv/Bq 0.1 mSv/year $\text{MAC (Bq/L)} = \frac{1 \times 10^{-4} \text{ (Sv/year)}}{730 \text{ (L/year)} \times \text{DCF } (1.8 \times 10^{-11} \text{ Sv/Bq})}$

Comment	Calculation = 7,610 Bq/L, rounded down to 7,000
Safety factor	A recommended reference dose level (RDL) of the committed effective dose, equal to 0.1 mSv from 1 year's consumption of drinking water (from the possible total radioactive contamination of the annual drinking water consumption). This comprises 10% of the intervention exemption level recommended by the ICRP for dominant commodities (e.g., food and drinking-water) for prolonged exposure situations, which is most relevant to long-term consumption of drinking water by the public (ICRP, 2000). The RDL of 0.1 mSv is also equal to 10% of the dose limit for members of the population, recommended by both the ICRP (1991) and the International Basic Safety Standards (IAEA, 1996).
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing Tritium removal facility	 16 0 4 2* 1
General comments	When two or more radionuclides are found in drinking water, the following relationship should be satisfied: $\frac{C1}{MAC1} + \frac{C2}{MAC2} + \ldots \frac{Ci}{MACi} \leq 1$ where Ci and MACi are the observed and maximum acceptable concentrations, respectively, for each contributing radionuclide.

* 1 operating facility in September 2007

Jurisdiction	**QUEBEC**
Tritium limit in drinking water	7,000 Bq/L
Committed effective dose	0.1 mSv/year
Additional considerations	The sum of the committed effective doses from all radionuclides is not to exceed 0.1 mSv/year.
Exact / Rounded	Rounded down the the next 1,000
Scope	Provincial
Policy point of origin	Guidelines for Canadian Drinking Water Quality
Legal standard / Guideline	☒standard ☐guideline
Year of adoption	2003
Technical / legal reference(s)	Regulation Respecting the Quality of Drinking Water (Q-2, r.18.1.1) http://www.canlii.org/qc/laws/regu/q-2r.18.1.1/20070717/whole.html
Enforcement	The Ministère du Développement durable, de l'Environnement et des Parcs is responsible for enforcement, as per the regulation mentioned above.
Consequences of exceeding limit	
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : adult dose conversion factor ☒ yes ☐ no ☒ yes ☐ no
Applicability	
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	 2 L/day (730 L/year) 1.8×10^{-11} Sv/Bq 0.1 mSv/year $\text{MAC (Bq/L)} = \frac{1 \times 10^{-4}\ \text{(Sv/year)}}{730\ \text{(L/year)} \times \text{DCF}\ (1.8 \times 10^{-11}\ \text{Sv/Bq})}$ Calculation = 7,610 Bq/L, rounded down to 7,000
Safety factor	A recommended reference dose level (RDL) of the committed effective dose, equal to 0.1 mSv from 1 year's consumption of drinking water (from the possible total radioactive contamination of the annual drinking water consumption). This comprises 10% of the intervention exemption level recommended by the ICRP for dominant commodities (e.g., food and

	drinking-water) for prolonged exposure situations, which is most relevant to long-term consumption of drinking water by the public (ICRP, 2000). The RDL of 0.1 mSv is also equal to 10% of the dose limit for members of the population, recommended by both the ICRP (1991) and the International Basic Safety Standards (IAEA, 1996).
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 1 0 0 0
General comments	When two or more radionuclides are found in drinking water, the following relationship should be satisfied: $\frac{C1}{MAC1} + \frac{C2}{MAC2} + \dots \frac{Ci}{MACi} \leq 1$ where Ci and MACi are the observed and maximum acceptable concentrations, respectively, for each contributing radionuclide.

