



**2018 Annual Compliance Monitoring
&
Operational Performance Report**

Reporting Period January 1 – December 31, 2018

**Blind River Refinery
Operating Licence
FFOL-3632.00/2022**

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Executive Summary

Cameco Corporation (Cameco) is a major supplier of uranium processing services required to produce nuclear fuel for the generation of safe, clean and reliable electricity around the world. Cameco's Fuel Services Division (FSD) is comprised of the Blind River Refinery (BRR), the Port Hope Conversion Facility (PHCF), Cameco Fuel Manufacturing Inc. (CFM) and a divisional head office located in Port Hope Ontario.

BRR operates a Class IB nuclear facility in Blind River, Ontario under Canadian Nuclear Safety Commission (CNSC) Fuel Facility Operating Licence FFOL-3632.00/2022 and employs approximately 120 workers.

BRR processes natural uranium ore concentrates into natural uranium trioxide (UO₃). Cameco receives uranium ore concentrates from mines and mills worldwide. In 2018, BRR had licensed production capacity of 18,000 tonnes of uranium as UO₃. The majority of the UO₃ produced at BRR is shipped to the PHCF, where it is converted to either uranium dioxide (UO₂) or uranium hexafluoride (UF₆). BRR also prepares and ships small quantities of UO₃ to other customers around the world who are licensed by the CNSC or the equivalent authority in another country.

Cameco is committed to the safe, clean and reliable operations of all of its facilities and continually strives to improve safety performance and processes to ensure the safety of both its employees and local residents. Corporate policies and programs, including the Safety, Health, Environment and Quality (SHEQ) policy provide guidance and direction for the development of site-based programs and procedures. BRR also has a Facility Licensing Manual (FLM) that describes the commitment by Cameco Corporation to operate a safe and efficient nuclear facility which meets the requirements of the CNSC.

BRR continues to maintain the safety analysis for its site operations. The approach used to assess risks to workers, the public and the environment is described in the Safety Report for the site.

At BRR changes to the physical design of equipment, processes and the facility with the potential to impact safety are evaluated using a design control process from project planning through to completion of the project. This review identifies impacts and potential impacts to the environment and health and safety. There were no significant modifications made in 2018.

BRR has programs and procedures that ensure the facility is operated in a safe, clean and reliable manner. BRR has an established Preventive Maintenance (PM) program. All PM tasks are initiated and documented through the work notification system in SAP. SAP is corporate-wide enterprise application software for asset management, accounting, and purchasing functions.

BRR maintains a number of programs, plans and procedures in the areas of health and safety, radiation protection, environment protection, emergency response, fire protection, waste management, and training. A SAT based training programs for all necessary positions is in place.

As a result of these programs, plans and procedures, BRR's operations have maintained radiation exposures well below the dose limits. Environmental emissions are being controlled to levels that are a fraction of the regulatory limits, and public radiation exposures are also well below the regulatory limits. There were no CNSC action level exceedances reported in 2018.

BRR has an Emergency Response Plan in place to cover potential on-site and off-site emergency situations. BRR also has a comprehensive Fire Protection Program (FPP) in place to minimize both the probability of occurrence and the consequence of fire at the facility. Annual Third Party Reviews of compliance with the inspection requirements of the National Fire Code and the National Fire Protection Association, NFPA-801 are carried out. The site also maintains a Fire Hazard Analysis (FHA). Lastly, BRR has a mutual aid agreement in effect with the Town of Blind River Fire Department.

BRR has a Waste Management Plan which meets applicable requirements. The refinery also has an approved Preliminary Decommissioning Plan and financial guarantee.

The security plan in place for BRR provides the basis for security operations at the facility and identifies the systems and processes in place to meet security program objectives.

A comprehensive uranium inventory system to demonstrate compliance with Safeguards requirements is maintained by BRR. Receipts and shipments of natural uranium material are recorded and all uranium transfer reports are submitted to CNSC. In 2018 three short notice random inspections (SNRI) of this inventory system were conducted by the International Atomic Energy Agency (IAEA).

The scope of transportation activities at BRR includes the transport of Class 7 radioactive materials outlined in the *Transportation of Dangerous Goods Act* and associated regulation. Shipments included both incoming uranium ore concentrate from around the world and outgoing UO₃. BRR staff responded to one transportation related event in 2018.

Cameco works to build and sustain the trust of local residents by acting as a good corporate citizen in the communities in which it operates. A key element of building and sustaining that trust is a commitment to provide those in the community with accurate and transparent reporting of our performance. As part of this strategic approach to community outreach, Cameco met regularly with both the Mayor of the Town of Blind River and with the Chief of the Mississauga First Nation to discuss issues of mutual concern and interest. A number of plant tours were also provided to interested parties. Lastly, an independent public opinion telephone survey in the Blind River area found that 97% of respondents were supportive of the BRR. This is consistent with previous public opinion survey findings.

