Canada's Nuclear Regulator

CNSC Staff Report on the Performance of Uranium Fuel Cycle and Processing Facilities: 2012




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CNSC Staff Report on the Performance of Uranium Fuel Cycle and Processing Facilities: 2012

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EXECUTIVE SUMMARY

The operating performance of the uranium fuel cycle and processing facilities regulated by the Canadian Nuclear Safety Commission (CNSC) is presented in this Commission member document titled *CNSC Staff Report on the Performance of Uranium Fuel Cycle and Processing Facilities: 2012*. The information covers the 2012 calendar year and, when applicable, shows trends and compares information to previous years.

The operating performance for uranium mines and mills, uranium processing facilities and nuclear substance processing facilities is discussed. The report focuses on the three safety and control areas (SCAs) of radiation protection, environmental protection, and conventional health and safety since these cover the key performance indicators for these facilities. Also highlighted in the report are rating changes for all 14 SCAs, major events, significant facility modifications and areas of increased regulatory focus.

In 2013, the CNSC conducted licence renewal hearings for several uranium mines and mills including Cameco’s Cigar Lake Project (public hearing in April 2013) and Cameco’s Key Lake, Rabbit Lake and McArthur River operations (public hearings in October 2013). At the time of writing this report, the Commission had not yet rendered its decision following the hearings held in La Ronge, Saskatchewan in October 2013. During those hearing, CNSC staff heard recommendations from the Commission for opportunities to further improve and strengthen the CNSC staff report on the performance of uranium mines and mills. While the current report is generally consistent with the report presented in 2012, CNSC staff will re-structure next year’s report to incorporate the Commission’s final recommendations arising from the October hearing.

Evaluations conducted by CNSC staff identified that the uranium fuel cycle and processing facilities in Canada operated safely during 2012. This conclusion was based on assessment of licensee activities which included site inspections, review of reports submitted by licensees, event and incident reviews with follow-up, and general communication and exchange of information with the licensees.

As part of the 2012 report, the Directorate of Nuclear Cycle and Facilities Regulation presents an introductory section on radiation protection. Section 1.3 describes general information and concepts on dose limits to members of the public and workers at uranium mining and processing facilities. The report further describes several measures taken by the CNSC to help protect the public and workers from radiation exposure.

CNSC staff conclude that in 2012 each regulated facility met performance expectations with respect to the health and safety of persons and to the protection of the environment, and to Canada’s international obligations.

CNSC STAFF REPORT ON THE PERFORMANCE OF URANIUM FUEL CYCLE AND PROCESSING FACILITIES: 2012

1 OVERVIEW

1.1 Background

The *CNSC Staff Report on the Performance of Fuel Cycle and Processing Facilities: 2012* summarizes the Canadian Nuclear Safety Commission (CNSC) staff's assessment of the safety performance of:

- uranium mines and mills
- uranium processing facilities
- nuclear substance processing facilities

The assessment aligns with the legal requirements of the *Nuclear Safety and Control Act* (NSCA) and its associated regulations, facility licences, applicable standards and regulatory documents.

The report highlights the areas of the CNSC staff's regulatory focus including information on regulatory requirements and expectations in selected areas, and discusses significant events, licence changes, major developments and overall performance. It provides performance data on the safety and control areas (SCAs) of radiation protection, environmental protection and conventional health and safety.

The report is organized by industry sector, covering uranium mines and mills, uranium processing facilities and nuclear substance processing facilities. The information presented covers the 2012 calendar year and, when applicable, compares information to previous years.

The 2012 report has 10 appendices:

- Appendix A: Safety and Control Area Framework for Uranium Mines and Mills, Uranium Processing Facilities, Tritium Processing Facilities and Nordion
- Appendix B: Rating Methodology and Definitions
- Appendix C: Trend in Safety and Control Area Ratings
- Appendix D: Financial Guarantees
- Appendix E: Worker Dose Data
- Appendix F: Environmental Data
- Appendix G: Environmental Reportable Spills in 2012
- Appendix H: Lost-time Incidents in 2012
- Appendix I: Links to Licensee Web Sites

- Appendix J: Acronyms

1.2 CNSC Regulatory Efforts

As part of its mandate, the CNSC regulates Canada's uranium mines and mills, uranium processing facilities and nuclear substance processing facilities, to protect the health and safety of persons, to protect the environment and to ensure that Canada continues to implement its international obligations on the peaceful use of nuclear energy. The CNSC achieves this mission by ensuring licensee compliance through verification, enforcement and reporting.

CNSC staff establish compliance plans for each facility based on risk-informed regulatory oversight of the facility's activities in order to identify appropriate levels of regulatory monitoring and control. Modifications to the compliance plans are made on an ongoing basis in response to events, facility modifications and changes in licensee performance.

In 2012, CNSC staff efforts continued to focus on the lessons learned from the nuclear accident at TEPCO's Fukushima Daiichi nuclear power plant in Japan. For each of the facilities covered by this report, licensees reviewed existing safety cases and emergency management programs against their ability to withstand extreme external events. CNSC staff reviewed and verified the licensee reports and findings. CNSC staff conclude that the underlying defence-in-depth controls were in place to deal with natural disasters and severe accidents and confirmed that the facilities continue to be operated safely. Licensees continue to make improvements when identified.

CNSC staff previously updated the Commission on CNSC's action plans on Fukushima. These updates were presented in October 2012 and August 2013 as referenced below:

- CMD 12-M56 Status Update on the CNSC Action Plan: Lessons Learned from the Fukushima Accident, October 2012; and
- CMD 13-M34 Status Update on the CNSC Integrated Action Plan: Lessons Learned from the Fukushima Accident, August 2013.

Inspections conducted in 2012 covered various aspects of many SCAs, applying a risk-informed decision process for compliance activities, commensurate with the risk associated with these facilities. The inspections confirmed that:

- radiation protection measures were effective and results remained as low as reasonably achievable (ALARA)
- conventional health and safety programs continued to protect workers
- the environmental protection program was effective and results remained ALARA
- construction activities at the facilities were continuously monitored

CNSC staff also verify compliance through desktop reviews of reports, applications and licensee programs which are supplemented with meetings, presentations, and facility visits.

A CNSC-wide inspector training and qualification program for inspectors, first introduced in 2009, made further advances in 2012. The program standardized the core training courses required for inspectors to ensure uniform and consistent training throughout the CNSC. The Directorate of Nuclear Cycle and Facilities Regulation developed and implemented a "conduct of inspections" procedure for inspectors to maintain a consistent approach. New inspectors are trained through a process of training courses and on-the-job training.

1.3 Understanding Radiation Protection

As Canada's nuclear regulator, the CNSC establishes and enforces strict radiation protection requirements. These rules, which include dose limits, protect workers at nuclear facilities and members of the public. All Canadian nuclear facilities must comply with these requirements, which are formally stated in the *Radiation Protection Regulations* made under the NSCA.

Under the *Radiation Protection Regulations*, CNSC-licensed uranium mining and processing facilities must take measures to limit radiation doses and report performance regularly to the CNSC. These reports show that radiation doses remain well below regulatory limits assuring workers and the public are safe.

Radiation comes from natural and man-made sources

Radiation is energy in motion, in the form of waves or streams of particles, and is around us all the time. In general, about 60% of radiation exposure in Canada comes from natural background sources (such as the sun and some elements such as uranium or radium) and the remaining 40% comes from man-made sources like x-rays and other medical treatments.

In Canada, the average individual effective dose from natural background radiation is approximately 1.8 mSv per year. Exposure to high levels of radiation (i.e., above 100 mSv) can affect health or cause diseases which is why the CNSC has established dose limits that control radiation exposure for workers and the public.

> Dose is a general term that refers to the amount of energy absorbed by tissue from ionizing radiation. The dose is measured in sieverts (Sv) and is more commonly expressed in units of millisieverts (mSv), which represents a thousandth of a sievert.

How the CNSC protects workers and the public?

The CNSC takes several measures to help protect people from radiation exposure. These include:

- **A strict licensing process:** No nuclear facility in Canada can operate without a CNSC licence, which has a wide range of conditions to protect workers and the public. The CNSC evaluates all licence applications to ensure that safety measures are technically and scientifically sound, that legal requirements are met, and that appropriate safety systems are in place.

- **Mandatory radiation protection programs:** Licensees must design and implement radiation protection programs to keep radiation doses as low as reasonably achievable (ALARA). The CNSC will only approve radiation programs that meet regulatory requirements including radiation protection training and effective controls.
- **Regular reviews of licensee performance:** The CNSC reviews the SCA of radiation protection on an ongoing basis.

  CNSC inspectors visit facilities to perform both planned and unannounced inspections that include a radiation protection component. CNSC staff review and analyze radiation protection information from monthly, quarterly and annual reports that licensees must submit in accordance with licence conditions and regulatory requirements. Based on these reviews, CNSC staff will take actions as required to ensure that licensees conduct their operations safely with adequate protection of workers, the public and the environment.

  When non-compliance with the *Radiation Protection Regulation* or their approved radiation protection program is found, CNSC staff will require the licensee to take corrective actions and measures to prevent a reoccurrence. For more serious non-compliances, the CNSC may also restrict activities, revoke the licence or recommend criminal prosecution.

How radiation doses are measured?

Measuring or estimating radiation doses, then assigning those doses to individuals, is called “dosimetry”. Dosimetry involves various methods of measuring and calculating doses to workers and to the public. The sievert (Sv) is the unit of dose for measuring the “equivalent dose” and “effective dose”. Multiples of sievert used include millisievert (mSv) and microsievert (μSv). The mSv is the most commonly used measurement in Canada.

Measuring doses to the public

A public radiation dose limit of 1 mSv per year has been set to ensure protection of public health. This dose is over and above what someone may get from natural background radiation. Radiation exposure to the public is estimated by measuring the amount of nuclear substances released to the environment from a source (such as an exhaust stack) or by measuring the presence of nuclear substances in the environment. Relevant site-specific data, such as the amount of nuclear substances in local air, water or produce, are monitored and analyzed by CNSC staff and provincial agencies where applicable. The activities and dietary habits of people near CNSC-licensed facilities are also incorporated. All of these factors are combined to provide an estimate of the maximum possible total dose to members of the public.

Measuring nuclear energy worker doses

The effective dose limits for a nuclear energy worker is set at 50 mSv in any one year and 100 mSv in five consecutive years. Workers in the nuclear industry wear radiation detectors (called dosimeters) to measure external radiation exposure and limit the possibility of overexposure.

Internal exposures are monitored through direct measurement of airborne radioactive substances, as well as measurements of nuclear substances in the body and excreted by the body (i.e., urine samples) or a combination of all of these.

By analyzing this data along with other known information, such as how long workers spend in certain areas and the air-borne concentrations of radionuclides, radiation doses to workers can be estimated.

What if a worker dose is elevated?

In spite of the many strict controls on radiation exposure, a worker may accidentally receive a greater than anticipated dose. This may be a signal of a potential loss of control of a portion of the radiation protection program. Should this happen, the licensee reviews the worker's dose and the controls in place, and takes corrective measures if required. CNSC staff ensure that the licensee investigates overexposures and have processes to verify that the measures put in place are effective to prevent a similar occurrence.

CNSC licensees respect dose limits

The Canadian radiation dose limits are conservative and well below levels at which health effects would be expected. Through strong regulatory oversight and well established radiation protection programs, Canadian nuclear facilities are continuously below their dose limits year after year.

Reviews by CNSC staff of licensees reports and monitoring data demonstrated that in 2012 the annual effective radiation doses to the public from uranium fuel cycle and processing facilities range from 0 to 0.031 mSv, while for workers, the doses range from 0 to 14.1 mSv. These figures provide full confidence that the Canadian nuclear facilities are safe, and that the CNSC is effectively enforcing its requirements for the lowest radiation exposure achievable.

Protecting the health of communities near CNSC-licensed facilities is paramount – the CNSC will never compromise safety

The average annual effective radiation doses to the public from uranium fuel cycle and processing facilities continues to be well below the regulatory limits. Moreover, the CNSC has conducted several evidence-based health studies that have shown time and time again that residents residing near CNSC-licensed facilities are protected from radiation.

1.4 Public Information and Disclosure Program

Part of CNSC's mandate is to provide objective scientific and regulatory information to the public concerning nuclear activities. Licensees have an important role to inform the public about their nuclear facility and activities. Pictures of licensee-sponsored community activities are shown in figures 1-1 and 1-2. To ensure licensees provide open and transparent information to the public, the CNSC published in 2012, new regulatory requirements in RD/GD-99.3 *Public Information and Disclosure*.

Figure 1-1: An AREVA employee talks to local youth during its annual Saskatchewan northern tour of communities – Source: AREVA

Figure 1-2: Cameco staff offers science demonstrations and information at the Fall Fair in Port Hope, Ontario – Source: Cameco

These regulatory requirements include:

- identification of clear and measurable objectives
- identification of target audiences
- tracking of public comments and concerns related to licensee activities
- development of strategies for open and transparent communication of information
- establishment and implementation of rules for public disclosure of information
- review and evaluation of the public information and disclosure program for effectiveness and the identification of improvements
- documentation of records to demonstrate that public information and disclosure requirements are met

An important new requirement introduced through RD/GD-99.3 *Public Information and Disclosure* is for licensees to establish public disclosure protocols to ensure timely information is provided for activities and non-routine events. CNSC staff concluded licensees made satisfactory progress in 2012 in transitioning to the requirements of RD/GD-99.3 *Public Information and Disclosure* in effectively communicating information to the public on the health and safety and security of Canadians and for the protection of the environment. CNSC staff will continue to oversee the transition of RD/GD-99.3 with emphasis on licensee performance.

PART I: URANIUM MINES AND MILLS

2 OVERVIEW

Part I of this report focuses on the uranium mine and mill facilities currently operating in Canada. Although the Cigar Lake Project is not yet in mining operations, the facility is included because construction of the underground mine is near completion, with initial production targeted for 2013. The uranium mine and mill facilities discussed in this report are located within the Athabasca Basin of northern Saskatchewan. They are:

- Cameco Corporation (Cameco): Cigar Lake Project
- Cameco Corporation (Cameco): McArthur River Operation
- Cameco Corporation (Cameco): Rabbit Lake Operation
- Cameco Corporation (Cameco): Key Lake Operation
- AREVA Resources Canada Inc. (AREVA): McClean Lake Operation

The locations of the uranium mine and mill facilities are shown in figure 2-1 below:

Figure 2-1: Location of uranium mines and mills in Saskatchewan

In 2012, CNSC staff performed a total of 23 planned inspections at all of the uranium mines and mills. Other regulatory bodies, including Saskatchewan's Ministry of Environment, Saskatchewan's Ministry of Labour Relations and Workplace Safety and Environment Canada, also conducted inspections at these facilities. CNSC staff consider the findings from other regulatory bodies when assessing the licensees' performance.

In the management of these facilities, the licensees are responsible for the health and safety of all workers on site. Table 2-1 shows the total number of nuclear energy workers (NEWs) monitored at each of the five operating mines for 2012. An individual worker who is required to work with a nuclear substance or in a nuclear industry is designated as a NEW because there is a reasonable probability of receiving an individual effective dose greater than the prescribed limit of 1 mSv for the general public. At uranium mine and mill facilities, persons designated as NEWs are issued optically-stimulated luminescence dosimeters (OSLD) to directly monitor gamma radiation dose (figure 2-2). The effective dose limit for a NEW is 50 mSv in a one-year dosimetry period and 100 mSv in a five-year period. Appendix E shows the average and maximum individual effective dose for each operating facility during the 2008-2012 period. No radiation dose at any operating uranium mine or mill exceeded a regulatory effective dose limit.

Figure 2-2: An optically-stimulated luminescence dosimeter – Source: Cameco

Table 2-1: Total Number of NEWs at each of the five operating facilities, 2012

	2012 Year				
	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClean Lake
Total NEWs	2,420	1,276	1,257	1,345	174

Appendix A describes the 14 SCAs that the CNSC applies in regulatory evaluations of each facility. The licensee's requirements to satisfy each SCA generally depend on facility-specific activities and the risk that the activities comprise.

The 2012 SCA performance ratings for the uranium mines and mills facilities are also presented in table 2-2. In 2012, all SCAs were rated as "satisfactory" (SA) except for the conventional health and safety SCA for Cigar Lake Project which was rated as "fully satisfactory" (FS). A discussion of rating methodologies and definitions can be found in appendix B. Appendix C contains the SCA performance ratings for each facility from 2008 to 2012.

Table 2-2: Uranium mines and mills – SCA performance ratings, 2012

Safety and control area	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClean Lake
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	FS	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

The 2012 uranium production data for the mine and mill facilities is provided in table 2-3 to provide a sense of the relative magnitude of mining and milling activities. The table shows that Cigar Lake had no mining operations (under construction) and that McClean Lake was under temporary shutdown for both mining and milling during 2012. The upper half of table 2-3 shows the mining production data for the two operating mines at Rabbit Lake and McArthur River. The bottom half of table 2-3 displays the milling production data for the two operating mills at Rabbit Lake and Key Lake. The production differences between the two mills is primarily due to the difference in mill feed grade (Key Lake at 4.61% vs Rabbit Lake at 0.71%). CNSC staff verified that production at each facility remained within licence limits. In addition, production limits may be reviewed and revised subject to regulatory reviews and approvals including licence amendments, as appropriate.

Table 2-3: Uranium mines and mills – 2012 production data

2012 Production data	Cigar Lake*	McArthur River	Rabbit Lake	Key Lake	McClean Lake**
Mining – ore tonnage (tonnes/year)	No mining	115,107	225,282	No mining	1,022
Mining – average ore grade mined (% U expressed as U_3O_8)	Not applicable	7.78%	0.84%	No mining	4.76%
Mining – U mined [expressed as U_3O_8 (kg)]	Not applicable	8,958,578	1,903,519	No mining	48,653
Mining - Licence production limit [expressed as U_3O_8 (kg)]	Not applicable	9,551,887	Not applicable	Not applicable	Not applicable
Milling – mill ore feed (tonnes/year)	No milling	No milling	260,299	193,511	0
Milling – average mill feed grade (%U expressed as U_3O_8)	Not applicable	Not applicable	0.71%	4.61%	Not applicable
Milling – mill recovery (% of U)	Not applicable	Not applicable	96.8%	98.9%	Not applicable
Milling – U concentrate produced (kg U_3O_8)	Not applicable	Not applicable	1,743,702	8,867,584	0
Milling – Licence production limit [expressed as U_3O_8 (kg)]	Not applicable	Not applicable	7,665,094	9,257,075	5,909,090

* Cigar Lake mine under construction in 2012.

** The last ore from the Sue E pit was mined on March 15, 2008 and the Sue B pit's last ore was mined on November 26, 2008. Mined production since then is from the SABRE Project.

Uranium mine and mill facilities are required to develop decommissioning plans which are reviewed and approved by CNSC staff. Each plan is accompanied by a financial guarantee that provides the funding necessary to complete the decommissioning work. The decommissioning plan and financial guarantee for each facility is updated when their CNSC licence is renewed and/or every five years as required by both the CNSC and the Saskatchewan Ministry of Environment. The decommissioning financial guarantee for each facility is provided through letters of credit that are held in trust by the Province of Saskatchewan. Appendix D lists the 2012 financial guarantees for the mine and mill facilities. They range from C$27.7 million at Cigar Lake to C$120.7 million at Key Lake, with a total of C$332.77 million for the five facilities.

A continued focus area for CNSC staff in 2012 consisted of the lessons learned from the nuclear accident at TEPCO’s Fukushima Daiichi nuclear power plant in Japan. For the facilities covered by this report, licensees reviewed existing safety cases and emergency management programs against the ability to withstand extreme external events.

In follow-up to Fukushima, Cameco conducted formal reviews of their emergency preparedness and response plans at their northern Saskatchewan facilities. In particular, site capabilities to deal with multiple natural disaster scenarios, such as a forest fire and power outage, were evaluated. These exercises confirmed the appropriateness of the programs to protect the health and safety of people and the environment during potential natural disaster situations.

In follow-up to Fukushima, AREVA conducted a multi-incident mock scenario which included power loss to evaluate the effectiveness of their emergency response. Corrective actions as a result of the exercise included identification of ways to summon the emergency response team without the use of radios, computers or a paging system. This exercise confirmed the appropriateness of the programs to protect the health and safety of people and the environment during a potential power loss scenario.

CNSC staff reviewed and verified the licensee reports and findings. The reviews determined that the underlying defence-in-depth controls were in place to deal with natural disasters and severe accidents. The reviews confirmed the facilities are safe; however, licensees make improvements, when identified, on a continual basis.

2.1 Radiation Protection

For 2012, CNSC staff rated the radiation protection SCA at all five uranium mines and mills as “satisfactory”. Uranium mines and mills in Canada are required to implement and maintain a comprehensive radiation protection program in accordance with section 4 of the CNSC’s *Radiation Protection Regulations*.

Primary sources of radiation exposure at uranium mines and mills include:

- gamma radiation
- long-lived radioactive dust
- radon progeny
- radon gas

Activities that CNSC staff conduct to ensure compliance with radiation protection included regular inspections of the uranium mines and mills, and reviews of radiation protection programs, compliance reports, monitoring data and radiation dose statistics.

To monitor radiation exposure, workers are issued optically-stimulated luminescence dosimeters that measure external gamma radiation dose and, when working underground, personal alpha dosimeters to measure radon progeny and long-lived radioactive dust. Where direct monitoring through dosimeters is not practical, area/group monitoring and time cards are used for worker dose estimates.

Workers at facilities are subject to regulatory dose limits of 50 mSv individual effective dose in a one-year dosimetry period, and 100 mSv effective dose in a five-year dosimetry period. In addition, radiation action levels have been developed and, if exceeded, signify a potential loss of control of a portion of the radiation protection program. All five of the uranium mine and mill facilities have the same action levels of 1 mSv/week and 5 mSv/quarter of a year.

The uranium mines and mills operations have continued to maintain and implement comprehensive radiation protection programs at their facilities that are based on the ALARA principle (As Low As Reasonably Achievable). As part of the ALARA program, facilities set objectives to keep doses well below the regulatory limits.

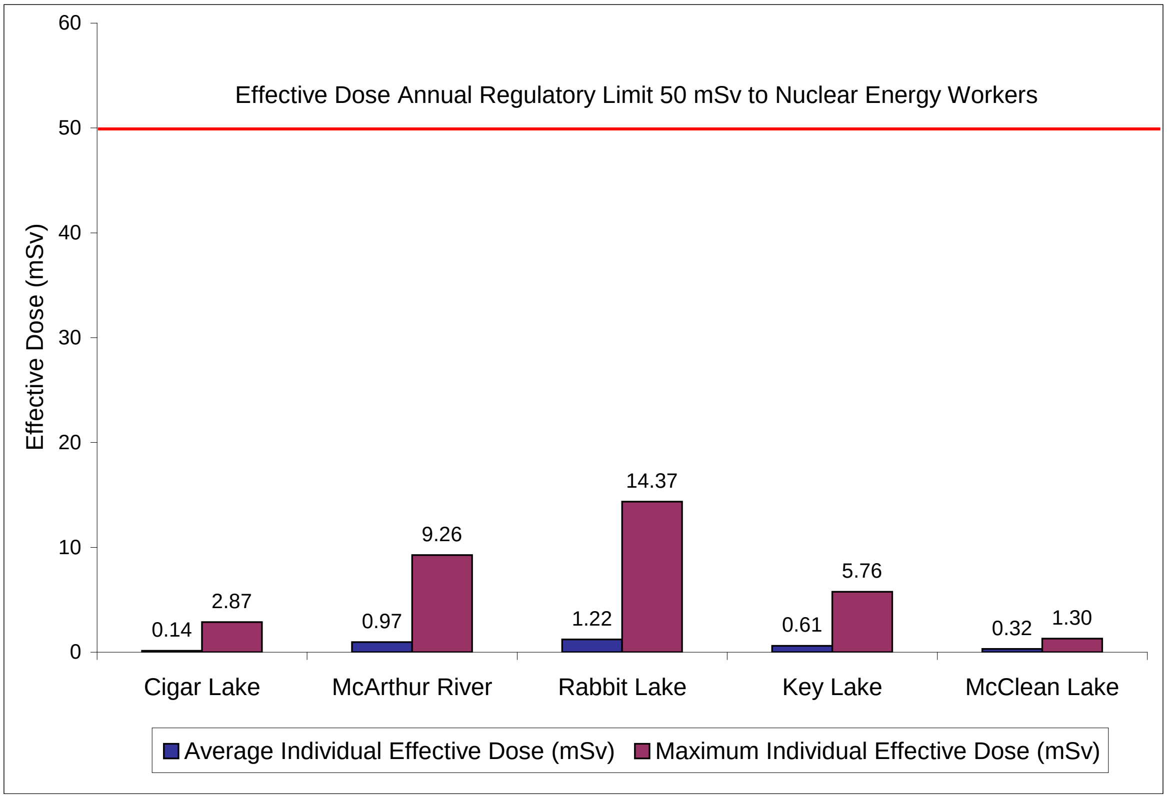
Uranium mines and mills operations are remote from local populations. Radiological exposures measured at the licensed facilities are maintained near background radiation levels.

In 2012, no worker at any uranium mine or mill facility exceeded the regulatory effective dose limits.

2.1.1 Radiation Doses

Figure 2-3 compares the average individual effective dose and maximum individual effective dose at each uranium mine and mill during the 2012 reporting period. The annual worker effective dose statistics are further detailed in appendix E.

Figure 2-3: Uranium mines and mills – comparisons of individual average and maximum effective dose to NEWs, 2012



There were no exceedances of the 50 mSv/yr regulatory limit for NEWs at any of the uranium mine and mill facilities in 2012. The maximum individual exposure at any uranium mine and mill facility in 2012 was 14.37 mSv. The Rabbit Lake and McArthur River facilities had the highest average and maximum individual effective dose exposures, as underground mining work activities are conducted closer to the radioactive source than occurs in milling operations. The Rabbit Lake and McArthur River Operations recorded average individual effective dose exposures of 1.22 and 0.97 mSv, respectively, and maximum individual effective dose exposures of 14.37 and 9.26 mSv, respectively. The Rabbit Lake Operation includes both a mine and a mill, so the average individual effective dose shown in figure 2-3 includes both mine and mill workers. The maximum mill worker effective dose in 2012 was 3.84 mSv and for an underground miner it was 14.37 mSv at the Rabbit Lake Operation.

The Key Lake and McClean Lake facilities are mills with no currently active mining operations. The Key Lake Operation had an average individual effective dose of 0.61 mSv and a maximum individual effective dose of 5.76 mSv. The McClean Lake Operation remained in a state of temporary shutdown in 2012, resulting in reduced average and maximum worker exposures. The Cigar Lake Project continued construction activities in 2012 and, therefore, worker exposures were also very low, with an average worker effective dose of 0.14 mSv. The maximum individual effective dose for a full-time worker at Cigar Lake was 2.87 mSv.

Based on the outcome of inspections, and reviews of the radiation protection program, work practices, monitoring results and effective doses, CNSC staff were satisfied that uranium mine and mill licensees are adequately controlling radiation doses to levels well below the regulatory limits, keeping doses ALARA.

2.2 Environmental Protection

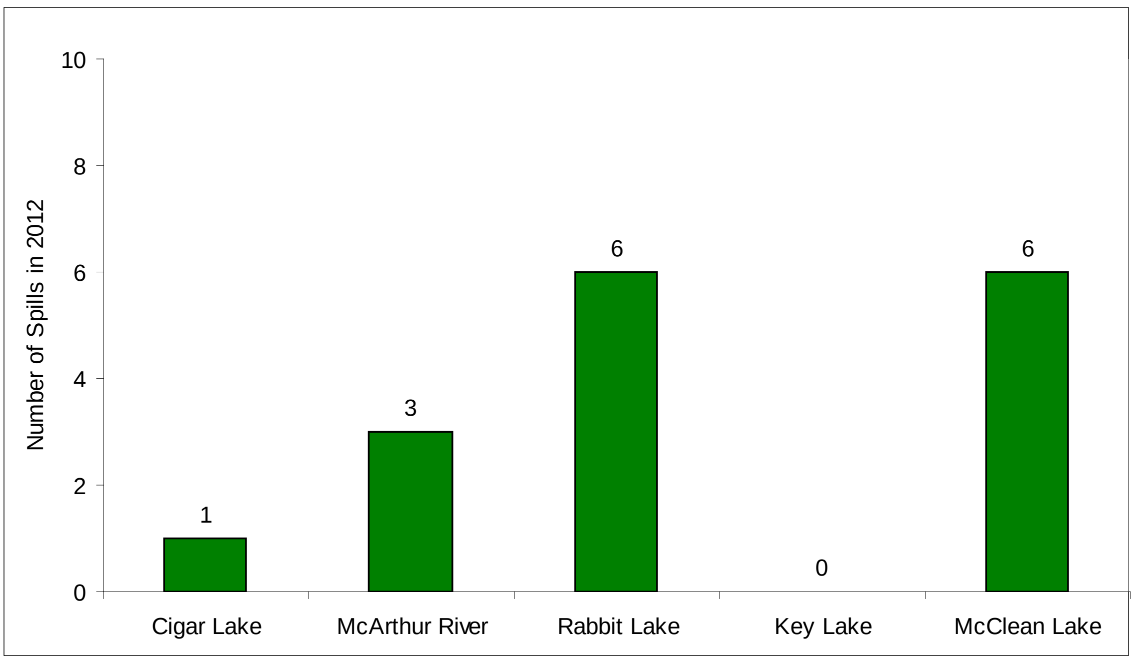
For 2012, CNSC staff rated the performance of all five uranium mine and mill facilities for the environmental protection SCA as “satisfactory”.

The environmental protection SCA covers programs that identify and monitor all releases of radioactive and hazardous substances and their effects on the environment resulting from licensed activities. Licensees are required to develop and implement policies, programs and procedures to comply with all applicable federal and provincial regulatory requirements, in order to control the release of radioactive and hazardous substances into the environment. Licensees are also expected to have suitably trained and qualified staff to effectively develop, implement and maintain their environmental protection programs. These programs include environmental codes of practice that set out licensee administrative levels and action levels for effluent released to the environment.

Licensees are required to report to the CNSC any unauthorized release of hazardous or radioactive material to the environment. CNSC staff verified and are satisfied that reporting, communication and response to environmental spills and other environmental incidents by licensees was in conformance with regulatory requirements during 2012.

Figure 2-4 depicts the number of environmental reportable spills for the uranium mine and mill facilities in 2012. The reported spills were remediated resulting in negligible risk to personnel, the public or the environment. As a result of activity undertaken by Cameco to increase awareness, Key Lake showed a significant change by having no reportable spills in 2012 as compared to nine in 2011.

Figure 2-4: Uranium mines and mills – environmental reportable spills, 2012



Appendix G further describes each reportable spill and the corrective action taken by the licensee in response to the spill. The spills were of low significance with no residual impact to the environment. The licensee investigates the causes of spills and implements corrective actions to remediate and prevent a recurrence. CNSC staff review licensee actions to ensure effective remediation and prevention.

In 2012, all treated effluents released to the environment from licensed mining and milling activities met effluent discharge limits stipulated in the CNSC operating licences. Effluent discharge is also subject to regular toxicity testing and measured against the administrative levels and action levels specified in each licensee environmental code of practice. Exceedance of an administrative level may indicate a processing problem, and triggers an internal investigation by the licensee. Exceedance of an action level indicates a potential loss of control which triggers actions that must be taken by the licensee to correct the problem. An action level thus provides an early warning to prevent exceedance of a regulatory discharge limit. Facility administrative and/or action levels are determined through the identification and proper operation of available treatment technologies, as well as facility-specific environmental risk analyses. During 2012, no effluents released to the environment from the mine and mill facilities exceeded their action levels.

Risk assessments prior to 2009 conducted on uranium mine and mill facilities by the CNSC and the licensees identified releases of molybdenum, selenium and uranium as constituents of potential concern. As a result, licensees were required to improve engineering controls and treatment technologies to reduce effluent releases of these contaminants. Technologies put in place continue to effectively keep these contaminants stable and at acceptable levels in 2012.

Treated effluent monitoring data provides an overview of the quality of the effluent released from these facilities. Figures 2-5 to 2-8 display the 2012 average annual effluent concentrations for radium-226, molybdenum, selenium and uranium at the five mine and mill facilities. Table 2-4 displays the 2012 annual average parameter concentration values in effluent released to the environment of arsenic, copper, lead, nickel, zinc, total suspended solids (TSS) and pH.

The 2012 radium-226 annual average effluent concentrations for the five facilities was well below the CNSC's licence-authorized effluent discharge limit as shown in figure 2-5.

In the absence of a federal or Province of Saskatchewan limit for molybdenum, the CNSC requires licensees to develop facility-specific effluent controls within their individual environmental codes of practice. For molybdenum effluent concentrations (figure 2-6), the approved Cigar Lake code of practice action level is shown for reference only.

Figure 2-5: Annual average concentration of radium-226 in effluent released to the environment, 2012

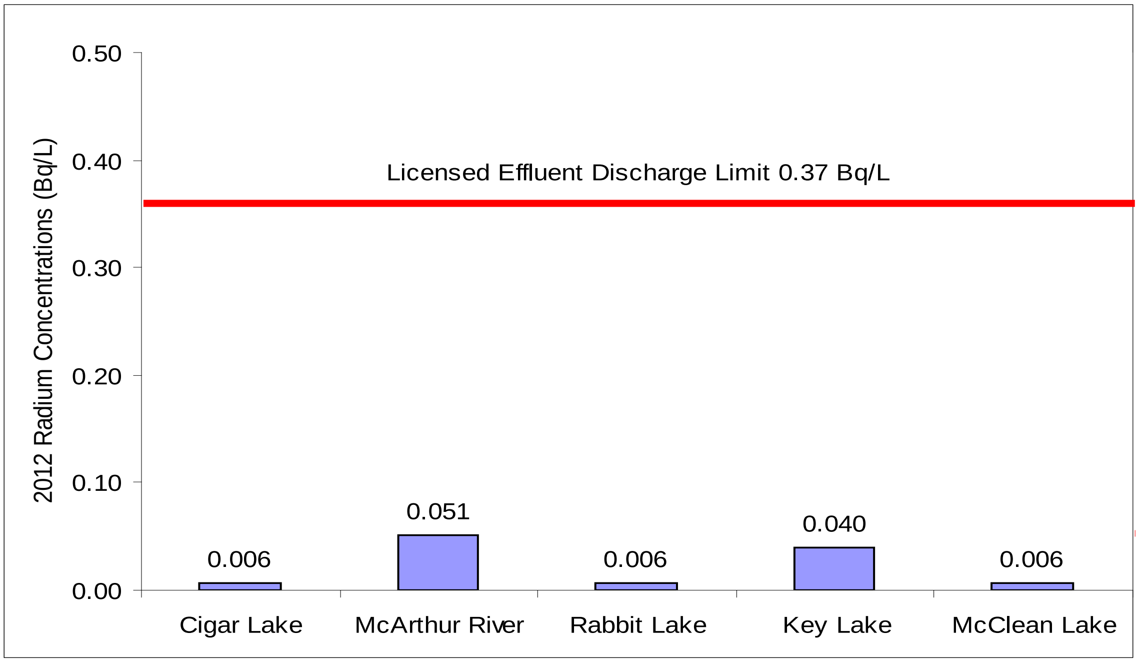
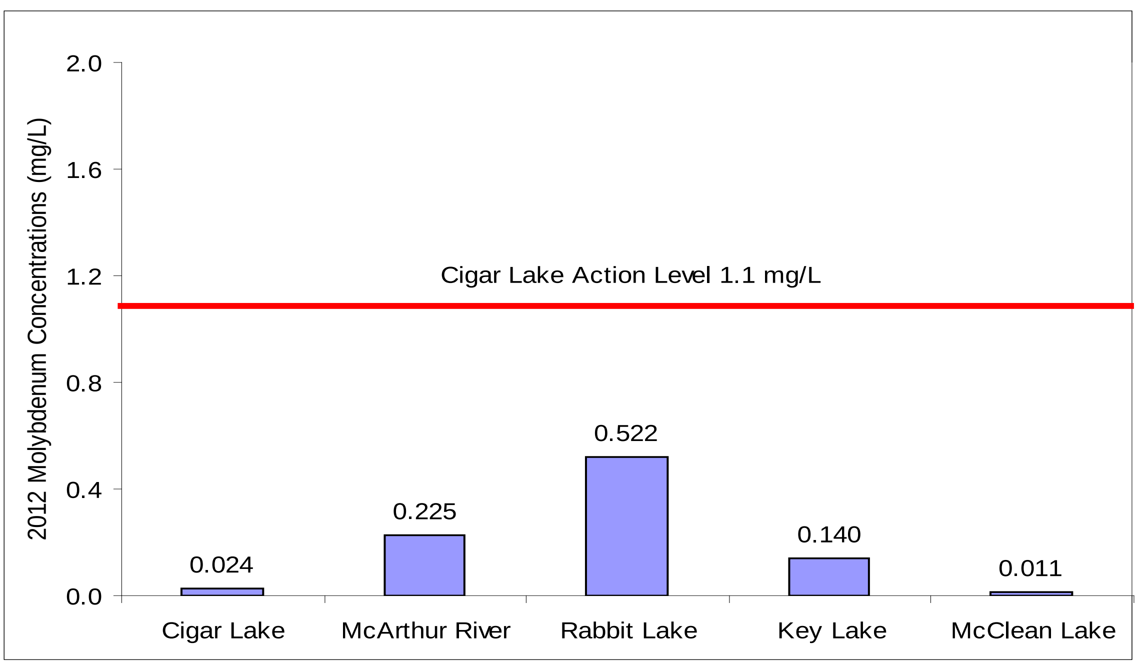


Figure 2-6: Annual average concentration of molybdenum in effluent released to the environment, 2012 (the Cigar Lake action level for molybdenum is shown for reference only)



The Province of Saskatchewan's licensed effluent discharge limits for selenium and uranium are shown on figures 2-7 and 2-8 for reference only as no federal limits are established at this time. Nevertheless, the CNSC expects performance well below these limits and require licensees to continually try to reduce effluent contaminant concentrations to be as low as reasonably achievable (ALARA). Figures 2-7 and 2-8 demonstrate that both selenium and uranium concentrations in treated effluent released to the environment have remained well below the provincial licence limits. Details on effluent release concentrations at each facility are discussed in the facility-specific sections of the report.

Figure 2-7: Annual average concentration of selenium in effluent released to the environment, 2012 (the Province of Saskatchewan's licensed effluent discharge limit for selenium is shown for reference only)

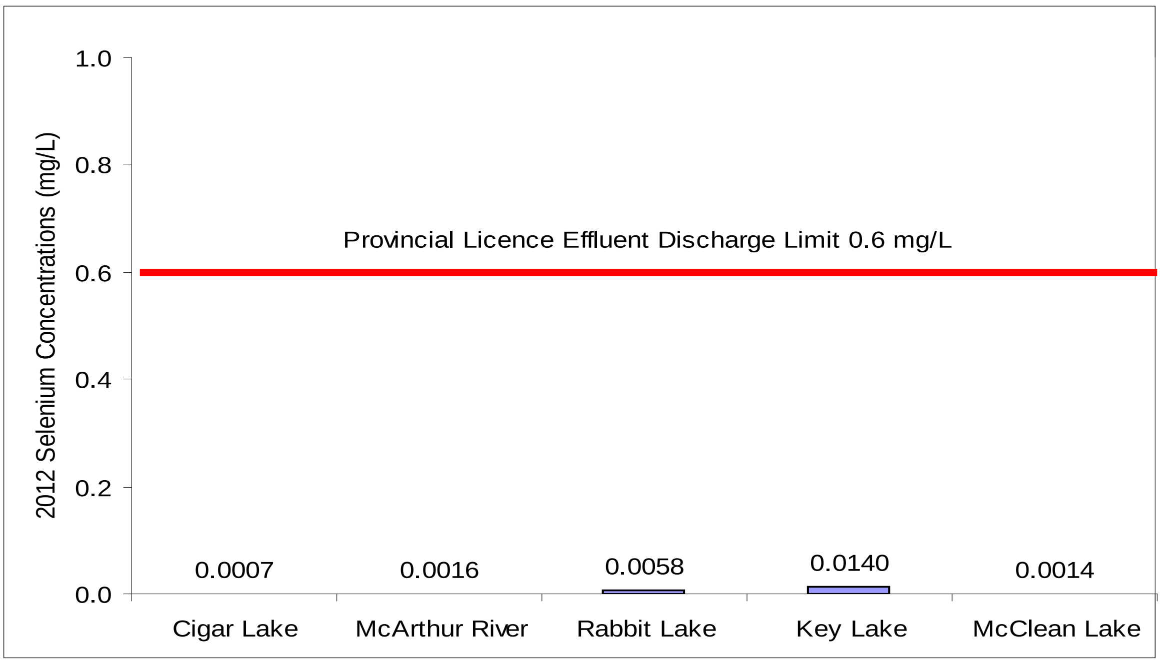
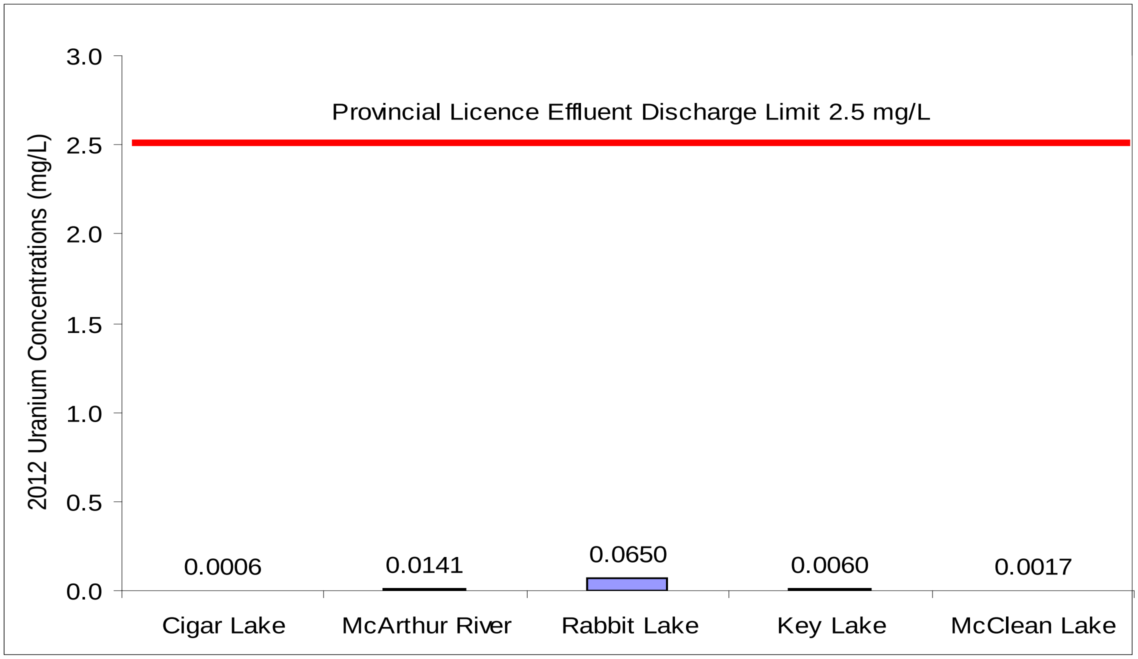


Figure 2-8: Annual average concentration of uranium in effluent released to the environment, 2012 (the Province of Saskatchewan's licensed effluent discharge limit for uranium is shown for reference only)



In addition to concentration results of molybdenum, selenium, uranium and radium-226 in treated effluent released to the environment, the facilities also analyze treated effluent released to the environment for arsenic, copper, lead, nickel, zinc, total suspended solids (TSS), and pH. Table 2-4 displays the licensed discharge limits and the annual average parameter concentration values in effluent released in 2012 for these additional parameters. The annual average parameter concentration values in effluent released to the environment are shown to be well below the licensed discharge limits.

Table 2-4: Annual average parameter concentration values in effluent released to the environment in 2012

Parameters	Licensed Discharge Limits	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClean Lake
Arsenic (mg/L)*	0.5	0.0007	0.0018	0.0037	0.0080	0.0019
Copper (mg/L)	0.3	0.0018	0.0013	0.0035	0.008	0.0013
Lead (mg/L)	0.2	0.0001	0.0001	0.0001	0.010	0.0001
Nickel (mg/L)	0.5	0.0038	0.0011	0.0069	0.053	0.032
Zinc (mg/L)	0.5	0.0125	0.0013	0.0020	0.008	0.0012
TSS	15	1.3	1.0	2.0	2.4	1.0
pH	6.0-9.5	7.2	7.2	7.2	6.3	7.2

* mg/L – milligram per litre

CNSC staff review the licensees' environmental monitoring results submitted to the CNSC in monthly, quarterly and annual reports. In addition, each licensee submits a *Status of the Environment Report* every five years providing CNSC staff with more detailed monitoring information with comparisons to environmental assessment predictions.

2.2.1 Treated Mining/Milling Effluent: A Comparison of the Uranium Mining Sector with other Mining Sectors Across Canada

The uranium mines and mills facilities' effluent quality compare favorably to the other mining sectors of base metal, precious metal and iron metal mines as shown within the following comparisons.

Basis for Comparison

All metal mines and mills in Canada are subject to the *Metal Mining Effluent Regulations* (MMER) of the federal *Fisheries Act*. The CNSC incorporates in each uranium mine and mill licence, the effluent limit requirements of the MMER. Compliance with the MMER limits is a good environmental performance indicator across the metal mining industry. Although this report summarizes performance for 2012, MMER data from 2011 are used for comparison, as this is the most current sector-specific MMER information available. Effluent quality data for uranium mines and mills are compared to base metal, precious metal and iron mines.

The MMER specifies the maximum concentration limits in effluent for arsenic, copper, lead, nickel, zinc, radium-226, TSS and an allowable pH range. Effluents must also be non-toxic and pass the trout acute-lethality test.