Jurisdiction	**REPUBLIC OF KOREA**
Tritium limit in drinking water	No guideline or standard
Committed effective dose	
Additional considerations	
Exact / Rounded	
Scope	
Policy point of origin	
Legal standard / Guideline	
Year of adoption	
Technical / legal reference(s)	Personal communication with the Korea Institute of Nuclear Safety (KINS) (26 July, 2007)
Enforcement	
Consequences of exceeding limit	
Target population : All ages and sexes Urban Rural	
Applicability	
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	
Safety factor	
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 4 20
General comments	

Jurisdiction	**ROMANIA**
Tritium limit in drinking water	100 Bq/L
Committed effective dose	0.1 mSv/year
Additional considerations	Total indicative dose from radionuclides not to exceed 0.1 mSv/year
Exact / Rounded	Exact
Scope	National
Policy point of origin	EU Directive 98/83/EC
Legal standard / Guideline	☒standard ☐guideline
Year of adoption	2002
Technical / legal reference(s)	Water Law No. 458/2002 "Concerning the Quality of Potable Water" [in Romanian] http://www.phg.ro/showlege.php?id=1900
Enforcement	Transposition of EU Directive 98/83/EC into national law. Amendment 311/2004 (to law 458/2002). The Ministry of Health supervises and controls the monitoring of water quality.
Consequences of exceeding limit	
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : Adult dose conversion factor ☒ yes ☐ no ☒ yes ☐ no
Applicability	As defined in the EU Directive 98/83/EC: <u>'water intended for human consumption' shall mean</u>: (a) all water either in its original state or after treatment, intended for drinking, cooking, food preparation or other domestic purposes, regardless of its origin and whether it is supplied from a distribution network, from a tanker, or in bottles or containers; (b) all water used in any food-production undertaking for the manufacture, processing, preservation or marketing of products or substances intended for human consumption unless the competent national authorities are satisfied that the quality of the water cannot affect the wholesomeness of the foodstuff in its finished form; <u>Exclusion</u>: (a) natural mineral waters recognised as such by the

	competent national authorities, in accordance with Council Directive 80/777/EEC of 15 July 1980 on the approximation of the laws of the Member States relating to the exploitation and marketing of natural mineral waters (1); (b) waters which are medicinal products within the meaning of Council Directive 65/65/EEC of 26 January 1965 on the approximation of provisions laid down by law, regulation or administrative action relating to medicinal products (2).
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	 730 L/year 1.8×10^{-11} Sv/Bq 0.1 mSv/year Level (Bq/L) = $\frac{1 \times 10^{-4} \text{ (Sv/year)}}{730 \text{ (L/year)} \times \text{DCF } (1.8 \times 10^{-11} \text{ Sv/Bq})}$ Calculation = 7,610 Bq/L. Adoption of 100 Bq/L indicator parameter according to Council Directive 98/83/EC.
Safety factor	Maximum dose (0.1 mSv/y) is 10% of the dose limit for members of the population (see WHO form for details).
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 2 2 1 0
General comments	See WHO comments.

Jurisdiction	**RUSSIA**
Tritium limit in drinking water	7,700 Bq/L
Committed effective dose	0.1 mSv/year
Additional considerations	
Exact / Rounded	Rounded to the nearest 100
Scope	National
Policy point of origin	Assumed ICRP
Legal standard / Guideline	☒ standard ☐ guideline
Year of adoption	1999
Technical / legal reference(s)	Radiation Safety Norms (NRB-99)
Enforcement	
Consequences of exceeding limit	
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : Value identified for "critical receptor" of child 1-2 years ☐ yes ☐ no ☐ yes ☐ no
Applicability	
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	 730 L/year 1.8×10^{-11} Sv/Bq 0.1 mSv/year Level (Bq/L) = $\frac{1 \times 10^{-4}\ (\text{Sv/year})}{730\ (\text{L/year}) \times \text{DCF}\ (1.8 \times 10^{-11}\ \text{Sv/Bq})}$ Calculation = 7,610 Bq/L, rounded to 7,700 Bq/L
Safety factor	Maximum dose (0.1 mSv/y) is 10% of the dose limit for members of the population.
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 0 31 0
General comments	See WHO comments.