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1. INTRODUCTION

1.1 General Introduction

Cameco Corporation (Cameco) is a major supplier of uranium processing services required to produce nuclear fuel for the generation of safe, clean and reliable electricity around the world.

Cameco's Fuel Services Division (FSD) is comprised of the Blind River Refinery (BRR), the Port Hope Conversion Facility (PHCF), Cameco Fuel Manufacturing Inc. (CFM), and a divisional head office located in Port Hope, Ontario.

BRR is the world's largest commercial uranium refinery and has been in operation since 1983.

BRR (Figure 1) is located approximately five kilometers to the west of the Town of Blind River in the District of Algoma. The property encompasses an area of approximately 258 hectares in total, which includes a secured area of approximately 11 hectares, representing the CNSC-licensed area. Cameco has a lease arrangement for an additional 195 hectares to the east of the existing property boundary. While located in Blind River, the refinery is also located adjacent to and south of the Mississauga First Nation, our closest neighbor.

Figure 1 – Blind River Refinery



BRR operates a Class 1B nuclear facility in Blind River, Ontario under operating licence FFOL-3632.0/2022. The current licence is valid until February 28, 2022. The current licensed production capacity is 18,000 tonnes of uranium as UO_3 but provision has been made to increase capacity to 24,000 tonnes of uranium as UO_3 , once certain conditions have been met and the business climate warrants.

BRR processes natural uranium ore concentrates into natural uranium trioxide (UO_3). Cameco receives uranium ore concentrates from mines and mills worldwide. In 2018, BRR was licensed to produce up to 18,000 tonnes of uranium as UO_3 . The majority of the UO_3 produced at BRR is shipped to the PHCF, where it is converted to either uranium dioxide (UO_2) or uranium hexafluoride (UF_6). BRR also prepares and ships UO_3 to other customers around the world who are licensed by the CNSC or the equivalent authority in another country. BRR employs approximately 120 workers.

The purpose of this document is to summarize the performance of BRR in 2018 and to demonstrate that BRR has met the regulatory requirements of the *Nuclear Safety and Control Act*. It is submitted in accordance with the CNSC license FFOL-3632.00/2022 section 2.2 and organized based on the CNSC document “Annual Compliance Monitoring and Operational Performance Reporting Requirements for Class 1 A & B Nuclear Facilities”. There were no operational challenges experienced at the facility and the workforce remained relatively stable.

There were no exceedences of CNSC regulatory limits or action levels in 2018.

The refinery employs qualified personnel and has established a strong management system to ensure compliance with other federal and provincial regulations.

In addition to the CNSC, BRR is regulated by other federal and provincial regulators, such as the Ontario Ministry of the Environment, Conservation and Parks (MECP), Environment and Climate Change Canada (ECCC), Employment and Social Development Canada (ESDC) and Transport Canada (TC).

The acronyms in Table 1 are, or may, be used in this report.

Table 1

List of Acronyms	
Acronym	Description
ALARA	As Low As Reasonably Achievable
BRFD	Blind River Fire Department
BRR	Blind River Refinery
CCM	Contaminated Combustible Material
CCME	Canadian Council of Ministers of the Environment
CFM	Cameco Fuel Manufacturing
CGSB	Canadian General Standards Board
CNC	Contaminated Non-combustible Material
CNSC	Canadian Nuclear Safety Commission
DRaff	Dried Raffinate
DRL	Derived Release Limit
ECCC	Environment and Climate Change Canada
ECA	Environmental Compliance Approval
ERAP	Emergency Response Assistance Plan
ERP	Emergency Response Plan
ERT	Emergency Response Team
ESDC	Employment and Social Development Canada
FAA	First Aid Attendant
FFOL	Fuel Facility Operating Licence
FHA	Fire Hazard Analysis
FHSC	Facility Health and Safety Committee
FLM	Facility Licensing Manual
FPP	Fire Protection Program
FSD	Fuel Services Division
IAEA	International Atomic Energy Agency
IAL	Internal Administrative Level
ISI	In-Service Inspection
KPI	Key Performance Indicator