The *Summary Review of Performance of Metal Mines Subject to the Metal Mining Effluent Regulations*, a report published annually by Environment Canada, provided the data used in this analysis. The mines reporting under the MMER are grouped into four metal mining sectors based on the primary metal produced. The metal mining sectors are:

- uranium – 5 mines
- base metals (such as copper, nickel, molybdenum or zinc) – 48 mines
- precious metals (such as gold or silver) – 53 mines
- iron – 6 mines

Performance Indicators

The environmental performances of the four metal mining sectors are compared using the following performance indicators:

1. compliance with the effluent concentration and pH limits at all times
2. average concentrations of contaminants in the metal sector effluent
3. toxicity test results

Performance Data and Results

1. Compliance with the effluent concentration limits and pH at all times

For this comparison, a mine is "in compliance" if, at all times, it adheres to all regulated parameters (excluding toxicity tests).

The following table 2-5 presents the compliance data with the effluent limits for the most recent five years, 2007 to 2011. The uranium sector maintained 100 percent compliance with the effluent contaminant concentrations and pH limits. The performance of the uranium sector relative to the other metal mining sectors over the last five years is presented below.

Table 2-5: Percentage of mines in compliance with MMER by sector, 2007–2011

Mining sector	Year				
	2007	2008	2009	2010	2011
Uranium	100%	100%	100%	100%	100%
Base metal	67%	60%	58%	65%	65%
Precious metal	74%	80%	79%	87%	70%
Iron	50%	67%	50%	20%	33%
All metal mines	71%	71%	69%	75%	67%

2. Annual average effluent concentrations in the metal mine sectors

Table 2-6 presents the 2011 annual average effluent concentrations for parameters in comparison of the metal mine sectors. The *Metal Mine Effluent Regulations* (MMER) regulatory limits are also provided. CNSC staff note that uranium mine and mill operations have the same concentration for radium-226 as the base metal sector. CNSC staff also note that for the other effluent parameters, concentrations are comparable to or lower than the other metal mining sectors.

Table 2-6: A sector comparison of average effluent parameter concentrations, 2011

Parameters		MMER limit	Uranium	Base metals	Precious metals	Iron
Arsenic (mg/L)		0.5	0.004	0.003	0.033	0.001
Copper (mg/L)		0.3	0.002	0.014	0.025	0.002
Lead (mg/L)		0.2	0.0003	0.0060	0.0010	0.0006
Nickel (mg/L)		0.5	0.027	0.069	0.016	0.004
Zinc (mg/L)		0.5	0.006	0.036	0.012	0.008
TSS (mg/L)		15	1.3	3.2	7.2	12.6
Radium-226 (Bq/L)*		0.37	0.02	0.02	0.01	0.01
pH low		≥6.0	6.9	7.6	7.5	7.1
pH high		≤9.5	7.2	8.0	7.8	7.6
Rainbow trout acute lethality test	Pass		31	431	333	99
	Fail		0	15	6	2

* Bq/L – Becquerel per litre

3. Toxicity test results

Effluent toxicity is measured by using the acute-lethality test. Rainbow trout are used to routinely assess the toxicity of an effluent.

The rainbow trout acute-lethality test has become the world standard toxicity test for fresh-water cool-climate conditions. It has been part of Canadian regulations and guidelines for three decades. In this test, rainbow trout fingerlings or swim-up fry (0.3 to 2.5 g wet weight) are reared under controlled conditions. They are then placed in undiluted effluent for 96 hours (four days). If more than half of the fish die, the effluent is deemed acutely lethal. Effluent must be non-acutely lethal (i.e., pass the test) as a requirement of the MMER.

A mine is considered compliant if, throughout the year, the effluent passed all trout acute-lethality tests. All uranium mine and mill facilities were well below the authorized effluent discharge limits and met acute-lethality requirements from 2007 to 2011 with one exception. In 2008, one of the five uranium mine and mill facilities did not pass all trout acute-lethality tests, resulting in an 80 percent rating for the uranium mines sector as shown in table 2-7.

The Key Lake Operation had two trout acute-lethality tests fail in 2008 out of 14 tests completed. In the first instance, two containers of the same treated effluent were sent for testing with one container arriving one day later in a damaged condition with only 40% remaining in the container. The damaged container of effluent should not have been used because the sample had been compromised. However, it was used in the trout acute-lethality test, which failed. Chemical analysis showed that all parameters measured were within normal range. All follow-up trout acute-lethality testing on treated effluent samples passed. CNSC staff attribute the acute-lethality test failure to a transportation and laboratory protocol error and was not representative of effluent quality.

In the second instance, two containers of the same treated effluent were sent for trout acute-lethality testing. One container passed the test and one failed. Chemical analysis showed that all parameters measured were within the normal range. Follow-up tests and investigation by the Key Lake Operation were extensive but no cause for the trout acute-lethality failure could be ascertained.

CNSC staff were satisfied with the investigations and the follow-up actions taken. Since 2008, CNSC staff have continued to closely monitor the results and all acute-lethality tests have passed. Table 2-7 summarizes the performance of the metal mining sectors.

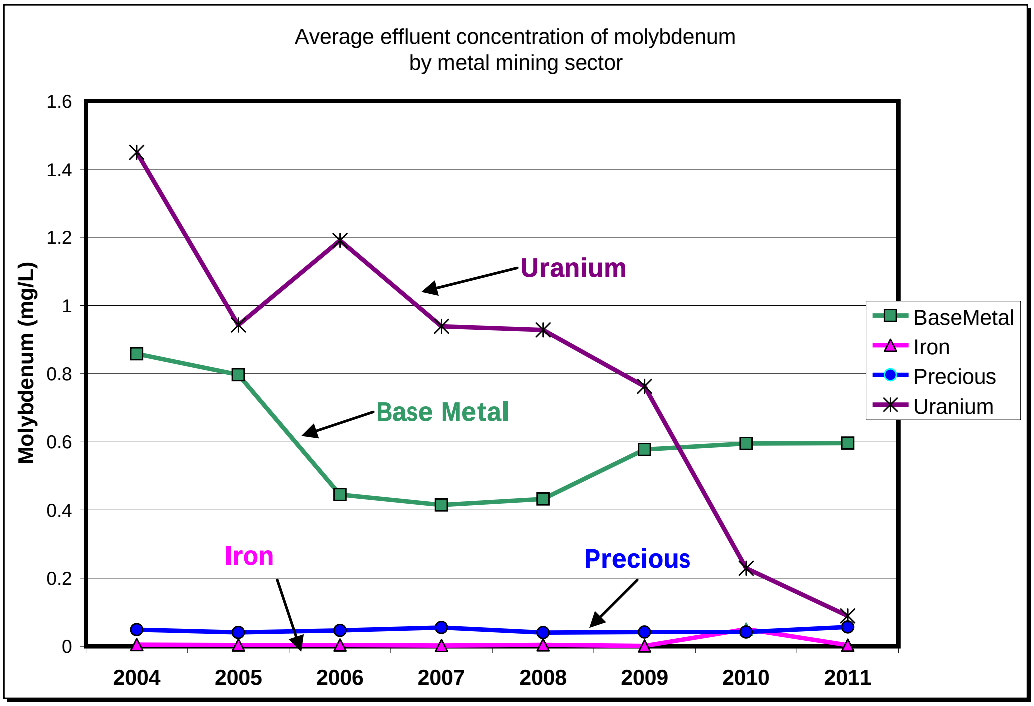
Table 2-7: Percentage by each mining sector passing all trout acute-lethality tests, 2007-2011

Mining sector	Year				
	2007	2008	2009	2010	2011
Uranium	100%	80%	100%	100%	100%
Base metals	84%	86%	80%	90%	85%
Precious metals	93%	91%	96%	96%	96%
Iron	75%	67%	67%	80%	83%

2.2.2 Comparative Performance of Molybdenum by Metal Mining Sector

Molybdenum is a parameter requiring routine monitoring of treated effluent subject to the MMER. Figure 2-9 shows the continuous improvement by the uranium sector in reducing molybdenum in its effluent. In 2011, molybdenum concentrations in uranium effluent were similar to those measured in the effluents of the precious metal and iron mines, and markedly less than in the effluents for the base metal mines as shown below.

Figure 2-9: The average effluent concentration of molybdenum by metal mining sector



2.3 Conventional Health and Safety

The conventional health and safety SCA covers the implementation of a program to manage workplace safety hazards and to protect personnel. Uranium mines and mills licensed by the CNSC must develop, implement and maintain effective safety programs to promote a safe and healthy workplace for workers, and to minimize the incidences of occupational injuries and illnesses. Licensees are expected to identify potential safety hazards, assess the associated risks, and put in place the necessary materials, equipment, programs and procedures to effectively manage, control and minimize these risks. CNSC staff work closely with Saskatchewan's Ministry of Labour Relations and Workplace Safety to provide regulatory oversight of conventional health and safety in uranium mines and mills. Routine compliance verification activities include inspections, reviews of health and safety events and compliance reports. CNSC staff observed and verified these safety practices during compliance inspections.

A key performance measure for conventional health and safety is the number of lost-time incidents (LTIs) that occur per facility. An LTI is an incident that takes place at work and results in the worker being unable to return to work for a period of time. In reviewing LTIs, CNSC staff also consider the severity and frequency rates of accidents. Table 2-8 shows the number of LTIs at the uranium mine and mill facilities along with LTI severity and frequency rates, and the number of full-time equivalent (FTE) workers onsite during 2012.

Table 2-8: Total number of full-time equivalent (FTE) workers, number of lost-time incidents, severity rate and frequency rate for the five operating sites, 2012

Total number of FTE workers and lost-time incidents statistics	2012 Year				
	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClean Lake
Total number of FTE workers[1]	1277	1017	719	736	249
Number of lost-time incidents (LTIs)[2]	0	1	1	1	1
Severity rate[3]	0.0	8.0	22.6	21.6	1.2
Frequency rate[4]	0.0	0.1	0.1	0.1	0.4

[1] **Total number of workers** (employees and contractors) expressed as full-time equivalents (FTE). FTE = total person-hours / 2,000 hours worked per employee per year.

[2] **Lost-time Incident** — an incident that takes place at work and results in the worker being unable to return to work for a period of time.

[3] **Severity Rate —** the accident severity rate measures the total number of days lost to injury for every 200,000 person-hours worked at the site.

Severity = [(# of days lost in last 12 months) / (# of hours worked in last 12 months)] x 200,000

[4] **Frequency Rate —** the accident frequency rate measuring the number of LTIs for every 200,000 person-hours worked at the site.
Frequency = [(# of injuries in last 12 months) / (# of hours worked in last 12 months)] x 200,000

During 2012, there was one LTI at each facility, except for Cigar Lake, which had no LTIs. McClean Lake shows the highest frequency rate as they had fewer employees, thus fewer person-hours worked with respect to the single LTI. The higher severity rates at the Rabbit Lake and Key Lake Operations are due to each of their single LTIs having a greater number of missed work days.

Appendix H describes the 2012 LTIs and corrective actions taken by the licensees. CNSC staff and Saskatchewan's Ministry of Labour Relations and Workplace Safety monitor and review each reportable incident to ensure the cause is identified with satisfactory corrective actions taken. Incident information is shared amongst the facilities to improve safety at all the sites.

CNSC staff confirm that the mine and mill facilities implement effective management of conventional health and safety in all of their activities. The injury statistics demonstrate satisfactory performance of the uranium mine and mill operations to keep workers safe from occupational injuries. For 2012, CNSC staff rated the conventional health and safety SCA at Cigar Lake as "fully satisfactory" and the other four uranium mine and mill facilities continued to be rated as "satisfactory".

2.3.1 Lost-time Incident – Comparison of the Uranium Mines and Mills Performance to Other Mining Sectors

Uranium mining and milling activities continue to exhibit good performance compared to other mining sectors. Below is a table that compare the various safety statistics of mining sectors within Saskatchewan.

1. Saskatchewan Provincial Comparison

In 2012, the number of LTIs at the uranium mines was four, slightly less that the provincial average of five (table 2-9). The frequency and severity rates for the uranium sector were both lower than the provincial averages.

Table 2-9: Safety statistics of mining sectors in Saskatchewan in 2012 – Source: Saskatchewan Ministry of Labour and Workplace Safety

Mining Sector	Number of LTIs	Frequency Rate (200,000 person-hours)	Severity Rate (200,000 person-hours)
Potash (underground)	9	0.2	142.0
Solution (potash)	2	0.4	2.1
Minerals (sodium sulphate, sodium chloride)	0	0.0	0.0
Hardrock (gold, diamond)	16	0.9	64.4
Coal (strip mining)	0	0.0	0.0
Uranium	4	0.1	9.1
Average	**5**	**0.3**	**36.3**

3 CIGAR LAKE PROJECT

The Cigar Lake Project is a mine construction project operated by Cameco Corporation. The facility (figure 3-1) is located approximately 660 kilometres north of Saskatoon, Saskatchewan. Cigar Lake is the world's second-largest known high-grade uranium deposit following Cameco's McArthur River Operation.

Figure 3-1: View of the Cigar Lake Project facility – Source: Cameco

The Cigar Lake ore body was discovered in 1981. The first mine shaft was completed in 1990 to support underground exploration and testing of mining methods. A construction licence was granted in late 2004 after the completion of an environmental assessment.

Construction and development activities at the project were disrupted by the flooding of Shaft No. 2 and the flooding of the underground mine in 2006. In response to the two flooding events, Cameco was required to develop a Remediation Project Plan (Phases 1 to 4) which included completion of Shaft No. 2, followed by the resumption and completion of the underground development activities (Phase 5). During dewatering of the mine in August 2008, another mine water inflow event occurred. The licensee resumed dewatering of the underground mine in October 2009 and the mine was fully dewatered by February 2010. Cameco has since successfully secured the mine, restored underground mine services facilities, and has resumed Phase 5 development. Cameco completed Shaft No. 2 (figure 3-2) sinking to the 480 metre level in January 2012 and to the 500 metre level in May 2012. Shaft No. 2 provides a second means of egress from the mine and will serve as the main conduit for ventilation of the underground workings.

Figure 3-2: Cigar Lake Project's Shaft No. 2 – Source: CNSC image file

Following an environmental assessment, the Commission approved construction of Seru Bay pipelines for the Cigar Lake Water Inflow Management Project in 2011. This allowed an increase in the discharge capacity and moved the effluent release point from the current location on the Aline Creek drainage system to a location directly within Seru Bay. The new pipelines will prevent erosion concerns within the Aline Creek System in the event of a large volume non-routine mine inflow. Construction of the pipelines was completed in 2012 and the pipelines are expected to be operational by mid-2013.

In 2012, the Cigar Lake Project continued to focus on Phase 5 mine development and construction of the ore processing circuit in preparation for mining production estimated to begin in the fall of 2013. The ball mill, seen in figure 3-3, is an example of the construction currently taking place. When Cigar Lake operates, it is expected that ore recovered from Run of Mine will be fed into the ball mill where the ore will be ground and mixed with water to produce an ore slurry.

In July 2012, Cameco requested an early renewal of their licence for a 10-year term to authorize uranium ore production. A one-day public hearing for Cigar Lake was held in April 2013. At the time of writing this report, an 8-year licence was granted to Cameco's Cigar Lake Project.

Figure 3-3: Construction of the ball mill at Cigar Lake – Source: Cameco

3.1 Performance

In 2012, Cameco continued to focus on the Cigar Lake mine development and construction in preparation for mining production.

Cigar Lake's radiation protection program and radiation code of practice continued to be effective in controlling radiological exposure to workers during 2012. In the absence of ore production, the radiological risks remained low. Cameco revised the Cigar Lake radiation protection program and radiation code of practice to align with future mine operation requirements. Radiation doses were kept ALARA and to levels below regulatory limits. The radiation protection SCA was given a "satisfactory" rating.

Cameco continued to carry out rehabilitation of the underground workings and mine development at Cigar Lake in 2012 without any safety incidents. Both the employee and contractor camps were at capacity due to construction and mine development activities. Therefore, considering the increase in activities and the required personnel to complete those activities, Cameco's performance for Cigar Lake in the conventional health and safety SCA was rated as "fully satisfactory".

Cameco submitted an updated environmental management program and environmental code of practice in September 2012 for future Cigar Lake mine operations that was reviewed and found acceptable by staff. During 2012, parameter concentrations in effluent were low and remained below effluent discharge limits. There were no exceedances of the environmental action levels contained in the environmental code of practice. Monitoring and control systems related to spill control operated effectively with one reportable spill in 2012. Cameco continued to protect the environment and received a "satisfactory" rating in the environmental protection SCA.

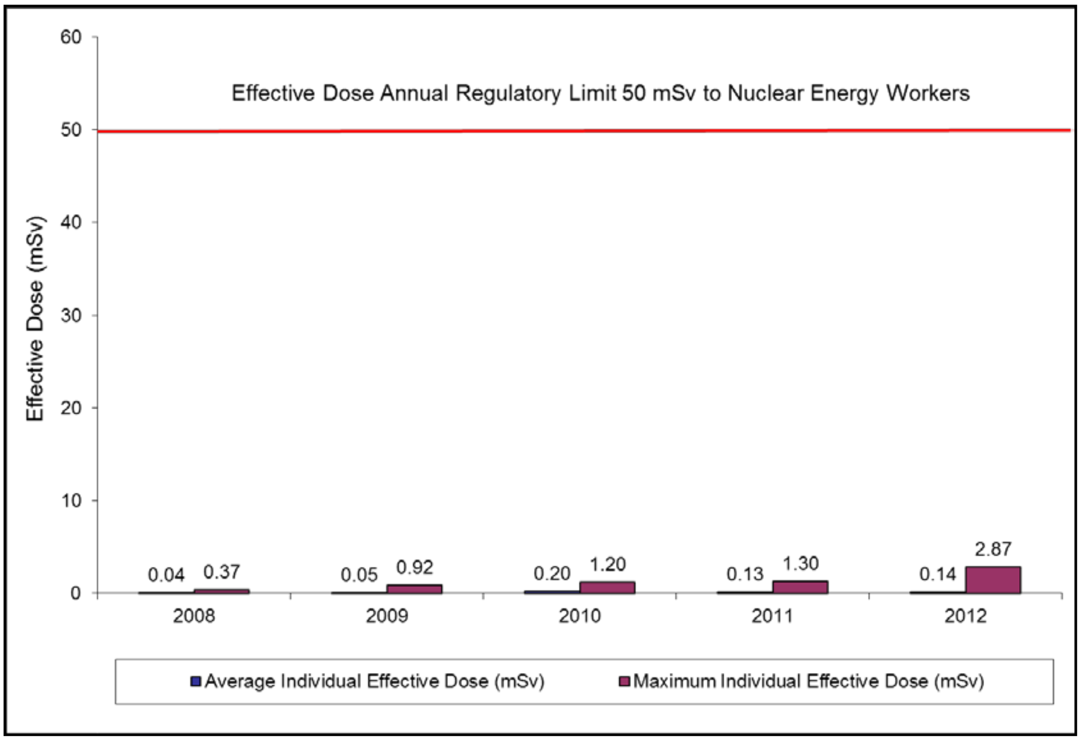
The Cigar Lake SCA ratings for the five-year period, 2008 to 2012, are shown in appendix C. For 2012, CNSC staff rated thirteen SCAs as “satisfactory” and one as “fully satisfactory”.

3.2 Radiation Protection

During the 2012 review period, most of the worker effective dose at Cigar Lake was from radon progeny, since activities did not include the processing of ore.

Figure 3-4 displays the average individual effective dose and the maximum individual effective dose for Cigar Lake’s NEWs from 2008 to 2012. In 2012, the average effective dose for workers was 0.14 mSv. The maximum effective dose in 2012 for a full-time worker at Cigar Lake was 2.87 mSv. The annual effective dose to workers at the Cigar Lake Project remains well below the 50 mSv/yr regulatory limit.

Figure 3-4: Cigar Lake Project – effective dose trend to NEWs, 2008–2012



All five of the uranium mine and mill facilities have the same individual worker action levels for effective dose of 1 mSv/week and 5 mSv/quarter of a year. There were no action level exceedances at Cigar Lake of individual effective dose in 2012.

Improvements in Radiation Protection

Continual improvements to the Cigar Lake Project’s radiation protection program were made in accordance with paragraph 4(*a*) of the *Radiation Protection Regulations* and CNSC guide document G-129, *Keeping Radiation Exposure and Doses “As Low as Reasonably Achievable”*.

Cameco has revised their Radiation Protection Program (RPP) and Radiation Code of Practice (RCOP) to align with future mining operation requirements. The program describes how the site manages radiation protection issues, meets applicable regulatory requirements and keeps radiation exposures as low as reasonably achievable, social and economical factors considered (the ALARA principle). CNSC staff performed a review of the revised RPP and RCOP and found them acceptable in meeting CNSC requirements. Cameco has implemented the RPP and RCOP revisions for mining operation providing assurance to operations and employees that the radiation protection controls and awareness are well established prior to production.

CNSC staff will continue to monitor the licensee's performance in maintaining radiation doses to personnel ALARA through reviews of compliance reports and conduct of facility inspections.

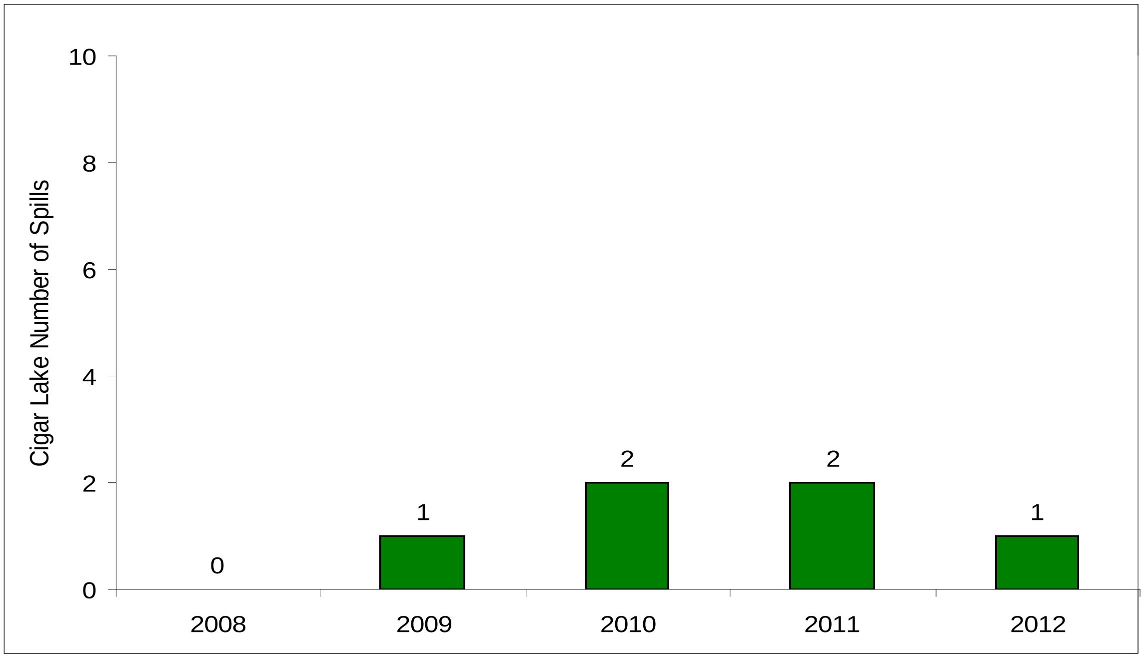
3.3 Environmental Protection

In accordance with Cigar Lake's environmental protection program, effluent and environmental monitoring, site inspections, environmental awareness training and program implementation audits were carried out by Cameco or third-party consultants during 2012.

CNSC staff assessed that Cigar Lake's environmental monitoring programs met all regulatory requirements during 2012 and all effluent discharged complied with licence requirements.

Figure 3-5 displays the number of environmental reportable spills from 2008 to 2012. CNSC staff were satisfied with Cameco on its reporting of spills in a timely manner and the corrective actions taken. One reportable spill occurred in 2012 when 500 L (0.5 m^3) of runoff collection water from stockpile C reported to the ground below the high-density polyethylene liner of the stockpile. Appendix G contains a brief description of the spill and the corrective actions taken by the licensee. There was minimal impact to the environment due to the timely response and effective corrective actions implemented by the Cigar Lake staff.

Figure 3-5: Cigar Lake Project – environmental reportable spills, 2008–2012



Treated Effluent Released to the Environment

The annual average parameter concentration values of the treated effluent at Cigar Lake were well below the regulatory limits and have been stable over the past five years. There were also no treated effluent action level exceedances during the 2008–2012 review period.

Molybdenum, Selenium and Uranium in Effluent

Figures 3-6, 3-7 and 3-8 display effluent discharge concentrations for molybdenum, selenium and uranium for the 2008–2012 period. Concentrations for all contaminants are low because the Cigar Lake Project is under construction, and mining or processing activities that would produce effluent with higher contaminant concentrations are not yet operating at this site. As Cigar Lake transitions from construction activities to operational activities, concentrations are expected to increase. CNSC staff will continue monitoring effluent quality to ensure that the environment is protected.

In 2009, an action level of 1.1 mg/L for molybdenum was added to the current Cigar Lake operating licence and their environmental code of practice. As production experience is gained at Cigar Lake, the action level for molybdenum will be revisited and finalized.

Figure 3-6: Cigar Lake Project – concentrations of molybdenum, 2008–2012
(the Cigar Lake action level for molybdenum is shown for reference only)

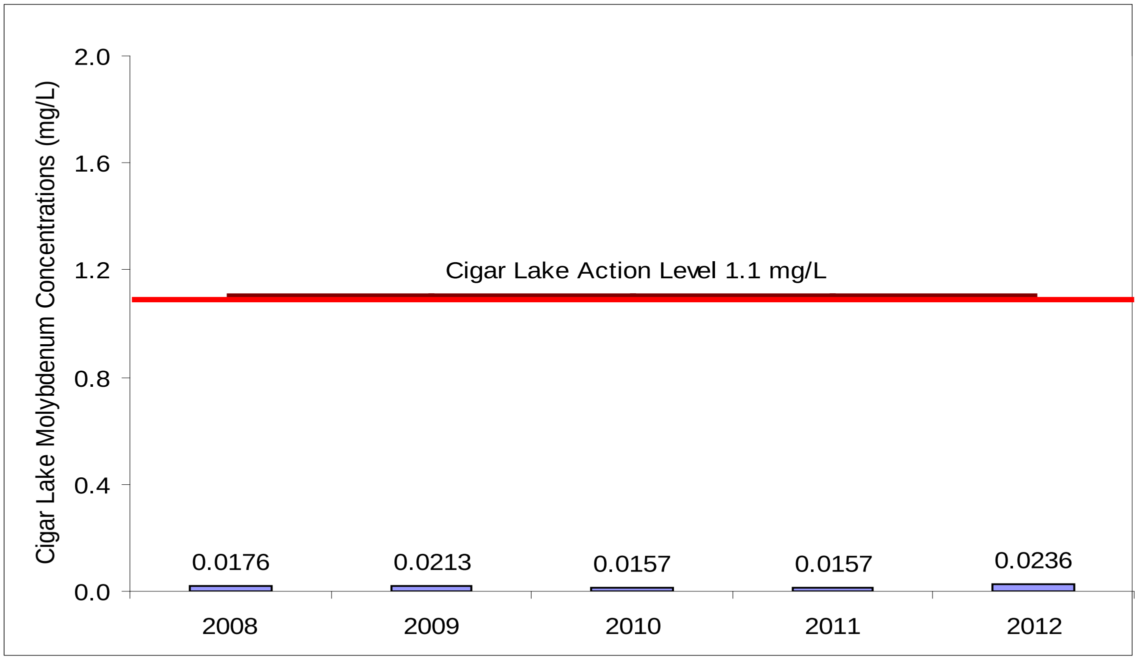


Figure 3-7: Cigar Lake Project – concentrations of selenium, 2008–2012
(the Province of Saskatchewan's discharge limit for selenium is shown for reference only)

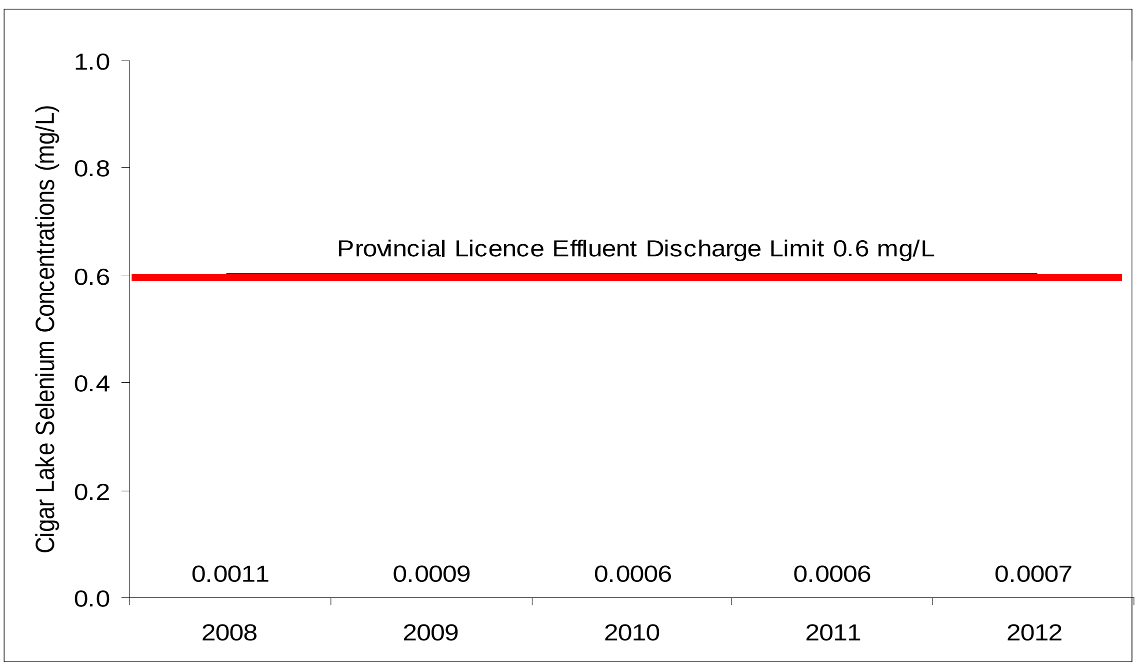
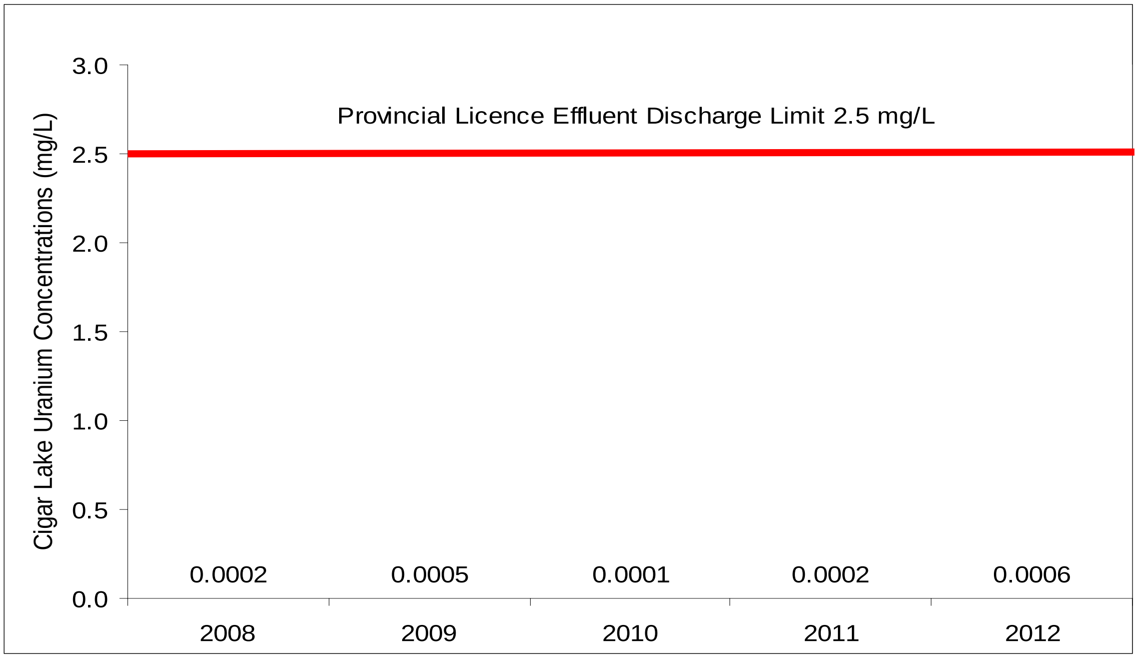


Figure 3-8: Cigar Lake Project – concentrations of uranium, 2008–2012
(the Province of Saskatchewan's discharge limit for uranium is shown for reference only)



3.4 Conventional Health and Safety

The CNSC expects licensees of uranium mines and mills to develop, implement and maintain effective safety programs to promote a safe and healthy workplace for employees and to minimize the incidence of occupational injuries and illnesses. Cameco is expected to identify potential safety hazards, assess the associated risks, and put in place the necessary materials, equipment, programs and procedures to effectively manage, control and minimize these risks. To assure continued strong safety performance and continual improvement, Cameco has implemented a revised safety and health management program to enhance identification and mitigation of risks and also to meet future operational requirements. The rewritten program includes provisions for planned internal inspections, a safety permit system, occupational health committees, health centre operation, incident investigations and the management of safety equipment.

Inspections regarding conventional health and safety were also carried out by the Saskatchewan Ministry of Labour and Workplace Safety inspectors during the current licensing period. Safety-related incidents were properly investigated by Cameco. The resulting investigative reports submitted were acceptable to both CNSC staff and Saskatchewan Ministry of Labour and Workplace Safety.

In 2012, safety incidents were reported in compliance with regulatory requirements. Cameco carried out the remediation, re-entry and rehabilitation of the underground workings without any significant safety incidents.

Cigar Lake reported a total of five LTIs from 2008 to 2012 with zero LTIs in 2012 for workers performing licensed activities (table 3-1).

Table 3-1: Cigar Lake Project – Total number of FTE workers and LTIs, severity rate and frequency rate, 2008–2012

CIGAR LAKE					
Year	**2008**	**2009**	**2010**	**2011**	**2012**
Total number of FTE workers*	453	365	649	971	1,277
No. of LTIs*	3	1	0	1	0
Severity rate*	32.0	2.5	0.0	1.6	0.0
Frequency rate*	0.7	0.3	0.0	0.1	0.0

* Definitions of these terms are located in the Glossary.

There were a high number of workers on site throughout 2012 due to continued remediation, re-entry, rehabilitation and development of the underground workings (figure 3-9).

Figure 3-9: Development of the underground workings and mine at the Cigar Lake Project – Source: CNSC image file

Because of the increase to the number of workers, Cameco undertook additional efforts to promote the existing safety culture through management oversight and safety training. In 2012, Cigar Lake also promoted increased reporting of near-miss incidents within their incident reporting system providing the opportunity to identify preventative actions.

CNSC staff observed that Cigar Lake continues to strive for improvement in its overall safety program and to build upon its safety culture. Cameco's performance in the conventional health and safety SCA was rated by CNSC staff in 2012 as "fully satisfactory".

4 McARTHUR RIVER OPERATION

Cameco Corporation operates the McArthur River Operation located approximately 620 kilometres north of Saskatoon, Saskatchewan. McArthur River is the world's largest high-grade uranium mine.

Facilities at the McArthur River Operation include an underground uranium mine operation, primary ore processing, ore slurry loading and transportation systems, waste management, a water treatment plant, surface freeze plants, administration offices and warehouse buildings (figure 4-1).

The photograph below displays the main shaft, surface water run-off pond, administrative offices and warehouse for the McArthur River Operation. The surface water from the run-off pond is treated in the water treatment plant before being released to the environment.

Figure 4-1: McArthur River mine facility – Source: CNSC file image

High-grade uranium ore is mined underground, then ground and mixed with water in the ball mill to form a slurry which is pumped to surface. The ore slurry is loaded into approved containers and transported to the Key Lake Operation for further processing (figure 4-2). Mineralized waste rock is also transported to Key Lake in covered haul trucks where these materials are milled and blended with high-grade ore slurry to create the mill ore feed.

Figure 4-2: Ore slurry truck being loaded – Source: CNSC file image

The McArthur River mine was in operation for all 365 days in 2012. McArthur River mine production data for 2008-2012 are shown below in table 4-1.

Table 4-1: Mining production data – McArthur River Operation, 2008–2012

Mining	2008	2009	2010	2011	2012
Ore tonnage (tonnes/year)	53,232	65,195	78,003	80,162	115,107
Average ore grade mined (% U_3O_8)	14.91%	12.89%	11.25%	11.17%	7.78%
U_3O_8 mined (kg)	7,939,080	8,405,106	8,772,920	8,950,340	8,958,578
Mining - Licence production limit expressed as U_3O_8 (kg)	8,490,566	8,490,566	9,551,887	9,551,887	9,551,887

Cameco’s licence for the McArthur River Operation was issued in October 2008 and expires on October 31, 2013. In March 2012, the licence was amended to modify the site boundary as referenced in appendix A of their licence. Cameco has applied for a licence renewal, and in October 2013 the Commission held a public hearing. At the time of writing this report, the Commission was in deliberation.

4.1 Performance

During 2012, Cameco's radiation protection program and radiation code of practice at the McArthur River Operation continued to be effective in controlling radiological exposure to workers. CNSC staff were satisfied that the McArthur River Operation is adequately controlling radiation doses to levels below the regulatory limits and conclude the radiation protection SCA remains "satisfactory".

CNSC staff determined that Cameco's McArthur River Operation environmental protection program was effective in protecting the environment and all treated effluent discharged complied with licence requirements. In 2012, three environmental spills and one regulatory effluent exceedance were reported to CNSC staff. They were remediated with no residual impacts to the environment. Cameco continued to protect the environment and received a "satisfactory" rating in the environmental protection SCA.

CNSC staff determined that Cameco's McArthur River Operation occupational health and safety program met regulatory requirements. The McArthur River Operation had one LTI in 2012. CNSC staff observed enhancements to their health and safety program including an improved reporting culture. CNSC staff's compliance verification activities confirmed Cameco's strong focus on the prevention of accidents. Cameco's McArthur River Operation performance in the conventional health and safety SCA was rated as "satisfactory".

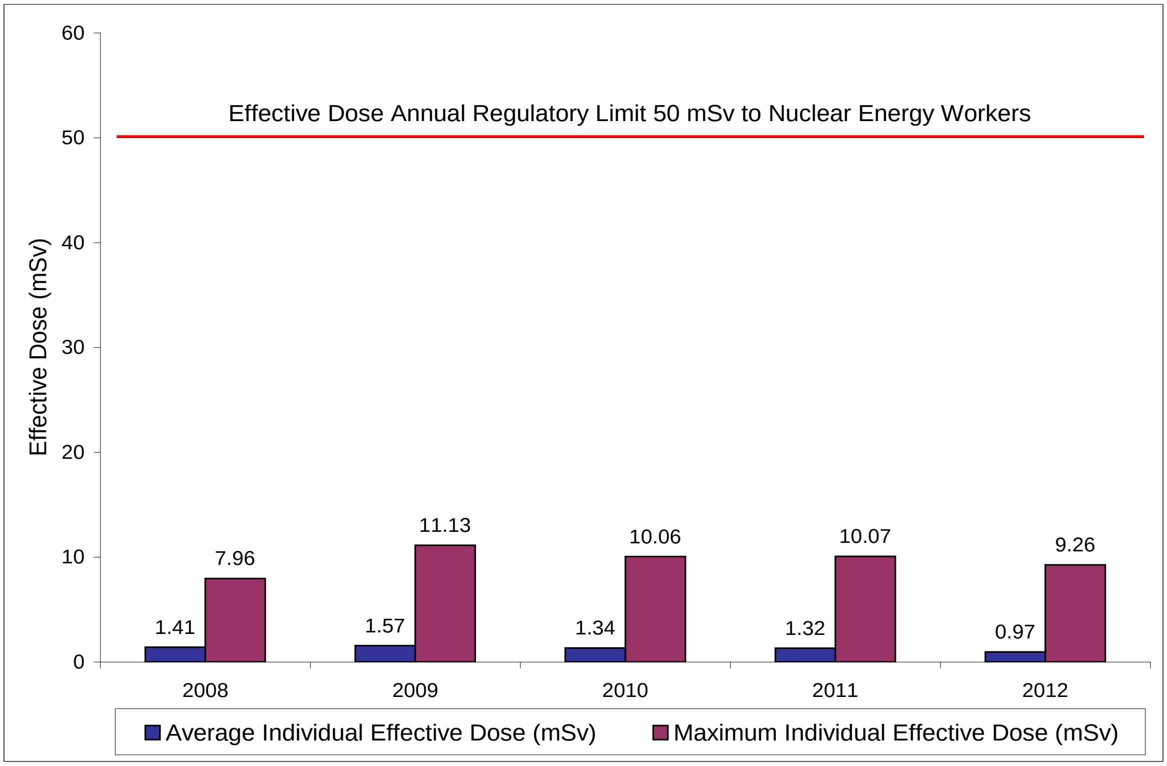
The McArthur River SCA ratings for the five-year period, 2008 to 2012, are shown in appendix C. For 2012, CNSC staff continue to rate all SCAs as "satisfactory".

4.2 Radiation Protection

The source of radiological exposure at the McArthur River Operation is from mining and the processing of high-grade uranium ore. The three primary effective dose contributors are gamma radiation, radon progeny and long-lived radioactive dust (LLRD). Worker effective dose from radon progeny is controlled through the effective use of ventilation, and by capture/exhaust of high radon sources.

In 2012, the average individual effective dose to all NEWs was 0.97 mSv. The group with the highest average effective dose was underground support workers at 2.2 mSv. The maximum individual effective dose in 2012 was 9.26 mSv. As figure 4-3 shows, the average and maximum individual effective dose to NEWs from 2008 to 2012 were well below the annual regulatory limit of 50 mSv.

Figure 4-3: McArthur River Operation – effective dose trend to NEWs, 2008–2012



All five of the uranium mine and mill facilities have the same individual worker action levels for effective dose of 1 mSv/week and 5 mSv/quarter of a year.

One worker in October 2012 received a 1.93 mSv effective dose exceeding the weekly action level of 1 mSv. The dosimeters showed an effective dose of 0.31 mSv radon progeny, 1.54 mSv long-lived radioactive dust (LLRD) and 0.08 mSv gamma. Following the incident, Cameco committed to placing additional focus on communicating and identifying high-risk LLRD activities. During a subsequent inspection, CNSC staff attended a safety meeting that identified the high-risk LLRD activities and how to better plan the work; this became part of a monthly radiation information package for all employees.

Improvements in Radiation Protection

Continual improvements to Cameco's McArthur River radiation protection program were made in accordance with paragraph 4(*a*) of the *Radiation Protection Regulations* and CNSC guide document G-129, *Keeping Radiation Exposure and Doses "As Low as Reasonably Achievable"*.

CNSC staff's compliance activities observed improvements to the application of ALARA (as low as reasonably achievable) including:

- increased mine ventilation of 150,000 cubic feet per minute (cfm) which resulted in a reduction in radon progeny levels
- an increased and focused effort on work planning to reduce exposures

4.3 Environmental Protection

In accordance with McArthur River's environmental protection program, effluent and environmental monitoring, site inspections, environmental awareness training and program implementation audits were carried out by Cameco or third-party consultants during 2012.

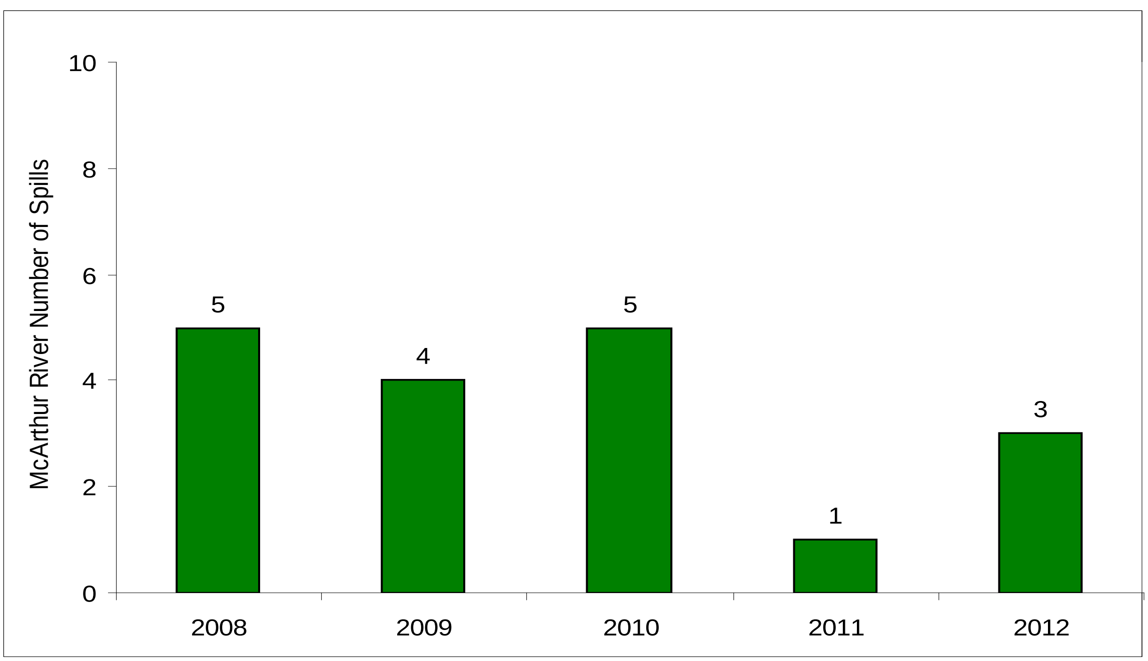
CNSC staff assessed that McArthur River's environmental monitoring programs met all regulatory requirements during 2012 and all effluent discharged complied with licence requirements.