Jurisdiction	**SCOTLAND**
Tritium limit in drinking water	100 Bq/L
Committed effective dose	0.1 mSv/year
Additional considerations	Total indicative dose from radionuclides not to exceed 0.1 mSv/year
Exact / Rounded	Exact
Scope	Regional
Policy point of origin	EU Directive 98/83/EC
Legal standard / Guideline	☒standard ☐guideline
Year of adoption	2001
Technical / legal reference(s)	2001 No. 207 The Water Supply (Water Quality) (Scotland) Regulations 2001 http://www.opsi.gov.uk/legislation/scotland/ssi2001/ssi_20010207_en.pdf
Enforcement	
Consequences of exceeding limit	
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : Adult dose conversion factor ☐ yes ☐ no ☐ yes ☐ no
Applicability	Applies to water supplied: (a) for such domestic purposes as consist in or include, cooking, drinking, food preparation or washing; or (b) for any of those domestic purposes to premises in which food is produced.
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	 2L/day (730 L/year) 1.8×10^{-11} Sv/Bq 0.1 mSv/year $\text{Level (Bq/L)} = \dfrac{1 \times 10^{-4}\ \text{(Sv/year)}}{730\ \text{(L/year)} \times \text{DCF}\ (1.8 \times 10^{-11}\ \text{Sv/Bq})}$ Calculation = 7,610 Bq/L. Adoption of 100 Bq/L indicator parameter according to Council Directive 98/83/EC.
Safety factor	Maximum dose (0.1 mSv/y) is 10% of the dose limit for members of the population (see WHO form for details).

Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 0 2 0 0
General comments	See WHO comments.

Jurisdiction	**SPAIN**
Tritium limit in drinking water	100 Bq/L
Committed effective dose	0.1 mSv/year
Additional considerations	Total indicative dose from radionuclides not to exceed 0.1 mSv/year
Exact / Rounded	Exact
Scope	National
Policy point of origin	EU Directive 98/83/EC
Legal standard / Guideline	☒standard ☐guideline
Year of adoption	2003
Technical / legal reference(s)	"Royal Decree 140/2003, by Which are Established the Sanitary Criteria of the Quality of Water for Human Consumption." [in Spanish] http://www.msc.es/ciudadanos/saludAmbLaboral/docs/rd_140_2003.pdf
Enforcement	Transposition of EU Directive 98/83/EC into national law. Non-conforming water quality results reported to the Sistema de Información Nacional de Agua de Consumo.
Consequences of exceeding limit	Depending on severity, possible stop to activities and water distribution and/or public warning. Sanctions (according to law 14/1986) if corrective measures not implemented quickly and completely.
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : Adult dose conversion factor ☒ yes ☐ no ☒ yes ☐ no
Applicability	Applies to: (a) all water either in its original state or after treatment, intended for drinking, cooking, food preparation or other domestic purposes, regardless of its origin and whether it is supplied from a distribution network, from a tanker, or in bottles or containers; (b) all water used in any food-production undertaking for the manufacture, processing, preservation or marketing of products or substances intended for human consumption unless the competent national authorities are satisfied that the quality of the water cannot affect the wholesomeness of the foodstuff in its

	finished form; Exclusions: (a) natural mineral waters recognised as such by the competent national authorities, in accordance with Council Directive 80/777/EEC of 15 July 1980 on the approximation of the laws of the Member States relating to the exploitation and marketing of natural mineral waters (1); (b) waters and mineral waters which are medicinal products within the meaning of laws 22/1976, 743/1928, and 25/1990. (c) water intended for human consumption from an individual supply providing less than 10 m³ a day as an average, or serving fewer than 50 persons, unless the water is supplied as part of a commercial or public activity.
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	 2 L/day (730 L/year) 1.8 x 10^{-11} Sv/Bq 0.1 mSv/year Level (Bq/L) = $\frac{1 \times 10^{-4} \text{ (Sv/year)}}{730 \text{ (L/year)} \times \text{DCF } (1.8 \times 10^{-11} \text{ Sv/Bq})}$ Calculation = 7,610 Bq/L. Adoption of 100 Bq/L indicator parameter according to Council Directive 98/83/EC.
Safety factor	Maximum dose (0.1 mSv/y) is 10% of the dose limit for members of the population (see WHO form for details).
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 0 8 1 0
General comments	See WHO comments.