LCH	Licence Condition Handbook
MFN	Mississauga First Nation
MNR	Ministry of Natural Resources
MECP	Ministry of the Environment, Conservation and Parks
mSv	millisievert
NEW	Nuclear Energy Worker
NFPA	National Fire Protection Association
NO _x	Nitrogen Oxides
NPRI	National Pollutant Release Inventory
OHSAS	Occupational Health and Safety Advisory Services
OSL	Optically Stimulated Luminescence
PHCF	Port Hope Conversion Facility
PIP	Public Information Program
PIV	Physical Inventory Verification
PM	Preventive Maintenance
PWQO	Provincial Water Quality Objectives
RL	Respirator Limit
S&FP	Sample & Feed Preparation
SAT	Systematic Approach to Training
SHEQ	Safety Health Environment and Quality
SNRI	Short Notice Random Inspection
SSC	Systems Structures and Components
TC	Transport Canada
TED	Total Effective Dose
TRA	Toxics Reduction Act
UF ₆	Uranium Hexafluoride
ug U/L	micrograms of uranium per litre
UOC	Uranium Ore Concentrate
UO ₂	Uranium Dioxide
UO ₃	Uranium Trioxide
uSv	microsievert

1.2 Facility Operation

Cameco continues to strive for operational excellence at all of its facilities through consistent application of management systems across its operations to ensure that they operate in a safe, clean and reliable manner. Corporate policies and programs, including that for Safety, Health, Environment and Quality (SHEQ) provide guidance and direction for all site-based programs and procedures that define the BRR Quality Management System.

At BRR changes to the physical design of equipment, processes and the facility with the potential to impact safety are evaluated using an internal design control process from project planning through to completion of the project. This review identifies impacts and potential impacts to the environment as well as to health and safety. There were no significant modifications carried out at the facility in 2018.

During 2018 BRR operated routinely with no major operating problems. The UO₃ plant shut down during the summer to allow for scheduled maintenance work, employee vacation time and to match Cameco PHCF production requirements. The UO₃ plant also shuts down for approximately two weeks at the end of the year for the Christmas and New Year's holiday period. BRR also has shorter shutdown periods throughout the year, ranging from a few hours to a few weeks. The shorter shutdowns are typically extended power outages due to storm events and/or to effect critical maintenance repairs, while the longer shutdowns are typically inventory or production requirements related.

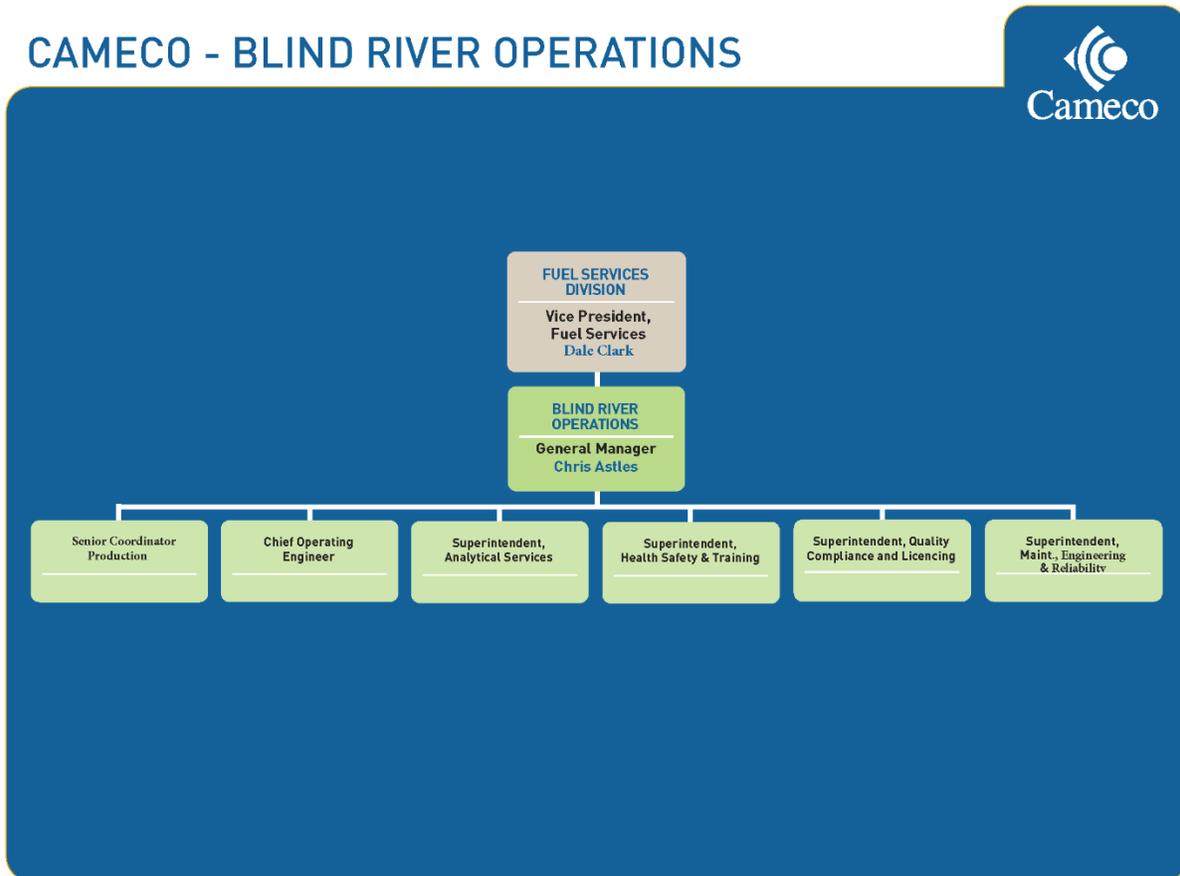
As specified in the Licence Condition Handbook (LCH) for BRR, an annual third party review of compliance with the inspection requirements of the *National Fire Code* and the *National Fire Protection Association*, NFPA-801 was carried out, with a copy of the report submitted to the CNSC.