Figure 4-4 shows the number of reportable spills to the environment from the licensed activities at the McArthur River Operation from 2008 to 2012. In 2012, three environmental spills were reported to CNSC staff:

- 170 L (0.17 m^3) of hydraulic oil
- 0.1 m^3 of contaminated solids
- 90 L (0.09 m^3) of contaminated water

All three spills were immediately cleaned up and there was no measurable impact to the environment. Identified corrective actions by Cameco were acceptable to CNSC staff. A brief description of the three spills and corrective actions implemented are provided in appendix G.

Figure 4-4: McArthur River Operation – environmental reportable spills, 2008–2012



Treated Effluent Released to the Environment

In 2012, Cameco reported one regulatory effluent exceedance when pH and total suspended solids (TSS) levels reached 11.3 pH and 46 mg/L TSS. This exceeded McArthur River's licensed upper limits for pH of 9.5 and for TSS of 15 mg/L. The incident occurred at Shaft No. 3 when concrete was inadvertently mixed with underground shaft water. Over the course of nine hours, 371,000 L (371 m^3) of this effluent was released to the environment before the exceedance was identified. Staff from both the CNSC and the Saskatchewan Ministry of Environment were appropriately notified of the incident. Cameco implemented corrective actions that included engineering controls which CNSC staff verified. No environmental effects were observed in the downstream environment as a result of this exceedance.

Molybdenum, Selenium and Uranium in Effluent

Molybdenum, selenium and uranium have been identified as constituents of concern from treated effluent at uranium mines and mills. Molybdenum was the constituent of concern at the McArthur River Operation. In response to CNSC staff concerns, Cameco implemented process changes to reduce molybdenum concentrations in treated effluent at the McArthur River Operation. In 2008, Cameco committed to achieving a molybdenum concentration lower than 1.0 mg/L. Molybdenum removal efficiency in treated effluent continued to improve every year decreasing from 1.34 mg/L in 2008 to 0.23 mg/L in 2012 (figure 4-5).

Figure 4-5: McArthur River Operation – concentrations of molybdenum, 2008–2012 (the Cigar Lake action level for molybdenum is shown for reference only)

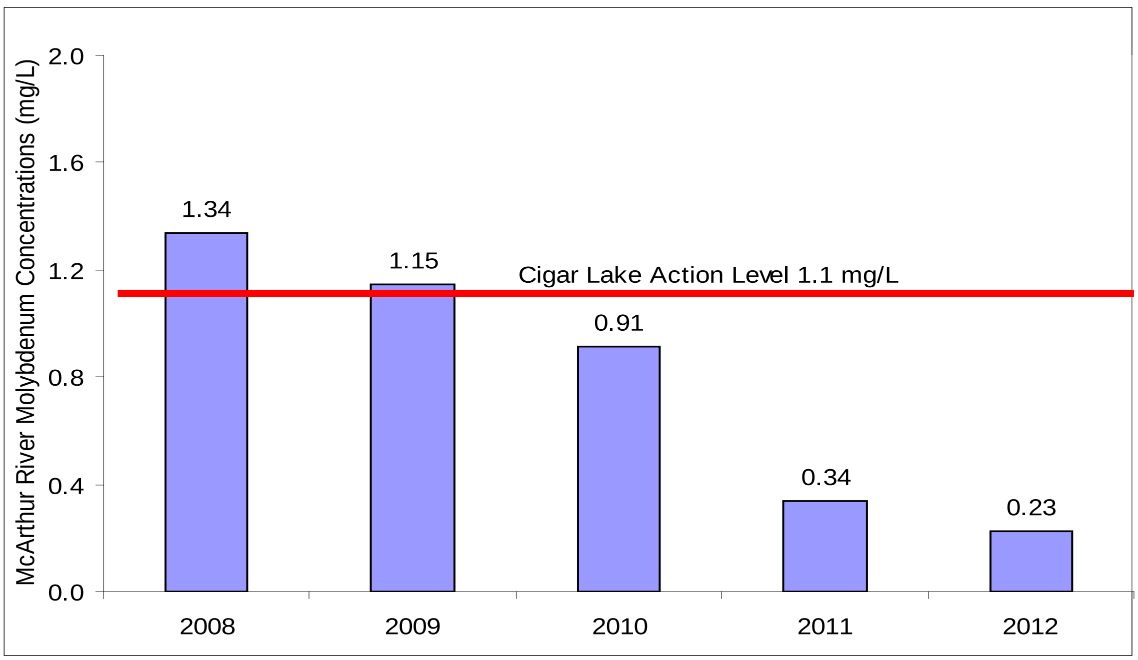


Figure 4-6: McArthur River Operation – concentrations of selenium, 2008–2012 (the Province of Saskatchewan's discharge limit for selenium is shown for reference only)

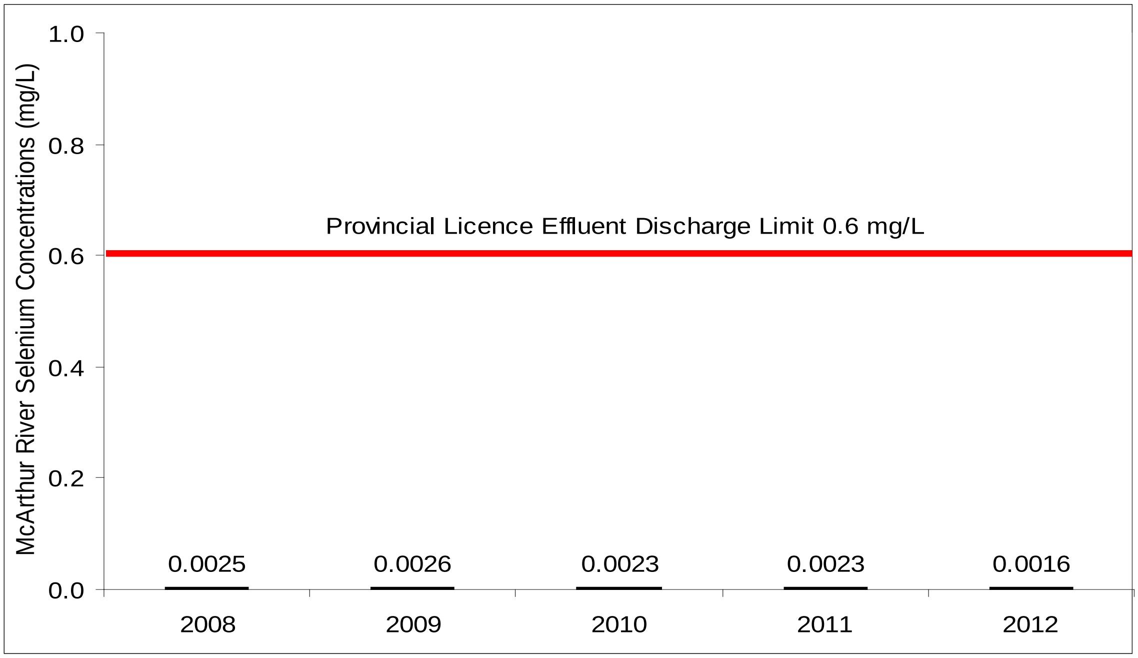


Figure 4-6 above shows that the concentrations of selenium in treated effluent remained consistently well below the Province of Saskatchewan's licence effluent discharge limit of 0.6 mg/L.

Figure 4-7: McArthur River Operation – concentrations of uranium, 2008–2012 (the Province of Saskatchewan's discharge limit for uranium is shown for reference only)

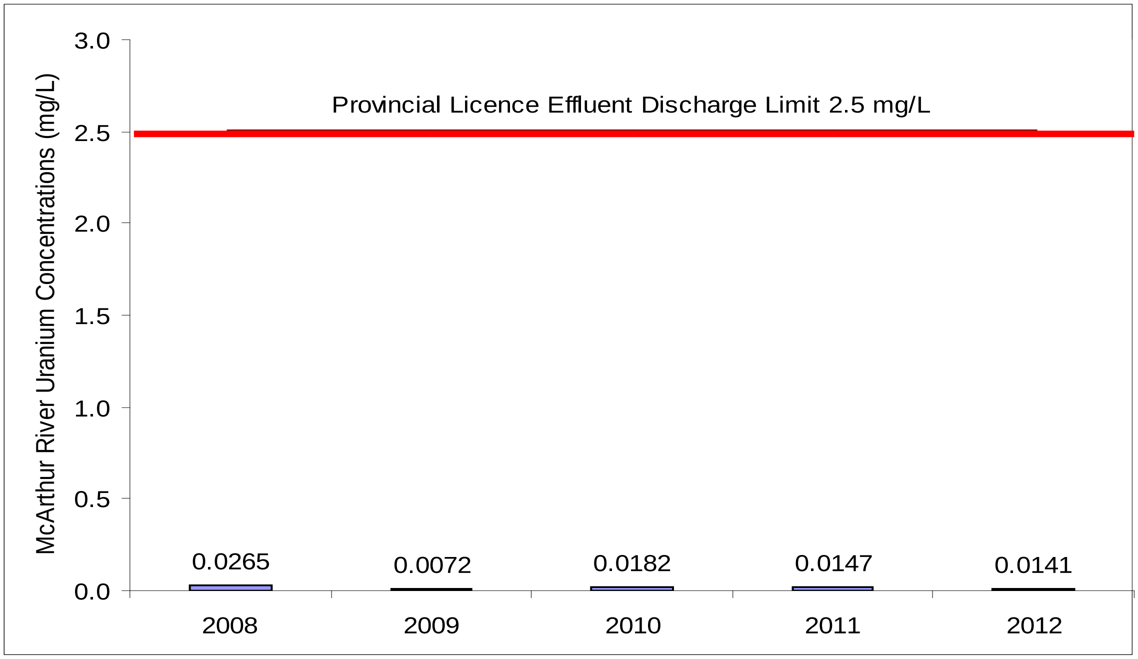


Figure 4-7 above displays the average annual uranium concentrations in treated effluent from 2008 to 2012. Uranium concentrations remain well below the Province of Saskatchewan's regulatory limit of 2.5 mg/L.

CNSC staff will continue to review the McArthur River Operation's treated effluent concentrations at the outflow (figure 4-8) and in the downstream environment.

Figure 4-8: Treated effluent from the McArthur River Water Treatment Plant – Source: CNSC file image

4.4 Conventional Health and Safety

The CNSC and Saskatchewan Ministry of Labour Relations and Workplace Safety monitor the implementation of Cameco's occupational health and safety program to ensure compliance with regulatory requirements. To ensure continued strong safety performance, Cameco has implemented a safety and health management program to enhance identification and mitigation of risks. The program includes planned inspections, a safety permit system, occupational health committees, health centre operation, incident investigations and the management of safety equipment.

The conventional health and safety SCA is evaluated by CNSC staff through regular compliance activities. Compliance activities include inspections, reviews of incident reports, and monthly health and safety reports. CNSC compliance verification activities confirmed Cameco's strong focus on the prevention of accidents, on reducing lost-time injuries and the number of injuries requiring medical treatment.

The McArthur River Operation had one LTI in 2012. On September 16, 2012, two workers were using a jackleg drill to install ground support. One of the workers caught their finger between a deck rail and the drill resulting in a lacerated and fractured finger and two days in lost time. Cameco's corrective actions included:

- increasing the use of mechanized bolting to reduce manual handling
- ensuring proper procedures and equipment are used
- increased management oversight

CNSC staff were satisfied and verified Cameco's corrective actions. Details on this event can be found in appendix H.

The 2012 LTI performance (table 4-2) shows an improvement in the severity and frequency rates with one LTI in 2012 as compared to three in 2011.

Table 4-2: McArthur River Operation – Total number of FTE workers and LTIs, severity rate and frequency rate, 2008–2012

McARTHUR RIVER					
Year	**2008**	**2009**	**2010**	**2011**	**2012**
Total number of FTE workers*	666	713	835	966	1,017
No. of LTIs*	1	2	1	3	1
Severity rate*	50.9	56.9	45.1	14.4	8.0
Frequency rate*	0.2	0.3	0.1	0.3	0.1

* Definitions of these terms are located in the Glossary.

Cameco's incident reporting system includes near-miss criteria injury report numbers. CNSC staff observed that, along with the broadened scope of the injury incident category, there is also an improved reporting culture. This originates from a facility-wide recognition that the reporting of incidents offers significant value. These improvements indicate an increased focus by the licensee on the safety culture at the facility.

5 RABBIT LAKE OPERATION

The Rabbit Lake Operation is located 750 kilometres north of Saskatoon, Saskatchewan and is owned and operated by Cameco Corporation. The facility consists of an active underground mine (Eagle Point mine), a mill (figure 5-1), and associated waste rock storage and tailings management facilities.

Figure 5-1: Rabbit Lake mill – Source: Cameco

Uranium mining operations first commenced in 1974. Based on results of ongoing exploration activities, Cameco expects the Eagle Point mine to operate until at least 2017. Rabbit Lake mining and milling data are provided in tables 5-1 and 5-2.

Table 5-1: Mining production data – Rabbit Lake Operation, 2008–2012

Mining	2008	2009	2010	2011	2012
Ore tonnage (tonnes/year)	178,500	193,006	199,026	197,397	225,282
Average ore grade mined (% U_3O_8)	0.96%	0.90%	0.89%	0.91%	0.84%
U_3O_8 mined (kg)	1,746,349	1,737,277	1,759,956	1,787,172	1,903,519

Table 5-2: Milling production data – Rabbit Lake Operation, 2008–2012

Milling	2008	2009	2010	2011	2012
Mill ore feed (tonnes/year)	190,044	216,389	234,076	209,040	260,299
Average annual mill Feed grade (% U_3O_8)	0.87%	0.82%	0.78%	0.83%	0.71%
% uranium recovery	96.7%	96.4%	96.8%	96.8%	96.8%
Uranium concentrate (kg U_3O_8)	1,612,673	1,705,803	1,725,741	1,720,827	1,743,702
Milling - Licence production limit expressed as U_3O_8 (kg)	7,665,094	7,665,094	7,665,094	7,665,094	7,665,094

The current licence was issued in October 2008 and expires October 31, 2013. Cameco has applied for a licence renewal, and in October 2013 the Commission held a public hearing. At the time of writing this report, the Commission was in deliberation.

5.1 Performance

Cameco's radiation protection, environmental protection, and occupational health and safety programs at the Rabbit Lake Operation met expectations and performed satisfactorily in 2012.

Based on site inspections, and reviews of the radiation protection program, work practices, monitoring results and effective dose calculations in 2012, CNSC staff were satisfied that Cameco's Rabbit Lake Operation adequately controlled radiation doses to levels below the regulatory limits. Radiation doses were kept below regulatory limits and ALARA. The radiation protection SCA was given a "satisfactory" rating.

Cameco's environmental protection program at the Rabbit Lake Operation was effectively implemented and met all regulatory requirements during 2012. All effluent discharged complied with licence requirements. For previously identified contaminants of concern, uranium, molybdenum, and to a lesser extent selenium, Cameco's effluent treatment system continues to meet performance expectations in reducing the concentrations of these parameters. There were five reportable spills at the Rabbit Lake Operation in 2012. Cameco continued to protect the environment and received a "satisfactory" rating in the environmental protection SCA.

CNSC staff concluded that the occupational health and safety program at the Rabbit Lake Operation continues to be effective in managing health and safety risks. Cameco's Rabbit Lake Operation reported one lost-time incident where a worker was struck by underground equipment and one noteworthy near-miss incident involving a fall of ground in 2012. The conventional health and safety SCA was rated as "satisfactory".

The Rabbit Lake SCA ratings for the five-year period, 2008 to 2012, are shown in appendix C. For 2012, CNSC staff continue to rate all SCAs as "satisfactory".

A licence condition required Cameco's Rabbit Lake Operation to develop and implement a site reclamation plan. In 2012, Cameco continued to make significant progress in reclaiming inactive areas with a focus on the B-zone waste rock pile and the Above Ground Tailings Management Facility (AGTMF):

- In 2005, the dyke that separated the A-Zone pit from Wollaston Lake was purposely breached and the A-Zone pit became part of Wollaston Lake. In 2012, water quality in the A-Zone pit area continued to be consistent with background values. The revegetation of the A-Zone continued to progress well in 2012.
- Several reclamation activities took place in the B-Zone area. A detailed design for the reclamation of the B-Zone waste rock pile was submitted by the licensee and approved by CNSC staff. The pile was shaped and covered in 2011 and 2012. After shaping, an engineered cover was placed and the area was hydro-seeded. Drainage channels and environmental instrumentation was installed to monitor the performance of the reclamation. In 2012, unused roads were also fertilized and revegetated. The flooded B-Zone pit remains isolated from Wollaston Lake.
- The AGTMF operated between 1975 and 1985. A conceptual decommissioning plan was developed in 1993. As part of that plan, a program of actively thawing and consolidating the 6.3 million tonnes of tailings in the AGTMF was initiated. Earth works to prepare for the installation of a vegetated cover on the AGTMF began in 2011. In 2012, construction of the cover began on the southern half of the AGTMF.

CNSC staff verified these 2012 reclamation activities through desktop reviews of applications and reports, and on-site inspections. The reclamation plan is updated annually and CNSC staff will continue to monitor and review Cameco's water management practices and reclamation activities to ensure that the environment is protected.

5.2 Radiation Protection

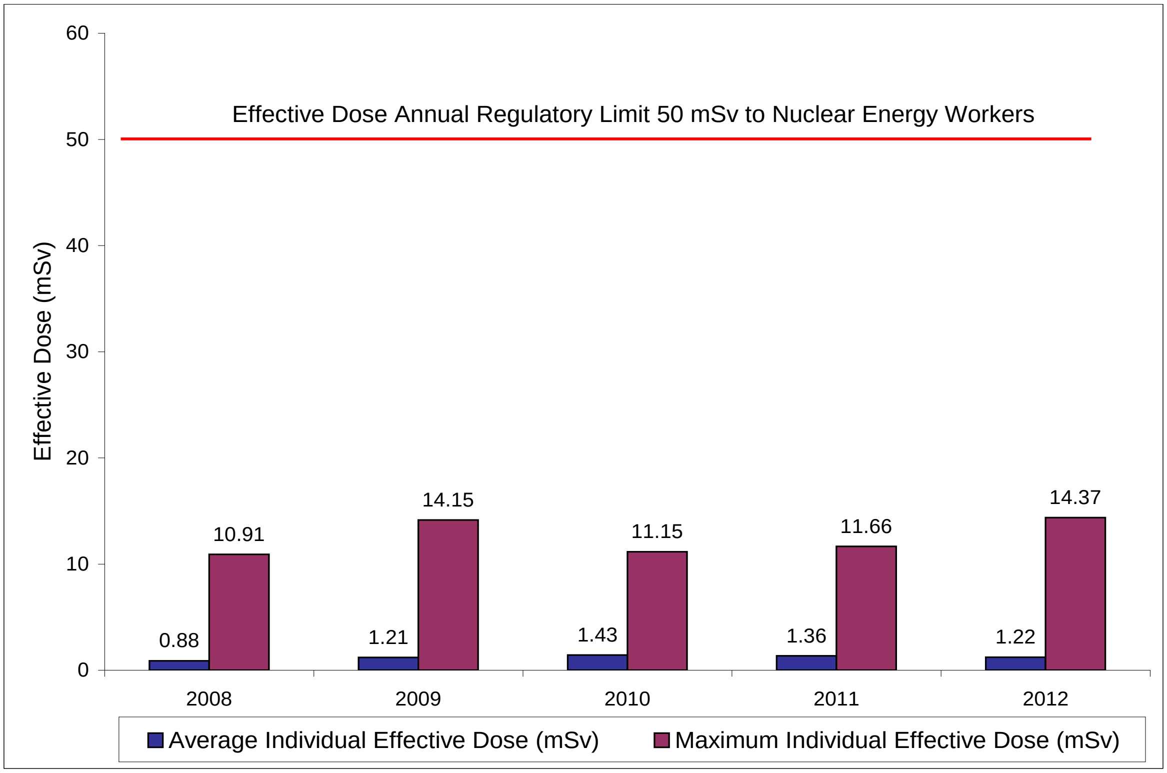
The source of radiological exposure at the Rabbit Lake Operation is mining at the Eagle Point underground mine and uranium ore milling at the Rabbit Lake mill. The three primary effective dose contributors are gamma radiation, radon progeny and LLRD.

Worker effective dose from radon progeny is controlled through the effective use of ventilation, and by capture/exhaust of high radon sources. Gamma radiation exposure is controlled through the application of time, distance and shielding. Gamma radiation and radon progeny account for approximately 70% of individual worker effective dose, with radon progeny contributing slightly more than gamma radiation.

The average individual effective dose for only the mill workers in 2012 was 1.5 mSv, consistent with values since 2010. The average individual effective dose in 2012 for only the underground miners was 4.3 mSv, also consistent with values since 2010.

In 2012, the average individual effective dose for all Rabbit Lake workers, as shown in figure 5-2, was 1.22 mSv, relatively consistent for the last five years. The maximum individual effective dose obtained by a worker in 2012 displayed a similar trend with a slight increase to 14.37 mSv. The effective dose values to all Rabbit Lake Operation workers continued to be well below the annual regulatory limit of 50 mSv.

Figure 5-2: Rabbit Lake Operation – effective dose trend to NEWs, 2008–2012



* The 2010 and 2011 maximum individual effective doses have been modified from the previous *CNSC Staff Report on the Performance of Canadian Uranium Fuel Cycle and Processing Facilities: 2011* as a result of dose changes approved through the National Dose Registry that resulted from previously rejected personal alpha dosimeter results that were later accepted in early 2012 (2010 changed from 10.7 mSv to 11.15 mSv; 2011 changed from 11.4 mSv to 11.66 mSv).

All five of the uranium mine and mill facilities have the same individual worker action levels for effective dose of 1 mSv/week and 5 mSv/quarter of a year.

A single event in November 2012 resulted in three exceedances of radiation exposure action levels (two weekly and one quarterly) at Rabbit Lake. Two workers were exposed to elevated levels of LLRD and radon progeny while cleaning out blast holes in a production stope. The resulting exposures remain below regulatory limits. A radiation work permit is normally required to conduct this routine activity, and this would identify the use of respiratory protection while undertaking this task. However, the workers did not obtain the permit or wear the appropriate protection. Cameco has taken actions to ensure that all workers obtain and follow the requirements of radiation work permits. Cameco also initiated a study to identify additional opportunities for reducing potential exposures while cleaning out blast holes. CNSC staff were satisfied with the actions taken by Cameco.

A non-conformance by Cameco occurred in October 2012 when a crane was transported off-site before being cleared radiologically. The error was identified and the transport truck was stopped in Saskatoon where the crane was then cleaned and cleared for release. As a result, Cameco identified corrective and preventative actions in its management of transported equipment. CNSC staff were satisfied with the actions taken.

Improvements in Radiation Protection

Continual improvements to the Rabbit Lake Operation's radiation protection program were made in accordance with paragraph 4(*a*) of the *Radiation Protection Regulations* and CNSC guide document G-129, *Keeping Radiation Exposure and Doses "As Low as Reasonably Achievable"*.

Through compliance activities in 2012, CNSC staff observed improvements in the area of radiation protection consistent with the application of ALARA, two examples were:

- On a quarterly basis the workers with the highest five individual effective doses at Rabbit Lake Operation are identified and actions plans are created with their supervisors to lower their future effective doses.
- Periodically, a weather phenomenon at Eagle Point creates a condition where a portion of the degraded exhaust from the underground mine is drawn into its fresh-air intake. A three-year program of study, design and testing into the prevention of such re-circulation conditions culminated in the construction of "snorkels" in 2012 (figure 5-3). The innovative snorkel elevates the mine's fresh-air intakes such that the air drawn into the mine is consistently of better quality and consequently reduces the inadvertent exposures to underground workers.

Figure 5-3: Rabbit Lake Operation – a picture of a "snorkel" – CNSC file image

5.3 Environmental Protection

Overall, CNSC staff found the Rabbit Lake Operation's environmental monitoring program and associated special studies effective in assessing environmental predictions. Where contaminant levels in the receiving environment in past years have been higher than predicted, Cameco has undertaken additional assessments to determine their significance and risk to the receiving environment and to identify further mitigation measures where appropriate.

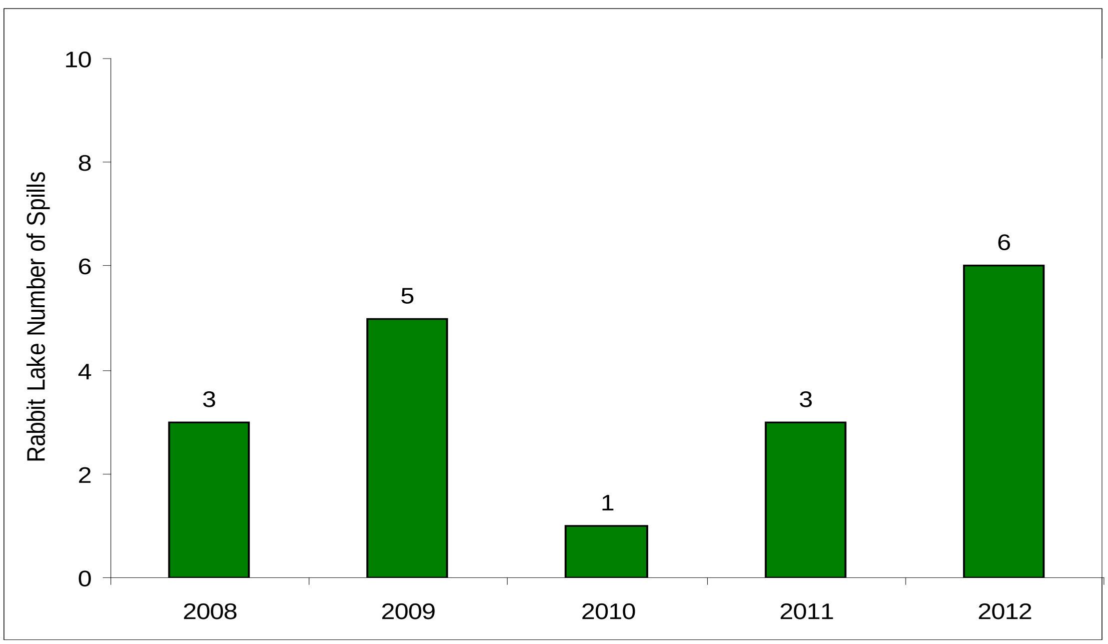
CNSC staff assessed that Rabbit Lake's environmental monitoring programs met all regulatory requirements during 2012 and all effluent discharged complied with licence requirements.

As shown in figure 5-4, there were six spills in 2012. The 2012 spills were:

- the release of approximately 120 L (0.12 m^3) of sulphuric acid
- the discovery at mill foundations of approximately 15,000 L (15.0 m^3) of mill process solution
- the inadvertent release of 1,000 L (1.0 m^3) of pregnant (uranium-bearing) aqueous mill feed into an excavation
- the escape of about 40 L (0.04 m^3) of treated effluent from the discharge pipeline
- the release of 30,000 L (30.0 m^3) (estimated) of mine water from a holding pond that had a damaged liner; and
- the release of 400 L (0.4 m^3) of transmission oil from a ruptured tote container

Appendix G further describes the above 2012 reportable spills and the corrective actions taken by the licensee. CNSC staff concluded through review of Cameco's reports that environmental impacts from these spills were negligible due to the prompt response and clean-up. The licensee continues to report environmental spills in a timely manner and applies a lessons-learned approach to reduce such spills in the future.

Figure 5-4: Rabbit Lake Operation – environmental reportable spills, 2008–2012



Treated Effluent Released to the Environment

There was one reported treated effluent grab sample exceedance to the Rabbit Lake Operation's regulatory licence limit for total suspended solids (TSS) in 2012. A single grab sample collected by mill operations measured TSS levels at 34 mg/L, exceeding the applicable grab sample limit of 30 mg/L. However, the follow-up investigation indicated that sampling and/or laboratory processing errors likely resulted in the elevated TSS concentration in the single sample. Rabbit Lake Operations reviewed its sample collection and handling procedure with staff. CNSC staff were satisfied with the investigation and corrective actions taken.

Molybdenum, Selenium and Uranium in Effluent

Molybdenum, selenium and uranium have been identified as constituents of concern from treated effluent at uranium mines and mills. Uranium and molybdenum were the constituents of concern at the Rabbit Lake Operation. Substantial water treatment modifications were completed at the Rabbit Lake Operation since 2007 to improve the quality of the treated effluent released to the environment. The licensee installed additional chemical treatment processes to reduce molybdenum, selenium and uranium levels. Molybdenum (figure 5-5) and selenium (figure 5-6) concentrations display significant reductions since 2009 when additional effluent treatment processes were installed. Molybdenum and selenium concentrations both display a slight increase from 2011 to 2012 but have been generally stable since 2010. Uranium concentrations in 2012 were lower than in all previous years (figure 5-7).

Figure 5-5: Rabbit Lake Operation – concentrations of molybdenum, 2008–2012
(the Cigar Lake action level for molybdenum is shown for reference only)

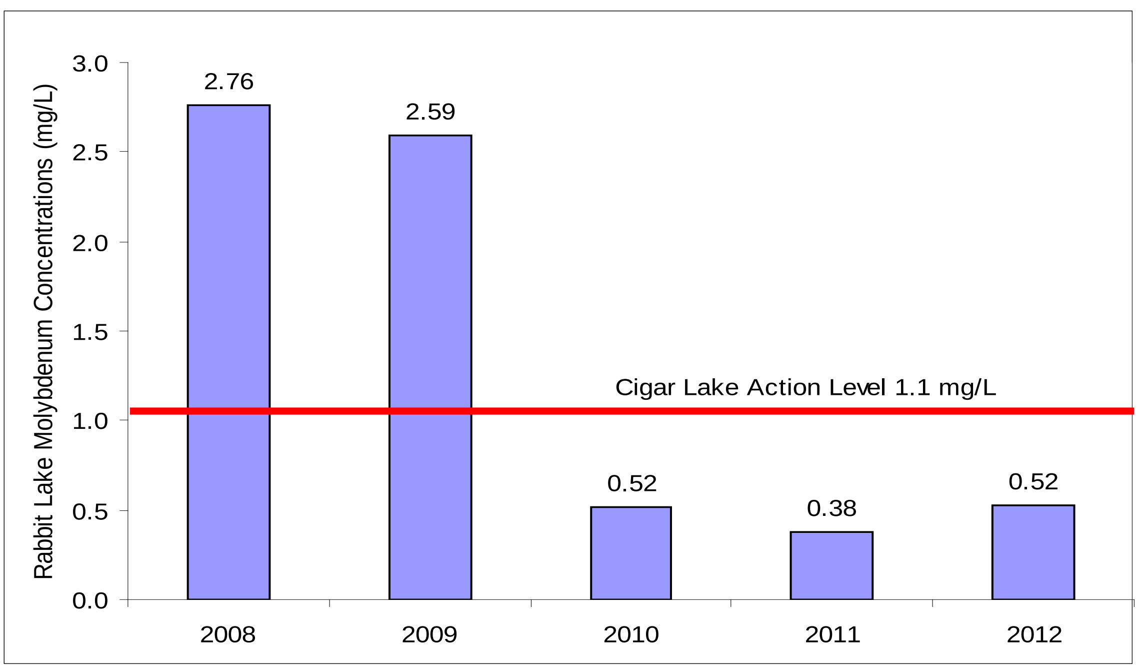
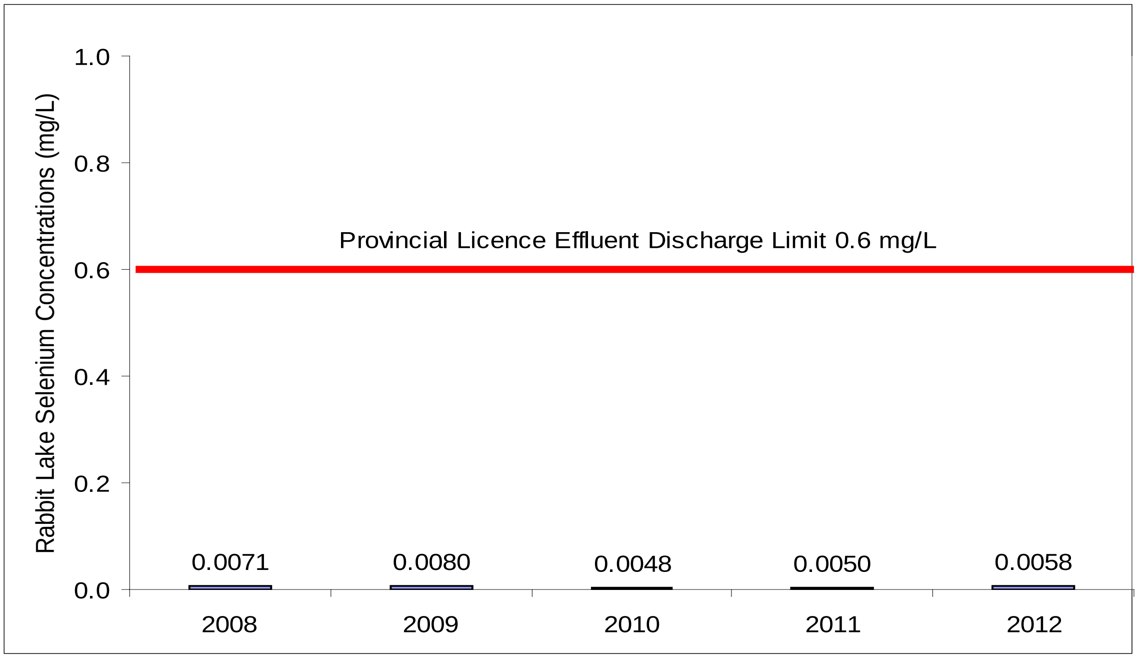
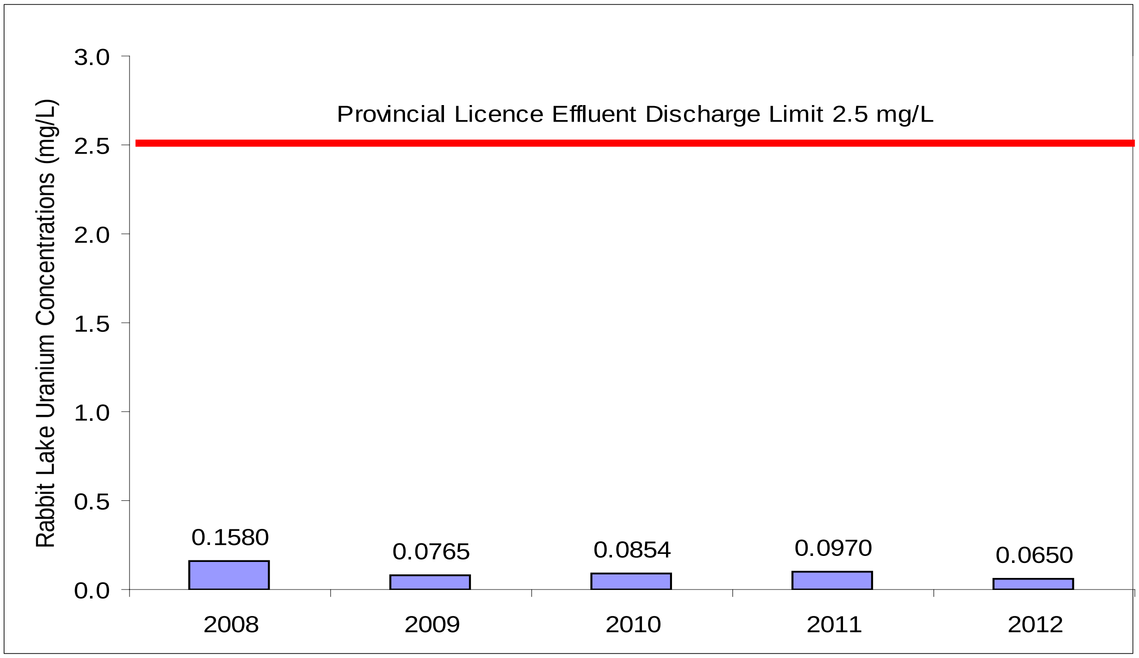


Figure 5-6: Rabbit Lake Operation – concentrations of selenium, 2008–2012
(the Province of Saskatchewan's discharge limit for selenium is shown for reference only)



The Rabbit Lake Operation is the oldest operating facility and is currently the only facility with both an operating mine and mill. It has a higher concentration of uranium in effluent relative to other operating mines. Uranium reduction, therefore, remains a key element of the facility's continuous improvement plans and is closely monitored by CNSC staff as required under a licence condition. Rabbit Lake has implemented mitigation measures in 2007 resulting in an approximate 86% reduction in the concentration of uranium in the treated effluent by May of 2007. The treatment circuit modifications have provided a steady reduction of uranium to meet the licensee's uranium target objective of 0.100 mg/L.

Figure 5-7: Rabbit Lake Operation – concentrations of uranium, 2008–2012
(the Province of Saskatchewan's discharge limit for uranium is shown for reference only)



5.4 Conventional Health and Safety

The CNSC and Saskatchewan Ministry of Labour Relations and Workplace Safety monitor the implementation of Cameco's occupational health and safety program to ensure compliance with regulatory requirements. To ensure continued strong safety performance, Cameco has implemented a safety and health management program to enhance identification and mitigation of risks. The program includes planned inspections, a safety permit system, occupational health committees, health centre operation, incident investigations and the management of safety equipment.

The conventional health and safety SCA is evaluated by CNSC staff through regular compliance activities. Compliance activities include inspections, reviews of incident reports, and monthly health and safety reports. CNSC compliance verification activities confirmed Cameco's strong focus on the prevention of accidents, on reducing lost-time injuries and the number of injuries requiring medical treatment.

Cameco's safety objectives for 2012 included adherence to routine requirements, increased safety awareness and incident reduction. CNSC staff agree with Cameco's strong focus on the prevention of accidents and on reducing LTIs.

In 2012, there was one LTI at the Rabbit Lake Operation. An underground mechanic was injured when he was struck by a scoop tram (a scoop tram is heavy front-loading equipment that scoops and loads underground ore). The mechanic entered the re-muck area unknown to the scoop tram operator. When the scoop tram entered the re-muck area, it struck the mechanic causing injury to his lower limbs. The emergency response team provided immediate emergency medical care and medivac'd the worker to the hospital who then underwent surgery. Also, as a consequence of the accident, radiological material was embedded in the lower limbs which resulted in a radiological exposure. Cameco will determine the actual internal radiation dose based on additional sampling. The preliminary estimate was an individual effective dose in the 10 to 20 mSv range.

Four corrective actions were identified as a result of the injury. The actions were to develop a formal communications protocol, improve training, limit the amount of communication/one-on-one contact between a vehicle operator and workers, and to develop a best practice in dealing with risks associated with employees and mobile equipment risks. Additional details on this LTI and Cameco's corrective actions are located in appendix H. CNSC staff will continue to monitor and ensure that effective corrective actions are implemented.

The Rabbit Lake LTI performance for 2008 to 2012 is shown in table 5-3.

Table 5-3: Rabbit Lake Operation – Total number of FTE workers and LTIs, severity rate and frequency rate, 2008–2012

RABBIT LAKE					
Year	**2008**	**2009**	**2010**	**2011**	**2012**
Total number of FTE workers*	610	528	524	551	719
No. of LTIs*	7	7	0	2	1
Severity rate*	14.9	86.0	27.6	10.9	22.6
Frequency rate*	1.2	1.3	0.0	0.4	0.1

* Definitions of these terms are located in the Glossary.

It should be noted that "days lost" used in the calculation of severity rate are recorded from the year in which they were lost. Therefore, the severity rate of 27.6 as shown in 2010 which had no lost-time injuries is a result of days lost from a lost-time injury which occurred in 2009.

There was a noteworthy near-miss incident at the Eagle Point mine in 2012. On October 23, 2012, an initial fall of ground within the mine was discovered. The rock fall continued incrementally over several days. While no one was hurt from the incident, there was the potential for injuries. Cameco implemented a series of measures which included: the immediate barricading of the area to prevent access; the initiation of an ongoing monitoring program of ground conditions in the affected area; the engagement of a third-party rock mechanics expert for an assessment; the inspection of the entire mine for similar geological conditions; and, the hiring of contract engineers to satisfy short-term staffing needs.

Root cause analyses identified two causes for the fall of ground:

1. The primary cause for this event was that the ground control monitoring program did not adequately recognize changing ground conditions and its impacts on the design. This root cause identified the lack of on-site mine engineering resources to adequately cover all the responsibilities and activities required of the department.
2. The incident occurred because the roof was not sufficiently supported for the combined span of the drift and stope. This root cause was an inadequacy in how potential ground control issues were being identified and dealt with at the Eagle Point mine.

As a result, seven corrective actions were identified. The corrective actions included:

- hiring of additional qualified personnel
- responsibilities to be clearly assigned
- identify and formalize ground control assessments
- review of the current weekly ground control inspection process
- review of the cable bolt design process
- increase frequency of procedural reviews
- specific ground control discussions at weekly mine safety meetings

CNSC staff will monitor the corrective actions to ensure they are effectively resolved and implemented.

Cameco’s incident reporting system includes near-miss criteria injury report numbers. CNSC staff observed that, along with the broadened scope of the injury incident category, there is also an improved reporting culture. This originates from a facility-wide recognition that the reporting of incidents offers significant value. These improvements indicate an increased focus by the licensee on the safety culture at the facility.

6 KEY LAKE OPERATION

Cameco's Key Lake Operation is located approximately 570 kilometres north of Saskatoon, Saskatchewan. The Key Lake Operation is owned and operated by Cameco Corporation. The Key Lake Operation began with two open pit mines and a mill complex. The Gaertner open pit was mined from 1983 to 1987, followed by mining of the Deilmann open pit until 1997. Milling of the Deilmann ore continued until 1999, when the McArthur River Operation began supplying ore slurry to the Key Lake mill (figure 6-1). The Key Lake Operation continues today as a mill operation processing McArthur River ore slurry.

Figure 6-1: Ore slurry being transported to the Key Lake Operation's mill – Source: Cameco

After open pit mining of the eastern pit of the Deilmann ore body was completed in 1995, the pit was converted into the engineered Deilmann Tailings Management Facility (figure 6-2). Mill tailings continue to be deposited into this facility today. Cameco envisions the Key Lake Operation as a "regional mill" in the future; offering milling services for a number of regional ore deposits.

Figure 6-2: Key Lake Operation's Deilmann Tailings Management Facility – Source: CNSC file image

Table 6-1 provides the Key Lake milling production data from 2008 to 2012. Both the mill feed grade and the percent uranium recovery have remained fairly consistent. Uranium concentrate production has increased with ore feed tonnage. It should be noted that while production of uranium concentrate has increased since 2008, the quality of mill effluent has improved significantly.

Table 6-1: Milling production data – Key Lake Operation, 2008–2012

Milling	2008	2009	2010	2011	2012
Mill ore feed (tonnes/year)	171,502	186,981	196,180	189,821	193,511
Average annual mill feed grade (%U_3O_8)	4.45%	4.68%	4.68%	4.85%	4.61%
% Uranium recovery	98.3%	98.5%	98.4%	98.7%	98.9%
Uranium concentrate produced (kg U_3O_8)	7,527,530	8,654,056	9,026,091	9,063,888	8,867,584
Milling - Licence production limit expressed as U_3O_8 (kg)	8,490,566	9,257,075	9,257,075	9,257,075	9,257,075

In 2009, the Key Lake mill licence was amended to allow annual production of 8,490,566 kg of U_3O_8 with the flexibility to produce 9,253,284 kg U_3O_8 to recoup production shortfalls accumulated since 2003.

The current licence was issued in October 2008 and expires on October 31, 2013. The licence was last amended in 2009 to allow for production flexibility. Cameco has applied for a licence renewal, and in October 2013 the Commission held a public hearing. At the time of writing this report, the Commission was in deliberation.

6.1 Performance

Based on the outcome of inspections, and reviews of the radiation protection program, work practices, monitoring results and effective doses in 2012, CNSC staff were satisfied that the Key Lake Operation is adequately controlling radiation doses to levels below the regulatory limits. CNSC staff concluded that the radiation protection program kept worker doses ALARA and the radiation protection SCA was rated as “satisfactory”.

CNSC staff concluded Cameco’s Key Lake Operation environmental program met all regulatory requirements during 2012 and all effluent discharged complied with licence requirements. This included the stabilization of reduced molybdenum and selenium concentrations in treated effluent. There were no reportable spills at the Key Lake Operation in 2012. The environmental protection SCA was rated as “satisfactory”.

CNSC staff observed that the health and safety program at Key Lake continues to be effective. CNSC staff verified that Cameco is committed to accident prevention and safety awareness. Improvements made to the health and safety program also indicated an increased focus by Key Lake on the safety culture at the facility. Cameco reported one lost-time injury at the Key Lake Operation in 2012. The conventional health and safety SCA was rated as “satisfactory”.

In follow-up to a Cameco’s Key Lake Operation licence condition, a significant excavation project was initiated in 2012 on the Deilmann Tailings Management Facility “Slope Stability Project”. CNSC staff conducted on-site inspections and desktop reviews and verified the project is progressing in accordance with the approved plan. This project proceeded without significant incident and Cameco anticipates completion by the end of 2013.

Cameco’s revitalization activities at Key Lake in 2012 included commissioning of the new acid, steam and oxygen plants, initiation of new calciner construction, replacement of the yellowcake storage building, and continuation of mill secondary containment and sump improvement program.

The Key Lake SCA ratings for the five-year period, 2008 to 2012, are shown in appendix C. For 2012, CNSC staff continue to rate all SCAs as “satisfactory”.