Jurisdiction	**SWEDEN**
Tritium limit in drinking water	100 Bq/L
Committed effective dose	0.1 mSv/year
Additional considerations	Total indicative dose from radionuclides not to exceed 0.1 mSv/year
Exact / Rounded	Exact
Scope	National
Policy point of origin	EU Directive 98/83/EC
Legal standard / Guideline	☒standard ☐guideline
Year of adoption	2001
Technical / legal reference(s)	"The National Food Administration's Drinking Water Regulations (SLVFS 2001:30)" [in Swedish] http://www.slv.se/upload/dokument/Lagstiftning/2000-2005/2001_30.pdf
Enforcement	Transposition of EU Directive 98/83/EC into national law
Consequences of exceeding limit	As per Food Act (SFS 2006:804)
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : Adult dose conversion factor ☒ yes ☐ no ☒ yes ☐ no
Applicability	As defined in the EU Directive 98/83/EC: 'water intended for human consumption' shall mean: (a) all water either in its original state or after treatment, intended for drinking, cooking, food preparation or other domestic purposes, regardless of its origin and whether it is supplied from a distribution network, from a tanker, or in bottles or containers; (b) all water used in any food-production undertaking for the manufacture, processing, preservation or marketing of products or substances intended for human consumption unless the competent national authorities are satisfied that the quality of the water cannot affect the wholesomeness of the foodstuff in its finished form.

Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	 2 L/day (730 L/year) 1.8×10^{-11} Sv/Bq 0.1 mSv/year $\text{Level (Bq/L)} = \frac{1 \times 10^{-4}\ \text{(Sv/year)}}{730\ \text{(L/year)} \times \text{DCF}\ (1.8 \times 10^{-11}\ \text{Sv/Bq})}$ Calculation = 7,610 Bq/L. Adoption of 100 Bq/L indicator parameter according to Council Directive 98/83/EC.
Safety factor	Maximum dose (0.1 mSv/y) is 10% of the dose limit for members of the population (see WHO form for details).
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 0 10 1 0
General comments	See WHO comments.

Jurisdiction	**SWITZERLAND**
Tritium limit in drinking water	10,000 Bq/L
Committed effective dose	0.1 mSv/year
Additional considerations	
Exact / Rounded	Rounded up to the next 1000
Scope	National
Policy point of origin	National
Legal standard / Guideline	☒standard ☐guideline
Year of adoption	2006 (1995 originally)
Technical / legal reference(s)	Ordonnance du DFI sur les substances étrangères et les composants dans les denrées alimentaires (817.021.23) http://www.admin.ch/ch/f/rs/8/817.021.23.fr.pdf
Enforcement	
Consequences of exceeding limit	Tolerance value set at 1,000 Bq/L. Above tolerance value, water is designated to be "of lesser value". Above limit of 10,000 Bq/L, water is declared unfit for human consumption.
Target population : All ages and sexes Urban Rural	 ☐ yes ☐ no : _____ ☒ yes ☐ no ☒ yes ☐ no
Applicability	”Drinking water" means water, either in its original state or after treatment, intended for drinking, cooking, food preparation or for cleaning of objects coming into contact with foodstuffs.
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	 600 L/year (0.6 m3 / year) 1.8×10^{-11} Sv/Bq 0.1 mSv/year (determined by calculation below:) Level (Bq/L) = $\frac{1 \times 10^{-4} \text{ (Sv/year)}}{730 \text{ (L/year)} \times \text{DCF } (1.8 \times 10^{-11} \text{ Sv/Bq})}$ Calculation = 9,259.3 Bq/L, rounded up to 10,000
Safety factor	Maximum dose (0.1 mSv/y) is 10% of the dose limit for members of the population (see WHO form for details).

Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 0 5 1 1
General comments	See WHO comments.

Jurisdiction	**UNITED KINGDOM** **(England and Wales)**
Tritium limit in drinking water	100 Bq/L
Committed effective dose	0.1 mSv/year
Additional considerations	Total indicative dose from radionuclides not to exceed 0.1 mSv/year
Exact / Rounded	Exact
Scope	National
Policy point of origin	EU Directive 98/83/EC
Legal standard / Guideline	☒standard ☐guideline
Year of adoption	2000; 2001
Technical / legal reference(s)	2000 No. 3184 WATER, ENGLAND AND WALES The Water Supply (Water Quality) Regulations 2000 http://www.dwi.gov.uk/regs/si3184/3184.htm
Enforcement	Drinking Water Inspectorate
Consequences of exceeding limit	If the indicator value is exceeded, additional analysis should be undertaken to establish which isotopes are present and the total indicative dose calculated from the individual isotope concentrations. If the total indicative dose exceeds the indicator value of 0.10 mSv/year, appropriate medical advice should be sought.
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : Adult dose conversion factor ☐ yes ☐ no ☐ yes ☐ no
Applicability	Applies to water supplied: (a) for such domestic purposes as consist in or include, cooking, drinking, food preparation or washing; or (b) for any of those domestic purposes, to premises in which food is produced.

Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	 2L/day (730 L/year) 1.8×10^{-11} Sv/Bq 0.1 mSv/year $\text{Level (Bq/L)} = \frac{1 \times 10^{-4} \text{ (Sv/year)}}{730 \text{ (L/year)} \times \text{DCF } (1.8 \times 10^{-11} \text{ Sv/Bq})}$ Calculation = 7,610 Bq/L. Adoption of 100 Bq/L indicator parameter according to Council Directive 98/83/EC.
Safety factor	Maximum dose (0.1 mSv/y) is 10% of the dose limit for members of the population (see WHO form for details).
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 0 19 1 0
General comments	See WHO comments.

Jurisdiction	**UNITED STATES**
Tritium limit in drinking water	740 Bq/L* (20,000 pCi/L)
Committed effective dose	4 mrem/year (0.04 mSv/year)
Additional considerations	If two or more radionuclides are present, the sum of their annual dose equivalent to the total body or to any organ shall not exceed 4 millirem/year.
Exact / Rounded	Exact
Scope	National
Policy point of origin	National
Legal standard / Guideline	☒standard ☐guideline
Year of adoption	1976 (retained in 2003, although updated calculations would have resulted in a new standard of 2,253 Bq/L))
Technical / legal reference(s)	Title 40, Volume 19, Part 141—National Primary Drinking Water Regulations http://a257.g.akamaitech.net/7/257/2422/14mar20010800/edocket.access.gpo.gov/cfr_2002/julqtr/40cfr141.16.htm
Enforcement	USEPA Civil Enforcement program
Consequences of exceeding limit	EPA may issue administrative orders, take legal actions, or fine utilities for violation of the standards. Under Section 1414(b) of the SDWA, an imposed penalty not to exceed $25,000 per day; under Section 1414(g)(3) of the SDWA, an administrative order can result in a $5,000 maximum penalty assessed; up to $25,000 per violation per day; under Section 1431(b), the statutory maximum is $5,000 per violation per day of an emergency order; under Section 1432(c), tampering with a public water system carries a maximum civil penalty of $50,000; a maximum civil penalty of $20,000 can be imposed for an attempt or threat to tamper with a public water system; and under Section 1445(c), the statutory maximum penalty is $25,000 in a civil judical action for failing or refusing to keep appropriate records, make reports, etc.
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : adult ☒ yes ☐ no ☒ yes ☐ no

* Level currently under revision

Applicability	
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	 2 L/day (730 L/year) 4 mrem/year (0.04 mSv/year)
Safety factor	
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 0 103
General comments	Except for the radionuclides listed in Table A, the concentration of man-made radionuclides causing 4 mrem total body or organ dose equivalents shall be calculated on the basis of a 2 liter per day drinking water intake using the 168 hour data listed in "Maximum Permissible Body Burdens and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure," NBS Handbook 69 as amended August 1963, U.S. Department of Commerce. Table A--Average Annual Concentrations Assumed to Produce a Total Body or Organ Dose of 4 mrem/yr --- Radionuclide Critical organ pCi per liter --- Tritium................. Total body............. 20,000

Jurisdiction	**WORLD HEALTH ORGANISATION (WHO)**
Tritium limit in drinking water	10,000 Bq/L
Committed effective dose	0.1 mSv/year
Additional considerations	Total indicative dose from radionuclides not to exceed 0.1 mSv/year
Exact / Rounded	Other (Rounded by averaging the log scale values)
Scope	International
Policy point of origin	n/a
Legal standard / Guideline	☐standard ☒guideline
Year of adoption	2004
Technical / legal reference(s)	Guidelines for Drinking water Quality. Vol. 1 : 3rd ed. http://www.who.int/water_sanitation_health/dwq/GDWQ2004web.pdf
Enforcement	n/a
Consequences of exceeding limit	n/a
Target population : All ages and sexes Urban Rural	 ☐ yes ☒ no : Adult dose conversion factor ☒ yes ☐ no ☒ yes ☐ no
Applicability	
Technical basis for calculation: Drinking water intake rate Dose conversion factor Committed effective dose Comment	 2 L/day (730 L/year) 1.8×10^{-11} Sv/Bq 0.1 mSv/year $\text{Level (Bq/L)} = \frac{1 \times 10^{-4} \text{ (Sv/year)}}{730 \text{ (L/year)} \times \text{DCF } (1.8 \times 10^{-11} \text{ Sv/Bq})}$ Calculation = 7,610 Bq/L, rounded up to 10,000
Safety factor	A recommended reference dose level (RDL) of the committed effective dose, equal to 0.1 mSv from 1 year's consumption of drinking water (from the possible total radioactive contamination of the annual drinking water consumption). This comprises 10% of the intervention exemption level recommended by the ICRP for dominant commodities (e.g., food and drinking-water) for prolonged exposure situations, which is most relevant to long-term consumption of drinking water by the public (ICRP, 2000). The RDL of