The general manager of the Blind River refinery is accountable for the programs and procedures for operating and maintaining the facility. The responsibilities for these programs and procedures have been delegated amongst the management team at BRR and their respective personnel. All members of the BRR management team are held accountable for the roles and responsibilities that they hold.

There was a net increase of one employee in 2018, taking into account new hires, changes in employment status and terminations/retirements. There were also a number of internal transfers within the refinery last year. A 2018 organization chart for the management structure at BRR is provided below in Figure 2. There are no vacant positions at the refinery management level.

The superintendent, Quality, Compliance & Licensing is the site liaison with the CNSC and reports directly to the general manager. This position is responsible for the radiation, environment and quality management programs in place at BRR.

Figure 2 – BRR Organizational Chart



A Facility Health and Safety Committee (FHSC) has been in place for many years and includes representation from both management and workers. The general manager, the superintendent, quality, compliance & licensing, the superintendent, health safety & training and the health safety officer are permanent members of this committee. There is worker representation from all areas on this committee as well, including production, maintenance, powerhouse, analytical services, security and administration. In addition to conventional health and safety issues, this committee also discusses radiation and environment related issues. A separate ALARA committee is also in place.

BRR has a LCH issued by the CNSC. The purpose of this handbook is to establish and consolidate into one document the compliance framework related to the Cameco Blind River refinery facility licence. The LCH specifies the CNSC expectations by defining the licensing

basis, explaining the regulatory context related to each licence condition, and identifying the verification criteria for each licence condition.

BRR also has a Facility Licensing Manual (FLM) that describes the commitment by Cameco Corporation to operate a safe and efficient nuclear facility which meets the requirements of the CNSC. There is also a Management Systems manual that describes the CNSC accepted management systems program in place to ensure that the licensed activities at the site are controlled and conducted in a safe manner. The licensed activities are controlled by the use of documented procedures and the provision of qualified personnel. Controls are established commensurate with the safety significance of the activity, system or equipment.

As part of the management system programs, internal audits are conducted routinely to assess the level of conformance to these management systems. Starting in 2017 Cameco's corporate SHEQ group assumed responsibility for completion of required internal audits at Cameco licensed facilities, including the BRR.

The internal audit program encompasses all key areas of refinery operations including environmental protection, radiation safety, occupational health and safety and quality management. The audits include assessment of both conformance and legal compliance. The most recent corporate SHEQ audit was conducted in the third quarter of 2018. A summary of the 2018 audit program is being provided to the CNSC under separate confidential correspondence.

1.3 Production or Utilization

The annual licensed production limit of 18,000 tonnes of uranium as UO_3 was not exceeded in 2018.

Detailed plant production information is considered “protected proprietary” and is submitted to CNSC staff on an annual basis under a separate cover.

1.4 Facility Modification

There were no modifications affecting the safety analysis of BRR made in 2018 that required written approval of the Commission or a person authorized by the Commission.

The following BRR documents referenced in the LCH were updated and reissued or replaced in 2018:

- Management System Program Manual, AM 400 (*NEW - replacing Operations Quality Assurance Program Manual, PR 100*)
- Emergency Response Plan, EP 100
- Environmental Protection Program, ET 110 (*NEW - replacing Environmental Monitoring Plan, ET 220*)
- Waste Management Plan, PR 300
- FSD Environmental Management System, FSD-PGR-EMS-001(*NEW - replacing Environmental Management System Program, ET 100*)

2. SAFETY AND CONTROL AREAS

2.1 Management

2.1.1 Management Systems

This safety and control area covers the framework which establishes the processes and programs required to ensure that the organization achieves its safety objectives and continuously monitors its performance against these objectives, as well as fostering a healthy safety culture.