6.2 Radiation Protection

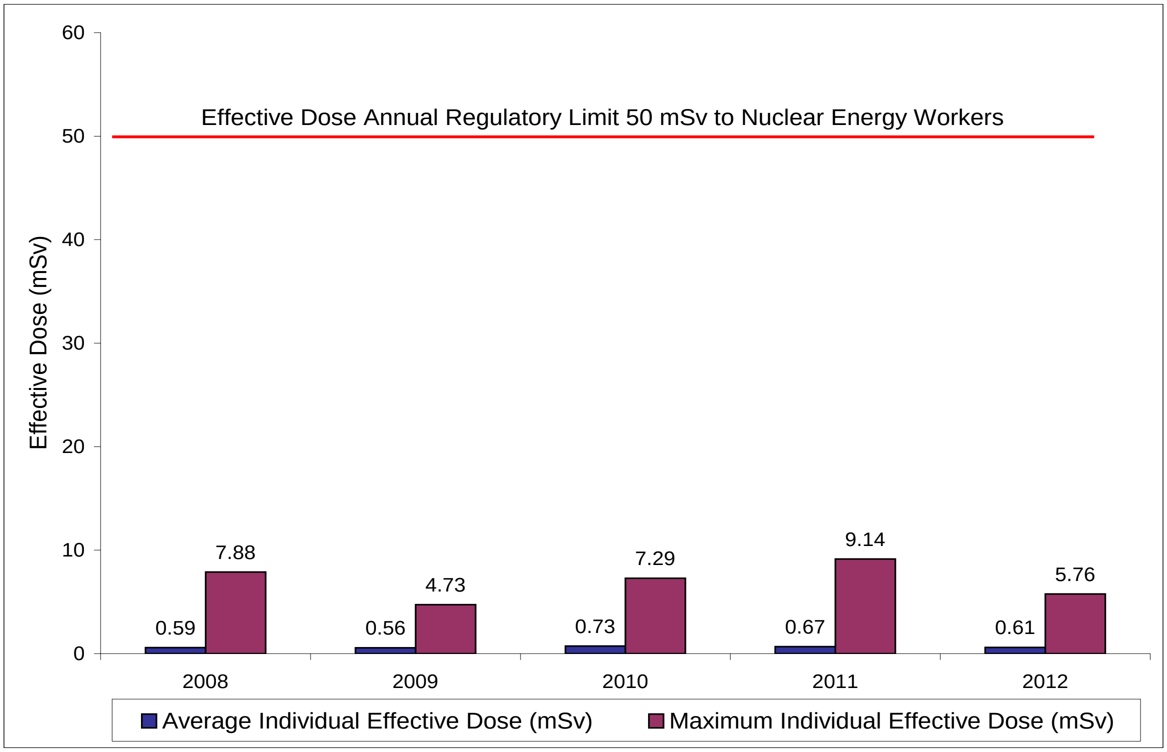
The source of radiological exposure at the Key Lake Operation is the milling of uranium ore received from the McArthur River mine. The three primary effective dose contributors are gamma radiation, radon progeny and long-lived radioactive dust (LLRD). During the 2012 review period, worker effective dose at the Key Lake mill was primarily from gamma radiation. Gamma radiation is controlled through the effective use of time, distance and shielding.

The alpha nuclear prism in figure 6-3 is a system that is intended for use in uranium mines and mills to provide a warning of potentially high working levels (WL) of radon progeny. The system incorporates three highly visible LED lamps of green, yellow and red. The green light as shown in figure 6-3 indicates that it is safe to enter and work in the area.

Figure 6-3: A prism located in the leaching area of the Key Lake Operation – Source: CNSC file image

As seen in figure 6-4, the individual effective doses to workers remains well below the annual regulatory limit of 50 mSv and has been consistently low from year-to-year. The average individual effective dose was 0.61 mSv while the maximum individual effective dose received was 5.76 mSv.

Figure 6-4: Key Lake Operation – effective dose trend to NEWs, 2008–2012



All five of the uranium mine and mill facilities have the same individual worker action levels for effective dose of 1 mSv/week and 5 mSv/quarter of a year.

There was one action level exceedance reported in 2012. In September 2012, a mill worker entered the calciner for routine cleaning and inspection. On completion of the work, the worker failed to submit a post-entry uranium-in-urine sample. As a result, although the worker was wearing appropriate personal protective equipment including a respirator, the worker did not receive a respirator credit. Therefore, the worker was assigned an event effective dose of 1.92 mSv, thereby exceeding the weekly action level of 1.0 mSv. The employee involved was disciplined for failing to follow procedure and the procedure was updated to assist in identifying similar events in time for alternative uranium-in-urine analysis.

In general, CNSC staff note that urine bioassay monitoring of employees in 2012 shows there was no general radioactive contamination or hygiene problems at Key Lake and that there was effective use of protective personal equipment to keep effective doses ALARA.

Improvements in Radiation Protection

Continual improvements to Cameco's radiation protection program were made in accordance with paragraph 4(*a*) of the *Radiation Protection Regulations* and CNSC guide document G-129, *Keeping Radiation Exposure and Doses "As Low as Reasonably Achievable"*.

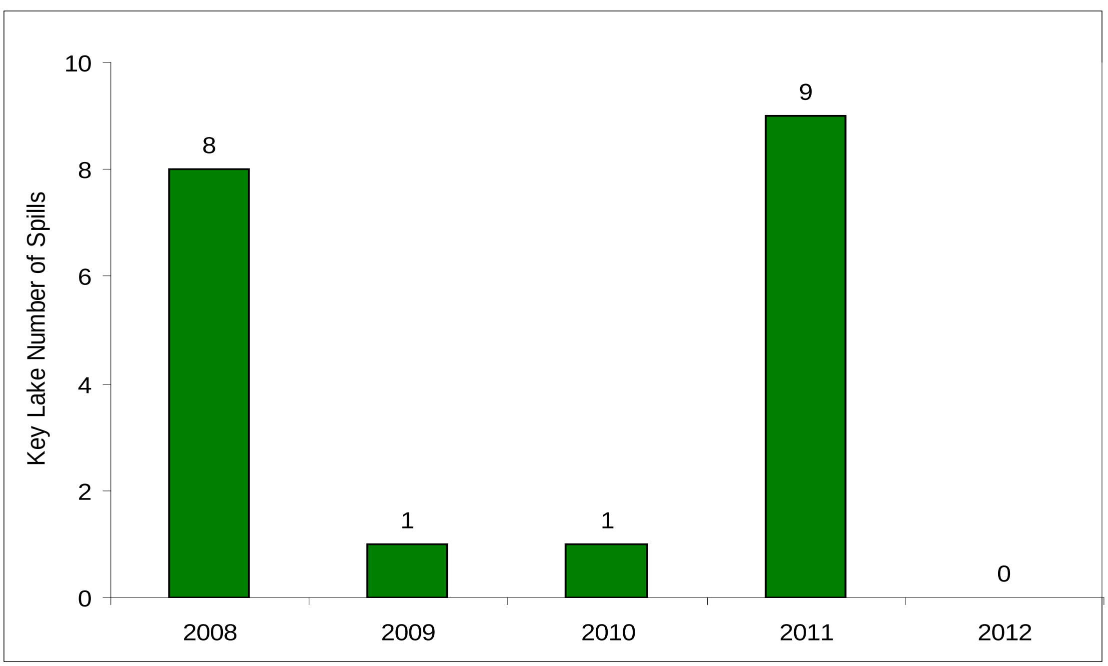
Through desktop reviews and inspections, CNSC staff concluded that an effective radiation protection program exists at the Key Lake Operation. In 2012, CNSC staff noted an improved training compliance program and the implementation of a radiation awareness campaign. The radiation awareness campaign targets Key Lake workers, through many activities, to enhance their knowledge and understanding of radiation.

6.3 Environmental Protection

In accordance with Key Lake's environmental protection program, effluent and environmental monitoring, site inspections, environmental awareness training and program implementation audits were carried out by Cameco or third-party consultants during 2012. CNSC staff assessed that Key Lake's environmental monitoring programs met all regulatory requirements during 2012 and all effluent discharged complied with licence requirements.

CNSC staff were concerned about the number of spills in the first eight months of 2011 resulting from regular operational activities. The facility's management confirmed they were equally concerned and took corrective actions. As a result of these corrective actions, such as raising awareness through town hall meetings and implementation of a breach of containment procedure, there were no reportable spills in the last four months of 2011 or in all of 2012 (figure 6-5).

Figure 6-5: Key Lake Operation – environmental reportable spills, 2008–2012



At the Key Lake Operation, there are two effluent streams that are processed in separate treatment facilities before being released to the environment:

- Mill effluent is processed with a treatment system of thickeners and sedimentation processes and released to the David Creek system.
- Effluent from dewatering wells of the Gaertner Pit and Deilmann Pit hydraulic containment systems is treated with a reverse osmosis system before being released to the McDonald Lake system.

The McDonald Lake system generally displays very clean effluent qualities from undergoing treatment through a reverse osmosis system. Concentrations of contaminants in treated effluent from the reverse osmosis system are extremely low and do not pose an environmental concern. The Key Lake treated effluent quality further discussed in this report refers only to the mill effluent as released to the David Creek system.

Molybdenum, Selenium and Uranium in Effluent

The annual average concentration values of the treated effluent were well below the regulatory limits. There were also no exceedances of treated effluent action levels at Key Lake during 2012.

Molybdenum, selenium and uranium have been identified as contaminants of concern from treated effluent at uranium mines and mills. As molybdenum and selenium concentrations were the primary concerns at Key Lake, Cameco targeted process changes to reduce these concentrations in treated effluent.

Cameco’s licence for the Key Lake Operation required an action plan to reduce molybdenum and selenium concentrations in the mill’s effluent to limit the risk to the environment. The molybdenum and selenium removal circuit shown in figure 6-6 became operational in 2009 and continued to operate effectively in 2012.

Figure 6-6: Key Lake’s effluent water treatment plant – Source: CNSC file image

Significant reductions and the stabilization of molybdenum and selenium concentrations in treated effluent from 2008 to 2012 are shown in figures 6-7 and 6-8. CNSC staff also note that reductions from 2009 to 2012 of molybdenum and selenium concentrations occurred during a period of increased uranium production. Continued monitoring of molybdenum and selenium in the receiving environment is expected to demonstrate stabilization and/or improvements over the coming years.

Figure 6-7: Key Lake Operation – concentrations of molybdenum, 2008–2012 (the Cigar Lake action level for molybdenum is shown for reference only)

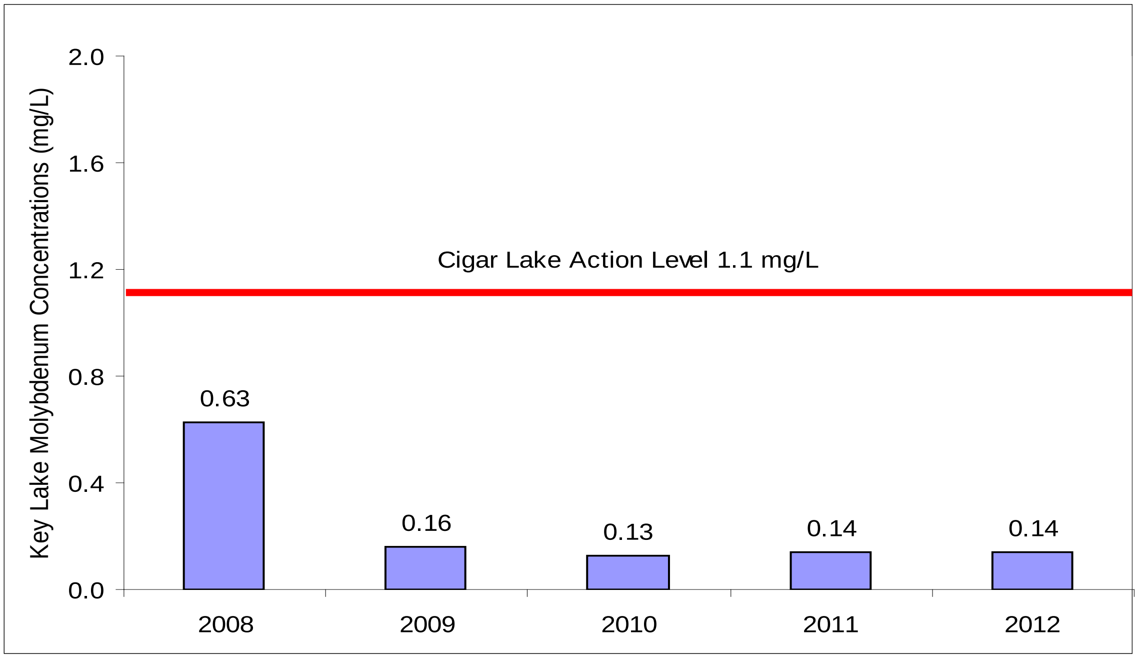
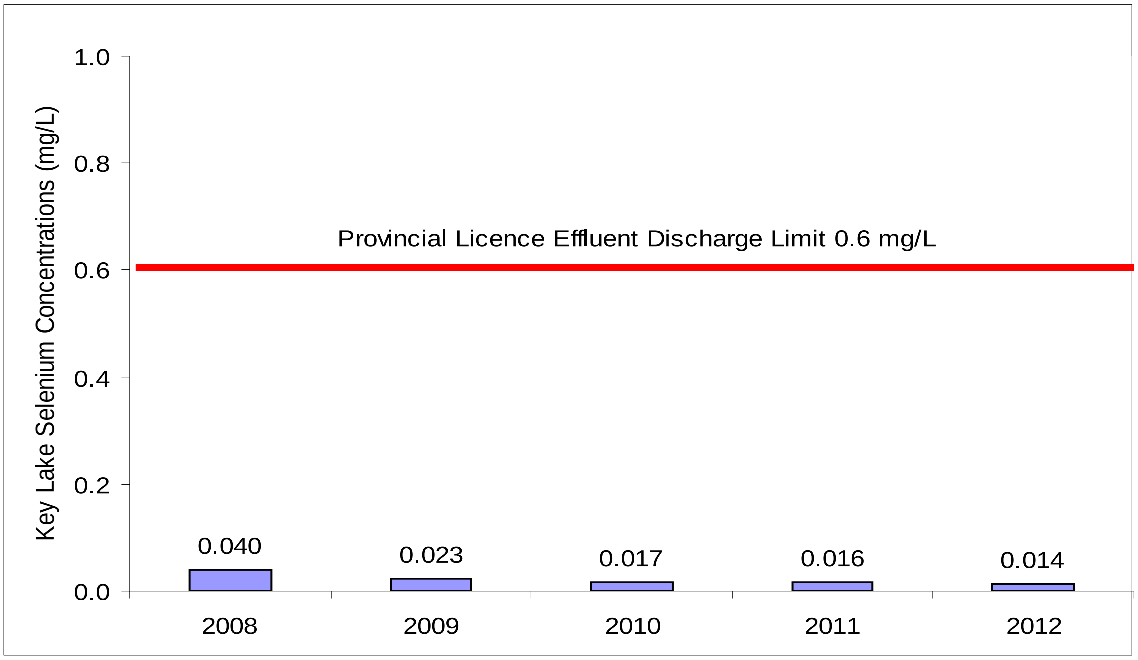
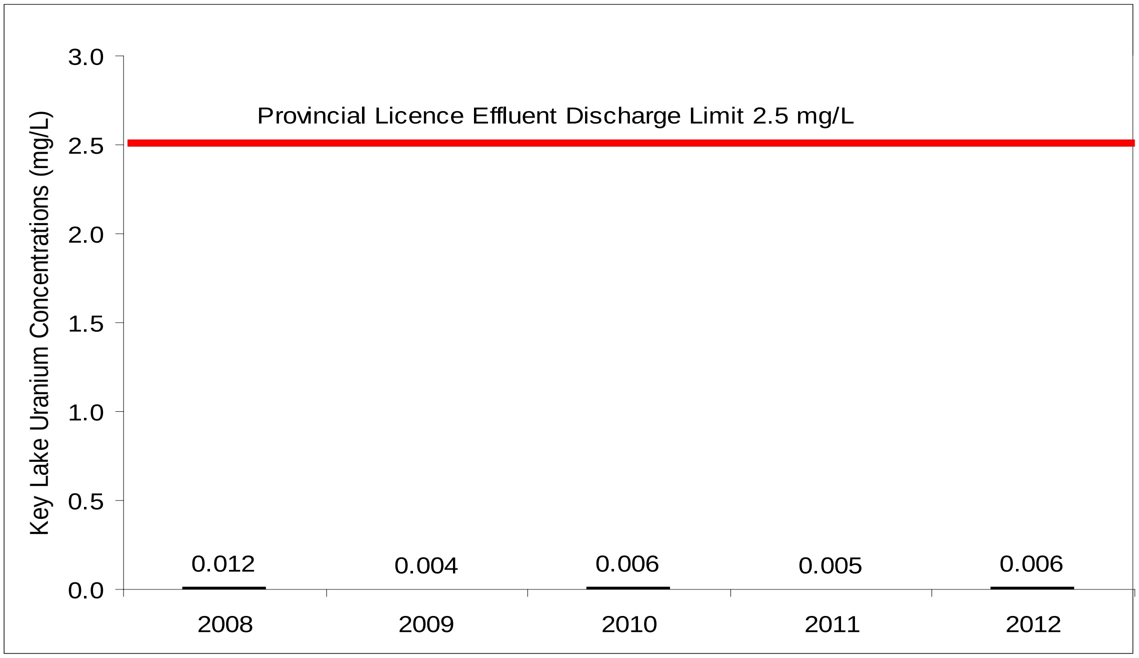


Figure 6-8: Key Lake Operation – concentrations of selenium, 2008–2012 (the Province of Saskatchewan's discharge limit for selenium is shown for reference only)



Uranium concentrations in treated effluent released from the Key Lake mill have always been low and have not required specific CNSC regulatory attention. However, figure 6-9 indicates a decrease of uranium in the effluent starting in 2009 in response to the series of mill and water treatment initiatives put in place.

Figure 6-9: Key Lake Operation – concentrations of uranium, 2008–2012 (The Province of Saskatchewan's discharge limit for uranium is shown for reference only)



6.4 Conventional Health and Safety

The CNSC and Saskatchewan Ministry of Labour Relations and Workplace Safety monitor implementation of Cameco's occupational health and safety program to ensure compliance with regulatory requirements. To ensure continued strong safety performance, Cameco has implemented a safety and health management program to enhance identification and mitigation of risks. CNSC staff observed that the safety program at the Key Lake Operation continues to provide education, training, tools and support to ensure safe, quality production. They also note that Cameco's approach continues to be that safety is the responsibility of all individuals on site, and that this is promoted by management, supervisors and workers. Cameco is continually seeking input from employees to be involved and to improve the program. During inspections, discussions and review of incidents, CNSC staff verified that Cameco is committed to accident prevention and safety awareness. Through regular communication, management oversight of work and continually improving safety systems, Cameco's management and supervisors stress the importance of conventional health and safety, both at work and at home.

There were a total of 13 lost-time incident (LTIs) from 2008 to 2012 at the Key Lake Operation, with one LTI occurring in 2012.

On May 11, 2012, an employee, while working on an engine, lost his footing and fell 0.6 m to the ground. The fall resulted in a badly fractured wrist. Cameco implemented one corrective action as a result of the injury which stressed the importance of pre-evaluating the risks of the job. Details on this event can be found in appendix H.

The 2012 LTI performance shows an improvement in the frequency rate with one LTI in 2012 (table 6-2).

Table 6-2: Key Lake Operation – Total number of FTE workers and LTIs, severity rate and frequency rate, 2008–2012

KEY LAKE					
Year	**2008**	**2009**	**2010**	**2011**	**2012**
Total Number of FTE Workers*	468	489	786	886	736
No. of LTIs*	2	4	3	3	1
Severity Rate	106.5	13.8	26.0	13.1	21.6
Frequency Rate	0.4	0.8	0.4	0.3	0.1

* Definitions of these terms are located in the Glossary.

The site uses leading key performance indicators (KPIs) to monitor preventative efforts. The indicators include compliance to completing job task observations, safety meeting attendance, and supervisory oversight. The site met all its KPI targets in 2012.

Contractor safety risk continues to be effectively managed. At the end of 2012, the site reported that contractors had no lost-time incident over the past five years.

The Key Lake site revitalization project continues to require increased manpower requirements, and three registered nurses maintain the occupational, chronic and acute care of workers with external health care providers; the workers received better quality care from the health care system as a result of the nurses' assistance.

Cameco's incident reporting system includes near-miss criteria injury report numbers. CNSC staff observed that, along with the broadened scope of the injury incident category, there is also an improved reporting culture. This originates from a facility-wide recognition that the reporting of incidents offers significant value. These improvements indicate an increased focus by the licensee on the safety culture at the facility.

7 McCLEAN LAKE OPERATION

The McClean Lake Operation is located about 750 kilometres north of Saskatoon, Saskatchewan, and is operated by AREVA Resources Canada Inc. (AREVA). Construction of the McClean Lake Operation began in 1994. Mining and milling of uranium ore from five open-pit mines has been completed. No conventional mining has been carried out at McClean Lake since 2008. The mill tailings resulting from these open pit operations have been deposited within the JEB Tailings Management Facility which was constructed in the mined-out JEB open pit.

The mill at the McClean Lake Operation is referred to as the JEB Mill. The JEB Mill stopped producing uranium concentrate during July 2010. No uranium concentrate was produced in 2011 or 2012. The only mill circuits that operated during 2012 were the water treatment plants, the tailings preparation circuit and the utilities plant. The McClean Lake Operation is expected to restart the uranium concentrate production circuits in mid-2013 to prepare for the receipt of ore from Cameco's Cigar Lake Operation during the last quarter of 2013.

AREVA is operating a test program to develop a mining method to extract uranium mineralization by hydraulic borehole (jet boring) from surface (figure 7-1). The name of this program was changed in 2012 from the Mine Equipment Development (MED) Program to the Surface Access Borehole Resource Extraction (SABRE) Project. A small amount of ore was extracted by the project in 2012.

Figure 7-1: AREVA's McClean Lake Operation's Surface Access Borehole Resource Extraction (SABRE) Project – Source: AREVA

Tables 7-1 and 7-2 display the production data for mining and milling from 2008 to 2012.

Table 7-1: Mining production data – McClean Lake Operation, 2008-2012

Mining*	2008	2009	2010	2011	2012
Ore tonnage (tonnes/year)	306,293	759	360	Nil	1,022
Average ore grade mined (%U_3O_8)	1.16%	7.43%	3.96%	Nil	4.76%
U_3O_8 mined (kg)	3,537,964	56,388	25,047	Nil	48,653

* The last ore from the Sue E pit was mined on March 15, 2008, and the Sue B pit's last ore was mined on November 26, 2008. Mined production since then is from the SABRE Project.

Table 7-2: Milling production data – McClean Lake Operation, 2008–2012

Milling	2008	2009	2010	2011	2012
Mill ore feed (tonnes/year)	160,829	181,203**	97,167**	Nil*	Nil*
Average annual mill feed grade (%U_3O_8)	0.96%	0.97%	0.80%	Nil*	Nil*
% Uranium recovery	94.3%	93.9%	95.7%	Nil*	Nil*
Uranium concentrate produced (kg U_3O_8)	1,474,455	1,634,220**	784,309**	Nil*	Nil*
Milling – Licence production limit expressed as U_3O_8 (kg)	3,629,300	3,629,300	3,629,300	3,629,300	5,909,090

* The JEB Mill stopped producing uranium concentrate during July 2010.
** Ore that had been mined before the end of 2008 and ore extracted during the SABRE Project were processed by the JEB Mill during 2009 and 2010.

The current licence was issued in July 2009, amended on December 19, 2012 and expires on June 30, 2017. The amended licence authorizes:

- the operation of the ore slurry receiving circuit and high grade milling circuits in the JEB Mill
- the processing of ore slurry from the McArthur River mine during the restart of the JEB Mill; and
- the increase of the maximum annual uranium concentrate (U_3O_8) production from 3,629,300 kg to 5,909,090 kg

The amended licence was issued in the new format accompanied by a licence conditions handbook (LCH).

7.1 Performance

In 2012, there was no mining or milling at AREVA's McClean Lake Operation. Significant activity in 2012 was focused on the hiring and training of staff in preparation for the restart of milling operations.

Based on CNSC staff's verification of program activities, AREVA is adequately controlling radiation doses at the McClean Lake Operation to levels below the regulatory limits. CNSC staff concluded that the radiation protection program kept worker doses ALARA and the radiation protection SCA was rated as "satisfactory".

CNSC staff concluded AREVA's McClean Lake environmental program met regulatory requirements during 2012 and effluent discharged complied with licence requirements. There were six reportable spills at the McClean Lake Operation in 2012 with no residual impacts to the environment. The environmental protection SCA was rated as "satisfactory".

AREVA continues to maintain a health and safety program at the McClean Lake Operation to minimize occupational health and safety risks and to continually improve performance. AREVA has an effective occupational health and safety committee and completes regular reviews of its safety program. CNSC staff verified that the health and safety program at McClean Lake continues to be effective. AREVA reported one lost-time incident at the McClean Lake Operation in 2012. The conventional health and safety SCA was rated as “satisfactory”.

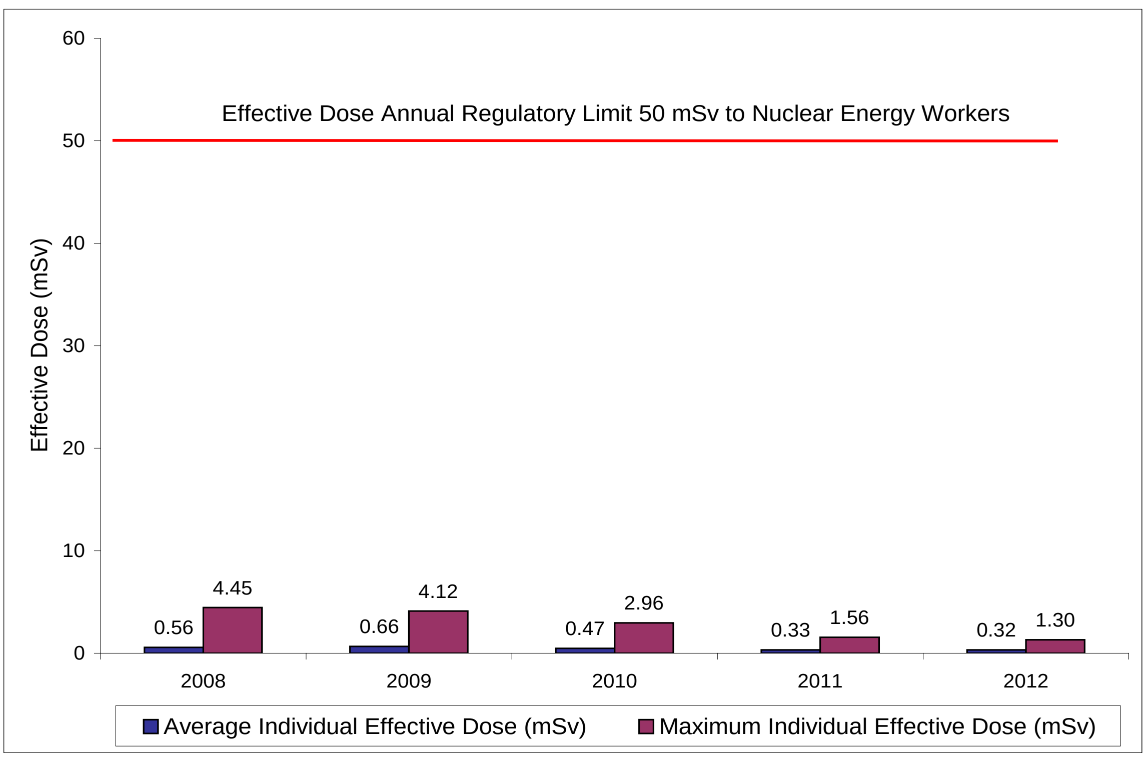
The McClean Lake SCA ratings for the five-year period, 2008 to 2012, are shown in appendix C. For 2012, CNSC staff continue to rate all SCAs as “satisfactory”.

7.2 Radiation Protection

The source of radiological exposure at the McClean Lake Operation is from the radioactive decay of natural uranium. The three primary effective dose contributors are gamma radiation, radon progeny and long-lived radioactive dust (LLRD).

Figure 7-2 displays the average individual effective dose and the maximum individual effective dose for 2008 to 2012. In 2011 and 2012, there was no mining or milling at McClean Lake Operation which resulted in lower average individual effective dose and maximum individual effective dose. Construction and maintenance were the main activities taking place at the mill during 2011 and 2012. Therefore, the average annual effective dose for mill maintenance workers was the highest of all groups at 0.40 mSv. The average individual effective dose was 0.32 mSv while the maximum individual effective dose received was 1.30 mSv. Annual individual effective doses to workers at the McClean Lake Operation remain well below the annual regulatory limit of 50 mSv.

Figure 7-2: McClean Lake Operation – effective dose trend to NEWs, 2008–2012



All five of the uranium mine and mill facilities have the same individual worker action levels for effective dose of 1 mSv/week and 5 mSv/quarter of a year. There were no exceedances of either the 1 mSv/week or 5 mSv/quarter action levels during 2012.

A procedural non-conformance occurred when a high-pressure water pump was transported from the McClean Lake Operation without first being cleared for release. The pump was later found to be contaminated with low levels of radiation and was returned to McClean Lake for decontamination. AREVA's subsequent investigation led to the implementation of corrective and preventative actions in the management of transported equipment. CNSC staff were satisfied with the corrective actions taken.

Improvements in Radiation Protection

Continual improvements to AREVA's radiation protection program at the McClean Lake Operation were made in accordance with paragraph 4(*a*) of the *Radiation Protection Regulations* and CNSC guide document G-129, *Keeping Radiation Exposure and Doses "As Low as Reasonably Achievable"*.

CNSC staff noted some improvements to the radiation protection program in 2012 including the revision of the advanced radiation protection training program to incorporate interactive learning techniques.

7.3 Environmental Protection

In accordance with AREVA's environmental protection program, effluent and environmental monitoring, site inspections, environmental awareness training and program implementation audits were carried out by AREVA or third-party consultants during 2012.

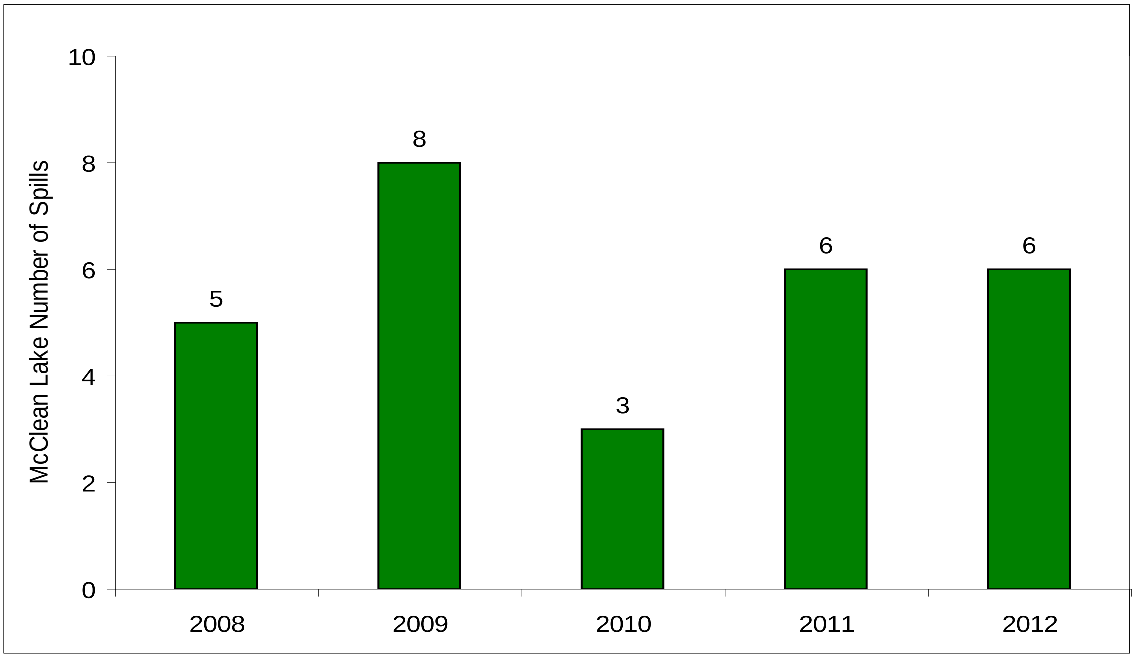
CNSC staff assessed that McClean Lake's environmental monitoring programs met all regulatory requirements during 2012 and all effluent discharged complied with licence requirements.

Six reportable spills occurred at McClean Lake during 2012 (figure 7-3). The spills did not result in significant impacts to the environment. Spilled materials included:

- 1,400 L (1.4 m^3) of diesel fuel
- 10 L (0.01 m^3) of radiologically contaminated pond water
- 0.25 m^3 of slightly radiologically contaminated soil
- 3,000 L (3.0 m^3) of treated mine water
- 4,500 L (4.5 m^3) of mill process water
- water seepage from under the surface mining test drill pad

Spilled materials were recovered in a timely manner. The spill events were investigated by AREVA with preventative and corrective measures implemented. CNSC staff were satisfied with the actions taken by AREVA. Appendix G further describes the spills and corrective actions that were implemented.

Figure 7-3: McClean Lake Operation – environmental reportable spills, 2008–2012



Treated Effluent Released to the Environment

At the McClean Lake Operation, the effluent is released to the environment via the Sink/Vulture treated effluent management system. There were no treated effluent regulatory discharge limit exceedances at the JEB water treatment plant during 2012. The JEB water treatment plant (figure 7-4) receives contaminated water, removes dissolved metals and suspended solids and then discharges the treated effluent to the Sink/Vulture treated effluent management system. Contaminated water inflows include mill facility runoff, tailings management facility raise and reclaim water, tailings thickener overflow, and sewage.

Figure 7-4: McClean Lake's JEB water treatment plant – Source: CNSC file image

Molybdenum, Selenium and Uranium in Effluent

The JEB mill ceased normal operations in July 2010. Since then the concentrations of molybdenum, selenium and uranium in treated effluent have decreased and remained low compared to the operating years (figures 7-5, 7-6 and 7-7). Figure 7-5 displays reduced molybdenum concentrations in treated effluent from 2008 to 2012 which are well below the Cigar Lake action level (shown for reference only).

Figure 7-5: McClean Lake Operation – concentrations of molybdenum from JEB water treatment plant, 2008–2012 (the Cigar Lake action level for molybdenum is shown for reference only)

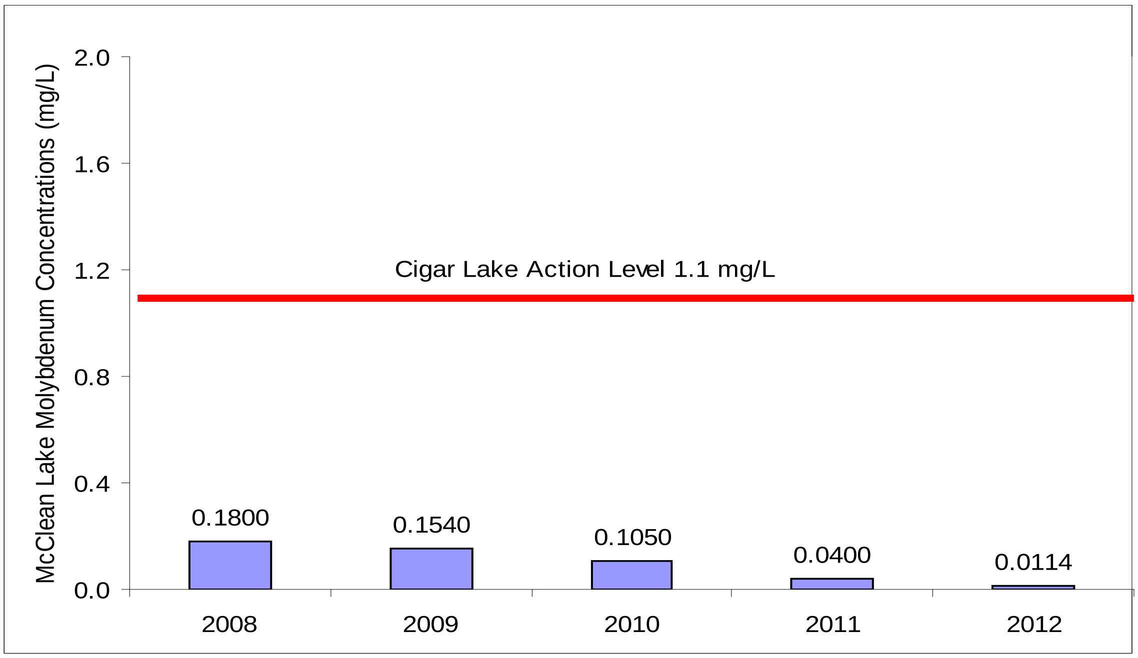


Figure 7-6 displays selenium concentrations in treated effluent well below the Saskatchewan Ministry of Environment licensed limit of 0.6 mg/L.

Figure 7-6: McClean Lake Operation – concentrations of selenium from JEB water treatment plant, 2008–2012 (the Province of Saskatchewan's selenium discharge limit is shown for reference only)

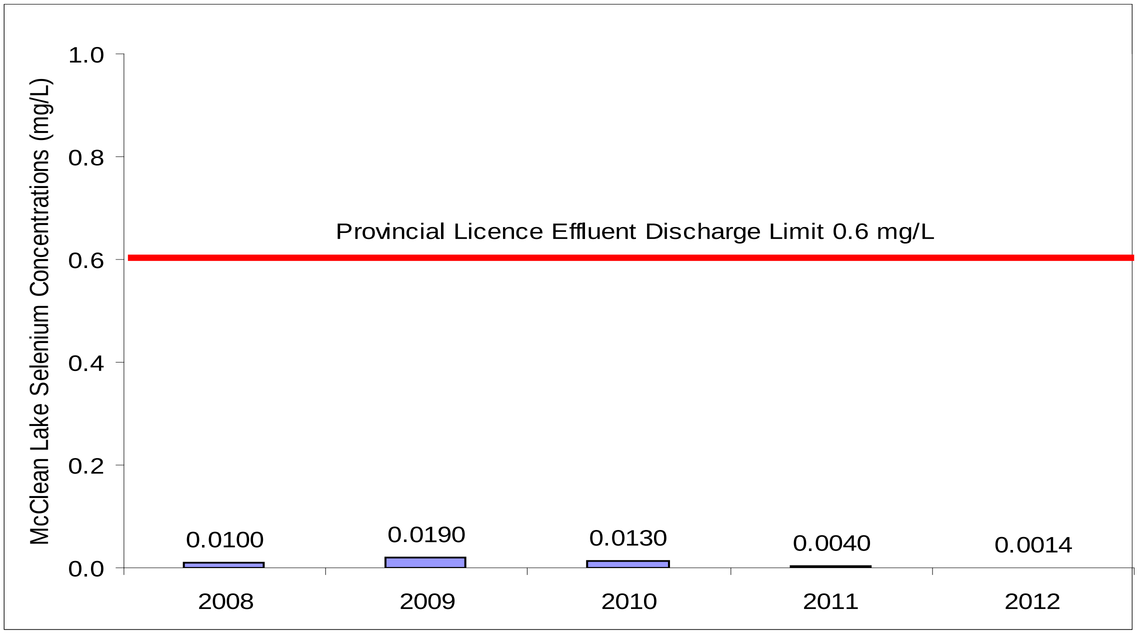
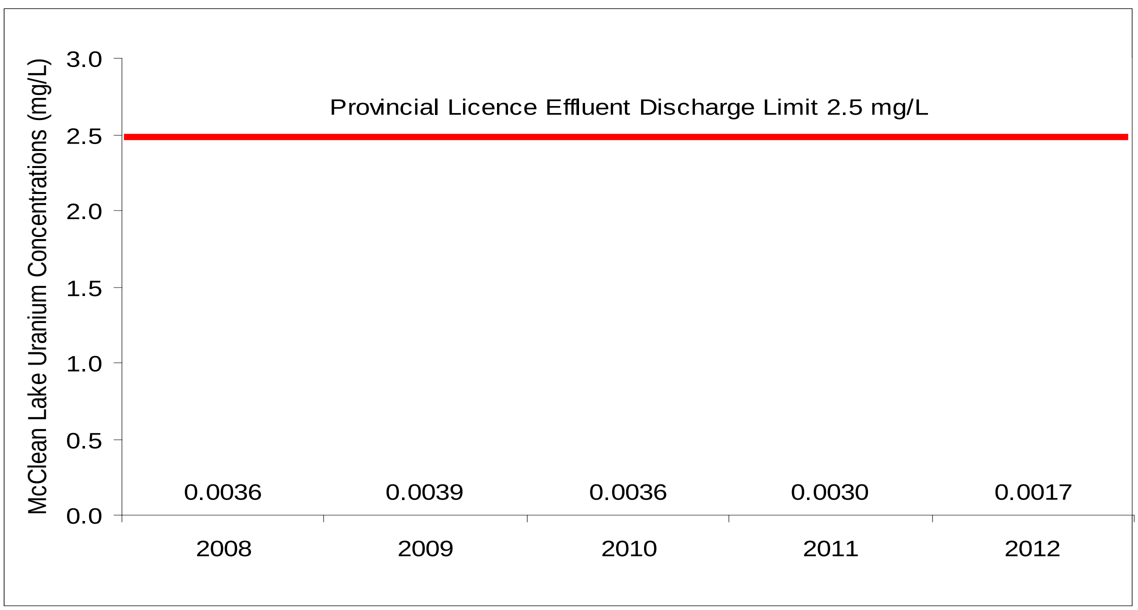


Figure 7-7 displays reduced concentrations of uranium in treated effluent from 2008 to 2012 and are well below the Saskatchewan Ministry of Environment licensed limit of 2.5 mg/L.

Figure 7-7: McClean Lake Operation – concentrations of uranium from JEB water treatment plant, 2008–2012 (The Province of Saskatchewan's uranium discharge limit is shown for reference only)



7.4 Conventional Health and Safety

The CNSC and Saskatchewan Ministry of Labour Relations and Workplace Safety monitor implementation of AREVA's occupational health and safety program to ensure compliance with regulatory requirements. To ensure a continued strong safety performance, AREVA has implemented a health and safety program to minimize occupational health and safety risks and to continually improve its health and safety performance. AREVA has an active joint occupational health and safety committee and completes regular reviews of its safety program.

In 2012, the McClean Lake Operation participated in a maintenance audit of the Occupational Health and Safety Assessment Series OHSAS 18001: 2007, verifying the adherence to the management system certification attained in 2008.

From 2008 to 2012, AREVA reported four LTIs with one reported in 2012. A worker strained his back when reaching to make a valve adjustment and lost three days of work. AREVA communicated and discussed the incident with employees re-emphasizing proper positioning and reach. AREVA also implemented an engineering control to prevent recurrence through positioning and reach. CNSC staff were satisfied with AREVA's corrective actions. Further details on this event can be found in appendix H.

Table 7-3 shows consistent performance to the number of LTIs and frequency rate with one LTI in 2012.

Table 7-3: McClean Lake Operation – Total number of FTE workers and LTIs, severity rate and frequency rate, 2008–2012

McCLEAN LAKE					
Year	**2008**	**2009**	**2010**	**2011**	**2012**
Total Number of FTE Workers*	452	308	225	163	249
No. of LTIs*	2	0	1	0	1
Severity Rate*	5.5	4.1	13.3	0.0	1.2
Frequency Rate*	0.4	0.0	0.4	0.0	0.4

* Definitions of these terms are located in the Glossary.

In addition to the above LTI, there was a conventional health and safety incident that occurred at the potable water treatment plant in 2012. Falling ice outside of the potable water treatment plant exerted pressure on the propane line causing it to fail inside the building. Propane gas was released and was ignited by a propane fired heater. The fire was controlled by the building sprinkler system and AREVA's emergency response team responded. The mill workers were temporarily evacuated. No workers were injured.

A third-party engineering contractor performed an assessment of the potable water treatment building's integrity and determined the event caused damage to a cinder block wall. The cinder block wall was stabilized, removed and rebuilt. All propane installations were reviewed to ensure they met regulatory requirements and AREVA installed propane gas detectors with alarms as applicable. CNSC staff verified and were satisfied with the corrective actions taken.

AREVA investigates safety concerns and incidents including near-miss events. Corrective actions are implemented and the effectiveness verified and documented by management. CNSC staff observed that AREVA actively strives to involve all levels of the organization in its health and safety program. Employees are actively encouraged and trained to continuously identify and assess risks and propose solutions.

PART II: URANIUM PROCESSING FACILITIES

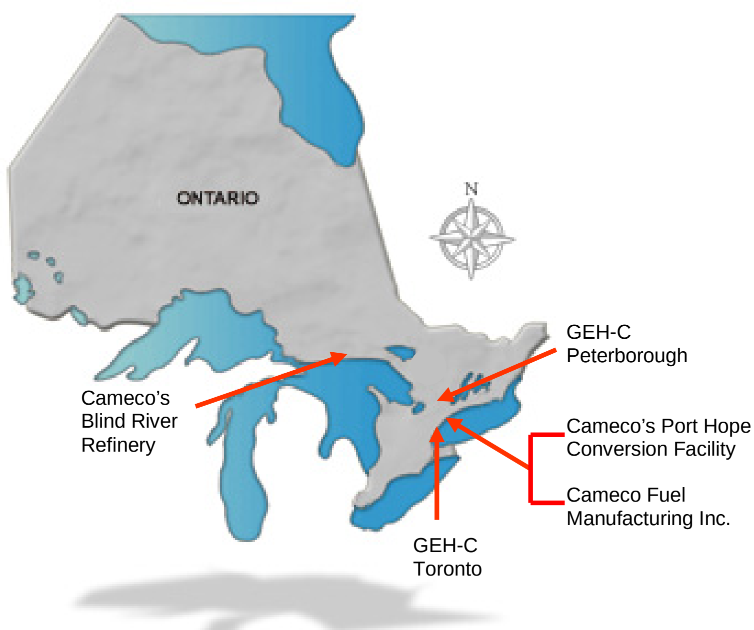
8 Overview

Part II of this report focuses on the five uranium processing facilities in Canada. They are:

- Cameco Corporation (Cameco): Blind River Refinery (BRR)
- Cameco Corporation (Cameco): Port Hope Conversion Facility (PHCF)
- Cameco: Fuel Manufacturing Inc. (CFM)
- GE Hitachi Nuclear Energy Canada Incorporated (GEH-C): Peterborough facility
- GE Hitachi Nuclear Energy Canada Incorporated (GEH-C): Toronto facility

The three Cameco facilities operate under separate operating licences issued in March 2012. Blind River Refinery and Fuel Manufacturing Inc. facility licences expire February 2022 and the Port Hope Conversion Facility licence expires February 2017. The two GEH-C facilities operate under a combined licence issued in January 2011 and expiring December 2020. All five facilities are located within the province of Ontario, as shown in figure 8-1 below.