	0.1 mSv is also equal to 10% of the dose limit for members of the population, recommended by both the ICRP (1991) and the International Basic Safety Standards (IAEA, 1996).
Context : CANDU reactors Total power reactors Research centres Tritium light manufacturing	 n/a n/a n/a n/a
General comments	The dose coefficient for adults was provided by the ICRP. The nominal probability coefficient for radiation-induced stochastic health effects, which include fatal cancer, non-fatal cancer and severe hereditary effects for the whole population, is 7.3×10^{-2}/Sv (ICRP, 1991). Multiplying this by an RDL equal to 0.1 mSv annual exposure via drinking water gives an estimated lifetime risk of stochastic health effects of 10^{-5}, which can be considered small in comparison with other health risks. This risk level is comparable to the reference level of risk used elsewhere in these Guidelines. Background radiation exposures vary widely across various regions of the Earth, but the average is about 2.4 mSv/year, with the highest local levels being up to 10 times higher without any apparent health consequences; 0.1 mSv therefore represents a small addition to background levels. Despite the uncertainties in the determination of risk from radiation exposure at low levels, radiation risks are probably well below those due to microbes and some chemicals in drinking-water.

Dr. Richard Osborne Presentation

Becquerels and Sieverts

Becquerel is a measure of the amount of radioactivity (the "activity").

The abbreviation is Bq.
1,000 Bq is a kilobecquerel, written as kBq
1,000,000 Bq is a megabecquerel, written as MBq
1,000,000,000 Bq is a gigabecquerel, written as GBq

S**ievert** is a measure of how much radiation has been effectively absorbed by a person (the "dose")

The abbreviation is Sv.
Because 1 Sv is a large dose, smaller subunits are usually used.
0.001 Sv is a millisievert, written as mSv
0.000001 Sv is a microsievert, written as μSv

Relationship between becquerels and sieverts for tritium

A dose from tritium only happens if tritium is taken into the body
1 megabecquerel (MBq) of tritium as tritiated water taken in by an adult results in 0.02 millisieverts (mSv)
Example: 1 cup of water with 4000 Bq per litre contains 1000 Bq
Drinking the water results in 0.00002 millisieverts

Members of the public receive radation doses from natural background radiation and from medical procedures. The **additional radiation dose** caused by emissions from a facility licensed by the Canadian Nuclear Safety Commission is not allowed to be greater than one millisievert (= 1,000 microsieverts) in any year.

Tritium intake needed to reach this limit is 50 million becquerels (MBq) in a year
Example: 2 litres of water with 70,000 Bq/L every day for a year

Natural background radiation gives a perspective on 1 millisievert in a year (= 1000 microsieverts per year)