BRR's operations quality assurance program identifies the controls required to ensure all processes are conducted in a safe manner and that processes applying to licensed activities are conducted in accordance with applicable CNSC management system requirements and other regulatory requirements. The application of management system requirements is scaled according to the complexity and hazard potential of a particular activity.

An annual site management review meeting is held to review the suitability, adequacy and effectiveness of the corporate SHEQ policy and the site programs and procedures to ensure conformance to both Cameco and CNSC requirements. The annual review meeting is typically held in the first quarter of the following year. The 2018 annual management review meeting was held in February 2019 and concluded that while there were opportunities for improvement, the site management systems were suitable, adequate and effective.

As noted previously, the corporate SHEQ group assumed responsibility for completion of required internal audits at Cameco licensed facilities, including the BRR, in 2017. In 2018 internal audits were focused in the areas of quality management, radiation protection, environmental protection, transportation, emergency preparedness and response and selected elements from the site License Conditions Handbook. Findings were assessed and corrective actions developed, as appropriate; in order to continually improve all aspects of site performance.

There were also a number of external audits/inspections carried out by third parties as follows:

- A third-party audit of the Fuel Services Internal Dosimetry Program. This audit is a requirement under the quality assurance program developed for the Internal Dosimetry Services License issued to the Cameco FSD sites.
- An annual third party review of compliance with the inspection requirements of the *National Fire Code, 2005* and the *National Fire Protection Association, NFPA-801, 2003*, as required by Section 3.11 of our LCH.
- The provincial Ministry of the Environment, Conservation and Parks conducted an Industrial Sewage Inspection.

- SAI Global carried out an ISO 14001:2015 re-registration audit. Cameco Corporation is ISO 14001:2015 registered, with BRR being one of the sites falling under the corporate registration.
- Transport Canada conducted a Transportation of Dangerous Goods inspection.
- The Boiler Inspection and Insurance Company of Canada (BI&I) carried out an inspection of the refinery's boilers and pressure vessels.
- The Technical Standard and Safety Authority (TSSA) also carried out an inspection of the facility in 2018.

It should be noted that the above list does not include inspections completed by CNSC staff as part of their oversight of licensed activities. There were no significant findings identified in any of the audits/inspections undertaken in 2018. Audits are documented in the Cameco Incident Reporting System (CIRS) and corrective actions taken to address any issues identified. More detail on the 2018 audit program is being provided to the CNSC under separate confidential correspondence.

All procedures that support licensed activities are subject to the site document control process. Documents that support licensed activities are maintained in electronic format on a database available to all site personnel. This includes, but is not limited to, procedures for operating and maintaining the facility, as well as environmental, health and safety, radiation protection and quality assurance documentation. A total of 369 site documents were either reviewed and updated, or created in 2018.

2.1.2 Human Performance Management

This safety and control area covers activities that enable effective human performance, through the development and implementation of processes that ensure that licensed staff members are sufficient in numbers in all relevant job areas, and have the necessary knowledge, skills and tools in place, in order to safely carry out their duties.

BRR has a sufficient number of qualified workers as well as the minimum number of responsible people to carry on the licensed activities safely and in accordance with the *Nuclear Safety and Control Act* and its Regulations.

BRR has a number of programs, procedures and processes that combine to form the framework for a safe environment and foster a sustainable safety culture. Management has focused on enhancing the site's safety culture by establishing comprehensive environmental, radiation and health and safety programs. These programs have contributed to the development of processes and practices such as the use of hazard recognition cards for maintenance activities and self-audit hazard recognition cards for other types of work.

All employees are encouraged to build and maintain a questioning attitude with respect to health, safety, radiation protection and environmental issues.

Cameco has implemented a standardized, systematic approach to training (SAT) across all of its operations. SAT applies a robust, risk-informed system to analyze and track training requirements and develop and deliver appropriate training programs. The SAT process covers the initial training of employees, routine re-qualification, as well as re-qualification of employees after an extended absence. The design and development of SAT-based training programs for positions considered "in-scope" was completed in 2011. Mandatory federal, provincial and/or Cameco-required training is tracked and trended, with 95.7% attendance achieved in 2018, the same level of attendance achieved in 2017. Employees on short or long-term absences due to illness or disability may affect these statistics. Cameco has processes in place to ensure employees are fully qualified to carry out the activities they have been assigned and also to ensure that employees who miss required training sessions are identified and scheduled to attend a subsequent training session.