Figure 8-1: Location of uranium processing facilities in Ontario, Canada



With recent licence renewals for Cameco's uranium processing facilities, the licence form and structure were updated, along with the inclusion of the licence conditions handbook (LCH). The LCH consolidates into one document the compliance verification criteria for applicable safety and control areas (SCAs); as well, it provides clarity on interpretations and administrative control of the licence conditions issued by the Commission.

In 2012, CNSC staff compliance activities were driven by desktop reviews of licensee updated programs in various SCAs, oversight of facility and equipment modifications, oversight of licensee response to events and incidents, and verification of licensee compliance to the LCH. CNSC staff adopt a graded approach to compliance oversight of these facilities, based on a risk ranking of the type of activities at these facilities and the associated hazards.

In 2012, CNSC staff performed 16 compliance inspections at the five uranium processing facilities. All issues identified during these inspections are being addressed by the licensees. On August 14, 2012, CNSC staff presented an event initial report (CMD 03-M68) to the commission on an incident that occurred at Cameco's Blind River Refinery on June 23, 2012. The incident occurred when an operator unknowingly opened a pressurized drum of uranium concentrate that resulted in contamination of three workers. Cameco conducted an investigation and took corrective actions to prevent a similar incident from occurring again. In September 2012, CNSC staff conducted an inspection to verify the effectiveness of Cameco's corrective actions. The inspection revealed that an inadequate job hazard analysis (JHA) had been performed to safely handle and process quarantined drums of uranium concentrate involved in the June 2012 incident. As a result, CNSC staff issued an order to Cameco to suspend all refining activities of uranium concentrates from Uranium One's Willow Creek Mine (product drums involved in the June 2012 incident), until such time that a safe work plan to depressurize them had been developed by Cameco and that the plan had been reviewed and deemed safe by a qualified third party, and that the plan had been reviewed and deemed satisfactory by CNSC staff. On October 26, 2012, CNSC staff closed the order following Cameco's JHA submission that was deemed safe by a qualified third party. Additional details of the June 2012 pressurized drum incident and associated corrective actions taken by Cameco are found in section 9.1 of this report.

Each of the five uranium processing facilities is also required, as per their operating licences, to submit an annual report by March 31 of each year, reporting on the operations of their facilities. These reports contain facility performance information including annual production volumes, improvements to programs in all SCAs, and details related to environmental, radiological and safety performance, including any events and associated corrective actions. CNSC staff review these reports as part of compliance oversight to ensure adherence of the licensee to production limits as specified in the licence, performance with respect to licence limits on effluents and emissions, and compliance to other licence conditions. The full versions of these reports are available on the licensees' Web sites.

A list of these Web sites is provided below:

Cameco – Blind River Refinery
cameco.com/fuel_services/blind_river_refinery/

Cameco – Port Hope Conversion Facility
cameco.com/fuel_services/port_hope_conversion/

Cameco Fuel Manufacturing
cameco.com/fuel_services/fuel_manufacturing/

GE Hitachi Nuclear Energy Canada
site.ge-energy.com/prod_serv/products/nuclear_energy/en/ge_canada.htm

CNSC staff used licensee submitted annual reports, review of licensee programs, and licensee response to events and incidents, as well as field observations during inspections, to compile the 2012 performance ratings for the uranium processing facilities, as presented in table 8-1. For 2012, CNSC staff ratings for all individual SCAs were "satisfactory" for the uranium processing facilities, except for GEH-C which was given a "fully satisfactory" rating in the SCA of environmental protection. Appendix C contains the ratings from 2008 to 2012 for each facility.

Table 8-1: Fuel cycle facilities – SCA performance ratings, 2012

Safety and control area	Blind River Refinery	Port Hope Conversion Facility	Cameco Fuel Manufacturing	GEH-C Toronto and Peterborough
Management system	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA
Physical design	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA
Environmental protection	SA	SA	SA	FS
Emergency management and fire protection	SA	SA	SA	SA

Safety and control area	Blind River Refinery	Port Hope Conversion Facility	Cameco Fuel Manufacturing	GEH-C Toronto and Peterborough
Waste management	SA	SA	SA	SA
Security	SA	SA	SA	SA
Safeguards	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA

8.1 Radiation Protection

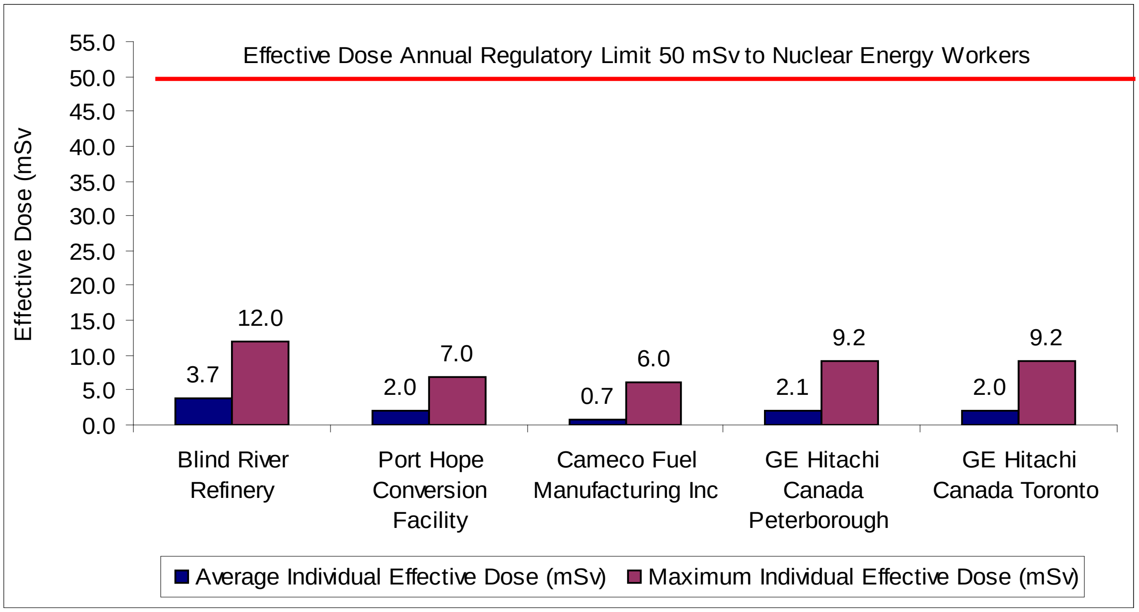
For 2012, CNSC staff continue to rate the radiation protection SCA at all five uranium processing facilities as “satisfactory”.

The *Radiation Protection Regulations* (RPR) requires each CNSC licensee to implement a radiation protection program that keeps radiation doses “as low as reasonably achievable” (the ALARA principle), social and economic factors taken into consideration. The RPR also require licensees to ascertain dose as a result of the licensed activity.

The CNSC evaluates each licensee’s radiation protection program through several methods, including desktop reviews, facility inspections and review of each licensee’s annual compliance report.

Radiological exposures to workers at these facilities primarily result from the internal (inhalation) of and external exposure to natural uranium. Internal doses are typically ascertained by a combination of air monitoring, urine bioassay and thorax burden measurements. Each facility uses a licensed dosimetry service provider to measure and monitor dose resulting from external exposures. External doses to a worker’s whole body are ascertained through a device such as a thermoluminescent dosimeter or an optically stimulated luminescence dosimeter. In 2012, no radiation exposures reported by any uranium processing facility exceeded any of the regulatory dose limits. The maximum exposure for all facilities ranged from 6 mSv to 12 mSv, well below the regulatory limit of 50 mSv/yr, as can be seen in figure 8.2.

Figure 8-2: Uranium processing facilities – comparisons of average and maximum effective doses to nuclear energy workers, 2012



Each facility is unique with regard to the type of work performed and hence is required to tailor its radiation protection program to the unique hazards posed by the processes used in handling uranium, in order to mitigate radiation doses to workers. For example, in facilities where the operator comes in direct contact with uranium pellets, extremity doses to a worker's hands are typically measured using a ring dosimeter, which is added to the equivalent dose of the individual.

Thus, annual effective doses for nuclear energy workers (NEWs) are based on complex and differing work environments, and direct comparisons of effective doses among facilities are challenging. However, the CNSC requirement to apply the ALARA principle has consistently resulted in doses well below regulatory limits. Based on the review of the dose data provided above, CNSC staff are satisfied that all uranium processing licensees are adequately controlling radiation doses to levels well below the regulatory limits, keeping doses in accordance with the ALARA principle, and have ascertained and recorded doses for each person performing duties in connection with their licensed activities. Refer to appendix E for details regarding radiation doses of the workers at these facilities and the facilities' respective regulatory limits.

8.1.1 Doses to the Public

The maximum potential dose to the public from licensed activity at each uranium processing facility is calculated using monitoring results from air emissions, liquid effluent releases and fence-line gamma monitoring. CNSC requirements to apply ALARA principles ensure that the licensees monitor their programs and take corrective actions whenever there is any noticeable upward trend in potential public dose values. In 2011, there was a noticeable increase in potential public dose at the CFM facility due to storage of fuel bundles in trailers.

CFM subsequently commissioned an indoor storage facility, which has resulted in the lowering of the potential public dose in 2012. Table 8-2 compares potential public doses from 2008 to 2012 for all five facilities.

Table 8-2: Fuel cycle facilities – public dose comparison table (mSv), 2008–2012

Facility	Year					Regulatory limit
	2008	2009	2010	2011	2012	
Blind River Refinery (BRR)	0.036	0.001	0.006	0.006	0.012	1 mSv/yr
Port Hope Conversion Facility (PHCF)	0.007	0.034	0.019	0.019	0.029	
Cameco Fuel Manufacturing (CFM)	0.014	0.002	0.002	0.042	0.031	
GEH-C Toronto	* <0.001	* <0.001	* <0.001	* <0.001	0.0008	
GEH-C Peterborough	* <0.001	* <0.001	* <0.001	* <0.001	0.00000	

* Prior to 2012, GEH-C did not report public dose results in its annual reports even though the doses were <0.001 mSv/yr.

In 2012, GEH-C started reporting its potential public dose results to ensure consistency with CNSC's annual reporting requirements.

Prior to 2012, GEH-C did not report potential public dose results in its annual reports, even though the doses from its operations were negligible (<0.001 mSv/yr). In general, potential doses to the public from all uranium processing facilities continue to be low and well below the regulatory annual public dose limit of 1 mSv.

8.2 Environmental Protection

For 2012 (as in 2011), CNSC staff continue to rate the environmental protection SCA as "satisfactory" for all uranium processing facilities.

The environmental protection SCA covers programs that identify and monitor all releases of radioactive and hazardous substances as the result of licensed activities, along with their effects on the environment. Licensees are required to develop and implement policies, programs and procedures that comply with all applicable federal and provincial regulatory requirements, in order to control the release of radioactive and hazardous substances into the environment and to protect the environment. Licensees are also expected to have suitably trained and qualified staff to effectively develop, implement and maintain their environmental protection programs. The uranium processing facilities located in Ontario are also regulated by Ontario's Ministry of the Environment (MOE). Because environmental protection is a shared federal and provincial responsibility, the CNSC avoids or minimizes any duplication of regulatory oversight for this SCA.

Historically, the licence emission limits for all uranium processing facilities were based on the annual public dose limit of 1 mSv; these emission limits are now based on a *de minimis* annual dose limit of 0.05 mSv. For the three Cameco facilities, the new emission limits came into effect on March 1, 2012, while the adjusted emission limits for the two GEH-C facilities came into effect on January 1, 2011. As such, all the uranium processing facilities have programs in place that identify, control and monitor all releases of nuclear and hazardous substances into the environment.

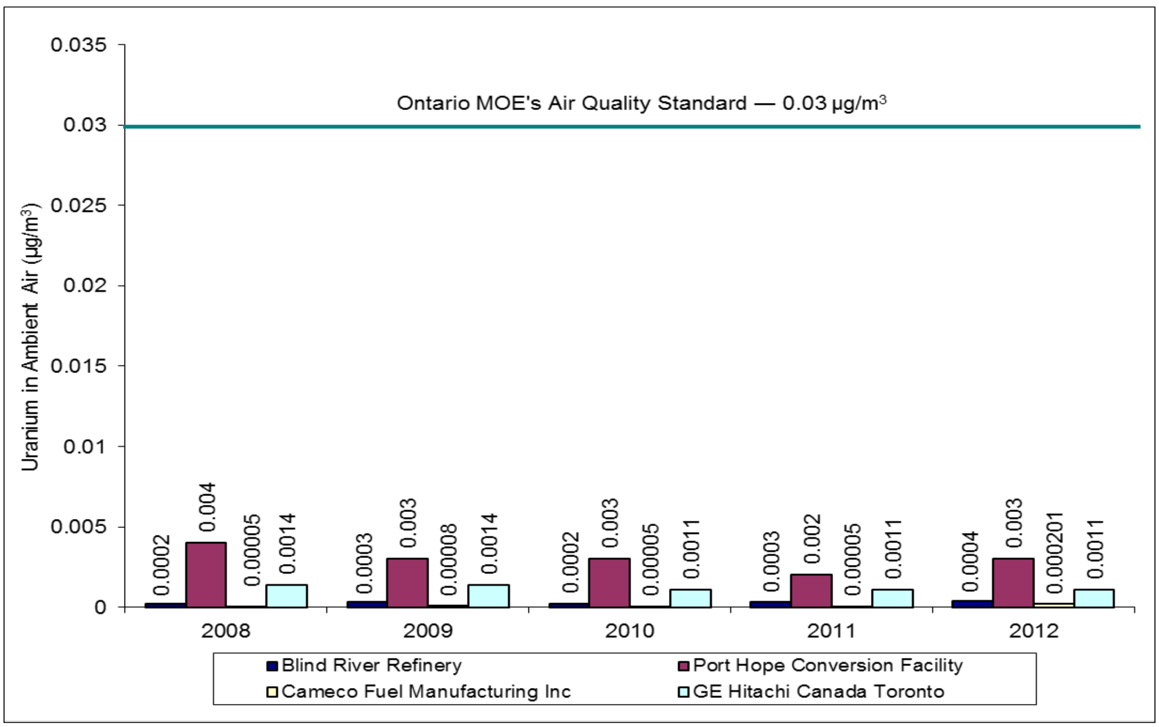
8.2.1 State of Receiving Environment

Uranium in Ambient Air

To confirm the effectiveness of emission abatement systems and to monitor the impact of uranium emissions from a facility on the environment, all facilities except GEH-C Peterborough operate "high-volume" air samplers. GEH-C Peterborough does not use air samplers due to the nature of its operations (the facility handles solid pellets in final form only), as well as having uranium releases from the stack (average of 0.0009 µg/m^3) already lower than the MOE standard for uranium concentrations in air at the fence line.

The results from the high-volume samplers for 2008 through 2012, as shown in figure 8-3, indicate that the maximum annual average concentration of uranium in ambient air measured around any uranium processing facility was well below the MOE air standard for uranium of 0.03 µg/m^3 and well below levels that would pose a risk to human health and the environment. This new MOE air standard for uranium takes effect on July 1, 2016.

Figure 8-3: Uranium concentration in ambient air (annual average), 2008–2012



Uranium in Soil

The three Cameco facilities and GEH-C Toronto have soil monitoring programs. Uranium releases from GEH-C's Peterborough facility are negligible as the fuel pellets received from the Toronto facility are in a solid form and uranium is not release to air. This is confirmed by monitoring in the stack. As such, uranium-in-soil monitoring is not warranted at GEH-C's Peterborough facility.

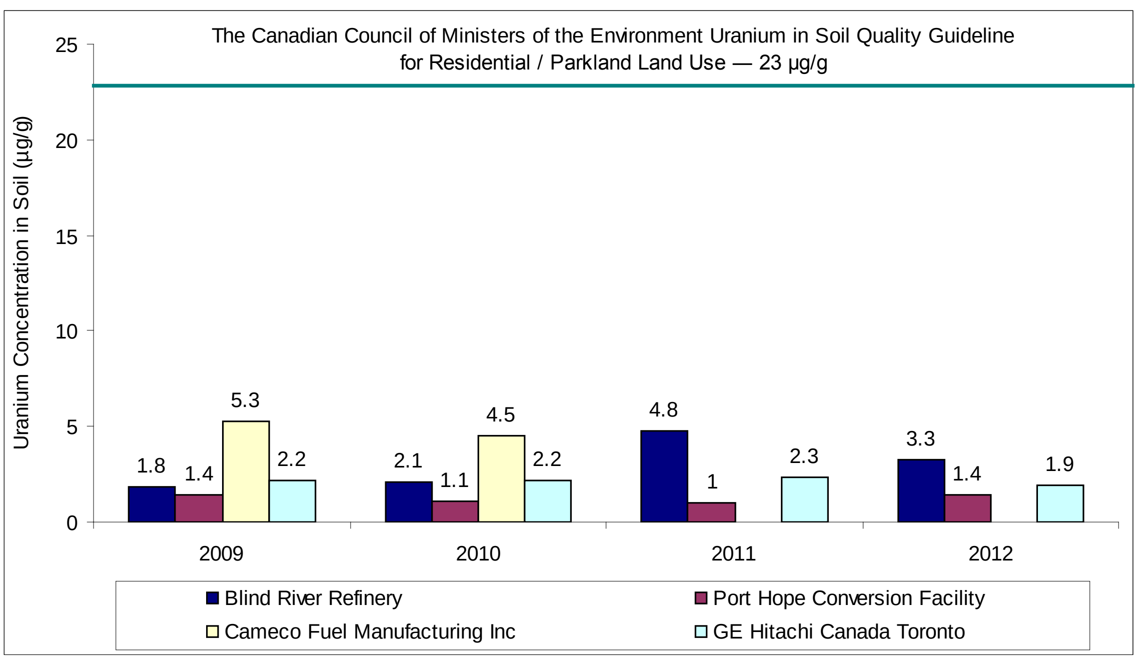
Soil monitoring programs are intended to monitor the long-term effects of air emissions to show whether there is accumulation of uranium in soil in the vicinity of the facility. Soil sampling results in 2012 continue to indicate that current uranium emissions from the uranium processing facilities have no measurable impacts on soil.

Figure 8-4 shows the annual average uranium concentrations in soil results for 2009 through 2012. The annual average concentration of uranium in soil is well below the most restrictive limit, the Canadian Council of Ministers of the Environment (CCME) soil quality guidelines for uranium of 23 μg/g for residential and parkland land use.

The Ontario Ministry of Environment conducted an independent monitoring program in the neighbourhood around the GEH-C facility. Uranium concentrations in boulevard, park and municipal right-of-way soils were all within the range of typical Ontario background concentrations. All soil uranium concentrations in this survey were relatively low and there is little evidence that uranium emissions from GEH-C have had a measurable impact on soil uranium concentrations in the surrounding residential neighbourhoods. The results from this report can be found at:

http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@ene/@resources/documents/resource/stdprod_109468.pdf

Figure 8-4: Uranium concentration in soil (annual average), 2009–2012



Elevated levels of uranium in soil at CFM are due to historic uranium contamination, which is common to the Port Hope area. Increased sampling was conducted at CFM to acquire additional baseline data for an Environmental Assessment. The sampling frequency is now reduced to every three years. The next uranium-in-soil sampling results will be reported by CFM in 2013.

8.3 Conventional Health and Safety

The conventional health and safety SCA covers the implementation of a program to manage workplace safety hazards and to protect personnel. For 2012, CNSC staff rated the conventional health and safety programs at all of its uranium processing facilities as “satisfactory”.

Each licensee is responsible for developing and implementing a conventional health and safety program for the protection of its staff and contract workers, regardless of their place of employment. In addition to the *Nuclear Safety and Control Act* and its associated regulations, activities and operations must comply with the *Canada Labour Code*, Part II, and with other applicable federal and provincial acts and regulations related to health and safety.

The regulation of conventional health and safety at uranium processing facilities involves Human Resources and Skills Development Canada (HRSDC) and the CNSC. CNSC staff monitor compliance with regulatory requirements and, on rare occasions where a concern is identified, HRSDC staff are consulted and asked to take appropriate action. Licensees submit hazardous occurrence investigation reports to both HRSDC and the CNSC, in accordance with their respective reporting requirements.

As summarized in table 8-3 below, the frequency of recordable lost-time incidents (LTIs) reported by all facilities has remained low from 2008 to 2012. Summaries of the two LTIs in 2012 appear in the facilities’ respective sections and are further described in appendix H.

CNSC staff conclude that the uranium processing facility licensees have been implementing their conventional health and safety programs satisfactorily during 2012 and that their programs are effective in protecting the health and safety of persons working in their facilities.

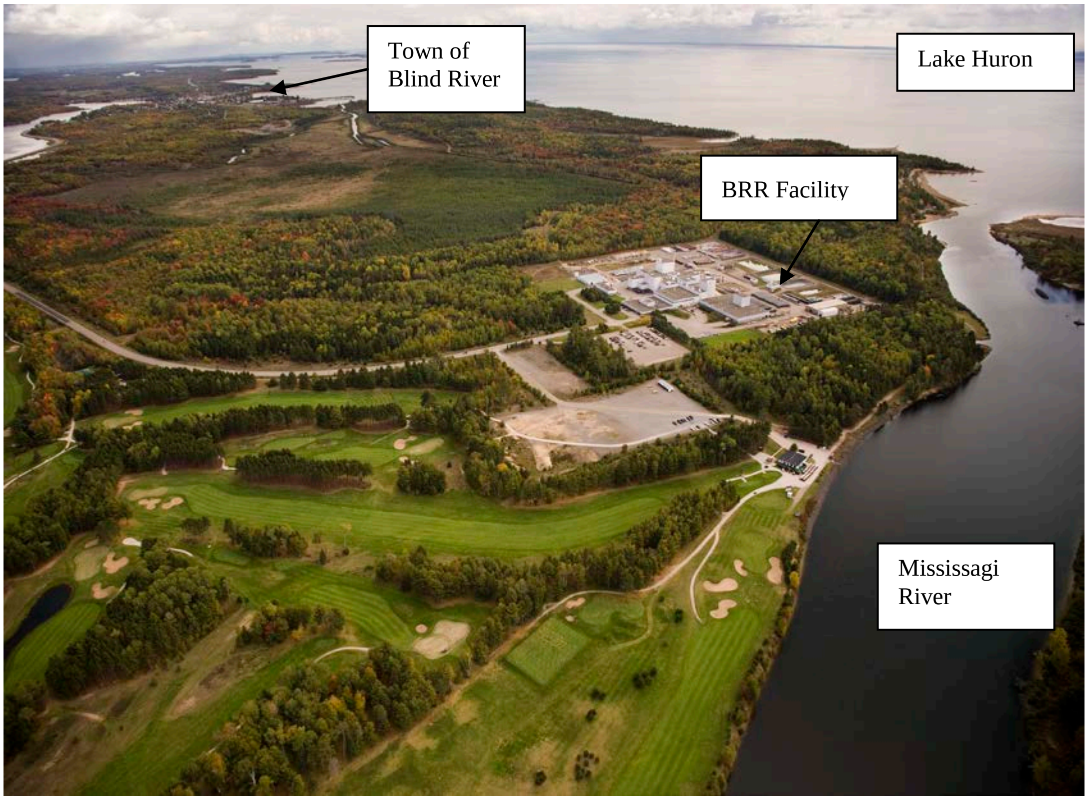
Table 8-3: Fuel cycle facilities – lost-time incidents, 2008–2012

Facility	2008	2009	2010	2011	2012
Blind River Refinery	0	0	0	0	0
Port Hope Conversion Facility	1	1	1	3	1
Cameco Fuel Manufacturing	1	1	0	2	0
GEH-C Toronto and Peterborough	0	0	1	0	1

9 Cameco's Blind River Refinery

Cameco Corporation owns and operates a Class IB nuclear fuel facility in Blind River, Ontario, under an operating licence that expires in 2022. The Cameco Blind River Refinery (BRR) facility is located about 5 kilometres to the west of Blind River, as shown in figure 9-1.

Figure 9-1: Aerial view of Cameco Blind River Refinery – Source: Cameco



The BRR facility refines uranium concentrates (yellowcake) received from uranium mines worldwide to produce uranium trioxide (UO_3), an intermediate product of the nuclear fuel cycle. The primary recipients of the product are Cameco's Port Hope Conversion Facility and Springfields Fuels Ltd. in the United Kingdom.

Since relicensing in March 2012, there have been no licence amendments or changes to the BRR LCH.

9.1 Performance

For 2012, CNSC staff rated BRR's performance as "satisfactory" in all 14 SCAs. The BRR facility ratings for 2008 to 2012 are found in appendix C.

For 2012, there were no modifications to the facility operations, processes and safety systems that affected the licensee's safety analysis report.

On June 23, 2012, there was a significant event at this facility when a BRR employee unknowingly opened a pressurized drum of uranium concentrate originating from the U.S., which caused a plume of approximately 26 kg of uranium concentrate to enter the surrounding area. This incident caused an increase in the level of uranium in air, which resulted in the operator receiving an uptake of uranium concentrate. Urine analysis measurements determined that the employee's concentration of uranium in urine exceeded BRR's action level for routine urine sample submissions, resulting in a dose to the employee of approximately 1.7 mSv.

BRR attributed the cause of the incident to a lack of information regarding pressurized drums containing uranium concentrates from uranium processing mills that use hydrogen peroxide in their refining process. CNSC staff issued a 12(2) Directive regarding BRR's investigation into the incident, including performing a root cause investigation and taking necessary corrective actions. CNSC staff also inspected all Canadian uranium mills and requested that licensees review their operations and confirm that similar conditions causing pressurization of drums do not occur. The inspections and reviews confirmed that Canadian uranium mills have controls in place that will prevent drum pressurization. CNSC staff also reported this event through an event initial report (EIR) to the Commission in 2012; this provided details of the event and of Cameco's BRR proposed corrective actions.

Cameco BRR has since made several improvements to its drum handling and processing operations as part of the lessons learned from the June 2012 incident, such as: updating their procedures to include verification steps to identify any pressurized drums when received at the facility, and prior to opening for sampling of the uranium concentrate. They established an additional layer of personal protection for their workers by requiring them to wear respirators when working with drums of uranium concentrate at specific handling and sampling workstations. BRR also performed a redesign of the drum auger sampling station that was involved in the June 2012 incident, so that the worker is removed from the hazard during the de-lidding process. CNSC staff have reviewed these corrective actions during compliance inspections and are satisfied with their implementation.

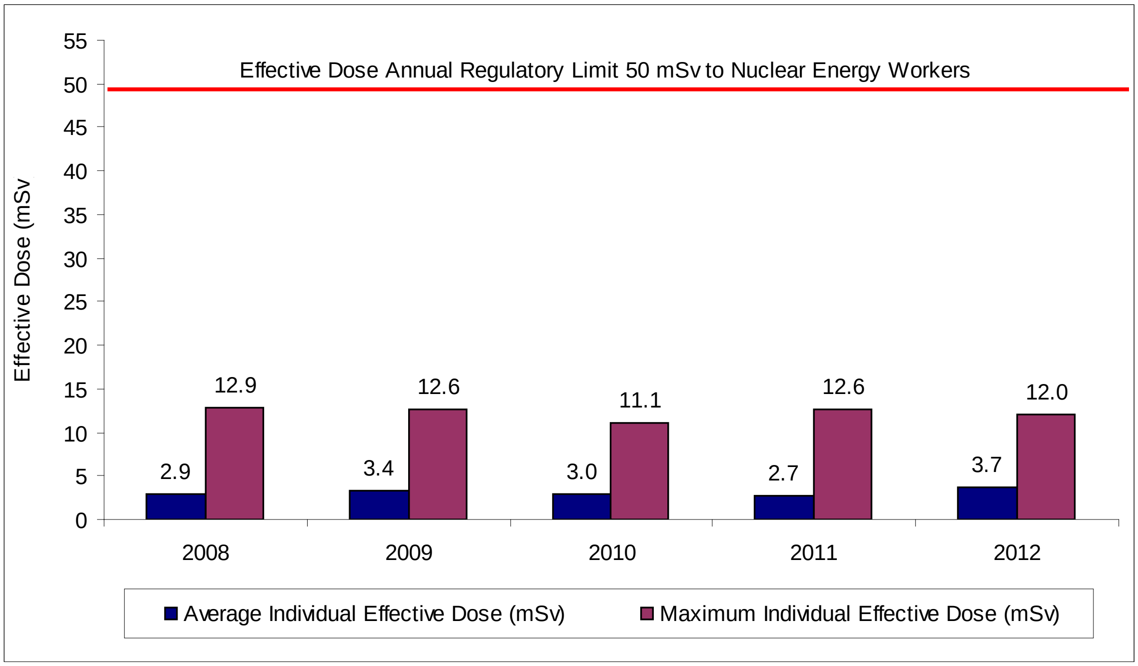
As part of follow-up activities from this incident, a working group was set up under the United States Nuclear Regulatory Commission (US-NRC) leadership that includes the IAEA, US-NRC, CNSC, Cameco and other industry stakeholders, with a mandate of issuing an information notice that disseminates lessons learned from this incident to the public and to industry. The information notice is expected to be published in late 2013.

9.2 Radiation Protection

For 2012, CNSC staff continue to rate BRR's radiation protection SCA as "satisfactory". Radiological doses to workers, including any action level exceedances, were well below regulatory limits. Moreover, Cameco's response to action level exceedances at BRR demonstrates a commitment to reducing radiological doses in accordance with the ALARA principle.

All workers are designated as NEWs, and radiation exposures are monitored to ensure compliance with the regulatory dose limits and with keeping radiation doses in accordance with the ALARA principle. For 2012, no worker's radiation exposure reported by BRR exceeded the regulatory dose limits. The maximum effective dose received by a worker in 2012 was 12 mSv, or 24 percent of the effective dose regulatory limit of 50 mSv in a one-year dosimetry period. Annual average and maximum effective dose results from 2008 to 2012 are provided in figure 9-2. During this period, average doses ranged from 3 mSv to 4 mSv, while the maximum doses ranged from 11 mSv to 13 mSv.

Figure 9-2: Blind River Refinery – average and maximum effective dose trends to nuclear energy workers, 2008–2012



In 2012, there were three action level exceedances related to radiation protection. The first action level exceedance was related to the significant event discussed earlier. The second action level exceedance occurred when a BRR employee's dosimetry result reported a dose to the skin exceeding BRR's skin dose action level of 10 mSv. The equivalent skin dose received was 15 mSv, or 3 percent of the skin exposure dose regulatory limit of 500 mSv in a one-year dosimetry period. BRR performed an investigation and implemented corrective actions, including reinforcing the ALARA principle and the need to minimize the time spent in high dose areas. CNSC staff are satisfied with Cameco's actions.

The third action level was an exceedance of Cameco's whole body action level. Cameco investigated the exceedance and determined that the worker had not been returning their dosimeter to the dosimeter rack at the end of their shift. As such, the dose was likely not received by the worker involved. There was no loss of control of part of Cameco's radiation protection program. Subsequently, Cameco submitted a dose change request form to remove the non-personal dose from the workers record in the national dose registry. CNSC staff accepted the dose change request.

9.3 Environmental Protection

For 2012, CNSC staff continue to rate BRR's environmental protection SCA as "satisfactory".

Releases of uranium from the BRR facility into the environment continue to be controlled and monitored to comply with the conditions of the operating licence and regulatory requirements. In addition, BRR continues to control releases of hazardous substances into the environment, in accordance with the Ontario MOE's applicable regulations and the certificates of approvals.

Releases to the environment during 2012 were well below regulatory limits.

Air Emissions

BRR monitors uranium, nitrogen oxides (NO_x) and particulates released from the facility stacks on a daily basis. The monitoring data in table 9-1 demonstrate that stack emissions from the facility in 2012 continued to be effectively controlled and consistently well below their respective licensed limits.

Table 9-1: Blind River Refinery – air emissions monitoring results (annual averages), 2008–2012

Parameter	2008	2009	2010	2011	2012	Licence limit
Dust collection and exhaust ventilation stack – Uranium (kg/h)	0.00010	0.00014	0.00009	0.00010	0.00006	**0.1**
Absorber stack – Uranium (kg/h)	0.00001	0.00001	<0.00001	<0.00001	0.00001	**0.1**
Incinerator stack – Uranium (kg/h)	0.00002	<0.00001	<0.00001	<0.00001	<0.00001	**0.01**
Nitrogen oxides (NO_X) + nitric acid (HNO_3) (kg/h)	3.6	3.8	4.4	3.9	3.3	**56.0**
Particulate (kg/h)	0.018	0.024	0.030	0.027	0.024	**11.0**

Liquid Effluent Monitoring

There are three sources of liquid effluents from the BRR facility: plant effluent, stormwater runoff and sewage treatment plant effluent. These effluents are collected in lagoons and treated, as required, prior to discharge into Lake Huron. Cameco monitors uranium, radium-226, nitrates and pH to demonstrate compliance with their respective licensed limits. The average monitoring results from 2008 to 2012 are summarized in table 9-2. For 2012, the liquid discharges from the facility continued to be below their respective licensed limits.

Table 9-2: Blind River Refinery – liquid effluent monitoring results (annual averages), 2008–2012

Parameter	2008	2009	2010	2011	2012	Licence limit
Uranium (mg/L)	0.01	0.02	0.02	0.02	0.01	**2**
Nitrates (mg/L)	22	30	24	30	28	**1,000**
Radium-226 (Bq/L)	<0.01	<0.01	<0.01	<0.01	<0.01	**1**
pH	6.9	7.1	7.2	7.1	7.4	**6.0-9.5**

9.3.1 State of Receiving Environment

Soil Monitoring

Cameco's BRR continues to monitor soil for the long-term effects of air emissions, to show whether there is accumulation of uranium in soil in the vicinity of the facility. The results in 2012 remained consistent with the previous years. The maximum uranium soil concentrations observed near the facility were well below the most restrictive limit the CCME soil quality guidelines for uranium of 23 µg/g for residential and parkland land use. Uranium soil concentrations were measured outside, 1,000 metres from the plant. Soil sampling results are provided in appendix F.

Uranium in Ambient Air

The concentrations of uranium in the ambient air as monitored by BRR's sampling network around the facility continue to be consistently low. In 2012, the annual average concentration of uranium in ambient air measured 0.0004 µg/m^3, which is below the MOE's new standard limit for uranium of 0.03 µg/m^3. This new standard limit for uranium takes effect in 2016.

Groundwater Monitoring

Currently, a total of 43 monitoring wells exist in and around the BRR (17 inside the perimeter fence and 26 outside the fence).

Based on the groundwater sampling data presented in Cameco's annual compliance reports, the results indicate that refinery operations are not causing any impact to groundwater quality. There are no groundwater plumes from either existing or historical operations.

Groundwater monitoring results are provided in appendix F.

9.4 Conventional Health and Safety

For 2012, CNSC staff continue to rate BRR's conventional health and safety SCA as "satisfactory".

CNSC staff note that the licensee has established conventional health and safety policies and programs to ensure the protection of workers from physical, chemical and industrial hazards that may arise in the course of their work at the facility.

For 2012, no injuries were reported. BRR has achieved seven years without a lost-time incident and continues to be a leader in conventional safety at Cameco.

10 Port Hope Conversion Facility

Cameco Corporation owns and operates the Port Hope Conversion Facility (PHCF). The current licence expires in 2017. PHCF is located in the municipality of Port Hope, Ontario, situated on the north shore of Lake Ontario approximately 100 kilometres east of Toronto (see figure 10-1). In 2011, PHCF employed approximately 400 workers.

PHCF primarily converts uranium trioxide (UO_3) powder produced by Cameco's Blind River facility into uranium dioxide (UO_2) and uranium hexafluoride (UF_6). UO_2 is used in the manufacture of CANDU reactor fuel (natural uranium), whereas UF_6 is exported for further processing into fuel for light-water reactors. The facility also includes analytical and research laboratories, and radioactive waste storage, recycling and decontamination capabilities. The facility uses anhydrous hydrofluoric acid, nitric acid, aqua ammonia, potassium hydroxide and hydrogen for the production of UF_6 and UO_2.

Figure 10-1: Port Hope Conversion Facility Site 1 (looking north) – Source: Cameco

Since relicensing in March 2012, there have been no licence amendments or changes to the PHCF LCH.

10.1 Performance

For 2012, CNSC staff rated the PHCF performance as, overall, “satisfactory”. The PHCF ratings for 2008 through 2012 are found in appendix C. All safety ratings remained satisfactory throughout this period.

For 2012, there were no major modifications to the facility operations, processes and safety systems that affected the licensee’s safety analysis report. Several minor changes were made to the facility, including moving and commissioning of the depleted dissolution circuit to the UO_2 building, replacement of the facility cooling water intake flow meter, addition of a whole body monitor to gate 12 and updates to the groundwater treatment system piping. Changes did not impact the licensing basis of the facility and changes to the PHCF LCH were not required. The two major plants in this facility also had scheduled shutdowns during summer 2012, as dictated by the licensee’s business planning.

For 2012, there was one reportable event related to a uranium action level exceedance for the UO_2 main stack. Details on this one action level exceedance will be discussed in the applicable section below.

PHCF also reported to the CNSC two incidents, one related to an August 2012 outdoor uranium spill from a waste container with contaminated combustible materials and another related to a November 2012 indoor leak of gaseous hydrogen fluoride (HF). For the August 2012 incident, the licensee submitted a root cause analysis and the corrective actions taken were reviewed as part of a CNSC type II inspection in October 2012. CNSC staff are satisfied with the corrective actions implemented by PHCF for this incident. There was no impact to the environment or the public due to this incident.

The November 2012 indoor leak of HF resulted in four employees requiring medical evaluation; two of those were further sent to the hospital for observations and were released with no impact to health. There was no impact to the environment or the public due to this incident. PHCF has submitted a root cause analysis for the November 2012 HF leak incident and has taken corrective actions that were reviewed by CNSC staff in March 2013 and found satisfactory.

In September 2012, CNSC staff were observers as part of the joint PHCF and municipality of Port Hope full-scale emergency response exercise “Brume”. The final report submitted by the licensee met the requirements of RD-353, *Testing the Implementation of Emergency Measures*, and demonstrated that the licensee is in compliance with Class I facilities’ regulations for emergency response.

For 2012, a key milestone related to the environmental assessment of PHCF’s proposed “Vision 2010” project was achieved when the comprehensive study report was accepted by the CNSC. In December 2012, Canada’s Environment Minister determined that Vision 2010 is unlikely to cause significant adverse environmental effects.

Currently, Cameco is in the process of reviewing the scope of the project, developing detailed plans, and is expected to submit a request for amendment to the facility licence with a detailed proposal in late 2013.

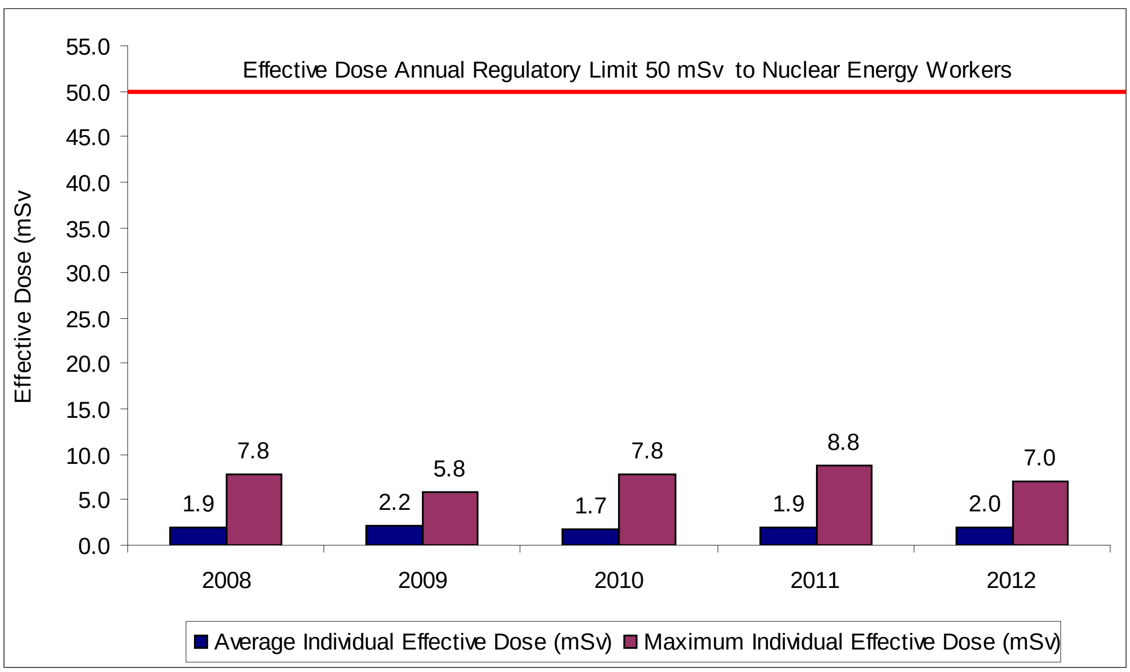
10.2 Radiation Protection

For 2012, CNSC staff continue to rate PHCF's radiation protection SCA as "satisfactory".

PHCF maintains a mature radiation protection program with several improvement initiatives implemented in 2012, including a new whole body monitor installed at the main gate, updated radiation protection procedures, a new data management system for the lung counting program and an upgraded system for dose assignment from urinalysis.

All workers are designated as NEWs, and radiation exposures are monitored to ensure compliance with the regulatory dose limits and with keeping radiation doses in accordance with the ALARA principle. For 2012, no worker's radiation exposure reported by PHCF exceeded the regulatory dose limits. The maximum effective dose received by a worker in 2012 was 7 mSv, or 14 percent of the effective dose regulatory limit of 50 mSv in a one-year dosimetry period. Annual average and maximum effective dose results from 2008 to 2012 are provided in figure 10-2. During this period, average doses remained relatively consistent at 2 mSv, while the maximum doses ranged from 6 mSv to 9 mSv.

Figure 10-2: Port Hope Conversion Facility – average and maximum effective dose trends to nuclear energy workers, 2008–2012



10.3 Environmental Protection

For 2012, CNSC staff continue to rate the PHCF's environmental protection SCA as "satisfactory".

Uranium releases from PHCF to the environment continue to be controlled and monitored to comply with the conditions of the operating licence and regulatory requirements. Releases of non-nuclear substances from the facility to the environment are controlled in accordance with the Ontario MOE's applicable regulations and the certificates of approvals.

One action level exceedance was reported for the UO_2 Plant on June 4, 2012. Uranium Air emission exceeded the 0.007 kgU/h action level and resulted in a 0.0072 kgU/h main stack emission from the UO_2 Plant. This action level exceedance was due to mobilization of Ammonium Diuranate (ADU) dust during the cleaning of a dry main stack demisting filter pad. This operation is usually performed while the filter pads are still wet to reduce dusting. PHCF has implemented corrective measures to ensure procedure adherence and ensure the filter pads are still wet during maintenance activities. CNSC staff are satisfied with Cameco's corrective actions.

Air Emissions

PHCF monitors uranium, fluorides and ammonia released from stacks at the facility. The monitoring data in table 10-1 demonstrate that stack emissions from the facility in 2012 continued to be effectively controlled and consistently below their respective licence limits and well below health limits.

Table 10-1: Port Hope Conversion Facility – air emissions monitoring results (annual averages), 2008–2012

Location	Parameter	2008	2009	2010	2011	2012	Licence limit
UF_6 plant	Uranium (kg/h)	0.0008	0.0033	0.0044	0.0051	0.0042	**0.290**
	Fluorides (kg/h)	0.0135	0.0280	0.0175	0.0199	0.0160	**0.650**
UO_2 plant	Uranium (kg/h)	0.0003	0.0014	0.0013	0.0013	0.0012	**0.150**
	Ammonia (kg/h)	0.0022	0.0048	0.0033	0.0024	0.0019	**58**

Liquid Effluent Monitoring

For 2012, PHCF continued to evaporate rather than discharge process liquid effluent. In August 2012, CNSC staff conducted an inspection focused on liquid effluent management. Although CNSC staff found no major deficiencies in PHCF's liquid effluent management program, some minor deficiencies were identified with no impact on the environment; however, PHCF has subsequently implemented corrective measures to address these.

10.3.1 State of Receiving Environment

Soil Monitoring

PHCF's soil monitoring program includes annual sampling in the municipality of Port Hope, including one location (Waterworks parking lot) remediated with clean soil to avoid interference from historic uranium soil contamination. Samples are taken at various depths within the soil profile to determine whether the concentrations of uranium change as compared to previous sample results.

The average uranium-in-soil concentrations in 2012 arising from current operations remained similar to past years. This indicates that uranium emissions from current operation of the PHCF facility have had no measurable impact on soil. Soil sampling results are provided in appendix F.

Uranium in Ambient Air

PHCF measures uranium in the ambient air around the facility to confirm the effectiveness of emission abatement systems and to monitor the impact of the facility on the environment. For 2012, results from these samplers show that uranium in the suspended particulate has consistently remained very low: the highest annual average concentration of uranium in ambient air measured around the facility in 2012 was 0.003 µg/m^3, well below the MOE's new standard for uranium, 0.03 µg/m^3.