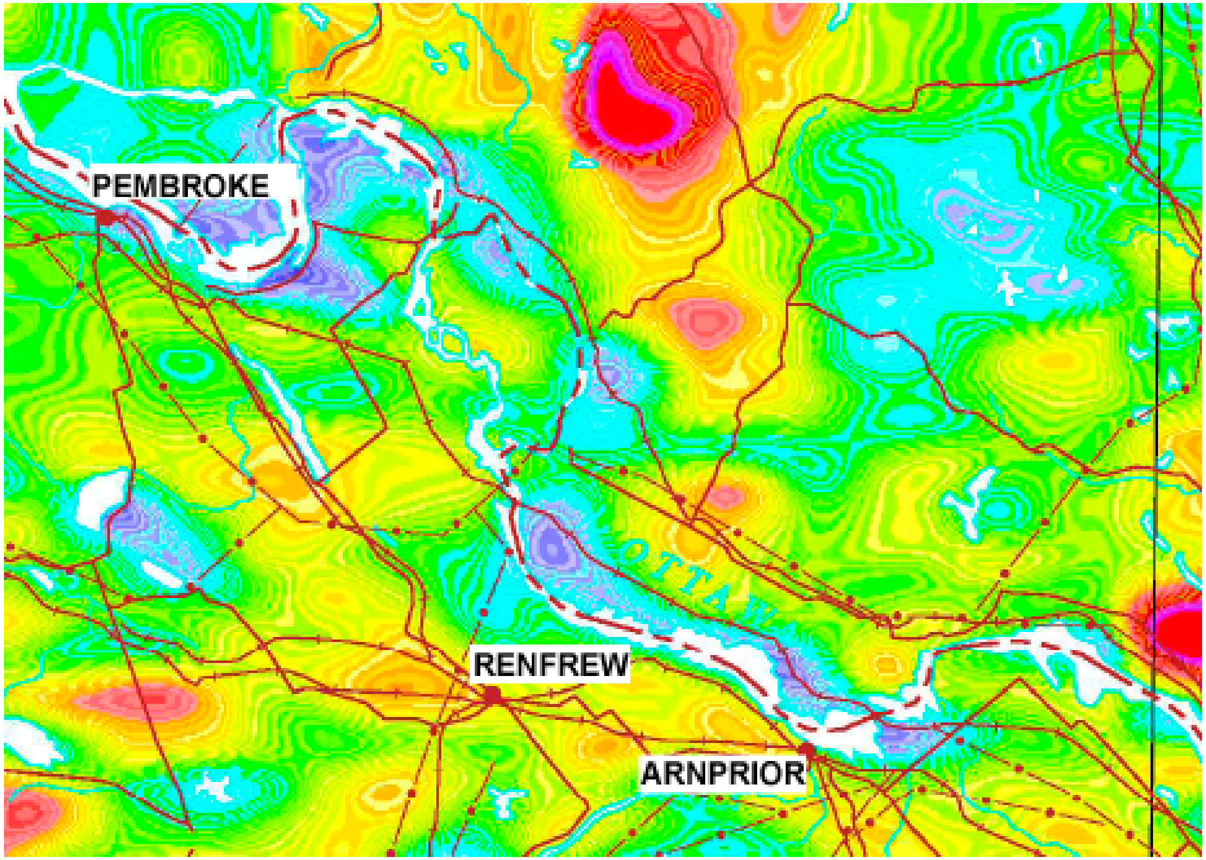
	millisieverts per year	
Cosmic rays	0.4	(0.3–1)
Terrestrial radioactivity	0.5	(0.2–0.6)
Radon	1.2	(0.2–10)
Ingested radionuclides	0.3	(0.2–0.8)
Total natural background	**2.4**	**(1–10)**

Example: Total for people living in: Toronto 1.5 millisieverts per year
Winnipeg 4 millisieverts per year

See map of Renfrew county for local example of terrestrial radioactivity

Richard V. Osborne 2008 March 2

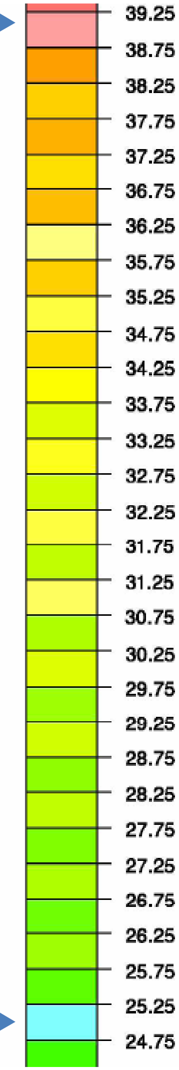
Extract from natural radiation map of Canada and part of radiation scale covering the Pembroke and Renfrew radiation levels



0.34 millisieverts per year

Range 0.12 millisieverts per year

0.22 millisieverts per year



From: Carson JM et al. Airborne Gamma Ray Spectrometry Survey Compilation Series, Ottawa, Ontario-Quebec; Geological Survey of Canada , Open File 4460, 2003

Richard V. Osborne, 2008 March 2

The original scale is in nanogray per hour. Multiplying by 0.00876 gives approximately the dose rate in millisieverts per year