BRR is a 24 hour a day, seven day a week operation. Following the requirements of Part II of the *Canada Labour Code*, BRR has defined maximum hours of work in a shift cycle for all employees. In addition, to ensure qualified personnel are available on-site to conduct licensed activities in a safe manner, minimum crew complements for UO₃ operations and emergency response have been defined.

A range of programs are in place to ensure that employees are fit for duty. They cover human resource matters such as a program for alcohol and substance abuse, safe haven, violence in the workplace, respectful workplace as well as addressing more general health matters such as medical surveillance and radiation protection monitoring.

Cameco has an audit program that routinely looks at various aspects of the site training program. Corrective actions are taken to address any issues identified during these audits.

A formal mentoring program pairs new employees with experienced workers for the first six months of their employment. The mentoring process helps to ensure that new employees are properly trained in how to carry out their duties safely and to minimize risks to people and the environment.

A safety culture self-assessment of the refinery operation is completed periodically, approximately every five years. The most recent assessment was completed in late 2018 and re-affirmed that BRR has a strong commitment to safety and a high degree of trust and confidence in the site management. Security culture was included in this assessment for the first time, with no specific issues noted. Overall, the results are comparable to those from the previous safety culture assessment, completed in 2013.

2.1.3 Operating Performance

This safety and control area includes an overall review of the conduct of the licensed activities and the activities that enable effective facility performance.

In 2018, BRR continued to operate in a manner that supports safe, clean and reliable production and in compliance with applicable acts and regulations.

There was a scheduled summer shutdown of the UO₃ plant to allow for planned maintenance activities, to allow for employees to utilize vacation time and to match Cameco PHCF production requirements. Refinery start-up after the extended summer shutdown period was routine. The refinery production schedule throughout the year closely aligned with that of Cameco's PHCF.

BRR operated in accordance with site programs and procedures and did not exceed any CNSC regulatory limits during the year. Annual operating targets are set and key performance indicators established for refinery operations.

As noted previously in this report, Cameco has an internal audit program that routinely looks at various aspects of site operations related to the licensed activities. BRR also had some external audits completed in 2018, as identified in Section 2.1.1 of this report. There were no significant issues identified from either internal or external audits in 2018.

2.2 Facility and Equipment

2.2.1 Safety Analysis

This safety and control area covers the maintenance of the safety analysis which supports the overall safety case for the facility. This 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 preventative measures and strategies in reducing the effects of such hazards.

BRR has a safety report that documents the detailed safety analysis carried out for the facility. Design reviews are done prior to making any plant modifications that may affect the safety case for the refinery, with the site safety report updated periodically to include the findings from design reviews completed since the last revision to the report. The safety report was last updated and reissued in 2016.

There were no modifications made in 2018 that affected the safety case for the refinery. The safety significant systems at the facility have been identified and a preventive maintenance program is in place to ensure that the equipment associated with these systems is properly maintained.

2.2.2 Physical Design

This safety and control area relates to activities that impact on the ability of systems, structures and components (SSCs) to meet and maintain their design basis, given new information arising over time and taking into account changes in the external environment.

As part of Cameco's budgeting process for capital expenditures, plant improvements related to physical design are identified and prioritized.

BRR contains numerous types of conventional industrial equipment including storage tanks, conveyors and associated piping, as well as specialized equipment for the UO₃ refining process.

Changes to the physical design of equipment, processes and the facility with the potential to impact safety are evaluated from project planning through to the completion of the project. This review identifies impacts and potential impacts to the environment and health and safety. A design control procedure is in place which ensures that any equipment changes or modifications will not have an adverse effect on the environment or on the health and safety of employees or members of the public.

BRR has a contractual arrangement with the provincial TSSA to ensure that oversight of pressure retaining components and systems continues to be carried out by a third-party expert. As part of this process, BRR continues to utilize non-destructive examination techniques to assess the integrity of pressure vessels and related systems. These examinations are primarily done in-house by qualified staff, though qualified third-party experts are used when necessary.

Examples of physical improvements implemented in 2018 include:

- Improvements to perimeter fencing;
- Installation of OK Liquor feed deviation alarm;
- West yard fire water and well water piping replacement;
- Removal of Cs-137 nuclear gauge from process and eventually from site;
- Refurbishment of motor control centre;
- Upgraded incinerator gas train;
- Installation of centrifuge vibration sensor;
- Cylinder room and Warehouse sprinkler upgrades,
- Elevator modernization and machine guarding; and
- Replacement of diesel firewater pumps and angle drive.

2.2.3 Fitness for Service

This safety and control area covers activities that impact on the physical conditions of systems, structures and components (SSCs), 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.