Groundwater Monitoring

By the end of the fourth quarter of 2011, the groundwater quality at PHCF had been sampled at:

- 13 active pumping wells on a monthly basis, four of which commenced operation in October 2011
- 59 monitoring wells on a quarterly basis
- 17 bedrock wells on an annual basis

In general, CNSC staff found that the groundwater quality across the PHCF site was similar to that of the groundwater quality in 2011, with the exception of nitrates, which showed a significant drop. As shown in table 10-2, the pump-and-treat wells continued to remove contaminants of potential concern before they reached the harbour.

Table 10-2: Port Hope Conversion Facility – mass (kg) of contaminants of potential concern (COPC) removed from the pumping wells, 2009–2012

COPC (kg)	Year			
	2009	2010	2011	2012
Uranium	17.2	14.0	19.7	19.3
Fluoride	65.7	43.5	38.6	41.9
Ammonia	51.1	26.1	20.9	24.0
Nitrate	72.4	27.8	41.2	26.1
Arsenic	4.1	3.5	2.6	2.1

Fluoride Monitoring

The impact of fluoride emissions from PHCF on the environment is determined each autumn, when samples of fluoride-sensitive vegetation are collected. The results in 2012 continued to be well below the MOE objective of 35 parts per million (ppm) in foliage for livestock consumption during the growing season. Details are provided in appendix F.

10.4 Conventional Health and Safety

For 2012, CNSC staff continue to rate PHCF's conventional heath and safety SCA as "satisfactory".

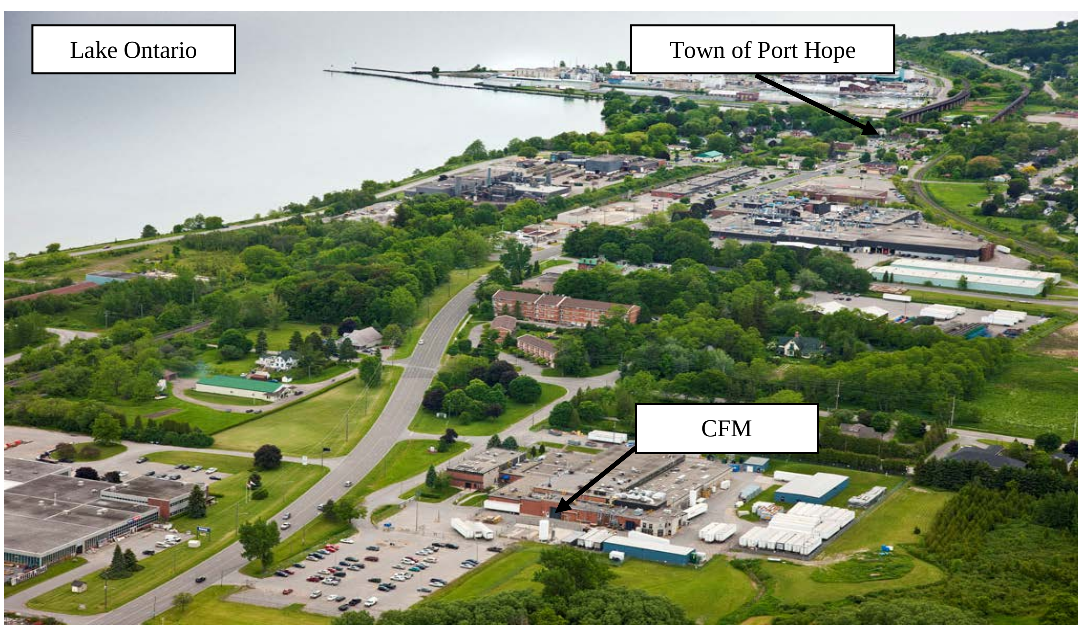
PHCF has established conventional health and safety policies and programs that meet CNSC staff expectations. All reported incidents are logged and tracked as part of PHCF's Cameco Incident Reporting System (CIRS) database and are reviewed regularly by management. The Conventional Health and Safety (CH&S) efforts are supported by two joint committees that include employees and management. The Policy Health and Safety Committee meets a minimum of four times per year to review and discuss matters involving CH&S policies, procedures and programs.

There was one LTI during 2012. Overall, Cameco operated PHCF in compliance with the regulatory requirements during 2012. The LTI is summarized in appendix H.

11 Cameco Fuel Manufacturing Inc.

Cameco Fuel Manufacturing Inc. (CFM) is a wholly owned subsidiary of Cameco Corporation and operates a Class IB nuclear fuel fabricating facility located at 200 Dorset Street East, Port Hope, Ontario. The current licence expires in 2022. The municipality of Port Hope is situated on the north shore of Lake Ontario, as shown in figure 11-1, approximately 100 kilometres east of Toronto.

Figure 11-1: Aerial view of Cameco Fuel Manufacturing – Source: Cameco



The CFM facility manufactures nuclear reactor fuel bundles from two basic materials, uranium dioxide (UO_2) and zircaloy tubes. CFM receives natural and depleted UO_2 powder and the zircaloy tubes from Canadian suppliers, and a limited amount of enriched UO_2 powder from a foreign supplier.

The finished fuel bundles are shipped to Canadian nuclear power reactors and research reactors. CFM's licence does not allow the facility to process more than 125 megagrams (Mg) of UO_2 as pellets contained in fuel bundles during any calendar month.

Since relicensing in March 2012, there have been no licence amendments or changes to the CFM LCH.

11.1 Performance

For 2012, CNSC staff continue to rate CFM's performance as "satisfactory" in all safety and control areas. The CFM facility ratings for 2008 through 2012 are found in appendix C.

For 2012, there were no modifications to the facility operations that impacted licensing basis; however, several reconfiguration activities to the facility were performed, including the relocation of change rooms and production offices. CFM, as part of its waste minimization initiative to reduce and eliminate legacy waste, began a plan in 2012 to process contaminated combustible material currently stored onsite at an appropriately licensed facility. CFM also continued its effort to upgrade its fuel bundle assembly process, by testing and commissioning its automated bundle manufacturing system.

At the time of this report's writing, one action level exceedance related to radiation protection was reported to CNSC staff; on January 23, 2013, CFM identified three issues regarding calculations used to assess worker doses. Although the changes in dose are relatively minor and well within the regulatory limit of 50 mSv/yr, CFM has undertaken a review of its dosimetry program and developed the necessary corrective actions. Details on the action level exceedances will be discussed in the applicable section below.

11.2 Radiation Protection

For 2012, CNSC staff continue to rate CFM's radiation protection SCA as "satisfactory".

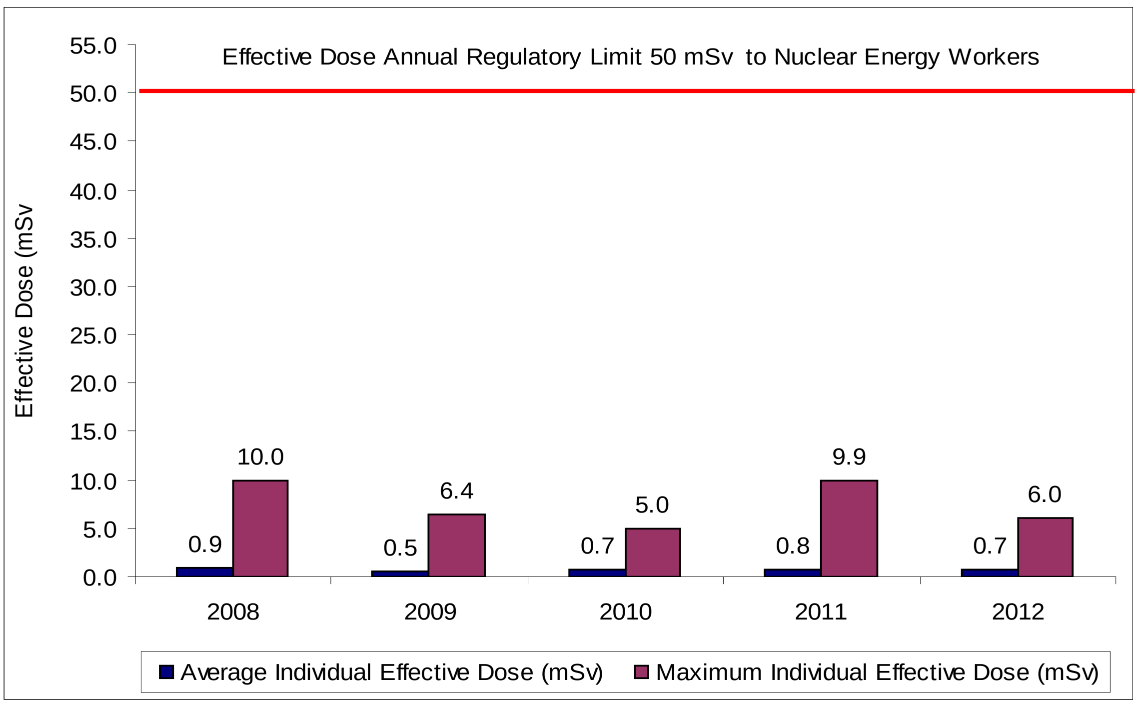
At the time of this report's writing, CFM had one reportable incident related to radiation protection. On January 23, 2013, CFM reported issues related to its internal dose calculations. CFM's dosimetry program consists of two components – external dose, which is determined through the use of dosimeter badges that are read and reported to CFM by an external dosimetry provider, and internal dose, which is determined through a urine analysis program. Cameco undertook an initiative to bring the various sites' radiation protection programs and their internal dose spreadsheets into one consistent database for Cameco's Fuel Services Division. During this initiative, they discovered that CFM had inconsistencies between its internal dose calculation methodology and the actual calculations being performed. These inconsistencies were corrected, and CFM's workers' internal dose results were recalculated from 2003 to the present. The newly calculated dose levels did not exceed the CNSC's regulatory dose limit; however, CFM's action level of 0.8 mSv was exceeded on 10 occasions during that period.

No health effects are expected as a result of this error, but the error prevented CFM from fully applying its ALARA program. CFM has committed to having an expert, independent third party review all changes made to its internal dose calculations (against its approved dosimetry program requirements) and to establishing a frequent and reoccurring review of its dosimetry program.

All workers are designated as NEWs, and radiation exposures are monitored to ensure compliance with the regulatory dose limits and with keeping radiation doses in accordance with the ALARA principle. For 2012, no worker's radiation exposure reported by CFM exceeded the regulatory dose limits.

The maximum effective dose received by a worker in 2012 was 6 mSv, or 12 percent of the effective dose regulatory limit of 50 mSv in a one-year dosimetry period. The corrected annual average and maximum effective dose results from 2008 to 2012 are provided in figure 11-2. During this period, average doses remained relatively consistent at 1 mSv, while the maximum doses ranged from 5 mSv to 10 mSv.

Figure 11-2: Cameco Fuel Manufacturing – corrected average and maximum effective dose trends to nuclear energy workers, 2008–2012



11.3 Environmental Protection

For 2012, CNSC staff continue to rate CFM's environmental protection SCA as "satisfactory".

Releases of uranium from CFM to the environment continue to be controlled and monitored to comply with the conditions of the operating licence and regulatory requirements. In 2012, these releases totalled 0.02 kg of uranium to the atmosphere and 0.6 kg of uranium in liquid effluent. In addition, CFM continues to control releases of hazardous substances to the environment, in accordance with the Ontario MOE's applicable regulations and the certificates of approvals.

For 2012, one action level exceedance was reported for the building ventilation. On August 21, 2012, a uranium powder spill caused a plume of powder to rise and blanket the work area. Due to an equipment failure, uranium powder reversed back down the extraction hose and into the drum, where it caused a plume that entered the surrounding workstation. This incident caused an increase in uranium emissions through the building ventilation. CFM reported that the calculated maximum concentration of uranium emitted to the building ventilation due to this incident was 1.9 g/hr, which exceeded its action level of 1.0 g/hr but remained well below the applicable licence limits. CFM performed a root cause investigation and implemented corrective actions to prevent uranium powder from reversing back down the extraction hose and into the drum in the event of loss of suction in the extraction hose. CNSC staff are satisfied with CFM's corrective actions.

Air Emissions

CFM continues to monitor uranium released as gaseous emissions from the facility. The monitoring data in table 11-1 demonstrate that stack emissions from the facility in 2012 continued to be effectively controlled and consistently well below their licence limits.

Table 11-1: Cameco Fuel Manufacturing – air emissions monitoring results, 2008–2012

Parameter	2008	2009	2010	2011	2012	Licence limit
Total discharge through stacks (kg/yr)	0.05	0.03	0.03	0.02	0.02	**14**

Liquid Effluent Monitoring

CFM also continues to monitor uranium released as liquid effluent from the facility. The monitoring data in table 11-2 demonstrate that liquid effluent from the facility in 2012 continued to be effectively controlled and consistently well below its licence limits.

Table 11-2: Cameco Fuel Manufacturing – liquid effluent monitoring results, 2008–2012

Parameter	2008	2009	2010	2011	2012	Licence limit
Total discharge to sewer (kg/yr)	1.03	0.65	1.05	0.68	0.61	**475**

11.3.1 State of Receiving Environment

Soil Monitoring

CFM collects soil samples from 23 locations surrounding the facility on a three-year sampling frequency. The last samples were collected in 2010. The soil samples were analyzed for uranium content and compared to the CCME soil quality guidelines for uranium of 23 µg/g for residential and parkland land use. The results indicate there is no increasing trend in uranium concentration in soil. Soil sampling results are provided in appendix F.

Uranium in Ambient Air

CFM operates high-volume air samplers to measure the airborne concentrations of uranium at points of impingement of stack plumes. The samplers are located on the east, north, southwest and northwest sides of the facility. The results from these samplers show that the maximum concentration of uranium in ambient air measured around the facility in 2012 was 0.0002 $\mu g/m^3$, well below the MOE's new standard limit for uranium of 0.03 $\mu g/m^3$.

Groundwater Monitoring

CFM has a network of 75 groundwater monitoring wells located onsite and offsite within the immediate area of the facility. These wells are screened within the overburden (soil) and some are within the underlining bedrock. The monitoring wells have a dual purpose. Their primary purpose is to investigate the extent of historical uranium in groundwater on the licensed property. The wells also serve to confirm that current operations are not contributing to the concentrations of uranium in groundwater on the licensed property. The results indicate there is no increasing trend in uranium concentration in groundwater and, based on available data, there is no evidence indicating offsite migration of uranium in groundwater.

11.4 Conventional Health and Safety

For 2012, CNSC staff continue to rate CFM's conventional health and safety SCA as "satisfactory".

CNSC staff confirm that CFM has established conventional health and safety policies and programs to ensure the protection of workers from physical, chemical and radiation hazards that may arise in the course of their work at the facility. The licensee has developed, and continues to deliver, safety-related training courses to its employees and contractors.

These courses encompass the safety areas of hoisting and rigging, musculoskeletal injuries prevention, use of personal protective equipment, winter safety and slips and falls prevention, injury reporting requirement and heat stress issues.

There were no lost-time incidents to workers during 2012.

12 GE HITACHI NUCLEAR ENERGY CANADA INCORPORATED (GEH-C)

GEH-C is a Canadian company that manufactures nuclear fuel bundles from uranium dioxide (UO_2) powder. The company makes fuel bundles exclusively for Canadian nuclear power plants. It operates two Ontario sites under one CNSC licence: one site in Toronto and one in Peterborough. Both facilities come under common management, with shared safety and control programs. One rating is given for the SCAs, but individual performance data are provided for each facility. GEH-C's licence expires on December 31, 2020.

GEH-C has been located in Toronto's Davenport area since the construction of their first building in 1905. At that time, GEH-C's buildings were located in an industrial area conveniently located close to a major rail line. In 1955, GEH-C started its nuclear fuel operations in Toronto and Peterborough. Over GEH-C's 50 years of operation, much of the industrial area transitioned from an industrial area to residential properties. As such, the GEH-C Toronto facility is now surrounded by residential homes. Notwithstanding, the CNSC provides regulatory oversight on both GEH-C facilities to ensure its operations remain safe, thus ensuring that the public and environment are safe.

For 2012, there were no licence amendments; however, changes to GEH-C's LCH were issued in April 2013. CNSC staff revised GEH-C's LCH to include CNSC's new annual reporting requirements, changes to the public information reporting requirements according to CNSC's regulatory document *Public Information and Disclosure* (RD-99.3), and to incorporate new document revisions. All of the amendments were administrative in nature and take into account adherence to the CNSC new requirements.

GEH-C Toronto

The Toronto facility occupies a small site in the city of Toronto. The immediate surroundings of the facility are shown in the aerial photo below (figure 12-1). The Toronto facility processes UO_2 powder into precision dimension ceramic pellets. Most of these pellets are shipped to GEH-C's Peterborough facility and assembled into CANDU reactor fuel bundles.

Figure 12-1: Aerial view of the GEH-C Toronto facility (shown in red) – Source: Google Maps

GEH-C Peterborough

The Peterborough facility is located on part of a larger industrial site that belongs to General Electric Canada. This site is located in the middle of the city of Peterborough. The aerial photo in figure 12-2 shows the location of the facility in the city.

Figure 12-2: Aerial view of the GEH-C Peterborough facility – Source: GE Hitachi Nuclear Energy Canada Inc.

The Peterborough facility takes the UO_2 pellets fabricated in Toronto and assembles them into CANDU reactor fuel bundles. In addition, GEH-C Peterborough has a nuclear services and design business, which includes work associated with receiving, repairing, modifying and returning contaminated equipment from offsite nuclear facilities.

12.1 Performance

For 2012, of the 14 SCAs, 13 are rated “satisfactory” while the environmental protection SCA remains “fully satisfactory”. The GEH-C facilities ratings for 2008 through 2012 are found in appendix C.

For 2012, there were no modifications to the facility operations that impacted licensing basis.

In 2012, GEH-C was required to strengthen its Public Information and Disclosure Program (PIDP) in accordance with CNSC’s new regulatory document/guidance document 99.3, *Public Information and Disclosure*, published in March 2012. This initiative was aligned to CNSC expectations and had started prior to the heightened local interest that occurred in the absence of factual information.

Accordingly, GEH-C was required to undertake several new initiatives to inform residents about its nuclear activities. GEH-C has committed to establishing a community liaison committee, distributing an annual newsletter to residents, holding an annual open house, and changing its signage to reflect that it is a nuclear facility, and it has improved its Web site. CNSC staff have required GEH-C to provide quarterly updates on its activities, and will continue to closely monitor the implementation of this program.

In 2012, there was one action level exceedance related to radiation protection. A worker at the GEH-C Toronto facility exceeded the annual extremity dose action level of 350 mSv, receiving an annual extremity dose of 357 mSv, which represents 71 percent of the regulatory annual equivalent dose limit of 500 mSv and well within levels known to cause health effects. Details regarding the action level exceedance are discussed in the applicable section below.

GEH-C’s preliminary decommissioning plan for both facilities was updated in 2012 to reflect the current decommissioning costs. As such, GEH-C is now required to revise its financial guarantee to reflect the new cost estimate. Submission of the revised financial guarantee for the Commission’s approval is expected in 2013.

12.2 Radiation Protection

For 2012, CNSC staff continue to rate GEH-C’s radiation protection SCA as “satisfactory”.

For 2012, the GEH-C Toronto facility had one reportable incident related to radiation protection. A worker at the GEH-C Toronto facility exceeded the 350 mSv extremity dose action level when he received an extremity dose of 357 mSv. This represents 71 percent of the regulatory annual equivalent dose limit of 500 mSv. GEH-C Toronto performed an investigation and implemented corrective actions by improving the scrap material handling process so that worker extremity exposures are kept as low as possible. In addition, GEH-C Toronto implemented a control level set well below its action level for extremity exposures, acting as an early detection mechanism. CNSC staff are satisfied with GEH-C’s corrective actions.

All workers are designated as NEWs, and radiation exposures are monitored to ensure compliance with the regulatory dose limits and with keeping radiation doses in accordance with the ALARA principle. For 2012, no worker's radiation exposure reported by GEH-C exceeded the regulatory dose limits. The radiation doses remained low at the Peterborough facility, with the maximum effective dose received by a worker in 2012 at 9 mSv, or 18 percent of the effective dose regulatory limit of 50 mSv in a one-year dosimetry period. Annual average and maximum effective dose results from 2008 to 2012 are provided in figure 12-3. During this period, average doses remained relatively consistent at 2 mSv, while the maximum doses ranged from 7 mSv to 11 mSv.

For 2012, radiation doses remained low at the Toronto facility, with the maximum effective dose received by a worker at 9 mSv, or 18 percent of the regulatory dose limit of 50 mSv in a one-year dosimetry period. Annual average and maximum effective dose results from 2008 to 2012 are provided in figure 12-4. During this period, average doses ranged from 2 mSv to 4 mSv, while the maximum doses ranged from 8 mSv to 14 mSv.

Figure 12-3: GEH-C Peterborough – average and maximum effective dose trends to nuclear energy workers, 2008–2012

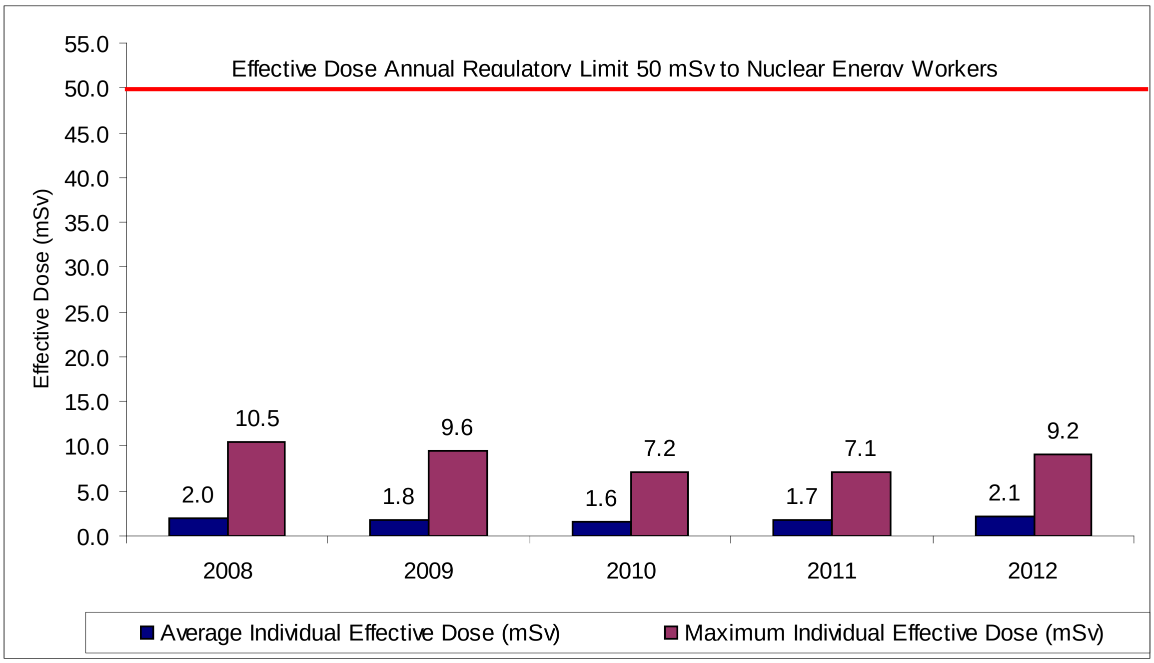
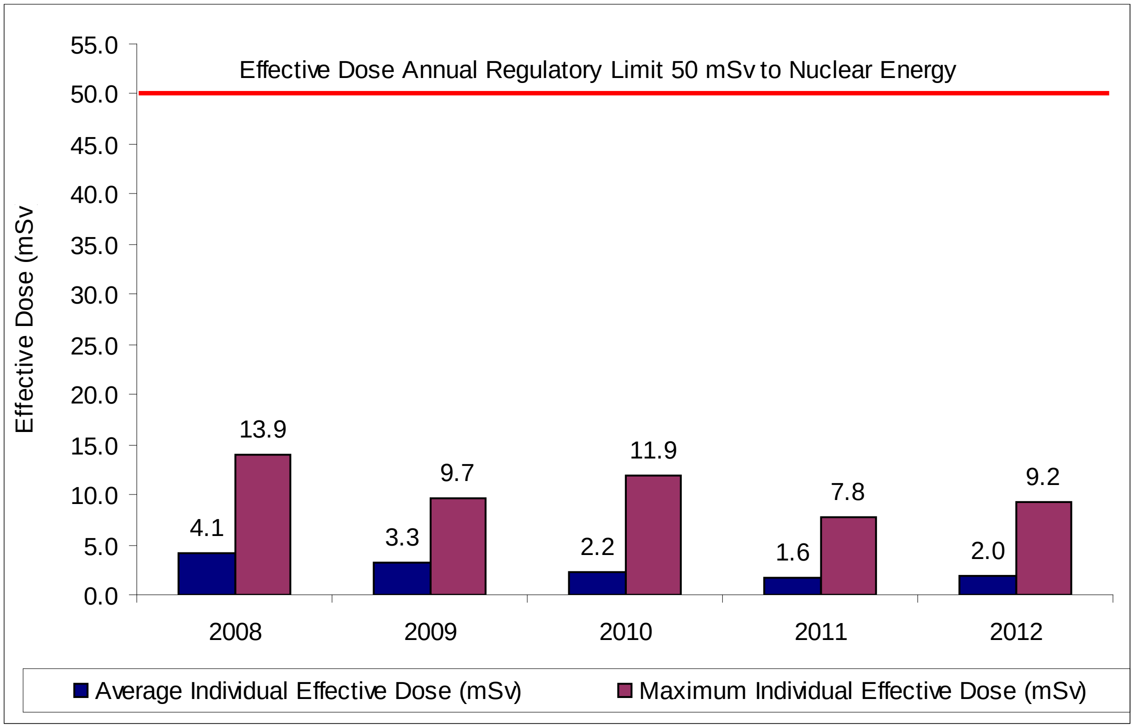


Figure 12-4: GEH-C Toronto – average and maximum effective dose trends to nuclear energy workers, 2008–2012



12.3 Environmental Protection

For 2012, CNSC staff continue to rate GEH-C's environmental protection SCA as "fully satisfactory".

Releases of uranium from the Toronto and Peterborough facilities into the environment continue to be controlled and monitored to comply with the conditions of the operating licence and regulatory requirements. In addition, GEH-C continues to control releases of hazardous substances to the environment, in accordance with the Ontario MOE's applicable regulations and the certificates of approvals.

Air Emissions

GEH-C's in-stack sampling results, as well as the annual uranium emissions from the GEH-C Toronto and Peterborough facilities, are provided in table 12-1. The annual uranium emissions remained well below the licence limits for both facilities. The results demonstrate that air emissions are being controlled effectively at the GEH-C facilities.

Table 12-1: GEH-C Toronto and Peterborough – air emissions monitoring results, 2008–2012

Parameter	2008	2009	2010	2011	2012	Licence limit
Toronto total discharged to air (kg/yr)	0.014	0.012	0.016	0.009	0.013	**0.76**
Peterborough total discharged to air (kg/yr)	0.000004	0.000006	0.000004	0.000011	0.000005	**0.55**

Liquid Effluent Monitoring

To ensure compliance with licence limits, waste water from the GEH-C facilities is collected, filtered and sampled prior to its discharge to the sanitary sewer. Table 12-2 summarizes the average discharges to the sewers from 2008 to 2012 for the Toronto and Peterborough facilities. In 2012, the releases continued to be well below the licence limit. A decrease in uranium emissions at the Toronto facility is due to changes in the waste water mixing and treatment process.

Table 12-2: GEH-C Toronto and Peterborough – liquid effluent monitoring results, 2008–2012

Parameter	2008	2009	2010	2011	2012	Licence limit
Toronto total discharged to sewer (kg/yr)	2.7	2.0	0.4	1.1	0.9	**9,000**
Peterborough total discharged to sewer (kg/yr)	0.001	0.002	0.001	0.001	0.0001	**760**

12.3.1 State of Receiving Environment

Soil Monitoring

As noted earlier, GEH-C conducts soil sampling at its Toronto facility as part of its environmental program. Samples are taken from 49 locations around the facility and analyzed for uranium content. The average concentration of uranium in soil in 2012 was 1.9 µg/g. The maximum concentration of uranium in soil was 10.8 µg/g. These were well below the CCME soil quality guidelines for uranium of 23 µg/g for residential and parkland land use. Soil sampling results are provided in appendix F.

Uranium in Ambient Air

GEH-C Toronto operates five high-volume air samplers to measure the airborne concentrations of uranium at points of impingement of stack plumes. The results from these samplers show that the average concentration of uranium in ambient air measured around the facility in 2012 was 0.001 µg/m^3, well below the MOE's new standard limit for uranium, 0.03 µg/m^3.

12.4 Conventional Health and Safety

For 2012, CNSC staff continue to rate GEH-C's conventional health and safety SCA as "satisfactory".

CNSC staff consider that GEH-C has a well-established conventional health and safety program that ensures the protection of workers from physical, chemical and radiation hazards that may arise in the course of their work at the facility. The licensee has developed, and continues to deliver, safety-related training courses to its employees and contractors.

GEH-C reported one lost-time incident at its Toronto facility in 2012. The incident was the result of a trip-and-fall accident to an operator who was working on a furnace.

Part III: Nuclear Substance Processing Facilities

13 Overview

Part III of this report deals with the two tritium processing facilities located in Ontario:

- Shield Source Incorporated (SSI), in Peterborough, Ontario
- SRB Technologies (Canada) Incorporated (SRB), in Pembroke, Ontario

SRB operates under an operating licence issued in July 2010 that expires in June 2015.

In April 2012, SSI submitted evidence that its total tritium discharge monitoring data had been under-reported for several years due to an instrument error. Because of this evidence, the Commission restricted SSI from processing tritium gas for the production of gaseous tritium light sources. In March 2013, SSI notified the CNSC of its plan not to apply for renewal of its operating licence. SSI is currently cleaning and decontaminating the facility for the purpose of final decommissioning and abandonment. Further details related to SSI are provided in section 14.1 of this report.

For 2012, CNSC staff performed seven inspections at the tritium processing facilities, three at SRB and four at SSI. One of the inspections was an unannounced verification at SSI, which confirmed that the licensee was in compliance with the restrictions set by the extended licence issued by the Commission. All issues identified during these inspections were minor deficiencies and are being addressed by the licensees.

Licensees are also required to submit annual reports by March 31 of each year, reporting on the operations of their facilities. The reports include all environmental, radiological and safety-related information, including events and associated corrective actions taken. The full versions of these reports are available on the licensees' Web sites. See appendix I for a list of these Web sites listed below:

Shield Source Incorporated
shieldsource.com

SRB Technologies (Canada) Inc.
betalight.com/index_can.htm

CNSC staff rated all SCAs for SRB as “satisfactory” with the exception of the conventional health and safety SCA, which was rated “fully satisfactory”. All ratings were “satisfactory” for SSI, with the exception of the SCAs of management system, operating performance, and environmental protection, which are rated “below expectations”. CNSC assessments of SSI’s SCAs rated “below expectations” are primarily based on the issues associated with SSI’s exceedance of its total air emission limits. In addition, SSI has not implemented all its corrective actions identified during its root cause investigation into this event. Appendix C contains the facilities ratings from 2009 to 2012. The 2012 performance ratings for the tritium processing facilities are presented in table 13-1.

Table 13-1: Tritium processing facilities – SCA performance ratings, 2012

Safety and control area	Shield Source Inc.	SRB Technologies Inc.
Management system	BE	SA
Human performance management	SA	SA
Operating performance	BE	SA
Safety analysis	SA	SA
Physical design	SA	SA
Fitness for service	SA	SA
Radiation protection	SA	SA
Conventional health and safety	SA	FS
Environmental protection	BE	SA
Emergency management and fire protection	SA	SA
Waste management	SA	SA
Security	SA	SA
Safeguards	N/A	N/A
Packaging and transport	SA	SA

13.1 Radiation Protection

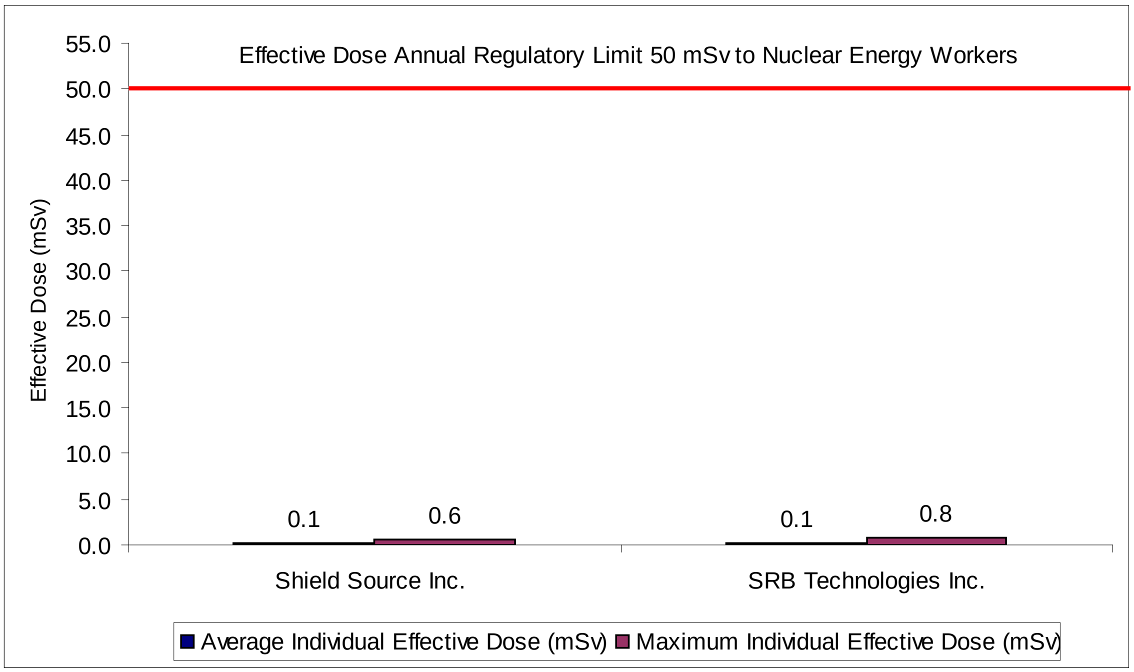
For 2012, CNSC staff continue to rate the radiation protection SCA at both tritium processing facilities as “satisfactory”. The recently discovered information associated with SSI under-reporting of their total air emissions had no impact on reported doses to workers.

CNSC licensees are required to implement a radiation protection program that keeps radiation doses in accordance with the ALARA principle and ascertains doses as a result of the licensed activity. Radiological exposures to workers at the tritium processing facilities primarily result from inhalation, ingestion or skin absorption of tritium. Internal doses are ascertained by a urine bioassay. The CNSC evaluates each licensee’s radiation protection program through several methods, including desktop reviews, inspections and review of the licensee’s annual compliance reports.

Both licensees have implemented and continue to maintain radiation protection programs to control the radiological hazards present in their facilities, and have ascertained and recorded doses for each person performing duties in connection with their licensed activities. In 2012, no radiation exposures reported by the tritium processing facilities exceeded the regulatory dose limit of 50 mSv in a one-year dosimetry period. Figure 13-1 compares the average and maximum effective doses at SSI and SRB during the 2012 reporting period.

The maximum exposure to workers at both facilities was well below the regulatory dose limit of 50 mSv in a one-year dosimetry period. The annual worker dose statistics are found in appendix E.

Figure 13-1: Tritium processing facilities – comparisons of average and maximum effective dose trends to nuclear energy workers, 2012



Based on the review of dose data provided above, CNSC staff are satisfied that the tritium processing facilities are adequately controlling radiation doses to levels well below the regulatory limits, keeping doses in accordance with the ALARA principle.

13.1.1 Doses to the Public

The calculated potential doses to the public from 2008 to 2012 for SSI and SRB are in table 13-2. Potential public doses continue to be well below the regulatory limit of 1 mSv/yr.

Table 13-2: Tritium processing facilities – public dose comparison table (mSv), 2008–2012

Facility	Year					Regulatory limit
	2008	2009	2010	2011	2012	
Shield Source Inc.	0.019	0.019	0.068	0.032	0.007	1 mSv/yr
SRB Technologies Inc.	0.0053	0.0066	0.0050	0.0050	0.0045	

Because any dose to the public is impossible to measure above the natural background radiation, potential doses to the public for both facilities are calculated using environmental monitoring data, which is based on modelling and provides an overall estimate of the public dose.

A comparison of the hypothetical doses from these calculations between SSI and SRB is difficult because SSI uses a much more conservative model than SRB. Given the very small calculated doses, CNSC staff are satisfied that both models are appropriate to demonstrate that the public continues to be protected.

13.2 Environmental Protection

For 2012, CNSC staff rated the environmental protection SCA at SRB as “satisfactory”, while the environmental protection SCA at SSI was rated as “below expectations”. The SSI rating is primarily based on the issues associated with the exceedance of its total air emission limits.

The environmental protection SCA covers programs that identify and monitor all releases of radioactive and hazardous substances as the result of licensed activities and their effects on the environment. Licensees are required to develop and implement policies, programs and procedures that comply with all applicable federal and provincial regulatory requirements, in order to control the release of radioactive and hazardous substances into the environment, and to protect the environment. Licensees are also expected to have suitably trained and qualified staff to effectively develop, implement and maintain their environmental protection programs.

Air Emissions

Table 13-3 shows SSI and SRB licence limits for tritium oxide (HTO), total tritium (HTO + HT gas) and air emissions, from 2009 to 2012. The licence limits for the two facilities are slightly different from each other because they were developed based on individual site characteristics and in order to control tritium exposure to levels in accordance with the ALARA principle.

Table 13-3: Tritium processing facilities – air emissions monitoring results, 2009–2012

Parameter	Facility	2009	2010	2011	2012	Licence limit
Tritium as tritium oxide (HTO), TBq/yr [1]	SSI	6.3	27.3	37.1	13.2	**70**
	SRB	14.25	9.17	12.50	8.40	**67**
Total tritium as HTO and tritium gas (HT) TBq/yr	SSI	1,435 [2]	1,564 [2]	1,475 [2]	380	**500**
	SRB	40.55	36.43	55.68	29.90	**448**

[1] Terabecquerel per year.
[2] These represent corrected values that were submitted to the CNSC in 2012.

Liquid effluent monitoring

Table 13-4 shows that both tritium facilities continued to effectively control the liquid effluent from their facilities and that tritium concentrations were consistently well below their respective licence limits.

Table 13-4: Tritium processing facilities – liquid effluent monitoring results, 2009–2012

Parameter	Facility	2009	2010	2011	2012	Licence limit
Tritium-water soluble – TBq/yr	SSI	**0.002**	**0.007**	**0.004**	**0.0006**	**0.100**
	SRB	**0.062**	**0.007**	**0.008**	**0.012**	**0.200**

13.3 Conventional Health and Safety

The conventional health and safety SCA covers the implementation of a program to manage workplace safety hazards and to protect personnel. For 2012, CNSC staff rated the conventional health and safety programs at SRB as “fully satisfactory”; the program is well developed and has been consistently satisfactory over several years. SSI’s program is rated as “satisfactory”.

The regulation of conventional health and safety at the tritium processing facilities involves Human Resources and Skills Development Canada (HRSDC) and the CNSC. CNSC staff monitor compliance with CNSC regulatory reporting requirements and on occasions, should a concern be identified, HRSDC staff are consulted and asked to take appropriate action. Licensees submit hazardous occurrence investigation reports to both HRSDC and the CNSC, in accordance with their respective reporting requirements.

Table 13-5 summarizes the recordable lost-time incidents (LTIs) reported by the tritium processing facilities from 2009 to 2012. Two LTIs occurred at SSI in 2012; both incidents were related to workers improperly lifting boxes. These are further described in appendix H.

CNSC staff conclude that the tritium processing facility licensees' programs related to the conventional health and safety SCA were effective in protecting the health and safety of persons working in those facilities.

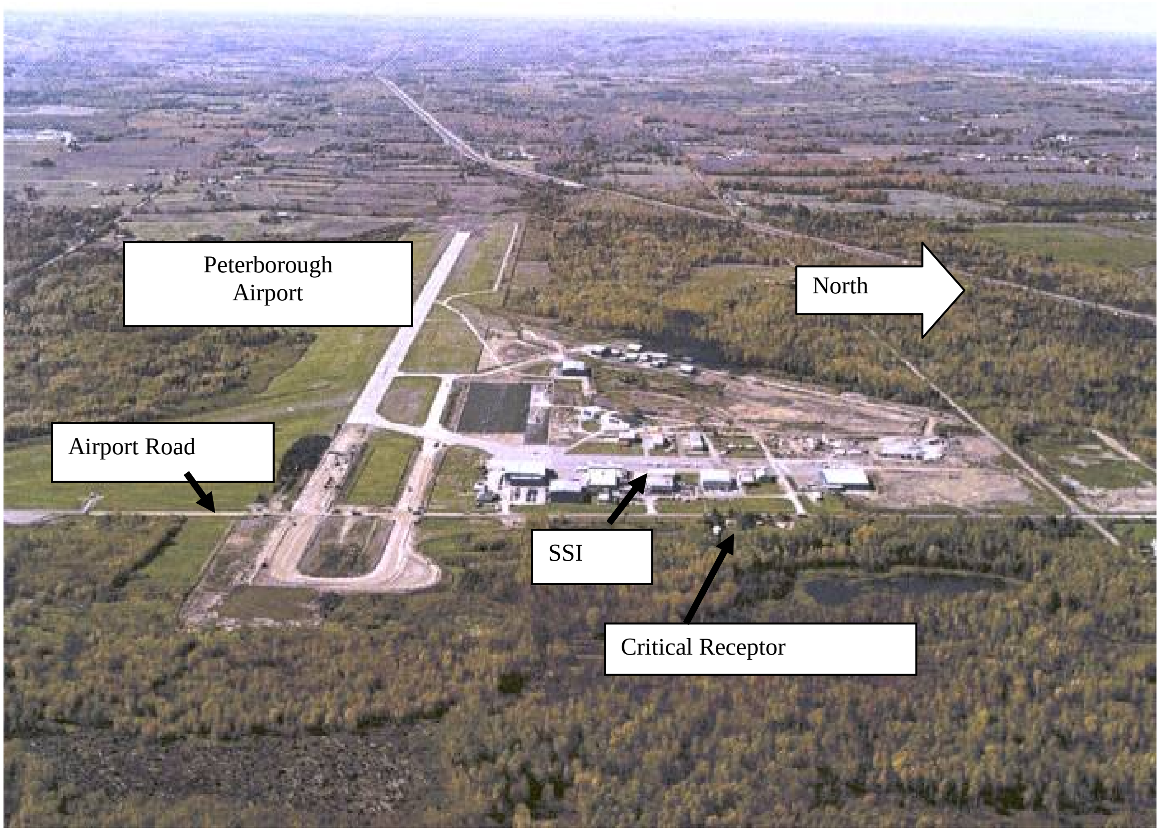
Table 13-5: Tritium processing facilities – lost-time incidents, 2009–2012

Facility	2009	2010	2011	2012
Shield Source Inc.	0	0	0	2
SRB Technologies Inc.	0	0	1	0

14 Shield Source Incorporated

Shield Source Incorporated (SSI) is classified as a nuclear substance processing facility. The facility is located at the Peterborough Municipal Airport in Peterborough, Ontario, and has been in operation since 1986. Figure 14-1 shows an aerial view of SSI and its surroundings. The facility occupies 300 square metres of leased commercial space within the airport. The closest residence is 220 metres northeast of the facility.

Figure 14-1: Aerial view of Shield Source Incorporated – Source: Shield Source Incorporated



The facility licence NSPFOL-12.00/2012 was due for renewal in June 2012. However, in April 2012, SSI submitted evidence that its total tritium discharge monitoring data had been under-reported for several years due to an instrument error. In May 2012, the Commission amended SSI's operating licence to restrict SSI from processing tritium gas for the production of gaseous tritium light sources and extended the licence period until December 2012. SSI was required to submit a root cause analysis report and corrective action plan before the Commission would remove restrictions on its operations.

In December 2012, CNSC staff recommended to the Commission that a one-year licence extension, with continued restrictions, would allow SSI time to complete the updates to programs and processes required to apply for a licence without restrictions. Based on this recommendation, the Commission, on its own motion, extended SSI's licence further with the same licence restrictions until December 2013.

In March 2013, SSI notified the CNSC of its plan to cease operations in 2013 and to apply for the Commission's approval to abandon the facility once the facility has been properly cleaned up to its intended future use.

14.1 Performance

SSI's 2012 performance ratings for all SCAs were "satisfactory" except for the SCAs of management system, operating performance, and environmental protection, which were rated as "below expectations". CNSC assessment of these SCAs were based on issues associated with SSI's exceedance of its total air emission limits and on areas of improvement, identified as part of SSI's root cause investigation, which had not all been implemented in 2012. Appendix C contains the facilities ratings from 2009 to 2012.

SSI is currently assembling and disassembling tritium signs but not producing gaseous tritium light sources. Based on recalculated values, SSI had one reportable event in 2012; an action level exceedance for tritium gas emissions before the current licence restrictions were put in place. Details of this event can be found in section 14.3 below. SSI has now discontinued all operations and has commenced clean-up activities. It is expected that equipment, office furniture and other waste will be removed from the facility by December 2013.

14.2 Radiation Protection

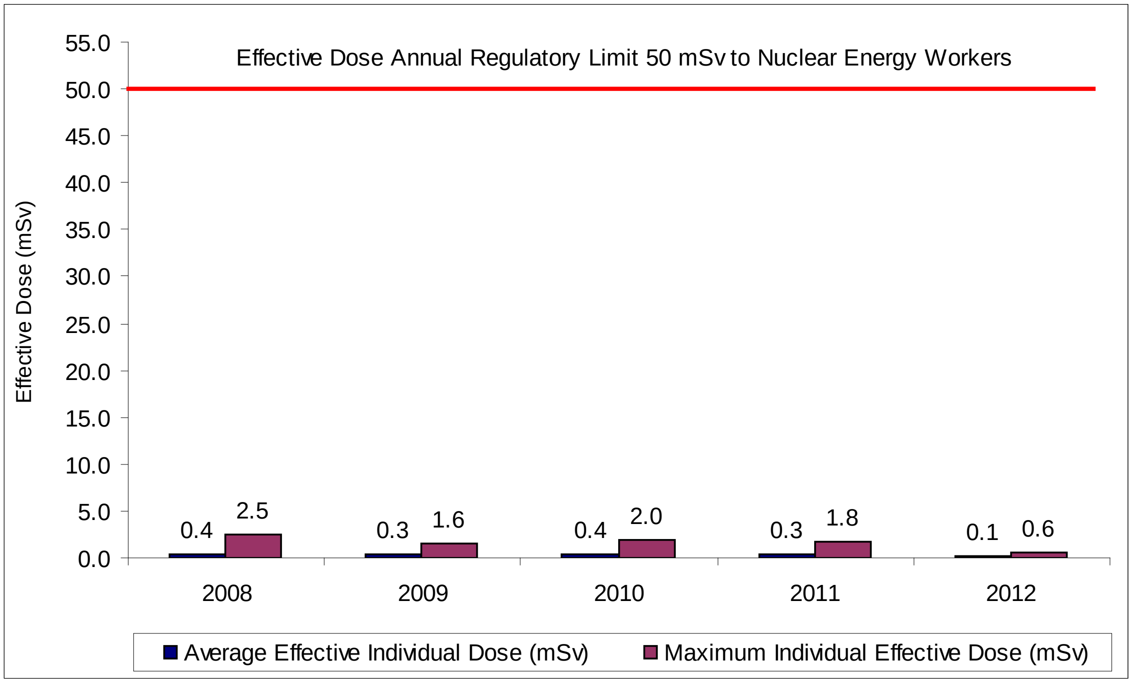
For 2012, CNSC staff rated SSI's radiation protection SCA as "satisfactory".

The risks associated with SSI's licensed activities derive from the radiological hazards of tritium, a beta emitter. The risk associated with tritium is from inhalation, ingestion or absorption through the skin.

All workers are designated as NEWs, and radiation exposures are monitored to ensure compliance with the regulatory dose limits and with keeping radiation doses in accordance with the ALARA principle. For 2012, no worker's radiation exposure reported by SSI exceeded the regulatory dose limits. The maximum effective dose received by a worker in 2012 was 1 mSv, or 2 percent of the effective dose regulatory limit of 50 mSv in a one-year dosimetry period. Annual average and maximum effective dose results from 2008 to 2012 are provided in figure 14-2.

During this period, average doses ranged from 0.1 mSv to 0.4 mSv, while the maximum doses ranged from 1 mSv to 3 mSv.

Figure 14-2: Shield Source Incorporated – average and maximum effective dose trends to nuclear energy workers, 2008–2012



Environmental sample results are used to estimate the dose to the public. The dose estimates for the last three years are well below the public dose limit of 1 mSv/yr. Table 14-1 provides the dose contributors for the most exposed member of the public (at the residence closest to the SSI facility).

Table 14-1: Shield Source Incorporated – dose contributors for the most exposed member of the public, 2009–2012

Dose contributor	Annual dose (mSv)				Regulatory limit	Background radiation
	2009	2010	2011	2012		
Total	0.019	0.068	0.032	0.007	**1 mSv/yr**	**1.8 mSv/yr**

14.3 Environmental Protection

As previously mentioned in the comparison section of this report for tritium processing facilities, CNSC staff rated SSI's environmental protection SCA as "below expectations" for 2012. This is related to the miscalculation of air emissions for the stack not its environmental monitoring program.

SSI has an environmental monitoring program that collects site-specific environmental data for tritiated water (HTO) in the environment at and around the facility. These data are used to calculate representative tritium exposure pathways for the public that result from SSI's licensed activities. The environmental data are collected independently of the total tritium release monitoring; these data help validate emissions monitoring information.

SSI's program includes the determination of tritium concentrations at various locations: in drinking water wells and numerous other wells, in vegetation and animal produce, in air, and in samples taken from nearby surface waters. The samples are analyzed by a qualified third party contracted by SSI. In the summer of 2012, CNSC staff collected a number of environmental samples to compare with SSI's third-party results. The results were used to calculate the dose consequences to the most exposed member of the public. The results provided on table 14-1 shows that the public is protected and safe from releases from the SSI facility even with the higher air emissions discussed below. Moreover, the SSI and CNSC laboratory results were found to be comparable which provided confidence in SSI's data.

The CNSC continues to conduct independent environmental monitoring around the SSI facility and will continue to do so until all activities (including clean-up) cease. This program is to support our current understanding that the area around the SSI facility is safe.

Air Emissions

The monitoring data in table 14-2 provide the stack emissions results for the facility from 2009 to 2012. The correct resulted in SSI exceeding its licence limit for total tritium in 2009, 2010 and 2011. These exceedances were determined in April 2012 and SSI shutdown tritium full operations, the main source of air emissions, once the exceedances were found.

Since air emissions were regulated to ensure tritium did not accumulate in groundwater, these releases had no impact on public doses that remain well below regulatory limits and the public has remained protected during the operation of the SSI facility. Most of the total tritium released for 2012 occurred prior to SSI's tritium processing stoppage. This release did not result in a measurable change in tritium concentrations at air monitoring stations near the facility. See discussion in section 14.3.1.

Table 14-2: Shield Source Incorporated – air emissions monitoring results, 2009–2012

Parameter	2009	2010	2011	2012	Licence limit
Tritium as tritium oxide (HTO), TBq/yr	6.3	27.3	37.1	13.2	**70**
Total tritium as HTO + tritium gas (HT), TBq/yr	1,435*	1,564*	1,475*	380	**500**

* These represent corrected values submitted to the CNSC in 2012.

Liquid Effluent Monitoring

In 2012, SSI continued to monitor tritium released as liquid effluent from the facility. The monitoring data in table 14-3 demonstrate that liquid effluent from the facility continues to be effectively controlled and that tritium concentrations are consistently well below the licence limit.

SSI has discontinued its procedure for washing low-level contaminated waste, which had been initiated in 2010; based upon that, its liquid effluent results have decreased even further.

Table 14-3: Shield Source Incorporated – liquid effluent monitoring results, 2009–2012

Parameter	2009	2010	2011	2012	Licence limit
Tritium-water soluble – TBq/yr	0.002	0.007	0.004	0.001	**0.100**

14.3.1 State of Receiving Environment

Tritium in Ambient Air Emissions

SSI has a total of 20 passive air samplers for HTO located throughout an area that is a 1-kilometre radius from the facility. The samples are analyzed monthly by a qualified third-party laboratory for tritium concentration assessment. The passive air samplers represent tritium exposure pathways for inhalation and skin absorption and are used in the calculations to determine the public dose.

In 2011, SSI commissioned a third party to conduct a parallel active air sampling program at the critical receptor. This program was initiated in January 2012. The results of the program found that SSI was under-reporting its passive air sampler results. The revised air sampler results had no noticeable impact on SSI’s revised public dose provided in table 14-1 that demonstrated the public is protected and safe from the releases from the SSI facility.

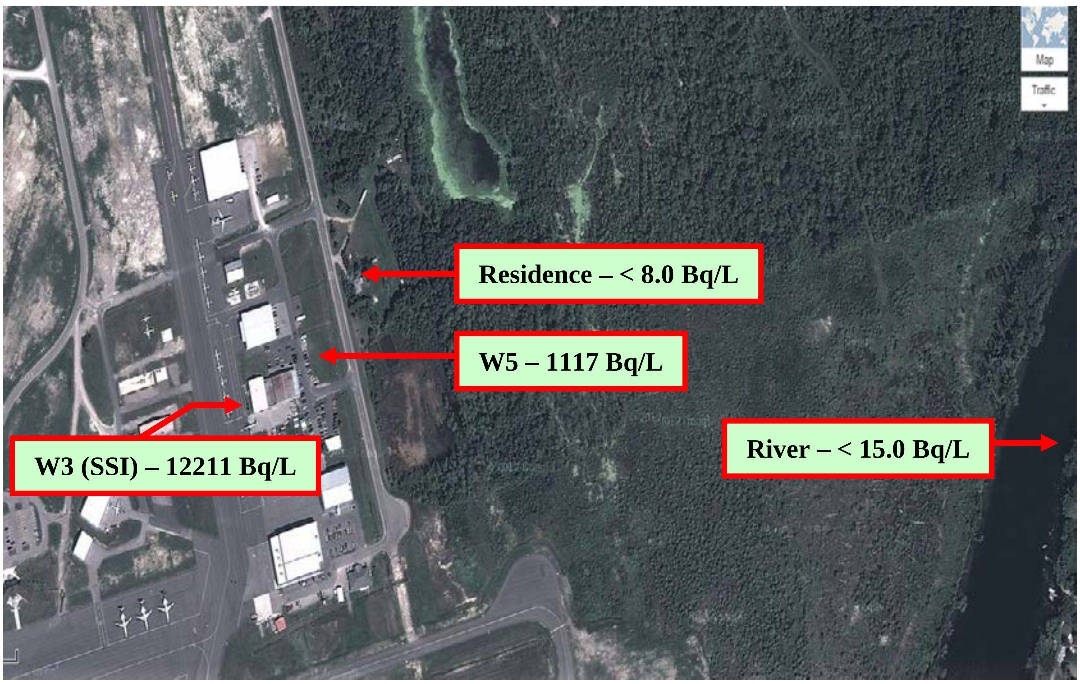
Groundwater Monitoring

Groundwater is sampled monthly in nine monitoring wells around SSI. As expected, the highest tritium concentration was detected at well 3 located close to SSI’s stack, averaging 15,664 Bq/L in 2011 and 12,211 Bq/L in 2012.

Except for the two wells closest to SSI’s stack (wells 2 and 3), tritium concentrations in all of the other monitoring wells have been below the Canadian Drinking Water Quality Guideline of 7,000 Bq/L. CNSC staff note that none of the monitoring wells are used for drinking purposes.

The one drinking water well in the vicinity of SSI is located at the residence across Airport Road. Samples taken from this well and analyzed for tritium concentration by two third-party laboratories indicate readings below detectable limit. While the detectable limit differs amongst the laboratories, the results confirm that tritium levels in groundwater and surface water are very low relative to the Ontario Drinking Water Standard (7000 Bq/L) and below 20 Bq/L. The observed tritium levels are expected to decrease with the cessation of processing activities at SSI. Samples taken from the Otonabee River and analyzed for tritium concentration by a second third-party laboratory also indicate readings below the detection limit. Figure 14-3 shows a spatial distribution of annual average tritium concentrations in the area in 2012.

Figure 14-3: Shield Source Incorporated – spatial distribution of annual average tritium concentrations around SSI in 2012 – Source: Google Maps



In 2012, SSI conducted further hydrogeological investigation, including installation of additional temporary groundwater samplers near the facility. The investigation confirmed that the overall tritium distribution in the groundwater around SSI remains in close proximity to the facility.

14.4 Conventional Health and Safety

For 2012, CNSC staff rated the conventional health and safety SCA for SSI as “satisfactory”.

The conventional health and safety SCA covers the implementation of a program to manage workplace safety hazards and to protect personnel. Each licensee is responsible for developing and implementing a conventional health and safety program for the protection of its personnel and contract workers, regardless of their place of employment. In addition to the *Nuclear Safety and Control Act* and its associated regulations, activities and operations must comply with the *Canada Labour Code*, Part II, and with other applicable federal and provincial health and safety-related acts and regulations.

In 2012, two LTIs occurred at SSI. Both incidents were due to improper lifting of boxes weighing less than 40 lbs. The injuries resulted in a total of 104 hours of lost time (13 working days). These two LTIs do not change the CNSC staff rating of "satisfactory" for this safety and control area, since SSI continues to maintain a well developed health and safety program at its facility.

To prevent reoccurrence, SSI held meetings to remind staff of proper lifting techniques.

14.5 Current Status and Path-Forward for the SSI Facility

On March 4, 2013, SSI announced that the company will not seek a renewal of its Nuclear Substance Processing Facility Operating Licence, but instead will cease operations and apply for the necessary licence to achieve this. On July 25, 2013, CNSC staff requested SSI to commence with clean-up and decontamination of the tritium fill room and associated structures (ventilation, stack) as soon as possible, and by a qualified third party under the conditions of its current licence. A detailed clean-up plan prepared by the third party was required to be submitted to CNSC for review before clean-up of the tritium fill room commences. However, other clean-up activities, such as the removal of waste and clean-up of office space, could proceed.

On October 4, 2013, SSI submitted the third parties clean-up and decontamination plan for the tritium fill room. This plan was approved by CNSC staff on October 18, 2013. The plan includes the following phases:

Phase 1: Clean-up and decontamination of the Tritium Fill Room: this work is anticipated to commence on October 21, 2013 and to be completed by October 31, 2013.

Phase 2: Active Duct and Stack Removal: this work will require approximately 3 days and will be completed by November 30, 2013.

Phase 3: A Final Report, which includes:

- A description of the end-state of the facility at the end of the clean-up and decontamination activities.
- Final contamination monitoring results.
- A summary of releases to the environment that occurred during the work.
- A summary of personnel doses during the work.
- A summary of Operating Experience gained during the work.

The report will be submitted to the CNSC by December 31, 2013.

The CNSC has increased its compliance and verification activities following SSI's announcement to not renew its operating licence. CNSC staff have visited the facility four times since March 2013. Meetings on site, as well as teleconferences with SSI and its contactors, were conducted to discuss the clean-up of the facility and to communicate CNSC staff's requirements and expectations.

When the clean-up of the Tritium Fill Room commences, CNSC inspectors, as well as CNSC laboratory personnel and a radiation protection specialist will be on site to monitor and verify compliance with the regulatory requirements. CNSC staff will be conducting independent analysis and monitoring throughout the clean-up activities. An air monitor will be installed by CNSC staff, outside of SSI's facility, to monitor the emissions in the environment. Daily samples will be submitted to CNSC laboratory for analysis.

CNSC staff expect to receive an application from SSI to release the facility from our regulatory oversight noting that SSI intends to return the building to the landlord for future industrial uses. However, this licence application would need to be informed with monitoring results obtained after clean-up activities. The nature of this licence will depend on the results of the clean-up activities. Nevertheless, the CNSC will continue its enhanced regulatory oversite of the facility until it is returned to unconditional industrial use.

15 SRB TECHNOLOGIES (CANADA) INCORPORATED

SRB Technologies (Canada) Incorporated (SRB) is a gaseous tritium light source manufacturing facility located in Pembroke, Ontario (see figure 15-1). The facility processes tritium gas to produce light sources and manufactures radiation devices for containing the sources. SRB leases a space in an industrial building similar to a strip mall. The closest residence is located approximately 255 metres from the facility. SRB employed 22 people in 2012.

Figure 15-1: Aerial view of SRB Technologies – Source: SRB Technologies (Canada) Inc.

The facility has been in operation since 1990, possessing a nuclear substance licence and, in 2000, was issued a Class IB nuclear substance processing facility operating licence.

The current licence was issued in July 2010 and expires in June 2015. In 2012, there were no licence amendments or updates to SRB's LCH.

15.1 Performance

For 2012, CNSC staff rated all of SRB's SCAs as "satisfactory" except one, the conventional health and safety SCA, which was rated as "fully satisfactory", based upon good implementation of this program. The performance ratings for SRB from 2009 to 2012 are found in appendix C.

In 2012, there were no building modifications that impacted the licensing basis, and no action level exceedances were reported for the year.

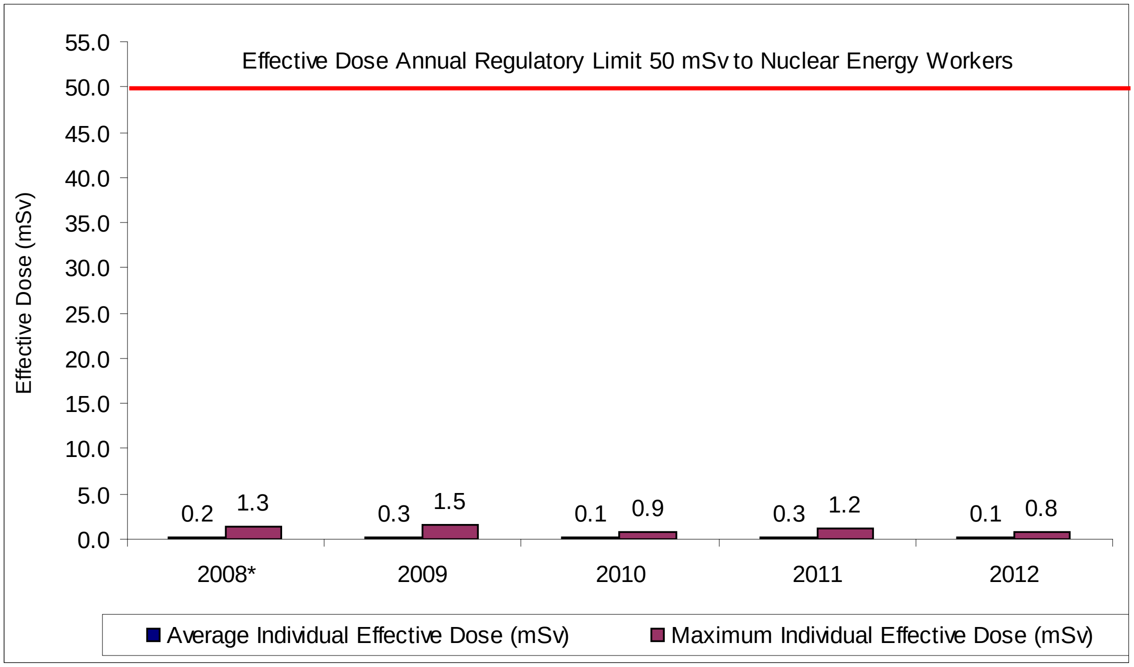
15.2 Radiation Protection

For 2012, CNSC staff rated SRB's radiation protection SCA as "satisfactory".

The risks associated with SRB's licensed activities result from the radiological hazards of tritium, a beta emitter. The risk associated with tritium is from inhalation, ingestion or absorption through the skin. In 2012, no action level exceedances or any safety-significant events related to radiation protection were reported.

All workers are designated as NEWs, and radiation exposures are monitored to ensure compliance with the regulatory dose limits and with keeping radiation doses in accordance with the ALARA principle. For 2012, no worker's radiation exposure reported by SRB exceeded the regulatory dose limits. The maximum effective dose received by a worker in 2012 was 1 mSv, or 2 percent of the effective dose regulatory limit of 50 mSv in a one-year dosimetry period. Annual average and maximum effective dose results from 2008 to 2012 are provided in figure 15-2. During this period, average doses ranged from 0.1 mSv to 0.3 mSv, while the maximum doses ranged from 1 mSv to 2 mSv.

Figure 15-2: SRB Technologies – average and maximum effective dose trends to nuclear energy workers, 2008–2012



* SRB resumed operation in July 2008 following a facility shutdown.

Environmental sample results are taken into account to estimate the dose to the public. The dose estimate for the last three years was less than 1 percent of the public dose limit of 1 mSv/yr. Table 15-1 provides the total dose from all contribution pathways for an adult who is a resident of the critical group and who works in the vicinity of SRB.

Table 15-1: SRB Technologies – dose contributors for an adult who is a resident of the critical group and works in the vicinity of SRB, 2009–2012

Dose contributor	2009 (mSv/yr)	2010 (mSv/yr)	2011 (mSv/yr)	2012 (mSv/yr)	Regulatory limit
Total	0.0066	0.0050	0.0050	0.0045	**1 mSv/yr**

15.3 Environmental Protection

For 2012, CNSC staff rated SRB's environmental protection SCA as "satisfactory".

SRB has an environmental monitoring program that collects site-specific environmental data at and around the facility. These data are used to calculate all possible tritium exposure pathways for the public that result from SRB's licensed activities.

SRB's environmental monitoring program includes the determination of tritium concentrations at various locations: in drinking water wells and numerous other wells, in milk and produce, in air, and in samples taken from nearby surface waters.

The samples are analyzed and collected by a qualified third party contracted by SRB. In September 2012, CNSC staff collected a number of environmental samples to compare with SRB's third-party results. Results were found to be comparable.

Air Emissions

SRB's releases to the atmosphere continued to be below the release limits prescribed in its operating licence. The monitoring data in table 15-2 demonstrate that stack emissions from the facility were effectively controlled and consistently well below SRB's licence limits. Action levels were not exceeded at any time from 2009 to 2012.

Table 15-2: SRB Technologies – air emissions monitoring results, 2009–2012

Parameter	2009	2010	2011	2012	Licence limit TBq/yr
Tritium as tritium oxide (HTO), TBq/yr	14.25	9.17	12.50	8.40	**67**
Total tritium as HTO + tritium gas (HT), TBq/yr	40.55	36.43	55.68	29.90	**448**

Liquid Effluent Monitoring

In 2012, SRB continued to monitor tritium released as liquid effluent from the facility. The monitoring data for 2009 through 2012, seen in table 15-3, demonstrate that liquid effluent from the facility continues to be effectively controlled and that tritium concentrations are consistently well below the licence limit.

Table 15-3: SRB Technologies – liquid effluent monitoring results, 2009–2012

Parameter	2009	2010	2011	2012	Licence limit
Tritium-water soluble – TBq/yr	0.062	0.007	0.008	0.012	**0.200**

15.3.1 State of Receiving Environment

Air Emissions

SRB has a total of 40 passive air samplers located within a 2-kilometre radius of the facility. The samples are collected and analyzed monthly by a qualified third-party laboratory for tritium concentration assessment.

The passive air samplers represent tritium exposure pathways for inhalation and skin absorption and are used in the calculations to determine the public dose. The results from these samplers show that air emissions measured in 2012 were well below SRB's licence limits.

Groundwater Monitoring

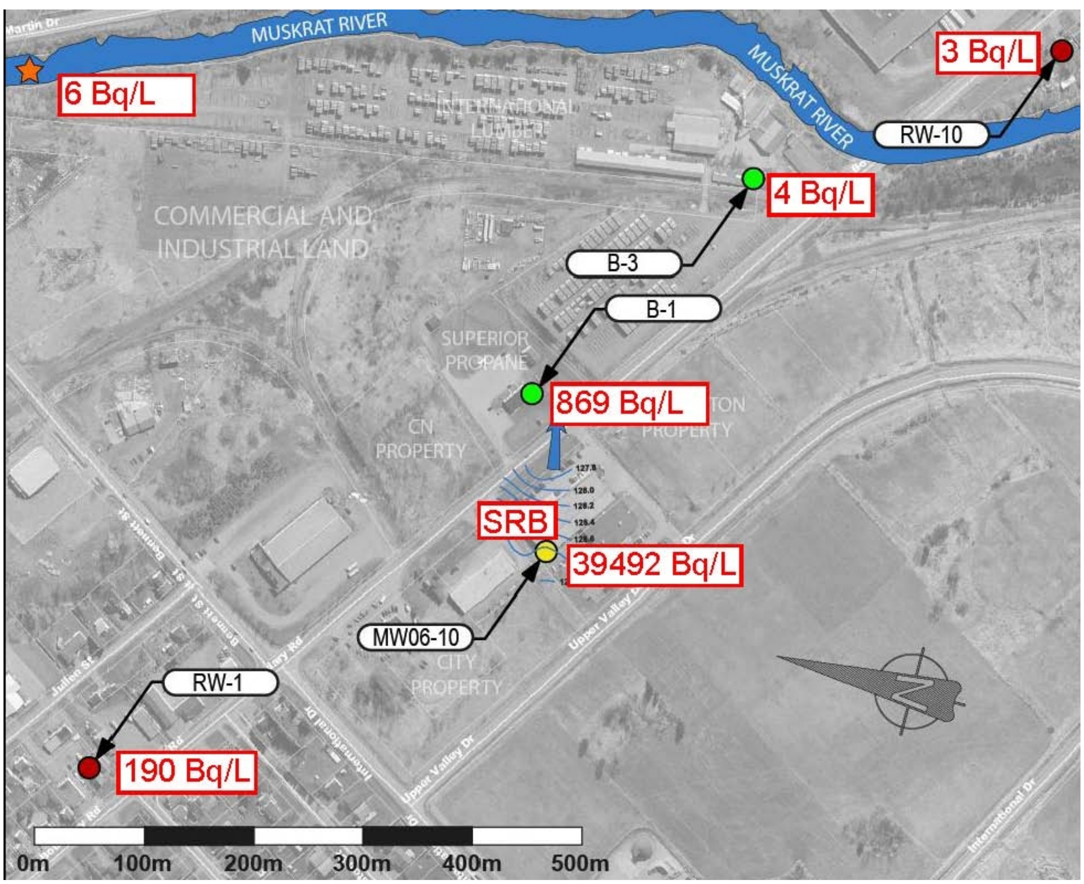
Since the last renewal of its licence in 2010, SRB has conducted a groundwater study, which confirmed that the residential wells (with highest tritium concentration of 869 Bq/L for 2012) and the Muskrat River (with tritium concentrations for the last two years in the range of 3.2 – 22 Bq/L) are not at risk of exceeding the Canadian Drinking Water Quality Guideline of 7,000 Bq/L currently or in the future.

Groundwater is sampled in 57 non-potable wells. The highest tritium concentration was found in well MW06-10, which is located near the SRB stacks, averaging 33,402 Bq/L in 2011 and 39,491 Bq/L in 2012. These values are restricted to a small area and represent the past releases of the facility. Values continue to be within the range anticipated from the soil profile data obtained when the wells were drilled.

Tritium concentrations were drastically lower further away from SRB. Figure 15-3 shows a few examples of the spatial distribution of tritium concentrations in groundwater in the area in 2012.

The highest tritium concentration in a potential drinking water well was found in business well B-1, averaging 1,063 Bq/L in 2011 and 869 Bq/L in 2012. SRB continued to provide bottled drinking water to the business, even though the tritium concentrations were well below the Canadian Drinking Water Quality Guideline of 7,000 Bq/L.

Figure 15-3: Tritium in groundwater around SRB – Source: SRB Technologies (Canada) Inc.



15.4 Conventional Health and Safety

For 2012, CNSC staff rated the conventional health and safety SCA for SRB as “fully satisfactory”. This is based on the continued good implementation of its health and safety program.

The conventional health and safety SCA covers the implementation of a program to manage workplace safety hazards and to protect personnel. Each licensee is responsible for developing and implementing a conventional health and safety program for the protection of its personnel and contract workers, regardless of their place of employment. In addition to the *Nuclear Safety and Control Act* and its associated regulations, activities and operations must comply with the *Canada Labour Code*, Part II, and with other applicable federal and provincial health and safety-related acts and regulations.

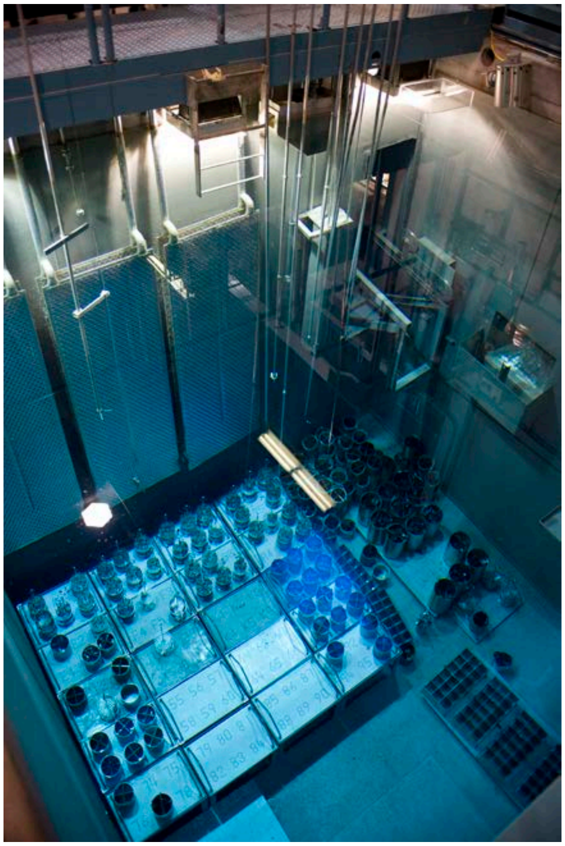
In 2012, there were no incidents at SRB that resulted in lost time.

PART IV: NORDION (CANADA) INC.

16 Processing Facility – Nordion (Canada) Inc.

Nordion (Canada) Inc. (Nordion) is licensed to operate a Class IB nuclear substance processing facility; it is located adjacent to industrial and residential property in Kanata (Ottawa), Ontario. Figure 16-1 shows one of the cobalt storage pools located within the Nordion facility.

Figure 16-1: Nordion – cobalt storage pool – Source: Nordion



At the facility, Nordion processes unsealed radioisotopes, such as iodine-131, for the health and life sciences, and manufactures sealed radiation sources for industrial applications.

The Commission amended Nordion's licence in 2012 to include four administrative changes related to clarification of wording, referencing current documents on the licence, and modifying the reporting to the Commission of certain sealed sources.

Nordion did not have an LCH in 2012.

In 2012, CNSC staff performed three inspections at the Nordion facility. Nordion is required to submit an annual report by March 31 of each year, reporting on the operation of the facility. The reports include all environmental, radiological and safety-related events. Much of the data in this report are obtained from Nordion's annual reports.

The 2012 performance ratings are presented in table 16-1. CNSC staff rated all but three SCAs as "satisfactory". The exceptions – environmental protection, conventional health and safety, and security – are rated as "fully satisfactory". Appendix C provides the ratings from 2010 to 2012. There were no reportable events at Nordion's facility in 2012 that impacted the health and safety of workers or the environment.

Table 16-1: Nordion (Canada) Inc. – SCA performance ratings, 2012

Safety and control area	2012 rating
Management system	SA
Human performance management	SA
Operating performance	SA
Safety analysis	SA
Physical design	SA
Fitness for service	SA
Radiation protection	SA
Conventional health and safety	FS
Environmental protection	FS
Emergency management and fire protection	SA
Waste management	SA
Security	FS
Safeguards	SA
Packaging and transport	SA

16.1 Performance

CNSC staff rated all of Nordion's SCAs as "satisfactory" for the years 2012, with the exception of environmental protection, conventional health and safety, and security, which were rated as "fully satisfactory". Environmental protection and conventional health and safety were rated "fully satisfactory" in 2011, and security was rated "satisfactory".

For 2011, CNSC staff reported they observed that Nordion had carried out several security improvements, having enhanced the overall site security program. In 2012, Nordion has continued to make further improvements to the security program and has continued to maintain its existing security program. This continued improved performance warrants a rating of "fully satisfactory" for 2012.

The performance ratings for Nordion for 2010 through 2012 are found in appendix C.

16.2 Radiation Protection

For 2012, CNSC staff rated Nordion's radiation protection SCA as "satisfactory", the same rating as in 2010 and 2011.

The RPR require CNSC licensees to implement a radiation protection program that keeps radiation doses in accordance with the ALARA principle. The RPR also requires licensees to ascertain doses as a result of the licensed activity. The CNSC evaluates each licensee's radiation protection program through several methods, including desktop reviews, inspections and review of the licensee's annual compliance reports.

Nordion's workers may be exposed to alpha, beta and gamma radiation emitted from the radioisotopes used in the nuclear medicine area, for medical diagnostic purposes and radiopharmaceuticals, and from the production of sealed sources for industrial applications. Internal radiation exposure from the inhalation, ingestion or absorption through the skin of radioisotopes can result in a radiation dose to internal organs. External exposure from gamma radiation can impart a whole body dose to individuals, while beta radiation can result in a radiation dose to the skin. Beta and gamma radiation can impart a dose to extremities as well.

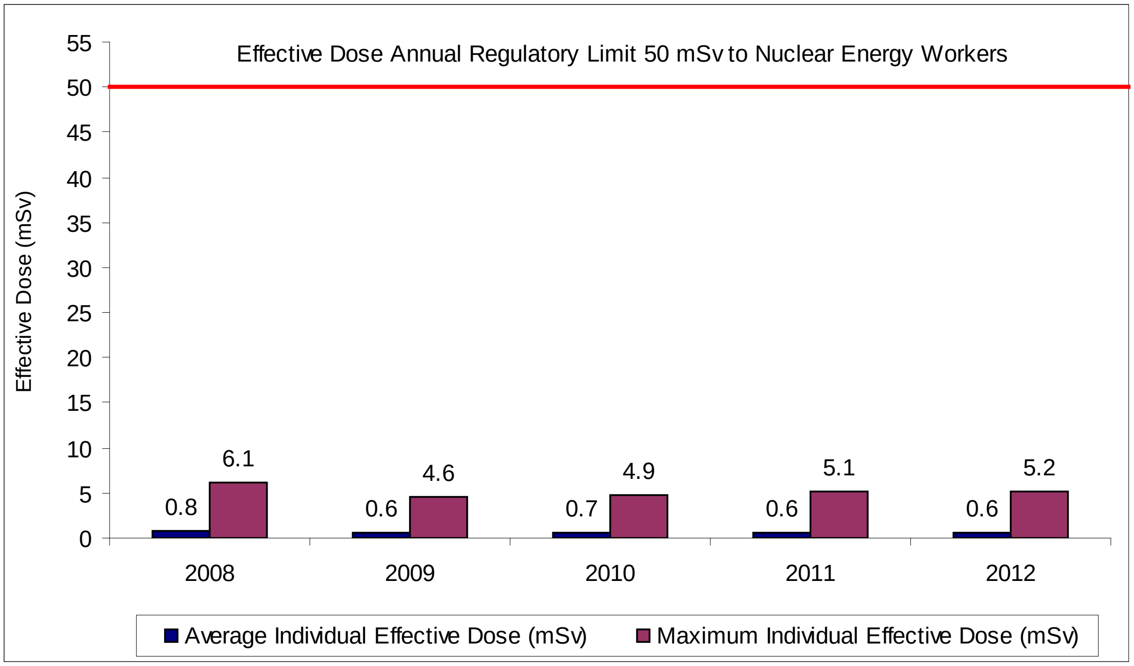
All workers (except contractors) are designated as NEWs, and radiation exposures are monitored to ensure compliance with the regulatory dose limits and with keeping radiation doses in accordance with the ALARA principle. For 2012, no worker's radiation exposure reported by Nordion exceeded the regulatory dose limits. The maximum effective dose received by a worker in 2012 was 5 mSv, or 10 percent of the effective dose regulatory limit of 50 mSv in a one-year dosimetry period. Annual average and maximum effective dose results from 2008 to 2012 are provided in figure 16-2. During this period, average doses remained relatively consistent at 1 mSv, while the maximum doses ranged from 5 mSv to 6 mSv.

Additional annual worker dose statistics are found in appendix E.

For internal radiation exposure monitoring, Nordion has a bioassay program at its facility for routine thyroid monitoring of NEWs working with iodine-125 and iodine-131. There are also provisions for whole body counting or urine analysis, should elevated air and/or contamination monitoring indicate a need.

For 2012, there were no exceedances of Nordion's investigation level for thyroid monitoring and there were no incidents requiring Nordion to conduct whole body counting or urine analysis.

Figure 16-2: Nordion (Canada) Inc. – average and maximum effective dose trends to nuclear energy workers, 2008–2012



Based on the review of radiation dose statistics for NEWs, CNSC staff are satisfied that in 2012 Nordion continued to adequately control radiation doses to workers, to levels well below the regulatory dose limits.

Public doses resulting from operations at the Nordion facility continued to be negligible (<0.001 mSv/yr). This was due to the very small quantities of nuclear substances released into the environment.

16.3 Environmental Protection

For 2012, CNSC staff conclude that the environmental protection SCA rating for the Nordion facility remains “fully satisfactory”. This rating is largely due to the continuing very small releases of nuclear substances.

The environmental protection SCA covers programs that identify and monitor all releases of radioactive and hazardous substances as the result of licensed activities and their effects on the environment.

Licensees are required to develop and implement policies, programs and procedures that comply with all applicable federal and provincial regulatory requirements, in order to control the release of radioactive and hazardous substances into the environment, and to protect the environment. Licensees are also expected to have suitably trained and qualified staff to effectively develop, implement and maintain their environmental protection programs.

CNSC staff conclude that Nordion continued to control and monitor liquid and air releases of nuclear and hazardous substances to the environment, which are released both through the stacks and through liquid effluent. Air emission results, liquid effluent monitoring results and groundwater monitoring results indicated that Nordion continued to protect the environment.

Air Emissions

Nordion continued to monitor and control the releases of radioactive and other hazardous materials from the facility. CNSC staff confirm that, as reported by Nordion in 2012, releases of nuclear substances were well below regulatory limits and no action limits were exceeded. In addition, the releases were a very small percentage of the regulatory limit (also known as the derived release limit, DRL). As shown in table 16-2, the maximum airborne emissions were less than 0.2 percent of the DRLs.

Table 16-2: Nordion (Canada) Inc. – air emissions monitoring results, 2010–2012

Parameter	2010	2011	2012	Derived release limit (DRL)	% of DRL in 2012
Cobalt-60 (GBq/yr) [1]	0.006	0.006	0.006	**78**	**0.01**
Iodine-125 (GBq/yr)	0.37	0.38	0.46	**990**	**0.04**
Iodine-131 (GBq/yr)	0.99	0.29	0.40	**1,110**	**0.03**
Xenon-133 (GBq/yr)	9,066	34,967	36,153	**29,000,000**	**0.12**

[1] Gigabecquerel per year

Although the iodine-131 releases are very small, air releases of iodine-131 have been trending upward over the past years due to production increases. In 2011, Nordion installed in-cell charcoal roughing filters; as a result there was a decrease in iodine-131 emissions from 2010. Nordion is currently examining the slight increase in 2012 to ensure that releases remain in accordance with the ALARA principle.

Liquid Effluent Monitoring

Nordion continued to monitor all liquid effluent releases prior to discharging them into the municipal sewer system. All liquid releases were found to be well below the DRLs (or CNSC licensed limits). Table 16-3 lists the liquid releases from 2010 to 2012. No action levels were exceeded from 2010 to 2012.

Table 16-3: Nordion (Canada) Inc. – liquid effluent monitoring results, 2010–2012

Parameter	2010	2011	2012	Derived release limit (DRL)	% of DRL in 2012
Iodine-125 (GBq/yr)	0.011	0.007	0.005	**14,700**	**0.0000359**
Iodine-131 (GBq/yr)	0.021	0.013	0.009	**10,800**	**0.0000792**
Molybdenum-99 (GBq/yr)	0.180	0.116	0.075	**467,000**	**0.0000162**
Cobalt-60 (GBq/yr)	0.044	0.027	0.017	**64,100**	**0.0000263**
Niobium-95 (GBq/yr)	0.001	0.001	0.0002	**64,100**	**0.000000358**
Zirconium-95 (GBq/yr)	0.001	0.001	0.0003	**64,100**	**0.000000497**
Cesium-137 (GBq/yr)	0.001	0.0004	0.0004	**64,100**	**0.000000663**

Other Monitoring

Nordion conducted groundwater sampling for non-radiological materials in 2012 but not for radioactive sampling, due to low water levels. CNSC staff noticed that elevated concentrations of contaminants were observed, including background well, and concurred that Nordion planned to conduct sampling in the early spring of 2013 to verify these levels were a result of low water levels and not released from the facility into the groundwater; the radioactive sampling is also planned for 2013.

Nordion conducts soil sampling every two years to determine radiological materials in the soil. Soil sampling was performed in 2012 and no nuclear substances attributable to the Nordion licensed activities were detected in the soil samples.

16.4 Conventional Health and Safety

For 2012, CNSC staff rated the conventional health and safety SCA for the Nordion facility as “fully satisfactory”, as in 2011. This rating is because of Nordion’s continued excellent implementation of its health and safety program.

The conventional health and safety SCA covers the implementation of a program to manage workplace safety hazards and to protect personnel. Each licensee is responsible for developing and implementing a conventional health and safety program for the protection of its personnel and contract workers, regardless of their place of employment. In addition to the *Nuclear Safety and Control Act* and its associated regulations, activities and operations must comply with the *Canada Labour Code*, Part II, and with other applicable federal and provincial health and safety-related acts and regulations.

As mentioned earlier in this report, HRSDC has the lead role in the regulation of conventional health and safety at uranium processing facilities. CNSC staff take an overview role and monitor compliance with CNSC regulatory reporting requirements. On occasion, should CNSC staff identify a concern, HRSDC staff are consulted and asked to take appropriate action. Licensees submit hazardous occurrence investigation reports to HRSDC and the CNSC in accordance with their respective reporting requirements.

CNSC staff note that, as summarized in table 16-4, the frequency of recordable LTIs reported by Nordion remained low.

Table 16-4: Nordion (Canada) Inc. – lost-time incidents, 2010–2012

Facility	2010	2011	2012
Nordion (Canada) Inc.	2	0	0

CNSC staff conclude that Nordion continued to implement its conventional health and safety program satisfactorily, and that its programs were effective in protecting the health and safety of persons working in its facilities.

GLOSSARY

Commission

A corporate body of not more than seven members, established under the *Nuclear Safety and Control Act* and appointed by the Governor in Council, to perform the following functions:

- regulate the development, production and use of nuclear energy and the production, possession, use and transport of nuclear substances
- regulate the production, possession and use of prescribed equipment and prescribed information
- implement measures respecting international control of the development, production, transport and use of nuclear energy and nuclear substances, including those respecting the non-proliferation of nuclear weapons and nuclear explosive devices
- disseminate scientific, technical and regulatory information concerning the activities of the CNSC and the effects on the environment and on the health and safety of persons, of the development, production, possession, transport and uses referred to above

Commission Member Document (CMD)

A document prepared for Commission hearings and meetings by CNSC staff, proponents and interveners. Each CMD is assigned a specific identification number.

Derived Release Limit (DRL)

A limit imposed by the CNSC on the release of a radioactive substance from a licensed nuclear facility, such that compliance with the derived release limit gives reasonable assurance that the regulatory dose limit is not exceeded.

effective dose

The sum of the products, in sieverts, obtained by multiplying the equivalent dose of radiation received by and committed to each organ or tissue set out in column 1 of an item of schedule 1 of the *Radiation Protection Regulations*, by the weighting factor set out in column 2 of that item.

equivalent dose

The product, in sieverts, obtained by multiplying the absorbed dose of radiation of the type set out in column 1 of an item of schedule 2 of the *Radiation Protection Regulations*, by the weighting factor set out in column 2 of that item.

frequency rate

The accident frequency rate measuring the number of LTIs for every 200,000 person-hours worked at the site. The frequency rate is calculated as follows:

Frequency = [(# of injuries in last 12 months) / (# of hours worked in last 12 months)] x 200,000

Full-time Equivalent (FTE)

Total person-hours divided by 2,000 hours worked per employee per year.

International Atomic Energy Agency (IAEA)

An independent international organization related to the United Nations system. The IAEA, located in Vienna, works with its Member States and multiple partners worldwide to promote safe, secure and peaceful nuclear technologies. The IAEA reports annually to the UN General Assembly and, when appropriate, to the Security Council regarding non-compliance by States with their safeguards obligations, as well as on matters relating to international peace and security.

lost-time incident

An injury that takes place at work and results in the worker being unable to return to work for a period of time.

root-cause analysis

An objective, structured, systematic and comprehensive analysis designed to determine the underlying reason(s) for a situation or event, which is conducted with a level of effort consistent with the safety significance of the event.

severity rate

The accident severity rate measures the total number of days lost to injury for every 200,000 person-hours worked at the site. Severity rate is calculated as follows:

Severity = [(# of days lost in last 12 months) / (# of hours worked in last 12 months)] x 200,000

total number of workers

The total number of workers includes employees and contractors and is expressed as full-time equivalents (FTE).

APPENDIX A: SAFETY AND CONTROL AREA FRAMEWORK FOR URANIUM MINES AND MILLS, URANIUM PROCESSING FACILITIES, TRITIUM PROCESSING FACILITIES AND NORDION

The CNSC evaluates how well licensees meet regulatory requirements and CNSC expectations for the performance of programs in 14 safety and control areas (SCAs), including the SCA for security. The specific areas within each SCA have been identified by CNSC staff. The specific areas are different for uranium mines and mills, uranium processing facilities, tritium processing facilities, and Nordion. The 14 SCAs are grouped according to their functional area as management, facility and equipment, or core control processes.