BRR has programs and procedures that ensure that the facility is operated in a safe, clean and reliable manner. These programs and procedures address the following areas that comprise this safety control area: a Preventive Maintenance program (PM), an in-service inspection program and other testing and review systems.

BRR has an established PM program as defined in the site PM plan. All PM tasks are initiated and documented through the work notification system in SAP, a corporate-wide enterprise application software package for asset management, maintenance management, accounting and purchasing functions. PM plans are issued, reviewed and updated periodically to ensure the PM routines developed continue to be effective and adequate. Key Performance Indicators (KPIs) are in place to monitor the effectiveness of the program.

All regulatory related preventive maintenance work orders driven by the preventive maintenance plans were completed.

BRR has an in-service inspection program which applies to both registered and non-registered piping and vessels in the refinery, including those related to safety significant systems. Technicians performing radiographic, ultrasonic, magnetic particle and liquid penetrant inspections are certified in accordance with the Canadian General Standards Board (CGSB). Test methods have been selected on the basis of the historical record of operating and inspecting the UO₃ plant. They are considered the most appropriate for detecting potential problems and for revealing the type of deterioration most likely to occur as a result of the service conditions to which the equipment is subjected.

The in-service inspection (ISI) program was maintained throughout the year with no significant issues identified. In 2018, 94% of all ISI's were completed within 10% of the frequency rate, similar to the 95% completion rate in the previous year.

In addition to the ISI program, a process is in place to identify equipment and components reaching the end of their service life through means such as increased maintenance requirements, lack of availability of replacement parts or manufacturers recommendations. Items identified for replacement are assessed through the design change process and may require a capital expenditure, depending on the nature and cost of the replacement component.

Based on the maintenance related KPI's, the maintenance program, which includes the aging management component, is considered to be effective.

Fire protection systems are tested according to an established schedule as outlined in the Fire Protection Program (FPP). Third-party reviews are conducted to confirm required tests and inspections with respect to fire protection are completed and these review reports are submitted to the CNSC.

Process monitoring is conducted through product and intermediate quality control testing (such as chemical analysis) to ensure that the equipment is functioning within design specifications. Additional measures to ensure that equipment is operating as designed include monitoring of environmental systems (i.e. conductivity probes in condensate return lines to detect leaks, in-plant uranium-in-air monitoring and real-time stack monitoring for oxides of nitrogen (NO_x)) as well as operator and specialist (i.e. safety officer and radiation safety officer) inspections.

2.3 Core Control Processes

2.3.1 Radiation Protection

This safety and control area covers the implementation of a radiation protection program, in accordance with the *Radiation Protection Regulations*. This program must ensure that contamination and radiation doses are monitored and controlled.

The refinery has an extensive Radiation Safety Program in place to meet the requirements of the *Nuclear and Safety Control Act* and the *Radiation Protection Regulations* and ensure exposures are kept to levels as low as reasonably achievable (ALARA). The program includes the following aspects:

- external dosimetry – personal monitors for assessment of whole body and skin exposure;
- internal dosimetry – urinalysis and lung counting programs;
- workplace air sampling program;
- a respirator program; and
- radiation surveys and contamination surveys.

The CNSC regulatory limits for effective dose for Nuclear Energy Workers (NEWs) are 50 milliSieverts (mSv) per year and 100 mSv over a five-year dosimetry period.

For various radiological parameters, Cameco has established action levels, accepted by the CNSC that may be indicative of a potential loss of control for that specific parameter. These action levels serve as an early warning of a condition that warrants further investigation. In addition, as a continual improvement tool, Cameco has established lower-tier internal administrative levels (IAL), which are set below the action levels and provide an even earlier warning of a potential concern. A result above an IAL is also investigated and remedial actions taken if necessary.

The current action levels for external dosimetry are 2.0 mSv whole body and 15 mSv skin exposure for people on a monthly dosimeter badge change frequency and 0.7 mSv whole body and 6 mSv skin exposure for people on a quarterly badge change frequency. BRR has also established actions levels with respect to urinalysis - 63 µg/L U for routine bi-weekly samples and 44 µg/L U for routine monthly samples. There is also a lung counting action level of 10 mSv between consecutive counts. There were no action level exceedance in 2018.

Radiation objectives and targets are established jointly by the site management team and site specialists, including the radiation safety officer, to ensure there is agreement, a commitment and awareness of these objectives and targets across all areas of the refinery's operation. These objectives and targets can address, among other things, worker dose reduction initiatives and

other projects which examine ways to reduce in-plant uranium-in-air concentrations. The status of these objectives and targets is reviewed by the site management team and resources are allocated as required to achieve the targets. Status reports on the objectives and targets are posted on the ALARA bulletin board outside the employee change rooms so that employees are aware and can review the status of the objectives and targets as well.