A.1 Safety and Control Framework

Functional area	Safety and control area	Definition	Uranium Mines and Mills Specific areas include but are not limited to:	Uranium Processing Facilities Specific areas include but are not limited to:	Tritium Facilities and Nordion Specific areas include but are not limited to:
Management	management system	Covers the framework that establishes the process and programs required to ensure an organization achieves its safety objectives, continuously monitors its performance against these objectives, and fosters a healthy safety culture	Management system (including safety management/quality management oversight) Organizational structure, roles and responsibilities, resource management, leadership	Management system Quality assurance	Management system Organizational structure, roles and responsibilities, resource management, leadership Organizational/-change management
	human performance management	Covers activities that enable effective human performance through the development and implementation of processes that ensure that enough licensee staff are in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safety carry out their duties.	Training Human performance programs (procedural adherence) Safety culture Awareness, safety meetings, review topics	Staffing Training	Safety culture Training
	operating performance management	Includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.	Conduct of licensed activities Reporting and trending Event investigation and corrective action programs General operating performance of mine, mill and waste management facilities (as applicable)	Conduct of licensed activities Work procedures Reporting and trending Reportable events	Conduct of licensed activities Work procedures Reporting and trending Reportable events
	safety analysis	Includes maintenance of the safety analysis that supports the overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventive measures and strategies in reducing the effects of such hazards.	Risk assessment and hazard analysis for new development or projects Change management Use of job hazard analysis process	Safety analysis report Flood risk assessment for the site Fire hazard analysis for the site	Facility safety analysis Fire hazard analysis for the site

Functional area	Safety and control area	Definition	Uranium Mines and Mills Specific areas include but are not limited to:	Uranium Processing Facilities Specific areas include but are not limited to:	Tritium Facilities and Nordion Specific areas include but are not limited to:
Facility and equipment	**physical design**	Relates to activities that impact the ability of structures, systems and components to meet and maintain their design basis, given new information arising over time and taking changes in the external environment into account.	Engineering change control Process and control systems Use of appropriate standards or codes Operating experience	Plant design and change control Pressure-retaining components	Facility design
	fitness for service	Covers activities that impact the physical condition of structures, systems and components to ensure that they remain effective over time. This includes programs that ensure all equipment is available to perform its intended design function when called upon to do so.	Maintenance Equipment revitalization Facility upgrades	Preventive maintenance program Inspection and testing program	Inspection and testing Maintenance
Core control processes	**radiation protection**	Covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations*. This program must ensure that contamination and radiation doses received are monitored and controlled.	Application of ALARA Worker dose control Personnel dosimetry Contamination control	Worker dose control Public dose Dosimetry services Contamination control Application of ALARA	Worker dose control Public dose Dosimetry services Contamination control Application of ALARA
	conventional health and safety	Covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment.	Compliance with the applicable regulations and programs Housekeeping (fire, chemical, tripping hazard, etc.) Safety statistics Safety awareness	Compliance with Part II of the *Canada Labour Code* Conventional health and safety program Housekeeping (fire, chemical, tripping hazard, etc.) Recordable lost-time incidents	Compliance with Part II of the *Canada Labour Code* Housekeeping Recordable lost-time incidents

Functional area	Safety and control area	Definition	Uranium Mines and Mills Specific areas include but are not limited to:	Uranium Processing Facilities Specific areas include but are not limited to:	Tritium Facilities and Nordion Specific areas include but are not limited to:
Core control processes (Cont'd.)	**environmental protection**	Covers programs that identify, control and monitor all releases of radioactive and hazardous substances and effects on the environment from facilities or as the result of licensed activities.	Effluent and emissions control/release Environmental monitoring and assessment Environmental risk assessment Environmental management system	Effluent and emissions control/release Environmental monitoring and assessment Environmental risk assessment Environmental management system	Effluent and emissions control/release Environmental monitoring and assessment Environmental risk assessment Environmental management system
	emergency management and fire protection	Covers emergency plans and emergency preparedness programs which exist for emergencies and for non-routine conditions. This also includes any results of exercise participation.	Emergency management program Fire protection and response	Emergency management program Fire protection program	Emergency management Fire protection and response
	waste management	Covers internal waste-related programs which form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. Also covers the planning for decommissioning.	Waste minimization, segregation and characterization Waste rock management Tailings management	Waste management program Preliminary decommissioning plan	Waste management program Preliminary decommissioning plan
	security	Covers the programs required to implement and support the security requirements stipulated in the Regulations, in the facility's licence, in orders, or in expectations for the facility or activity.	Facility security Material security	Facility security Material security	Facility security Material security
	safeguards	Covers the programs required for the successful implementation of the obligations arising from the Canada/IAEA Safeguards Agreement.	Safeguards	Safeguards	Safeguards (N/A for tritium facilities)
	packaging and transport	Includes programs that cover the safe packaging and transport of nuclear substances and radiation devices to and from the licensed facility.	Adherence to CNSC, Transport Canada and international regulations on packaging and transport	Adherence to CNSC, Transport Canada and international regulations on packaging and transport	Adherence to CNSC, Transport Canada and international regulations on packaging and transport

APPENDIX B: RATING METHODOLOGY AND DEFINITIONS

Performance ratings used in this report are defined as follows:

Fully Satisfactory (FS)

Safety and control measures implemented by the licensee are highly effective. In addition, compliance with regulatory requirements is fully satisfactory, and compliance within the SCA or specific area exceeds requirements and CNSC expectations. Overall, compliance is stable or improving, and any problems or issues that arise are promptly addressed.

Satisfactory (SA)

Safety and control measures implemented by the licensee are sufficiently effective. In addition, compliance with regulatory requirements is satisfactory. Compliance within the area meets requirements and CNSC expectations. Any deviation is only minor, and any issues are considered to pose a low risk to the achievement of regulatory objectives and CNSC expectations. Appropriate improvements are planned.

Below Expectations (BE)

Safety and control measures implemented by the licensee are marginally ineffective. In addition, compliance with regulatory requirements falls below expectations. Compliance within the area deviates from requirements or CNSC expectations to the extent that there is a moderate risk of ultimate failure to comply. Improvements are required to address identified weaknesses. The licensee or applicant is taking appropriate corrective action.

Unacceptable (UA)

Safety and control measures implemented by the licensee are significantly ineffective. In addition, compliance with regulatory requirements is unacceptable and is seriously compromised. Compliance within the overall area is significantly below requirements or CNSC expectations, or there is evidence of overall non-compliance. Without corrective action, there is a high probability that the deficiencies will lead to an unreasonable risk. Issues are not being addressed effectively, no appropriate corrective measures have been taken, and no alternative plan of action has been provided. Immediate action is required.

APPENDIX C: TREND IN SAFETY AND CONTROL AREA RATINGS

Table C-1: Cigar Lake Project – safety and control area summary

Safety and control areas	2008 rating	2009 rating	2010 rating	2011 rating	2012 rating
Management system	SA	SA	SA	SA	SA
Human performance management	BE	BE	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	FS
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table C-2: McArthur River Operation – safety and control area summary

Safety and control areas	2008 rating	2009 rating	2010 rating	2011 rating	2012 rating
Management system	BE	SA	SA	SA	SA
Human performance management	BE	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	BE	BE	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table C-3: Rabbit Lake Operation – safety and control area summary

Safety and control areas	2008 rating	2009 rating	2010 rating	2011 rating	2012 rating
Management system	BE	SA	SA	SA	SA
Human performance management	BE	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	BE	BE	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table C-4: Key Lake Operation – safety and control area summary

Safety and control areas	2008 rating	2009 rating	2010 rating	2011 rating	2012 rating
Management system	BE	BE	SA	SA	SA
Human performance management	BE	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	BE	SA	SA	SA	SA
Emergency management and fire protection	BE	BE	SA	SA	SA
Waste management	BE	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table C-5: McClean Lake Operation – safety and control area summary

Safety and control areas	2008 rating	2009 rating	2010 rating	2011 rating	2012 rating
Management system	SA	SA	SA	SA	SA
Human performance management	BE	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	BE	BE	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table C-6: Blind River Refinery – safety and control area summary

Safety and control areas	2008 rating	2009 rating	2010 rating	2011 rating	2012 rating
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	BE	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table C-7: Port Hope Conversion Facility – safety and control area summary

Safety and control areas	2008 rating	2009 rating	2010 rating	2011 rating	2012 rating
Management system	SA	SA	SA	SA	SA
Human performance management	SA	BE	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table C-8: Cameco Fuel Manufacturing – safety and control area summary

Safety and control areas	2008 rating	2009 rating	2010 rating	2011 rating	2012 rating
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table C-9: GEH-C Toronto and Peterborough – safety and control area summary

Safety and control areas	2008 rating	2009 rating	2010 rating	2011 rating	2012 rating
Management system	SA	SA	SA	SA	SA
Human performance management	*	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	*	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	*	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	FS	FS	FS	FS	SA
Environmental protection	FS	FS	FS	FS	FS
Emergency management and fire protection	*	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards	*	SA	SA	SA	SA
Packaging and transport	*	SA	SA	SA	SA

* Not separately assessed in the past.

Table C-10: Shield Source Incorporated – safety and control area summary

Safety and control areas	2009 rating	2010 rating	2011 rating	2012 rating
Management system	SA	SA	BE	BE
Human performance management	SA	SA	SA	SA
Operating performance	SA	SA	SA	BE
Safety analysis	SA	SA	SA	SA
Physical design	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA
Conventional health and safety	SA	SA	FS	SA
Environmental protection	SA	SA	SA	BE
Emergency management and fire protection	SA	SA	SA	SA
Waste management	SA	SA	SA	SA
Security	SA	SA	SA	SA
Safeguards*	N/A	N/A	N/A	N/A
Packaging and transport	SA	SA	SA	SA

* N/A: There are no safeguard verification activities associated with this facility.

Table C-11: SRB Technologies – safety and control area summary

Safety and control areas	2009 rating	2010 rating	2011 rating	2012 rating
Management system	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA
Physical design	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	FS
Environmental protection	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA
Waste management	SA	SA	SA	SA
Security	SA	SA	SA	SA
Safeguards*	N/A	N/A	N/A	N/A
Packaging and transport	SA	SA	SA	SA

* N/A: There are no safeguard verification activities associated with this facility.

Table C-12: Nordion (Canada) Inc. – safety and control area summary

Safety and control areas	2009 rating	2010 rating	2011 rating	2012 rating
Management system	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA
Physical design	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	FS
Environmental protection	SA	SA	SA	FS
Emergency management and fire protection	SA	SA	SA	SA
Waste management	SA	SA	SA	SA
Security	SA	SA	SA	FS
Safeguards	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA

APPENDIX D: FINANCIAL GUARANTEES

The following tables outline the current financial guarantees for the uranium mines and mills, uranium processing facilities, tritium processing facilities, and Nordion.

Table D-1: Uranium mines and mills – financial guarantees

Facility	Canadian dollar amount
Cigar Lake Project	$27,700,000
McArthur River Operation	$36,100,000
Rabbit Lake Operation	$105,200,000
Key Lake Operation	$120,700,000
McClean Lake Operation (includes Midwest)	$43,074,800
Total financial guarantee for the five facilities	$332,774,800

Table D-2: Uranium processing facilities – financial guarantees

Facility	Canadian dollar amount
Blind River Refinery	$38,600,000
Port Hope Conversion Facility	$101,700,000
Cameco Fuel Manufacturing	$19,500,000
GEH-C Peterborough	$3,027,000
GEH-C Toronto	$30,052,000
Total financial guarantee for the five facilities	$192,879,000

Table D-3: Tritium processing facilities – financial guarantees

Facility	Canadian dollar amount
Shield Source Incorporated	$365,798
SRB Technologies	$550,476
Total financial guarantee for the two facilities	$916,274

Table D-4: Nordion (Canada) Inc. – financial guarantee

Facility	Canadian dollar amount
Nordion (Canada) Inc.	$15,400,000

APPENDIX E: WORKER DOSE DATA

Uranium Mines and Mills

The following table compares the maximum and average individual effective dose for all five operating uranium mines and mills.

Table E-1: Radiation dose data to nuclear energy workers at uranium mines and mills

Facility	Average individual effective dose in 2012 (mSv/yr)	Maximum individual effective dose in 2012 (mSv/yr)	Regulatory limit
Cigar Lake Project	0.14	2.87	**50 mSv/yr**
McArthur River Operation	0.97	9.26	
Rabbit Lake Operation	1.22	14.37	
Key Lake Operation	0.61	5.76	
McClean Lake Operation	0.32	1.30	

The following tables provide a five-year trend (2008 to 2012) of the average and maximum effective annual doses, received at the various operating uranium mines and mills.

Each table also identifies the maximum five-year dose for a worker at each operating uranium mine and mill. In 2012, no radiation dose at any operating uranium mine or mill exceeded a regulatory effective dose limit.

Table E-2: Cigar Lake Project – worker effective dose

Dose data	2008	2009	2010	2011	2012	Regulatory limit
Total nuclear energy workers (NEWs)	1,043	792	1,266	1,932	2,420	**N/A**
Average individual effective dose (mSv)	0.04	0.05	0.20	0.13	0.14	**50 mSv/yr**
Maximum individual effective dose (mSv)	0.37	0.92	1.20	1.30	2.87	**50 mSv/yr**
Maximum five-year dose for an individual (mSv)	3.4					**100 mSv/5 yrs**

Table E-3: McArthur River Operation – worker effective dose

Dose data	2008	2009	2010	2011	2012	Regulatory limit
Total nuclear energy workers (NEWs)	814	993	1,189	1,253	1,276	**N/A**
Average individual effective dose (mSv)	1.41	1.57	1.34	1.32	0.97	**50 mSv/yr**
Maximum individual effective dose (mSv)	7.96	11.13	10.06	10.07	9.26	**50 mSv/yr**
Maximum five-year dose for an individual (mSv)	15.6					**100 mSv/5 yrs**

Table E-4: Rabbit Lake Operation – worker effective dose

Dose data	2008	2009	2010	2011	2012	Regulatory limit
Total nuclear energy workers (NEWs)	1,567	1,097	968	1,066	1257	**N/A**
Average individual effective dose (mSv)	0.88	1.21	1.43	1.36	1.22	**50 mSv/yr**
Maximum individual effective dose (mSv)	10.91	14.15	11.15*	11.66*	14.37	**50 mSv/yr**
Maximum five-year dose for an individual (mSv)	25.5					**100 mSv/5 yrs**

* The 2010 and 2011 maximum individual effective doses have been modified from the previous *CNSC Staff Report on the Performance of Canadian Uranium Fuel Cycle and Processing Facilities: 2011* as a result of dose changes approved through the National Dose Registry. This resulted from previously rejected personal alpha dosimeter results that were later accepted in early 2012 (2010 changed from 10.7 to 11.15 mSv; 2011 changed from 11.4 to 11.66 mSv).

Table E-5: Key Lake Operation – worker effective dose

Dose data	2008	2009	2010	2011	2012	Regulatory limit
Total nuclear energy workers (NEWs)	1,387	1,135	1,232	1,314	1,345	**N/A**
Average individual effective dose (mSv)	0.59	0.56	0.73	0.67	0.61	**50 mSv/yr**
Maximum individual effective dose (mSv)	7.88	4.73	7.29	9.14	5.76	**50 mSv/yr**
Maximum five-year dose for an individual (mSv)	11.5					**100 mSv/5 yrs**

Table E-6: McClean Lake Operation – worker effective dose

Dose data	2008	2009	2010	2011	2012	Regulatory limit
Total nuclear energy workers (NEWs)	407	343	219	120	174	**N/A**
Average individual effective dose (mSv)	0.56	0.66	0.47	0.33	0.32	**50 mSv/yr**
Maximum individual effective dose (mSv)	4.45	4.12	2.96	1.56	1.30	**50 mSv/yr**
Maximum five-year dose for an individual (mSv)	2.3					**100 mSv/5 yrs**

Uranium processing facilities

The following table compares the maximum and average individual effective doses in 2012 for all five uranium processing facilities.

Table E-7: Radiation dose data for nuclear energy workers at the uranium processing facilities

Facility	Maximum individual effective dose in 2012 (mSv/yr)	Average individual effective dose in 2012 (mSv/yr)	Regulatory limit
Blind River Refinery	12.00	3.70	**50 mSv/yr**
Port Hope Conversion Facility	6.95	2.04	
Cameco Fuel Manufacturing Inc.	6.00	0.70	
GEH-C Peterborough	9.16	2.09	
GEH-C Toronto	9.22	1.98	

The following tables provide a five-year trend (2008 through 2012) of average and maximum effective annual doses received at the various uranium processing facilities. In 2012, no radiation dose at a uranium processing facility exceeded regulatory dose limits.

Table E-8: Blind River Refinery – worker effective dose

Dose data	2008	2009	2010	2011	2012	Regulatory limit
Total persons monitored	171	168	176	170	173	**N/A**
Average individual effective dose (mSv)	2.90	3.40	3.00	2.70	3.70	**50 mSv/yr**
Maximum individual effective dose (mSv)	12.90	12.60	11.10	12.60	8.20	**50 mSv/yr**

Table E-9: Port Hope Conversion Facility – worker effective dose

Dose data	2008	2009	2010	2011	2012	Regulatory limit
Total persons monitored	458*	438	422	442	450	**N/A**
Average individual effective dose (mSv)	1.90	2.15	1.69	1.86	2.04	**50 mSv/yr**
Maximum individual effective dose (mSv)	7.80	5.80	7.82	8.82	6.95	**50 mSv/yr**

* Values for total persons monitored for 2008 have been corrected based on PHCF's 2012 annual report; values differed slightly from those reported in the 2011 CNSC staff report.

Table E-10: Cameco Fuel Manufacturing – worker effective dose

Dose data	2008	2009	2010	2011	2012	Regulatory limit
Total persons monitored	408	443	351*	359*	365	**N/A**
Average individual effective dose (mSv)**	0.9	0.5	0.7	0.8	0.7	**50 mSv/yr**
Maximum individual effective dose (mSv)**	10.0	6.4	5.0	9.9	6.00	**50 mSv/yr**

* Values for total persons monitored for 2010 and 2011 have been corrected based on CFM's 2012 annual report; values differed slightly from those reported in the 2011 CNSC staff report.
** Average and maximum individual effective doses have been recalculated for previous years and differ slightly from those reported in the 2011 CNSC staff report.

Table E-11: GEH-C Peterborough – worker effective dose

Dose data	2008	2009	2010	2011	2012	Regulatory limit
Total persons monitored	76	83	73	80	76	**N/A**
Average individual effective dose (mSv)	1.95	1.79	1.57	1.71	2.09	**50 mSv/yr**
Maximum individual effective dose (mSv)	10.53	9.57	7.20	7.06	9.16	**50 mSv/yr**

Table E-12: GEH-C Toronto – worker effective dose

Dose Data	2008	2009	2010	2011	2012	Regulatory limit
Total persons monitored	55	52	56	59	61	**N/A**
Average individual effective dose (mSv)	4.10	3.30	2.20	1.62	1.98	**50 mSv/yr**
Maximum individual effective dose (mSv)	13.90	9.70	11.90	7.78	9.22	**50 mSv/yr**

Tritium processing facilities

The following table compares the maximum and average individual effective doses for both tritium processing facilities.

Table E-13: Radiation dose data for nuclear energy workers at tritium processing facilities

Facility	Maximum individual effective dose 2012 (mSv/yr)	Average individual effective dose 2012 (mSv/yr)	Regulatory limit
Shield Source Incorporated	0.12	0.62	**50 mSv/yr**
SRB Technologies	0.11	0.80	

The following tables provide a five-year trend (2008 through 2012) of average and maximum effective annual doses received at the tritium processing facilities. In 2012, no radiation dose at a tritium processing facility exceeded regulatory dose limits.

Table E-14: Shield Source Incorporated – worker effective dose

Dose data	2008	2009	2010	2011	2012	Regulatory limit
Total persons monitored	42	26	25	27	26	**N/A**
Average individual effective dose (mSv)	0.35	0.31	0.36	0.32	0.12	**50 mSv/yr**
Maximum individual effective dose (mSv)	2.54	1.55	1.99	1.75	0.62	**50 mSv/yr**

Table E-15: SRB Technologies – worker effective dose

Dose data	2008*	2009	2010	2011	2012	Regulatory limit
Total persons monitored	16	18	17	18	24	**N/A**
Average individual effective dose (mSv)	0.16	0.25	0.11	0.25	0.11	**50 mSv/yr**
Maximum individual effective dose (mSv)	1.34	1.45	0.88	1.15	0.80	**50 mSv/yr**

* SRB resumed operation in July 2008 following a facility shutdown.

Nordion

The following table provides a five-year trend (2008 through 2012) of average and maximum effective annual doses received at the Nordion Class I facility. In 2012, no radiation dose at the facility exceeded regulatory dose limits.

Table E-16: Nordion (Canada) Inc. – worker effective dose

Dose data	2008	2009	2010	2011	2012	Regulatory limit
Total persons monitored	345	335	332	325	293	**N/A**
Average individual effective dose (mSv)	0.80	0.62	0.65	0.64	0.56	**50 mSv/yr**
Maximum individual effective dose (mSv)	6.12	4.63	4.86	5.08	5.19	**50 mSv/yr**

Extremity doses

Uranium processing facilities

The following tables provide the average and maximum annual equivalent extremity dose for each uranium processing facility.

In 2012, no worker at any of the uranium processing facilities exceeded the regulatory dose limit of 500 mSv/yr. The highest recorded extremity dose in 2012 was 357.29 mSv, or approximately 71 percent of the regulatory limit. This was for a worker at GEH-C Toronto.

Table E-17: Cameco Fuel Manufacturing – extremity dose

Dose data	2008	2009	2010	2011	2012	Regulatory limit
Average extremity dose (mSv/yr)	19.73	10.64	17.61	23.43	16.50	500 mSv/yr
Maximum extremity dose (mSv/yr)	76.54	52.29	103.39	111.30	107.50	

Table E-18: GEH-C Peterborough – extremity dose

Dose data	2008	2009	2010	2011	2012	Regulatory limit
Average extremity dose (mSv/yr)	19.70	12.90	6.29	9.36	9.36	500 mSv/yr
Maximum extremity dose (mSv/yr)	119.90	80.14	60.16	56.12	58.82	

Table E-19: GEH-C Toronto – extremity dose

Dose data	2008	2009	2010	2011	2012	Regulatory limit
Average extremity dose (mSv/yr)	66.80	37.60	50.60	41.02	46.41	500 mSv/yr
Maximum extremity dose (mSv/yr)	199.60	138.60	209.10	160.64	357.29	

Nordion

The following table provides the average and maximum annual equivalent extremity dose received at the Nordion Class I facility.

In 2012, no worker at the facility exceeded the regulatory dose limit of 500 mSv/yr. From 2008 through 2012, extremity radiation doses for NEWs were less than 20 mSv, or 4 percent of the annual equivalent dose regulatory limit.

Table E-20: Nordion (Canada) Inc. – extremity dose

Dose data	2008	2009	2010	2011	2012	Regulatory limit
Average extremity dose (mSv)	1.03	0.83	0.92	0.71	0.51	500 mSv/yr
Maximum extremity dose (mSv)	11.90	9.80	18.00	12.30	10.30	

Skin doses

Uranium processing facilities

The following tables provide the average and maximum annual equivalent skin dose for each uranium processing facility.

In 2012, no radiation dose at a uranium processing facility exceeded an equivalent skin dose regulatory limit. The highest recorded skin exposure dose in 2012 was 93.20 mSv, or approximately 19 percent of the regulatory limit. This was for a worker at Cameco Fuel Manufacturing.

Table E-21: Blind River Refinery – skin exposure dose

Dose data	2008	2009	2010	2011	2012	Regulatory limit
Average dose (mSv/yr)	4.4	5.3	5.8	5.5	6.0	**500 mSv/yr**
Maximum dose (mSv/yr)	31.6	34.6	45.3	48.8	39.2	

Table E-22: Port Hope Conversion Facility – skin exposure dose

Dose data	2008	2009	2010	2011	2012	Regulatory limit
Average dose (mSv/yr)	0.4	0.5	0.8	0.8	0.7	**500 mSv/yr**
Maximum dose (mSv/yr)	10.2	15.5	29.1	178.0	16.3	

Table E-23: Cameco Fuel Manufacturing – skin exposure dose

Dose data	2008	2009	2010	2011	2012	Regulatory limit
Average dose (mSv/yr)	7.23	4.37	6.64	6.85	6.45	**500 mSv/yr**
Maximum dose (mSv/yr)	105.92	70.66	72.06	95.36	93.20	

Table E-24: GEH-C Peterborough – skin exposure dose

Dose data	2008	2009	2010	2011	2012	Regulatory limit
Average dose (mSv/yr)	4.04	4.18	2.74	4.54	5.35	**500 mSv/yr**
Maximum dose (mSv/yr)	21.90	31.70	29.11	22.62	36.99	

Table E-25: GEH-C Toronto – skin exposure dose

Dose data	2008	2009	2010	2011	2012	Regulatory limit
Average dose (mSv/yr)	24.20	21.60	13.80	10.81	12.45	**500 mSv/yr**
Maximum dose (mSv/yr)	113.2	135.1	78.6	55.48	58.40	

Nordion

The following table provides the average and maximum annual equivalent skin dose received at the Nordion Class I facility.

In 2012, no worker at the facility exceeded the regulatory dose limit of 500 mSv/yr. From 2008 through 2012, extremity radiation doses for NEWs were less than 10 mSv/yr, or 2 percent of the annual equivalent dose regulatory limit.

Table E-26: Nordion (Canada) Inc. – skin exposure dose

Dose data	2008	2009	2010	2011	2012	Regulatory limit
Average dose (mSv)	0.67	0.46	0.57	0.50	0.40	**500 mSv/yr**
Maximum dose (mSv)	5.81	4.46	5.53	6.09	5.19	

APPENDIX F: ENVIRONMENTAL DATA

Blind River Refinery

Table F-1: Blind River Refinery – soil monitoring results

Parameter	2008	2009	2010	2011	2012
Minimum uranium concentration (µg/g)	0.4	0.2	0.2	0.2	0.1
Average uranium concentration (µg/g)	2.2	1.8	2.1	4.8	3.3
Maximum uranium concentration (µg/g)	5.4	3.0	4.0	18.0	12.1

Table F-2: Blind River Refinery – annual average groundwater monitoring results

Parameter	2008	2009	2010	2011	2012
Average uranium (µg/L)	0.8	0.5	0.4	0.4	0.3
Maximum uranium (µg/L)	8.3	4.8	2.9	4.1	2.0

Port Hope Conversion Facility

Surface water is sampled in the harbour at 13 locations. Samples include collections at just below the water surface and at just above the harbour sediment layer at each location. In addition, there is ongoing monitoring of the PHCF's cooling water intake, located in the Port Hope Harbour near the mouth of the Ganaraska River.

The surface water quality in the harbour adjacent to the PHCF has been monitored since 1977 through the analysis of samples collected from the south cooling water intake. The trend of surface water quality over time shows improvement since 1977.

Figure F-1: Port Hope Conversion Facility – average uranium concentrations from the south cooling water intake

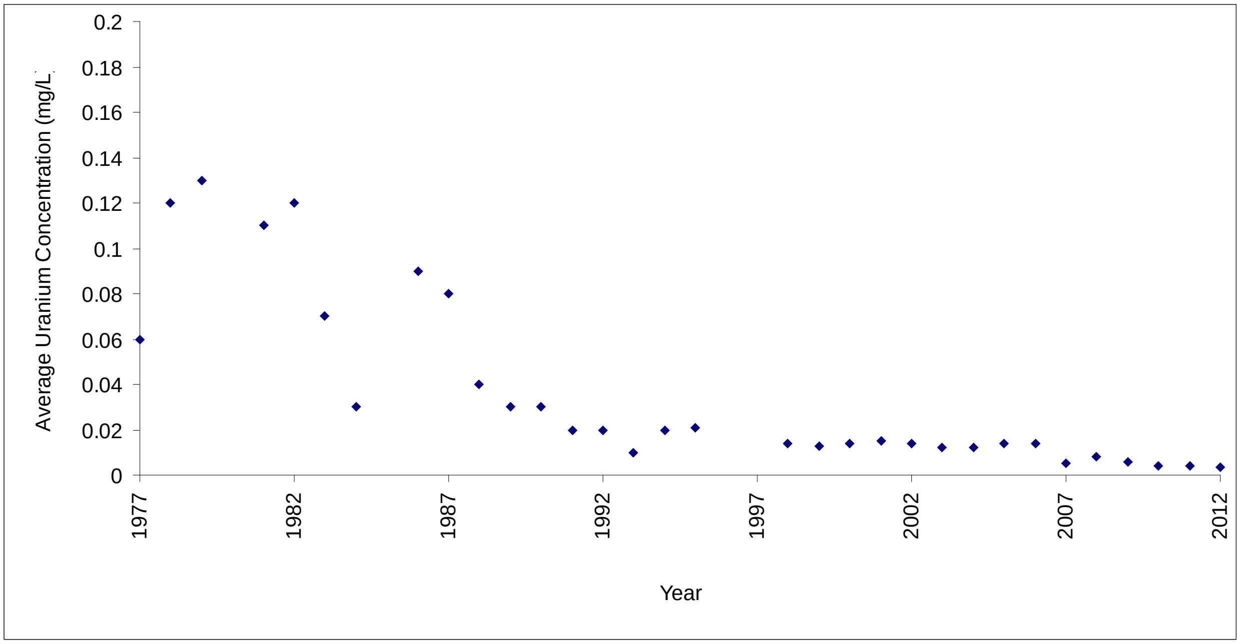


Table F-3: Port Hope Conversion Facility – uranium concentrations at the Waterworks parking lot remediated with clean soil (µg/g)

Depth (cm)	2008	2009	2010	2011	2012
0–2	1.1	1.4	1.1	1.0	1.4
2–6	0.9	1.1	1.0	0.7	1.1
6–10	0.9	1.1	1.0	0.3	1.3
10–15	1.0	1.1	1.0	0.8	1.5

The impact of fluoride emissions on the environment is determined each autumn when samples of fluoride-sensitive vegetation are collected by Ontario MOE and PHCF staff, from locations close to the PHCF. These samples are analyzed for fluoride content and for assessment of any leaf damage. The results presented in table F-4 indicate that there is no significant impact on vegetation caused by fluoride emissions from the PHCF. The results in 2012 continued to be well below the MOE objective of 35 parts per million (ppm) in foliage for livestock consumption during the growing season.

Table F-4: Port Hope Conversion Facility – fluoride concentration in local vegetation

Result/year	2008	2009	2010	2011	2012
Fluoride in vegetation (ppm)	9.0	2.1	2.3	3.6	2.1

Cameco Fuel Manufacturing

Table F-5: Cameco Fuel Manufacturing – soil monitoring results (note that CFM reverted to a three-year soil monitoring program and did not monitor soil in 2011 and 2012)

Parameter	2008	2009	2010
Minimum uranium concentration (µg/g)	0.4	0.0	0.0
Average uranium concentration (µg/g)	5.4	5.3	4.5
Maximum uranium concentration (µg/g)	20.8	17.0	21.1

GEH-C Toronto

Table F-6: GEH-C Toronto – soil monitoring results

Parameter	2009	2010	2011	2012
Average uranium concentration (µg/g)	2.2	2.2	2.3	1.9
Maximum uranium concentration (µg/g)	30.9	13.7	14.8	10.8

APPENDIX G: ENVIRONMENTAL REPORTABLE SPILLS IN 2012

Table G-1: Uranium mines and mills – environmental reportable spills

Facility	Environmental reportable spill	Corrective action
Cigar Lake Project	On September 19, 2012, an estimated 500 L (0.5 m^3) of run-off collection water from Stockpile C contaminated sump reported to the ground below the high-density polyethylene liner of the stockpile. A joint between two pieces of high-density polyethylene failed.	Soil (sand) material in the affected area was removed and placed on top of lined waste rock Stockpile C. Sump was repaired to prevent a recurrence of the event. CNSC staff were satisfied with the corrective actions taken.
McArthur River Operation	On July 23, 2012, approximately 170 L (0.17 m^3) of hydraulic oil from a failed hydraulic pump on a water wagon was released to the environment.	Spill matting was used to absorb the hydraulic oil and a sand berm was constructed to prevent any spreading of oil. The contaminated sand was excavated using a front-end loader and disposed of on Pad 4. CNSC staff were satisfied with the corrective actions taken.
McArthur River Operation	On September 21, 2012, workers were cleaning a pond of contaminated solids. They placed approximately 0.1 m^3 of contaminated solids on the ground, outside of the lined area.	The supervisor noticed the contaminated material on the ground and instructed the crew to move it back onto the lined pad. Additional sand was removed as a precaution. The supervisor discussed the importance of secondary containment with the crew. The incident was also reviewed with all employees to increase their focus on identifying hazards and following proper procedures. CNSC staff were satisfied with the corrective actions taken.
McArthur River Operation	On December 27, 2012, crews were pumping contaminated water to Pond A for treatment. Approximately 90 L (0.09 m^3) of contaminated water was released to the environment from a broken connection inside a junction box.	The liquid, contaminated sand and snow were collected and transferred to a lined pad. The broken connection in the junction box was repaired. CNSC staff were satisfied with the corrective actions taken.
Rabbit Lake Operation	On February 14, 2012, a valve between the sulphuric acid storage tank and the acid circulation tank was left open which resulted in an overflow of sulphuric acid from the circulation tank to secondary containment.	The spilled sulphuric acid was neutralized using soda ash, the soil from the excavation was collected and disposed of to the Above Ground Tailing Management Facility.

Facility	Environmental reportable spill	Corrective action
	The secondary containment was under repair and a portion of the acid flowed into an adjacent excavation. Of the estimated 3,000 L (3.0 m^3) (96%) of acid released to secondary containment, about 200 L (0.2 m^3) was released to the adjacent excavation.	CNSC staff were satisfied with the corrective actions taken.
Rabbit Lake Operation	On August 3, 2012, a pinhole leak in a pipeline resulted in the release of treated effluent onto the adjacent roadway. Approximately 40 L (0.04 m^3) of water was released.	Treated effluent flow from the mill to the pipeline was halted and mitigation measures initiated. The pipeline was drained, returning the treated effluent to the mill process. The pipeline was repaired. Impacted soil was removed from the roadway and disposed at the AGTMF. CNSC staff verified the corrective actions taken and were satisfied.
Rabbit Lake Operation	On August 7, 2012, during Cameco's annual inspection of the mine water pond liner, damage to a previous liner repair was discovered. Although not confirmed through visual observation, the potential for effluent release was identified and reported. Upon further investigation, water was observed behind the liner and samples were collected for chemical analysis.	The operating level of the pond water was brought down through diversion, which allowed for further inspection. Two additional breaches in the liner were identified. Approximately 30,000 litres of water was removed from behind the liner. The liner was then repaired. CNSC staff were satisfied with the corrective actions.
Rabbit Lake Operation	On August 9, 2012, a contractor discovered a stained area adjacent to the foundation of the mill raffinate tank. The stained area was caused by an unknown quantity of mill process solution released from the mill raffinate tank over an extended period of time. Soil and groundwater sample results indicated the impact of the leak was localized.	Cameco's investigation concluded the leak was due to the deterioration of the raffinate tank and the underlying foundation. Cameco's corrective actions were: ▪ Review the corrective actions associated with the Mill Hill Seepage event and ensure applicable corrective actions are applied to external tanks and process vessels. ▪ Conduct a review of the preventative maintenance (PM) for external tanks and process vessels to determine their adequacy for identifying degradation that could lead to leakage and contamination of underlying soil, and update any

Facility	Environmental reportable spill	Corrective action
		PM as required. ▪ Revise maintenance planning procedures to ensure containment related PM are not missed. ▪ Create a PM to manage annual inspections of containment areas, both inside and outside the mill. ▪ Inspect all external tanks and process vessels for constraints that would limit the ability of maintenance personnel to inspect the condition of the tank walls and floors to ensure leakage could be detected. Detail any required recommendations for site management to review and action. ▪ Revise CIRS procedures to include a requirement that information on reportable events (e.g., spills, action levels, etc.) entered into CIRS include the sample results associated with the event (e.g., volume of material spilled, dose received, etc.). ▪ Update sampling parameters for piezometer M0-4 so that hydrocarbons are sampled on an annual basis. ▪ Conduct a review of the corporate standard CAM-EMP-002 Containment Standard for applicability of design, inspection and maintenance controls to process tanks. CNSC staff confirmed and were satisfied with the corrective actions.
Rabbit Lake Operation	On August 23, 2012, while unloading a tote of transmission oil, the operator failed to lift the container properly. As are result, the container tipped releasing 400 L (0.4 m^3) of oil onto the ground.	The tote was immediately turned right side up and dirt berms were erected to prevent the spill from spreading. Spill response measures were initiated and the transmission oil was recovered with a vacuum truck. Recovered oil was deposited in the mill waste oil tank for off-site recycling. Contaminated soil was excavated and disposed of at the

Facility	Environmental reportable spill	Corrective action
		AGTMF. Safe driving and unloading practices were reviewed with the driver. CNSC staff were satisfied with the corrective actions taken.
Rabbit Lake Operation	An old storage tank was replaced. A bypass valve was inadvertently left open during the tank replacement. On August 28, 2012, during mill start-up, 1,000 L (1.0 m^3) of process water was released from the bypass valve.	The bypass line was shut off. Spill response was initiated, and material was recovered using a vacuum truck. Contaminated soil was excavated and placed on the mill ore pad to include in mill processing. CNSC staff were satisfied with the corrective actions taken.
McClean Lake Operation	On April 9, 2012, a diesel fuel line was left buried in the snow and ice, and freeze/thaw cycling from spring conditions caused the valve on the line to partially open releasing 1,400 L (1.4 m^3) of diesel fuel to the environment.	On discovery, the valve was closed to prevent further release and the line was capped to ensure that diesel could not escape should the valve accidentally open. Contaminated soil was collected and disposed of in the hydrocarbon landfarm. A corrective action plan was submitted to address additional remediation of the diesel fuel. Additional excavation of contaminated soil occurred in 2013 with follow-up confirmation samples sent to the lab. Site remediated to regulatory hydrocarbon standards. CNSC staff were satisfied with the immediate corrective actions taken.
McClean Lake Operation	On June 1, 2012, mill operations personnel were unplugging a line when a flange gasket failed causing approximately 10 L (0.01 m^3) of radiologically contaminated water to be released to the environment.	The pump was shut down and the contaminated material from the spill was cleaned up. The flange gasket was replaced. CNSC staff were satisfied with the corrective actions taken.
McClean Lake Operation	On September 14, 2012, the crew working at the SABRE Project noticed soft ground under the mining pad. During the investigation, the pad liner was damaged. An estimated 0.25 m^3 of contaminated material fell into a cavity that had formed under the drill mat.	The contaminated material was excavated and measurements taken to verify the radiological levels were at background. The excavation was filled with a grout/cement mixture and the liner repaired. CNSC staff were satisfied with the corrective actions taken.

Facility	Environmental reportable spill	Corrective action
McClean Lake Operation	On November 6, 2012, approximately 2,500 L (2.5 m^3) of contaminated water was observed on the road next to the Sue treated effluent discharge line. The cause was a vent pipe that froze and cracked.	Pumping of the Sue discharge line was stopped. The water on the road was collected with a vacuum truck and returned for treatment. All drain vents along the Sue discharge line were checked to ensure there were no further leaks. When discharge resumed, all the drain vents were once again checked to ensure their integrity. CNSC staff were satisfied with the corrective actions taken.
McClean Lake Operation	On November 6, 2012, AREVA staff observed water seeping from under the perimeter of the SABRE Project mining pad. The water contained elevated concentrations of radium (1.4 Bq/L). Approximately 10,000 L (10.0 m^3) of water seeped to the surface.	Water and contaminated solids located beyond the pad perimeter were recovered. Investigation revealed that the seepage was likely caused by modifications made to the mining equipment for the 2012 test mining. CNSC staff were satisfied with the corrective actions taken and will review mitigation measures proposed for future test mining.
McClean Lake Operation	On December 1, 2012, a geotechnical test hole was being drilled by contractors. Process water was accidentally used instead of fresh water for drilling. An estimated 4,500 L (4.5 m^3) of process water was released during drilling.	From the drill return, solids contaminated from the process water and drill return water were collected and disposed of into the mill process. Contractors are now prohibited from making water connections from the JEB mill. A tag was placed on the fresh water connection to instruct personnel to prevent a recurrence. All connections must now be made by mill operators. CNSC staff were satisfied with the corrective actions taken.

Table G-2: Uranium processing facilities – environmental reportable spills

Facility	Environmental reportable spill	Corrective action
	None	None

APPENDIX H: LOST-TIME INCIDENTS IN 2012

Table H-1: Uranium mines and mills – lost-time incidents

Facility	Lost-time incident (LTI)	Corrective action
Cigar Lake Project	There were no LTIs at Cigar Lake in 2012 resulting from licensed activities.	Not applicable
McArthur River Operation	On September 16, 2012, two contract employees were installing ground support at the 530 level North Exploration Bay 9. The employees were using a pneumatic air operated drill (jackleg drill) to install ground support. This work was being done off the deck of a mobile scissor lift. During the process of resetting the drill to position it for installation of ground support, the drill was inadvertently engaged when the controls were accidentally caught on the fall protection harness on the operator. This caused a sudden movement that resulted in the loss of control of the drill. This movement caused the employee's finger to become caught between the railing of the scissor deck and the drill. The employee was able to return to work two days after the incident performing modified work duties. The employee returned to normal work duties on November 16, 2012, 51 days following the incident.	Corrective actions: 1. Use mechanized bolting whenever possible to reduce the manual handling associated with the use of the jackleg drill. 2. Ensure workers are wearing the harness in the proper manner and fit. 3. Increase the number of Job Task Observations done on manual bolting methods.
Rabbit Lake Operation	On November 14, 2012, an underground mechanic was injured when he was struck by a scoop tram. The scoop tram operator was unaware the mechanic had entered the re-muck area. When the scoop tram entered the re-muck area, it struck the mechanic causing injury to his lower limbs. As a consequence of the accident, multiple surgeries to his lower limbs were required. Although the wound was cleaned and decontaminated promptly at site, radioactive debris and foreign matter were transferred and imbedded in the tissue and bone.	1. Establish a formal protocol setting out communication expectations when performing underground activities involving mobile heavy mining equipment. 2. Review the underground orientation training to incorporate a better understanding of the mining operation including: observing a scoop tram in a re-muck operation; sitting in the cab of a scoop tram; observing stages of the mining operations, use of the steel markers in, and assessing new hires for longer monitoring.

Facility	Lost-time incident (LTI)	Corrective action
	It is Cameco's protocol to take subsequent urine samples after an incident for an underground worker. It was not practical or possible to take immediate urine samples; however, uranium-in-urine samples were later taken when the worker was recovering from surgery. Analyses of these uranium-in-urine samples appear to reflect an analyses curve of uranium intake from a wound with low but persistent uranium concentrations. Currently, Cameco is proceeding on the basis of wound dosimetry and continues to collect urine samples to confirm the source of observed uranium-in-urine. It is hoped that by June or July of 2013, there will be enough data to indicate the correct model for a more accurate dose determination. The preliminary estimate is that the committed individual effective dose from the wound could be in the order of 10 to 20 mSv, a calculated value less than the regulatory limit. This may result in an action level exceedance; however, the excursion is not considered a loss of control event, but a consequence of the accident.	3. Consider the creation of a underground maintenance bay. 4. Scan the industry to identify, review and select ways to minimize or eliminate the people-mobile equipment risks, ensuring that Cameco has the best practice.
Key Lake Operation	On May 11, 2012, an employee was working on a PU15, an engine intake system, when he lost his footing and fell from a height of 0.6 m to the floor. This fall resulted in a fracture to the left arm.	The supervisor reviewed the pre-work assessment process with the employee stressing the importance of re-evaluating tasks throughout the job to ensure safe approaches are used.
McClean Lake Operation	On July 21, 2012, an employee was working in the JEB Water Treatment Plant. The employee reached to make a valve adjustment and immediately felt pain in his lower back.	1. Discussion of the event with other employees and re-emphasizing proper position and reach. 2. Additional use of an extended handle on the valve to reduce the reaching distance and make the valve easier to open and close.

Table H-2: Uranium processing facilities – lost-time incidents

Facility	Lost-time incident	Corrective action
Port Hope Conversion Facility	This event occurred when a contractor fell from a stepladder, injuring his neck and wrist.	PHCF investigated immediately, and the following corrective actions were implemented: • Proper ladder use was reviewed with all employees during group meetings • Contractor and new employee orientation was updated to show correct usage and positioning of a ladder • New rolling fixed frame adjustable height scaffolding was purchased to reduce the amount of time ladders must be used
GEH-C Toronto	This event occurred when a maintenance operator tripped and injured his shoulder while working on a furnace rebuild job.	The corrective actions involved a personal protective equipment review, a change to use magnetic barrier tape, and the inclusion of material and equipment storage planning stages for non-routine work.

Table H-3: Tritium processing facilities – lost-time incidents

Facility	Lost-time incident	Corrective action
Shield Source Inc.	This event occurred when a worker was injured while lifting boxes weighing less than 40 lbs.	SSI's Workplace Health and Safety Committee reviewed these injuries and determined that all employees needed to be reminded of proper lifting techniques. This was conducted at one of the production meetings.
Shield Source Inc.	A second event occurred when another worker was injured while lifting boxes weighing less than 40 lbs.	SSI assessed this second occurrence and determined that the same corrective action applied to the previous event was appropriate.

APPENDIX I: LINKS TO LICENSEE WEB SITES

Cameco – Key Lake

cameco.com/mining/key_lake/environment_and_safety/

Cameco – McArthur River
cameco.com/mining/mcarthur_river/environment_and_safety/

Cameco – Rabbit Lake

cameco.com/mining/rabbit_lake/environment_and_safety/

Cameco – Cigar Lake

cameco.com/mining/cigar_lake/environment_and_safety/

AREVA Resources Canada – McClean Lake

us.areva.com/EN/home-457/areva-resources-canand-uranium-mining-and-production.html

Cameco – Blind River Refinery
cameco.com/fuel_services/blind_river_refinery/

Cameco – Port Hope Conversion Facility
cameco.com/fuel_services/port_hope_conversion/

Cameco Fuel Manufacturing
cameco.com/fuel_services/fuel_manufacturing/

GE Hitachi Nuclear Energy Canada
site.ge-energy.com/prod_serv/products/nuclear_energy/en/ge_canada.htm

Shield Source Incorporated
shieldsource.com

SRB Technologies (Canada) Inc.
betalight.com/index_can.htm

Nordion (Canada) Inc.
http://nordion.com

APPENDIX J: ACRONYMS

AGTMF	Above Ground Tailings Management Facility
ALARA	As Low As Reasonably Achievable
AREVA	AREVA Resources Canada Inc.
Bq/L	Becquerel per litre
BRR	Blind River Refinery
CCME	Canadian Council of Ministers of the Environment
cfm	Cubic feet per minute
CFM	Cameco's Fuel Manufacturing Inc.
CMD	Commission member document
CNSC	Canadian Nuclear Safety Commission
DRL	derived release limit
EC	Environment Canada
ERT	emergency response team
GBq	Gigabecquerel
GEH-C	General Electric-Hitachi Canada
IAEA	International Atomic Energy Agency
LCH	licence conditions handbook
LLRD	long-lived radioactive dust
LTI	lost-time incident
mg/L	milligram per litre
mSv	millisievert
MMER	*Metal Mining Effluent Regulations*
MOE	Ontario's Ministry of the Environment
NEW	nuclear energy worker
PHCF	Port Hope Conversion Facility
SCA	safety and control area
SRB	SRB Technologies (Canada) Incorporated
SSI	Shield Source Inc.
TBq	Terabequerel
TMF	tailings management facility
TSS	total suspended solids