At the start of 2018 four radiation safety objectives were created. The first objective was to remove the last two Cs-137 nuclear gauges from site, utilizing a qualified vendor. This objective was completed. The second objective was to update the site ALARA Assessment Report, originally created in the late 1990's and last updated in 2013. Upon reviewing the content of the report however, it was determined that the site annual management review process and the preparation of the CNSC annual report, provide basically the same information as could be found in this report, hence the decision was made to obsolete this report. The third objective was to provide off-site ERT training to the alternate monitoring leader. This objective is in progress and will now be completed in the second quarter 2019. The last objective was to assess the use of carpets in Zone 2 areas from a contamination control perspective. This assessment has been completed with no changes to the current carpet usage planned.

Three new radiation safety objectives have been created in 2019 related to the following activities/topics: upgrading the gamma spectroscopy equipment on site used for in-plant air monitoring, assess UO₃ drum loading practices in order to minimize dose to workers, and to conduct fence line monitoring to determine whether additional shielding should be placed along any of the perimeter fence lines.

As part of the work of the joint workplace health and safety committee, updates on the status of the radiation protection program are discussed at the monthly meetings and employees are encouraged to bring forward any questions or concerns. In addition to this committee, a separate ALARA committee is in place. This committee meets regularly to review and discuss radiation safety related incidents and issues, and to make recommendations for improvements.

Any issues identified during either regulatory or internal audits are documented in the CIRS database so that corrective actions can be identified and implemented.

There were a total of fifty-eight separate radiation training sessions held in 2018 covering a variety of radiation safety topics including respirator training, radiation meter training, dosimeter training, procedural review and radiation theory training. At the end of 2018, 99.6% of the required training was completed. The outstanding required training has since been completed.

There were 29 radiation-related documents updated in 2018. These included procedures and forms related to air sampling, urine sampling, lung counting, dosimetry, respiratory protection

and surveying. All radiation safety procedures and forms are reviewed and updated as required on a regular basis.

An inventory of sealed and unsealed sources that are used or possessed on site is listed in the radioisotope source control procedure. Regular inspection and leak tests of the sealed sources were carried out in 2018 following this procedure. Results showed that all sources are accounted for and pose no undue risk to workers. Control of sealed sources was maintained throughout the year.

All radiation monitoring devices and instrumentation are routinely checked and calibrated as required. Calibration frequencies are identified and a calibration schedule maintained. Equipment that is damaged or non-operational is removed from service until it can be repaired and recalibrated. In 2018 new radiation protection monitoring devices/instrumentation was purchased to either augment the existing equipment inventory or to replace non-operational equipment that was deemed no longer repairable.

Calibration of contamination monitoring instrumentation is done in-house or by a qualified third party vendor, while calibration of gamma survey meters is done by a qualified third party vendor. Other radiation protection instrumentation such as air flow calibrators and respirator fit testing equipment is also sent off-site for calibration by a qualified third party.

Dosimetry

Cameco uses a licensed dosimetry services provider accredited by the CNSC. The dosimetry service provides optically stimulated luminescence (OSL) dosimeters to monitor whole body and skin dose for employees, contractors and visitors as required. Ring dosimeters are also issued to certain employees, dependent on their job duties. Dosimeters are changed monthly for operations (production and maintenance) personnel and quarterly for administration and support staff. Results are provided by the dosimetry services provider to both Cameco and to the National Dose Registry.

The following tables and graphs summarize individual exposure results. Note that in figures with ranges on the horizontal axis, a range of 1 – 2, for example, means all results greater than or equal to (\geq) 1 and less than ($<$) 2.

Whole Body Dose

Table 2 shows the annual external dose results for three work groups, employees in operations, employees in administration and/or support roles and contractors who have been made nuclear energy workers (NEWs). All employees are also NEWs. The highest doses are from the operations work group, consisting of production and maintenance personnel.

Table 2

2018 Annual External Dose Results (mSv)							
Work Group	Number of Individuals	Whole Body Dose			Skin Dose		
		Min.	Average	Max.	Min.	Average	Max.
Operations	70	0	1.0	3.7	0.1	7.8	28.4
Administration/Support	61	<0.1	0.3	0.7	0.1	0.8	5.1
NEW Contractors	17	<0.1	0.1	0.2	<0.1	0.2	1.1

As illustrated in Table 3 and Figure 3, approximately 81% of external whole body doses in 2018 were less than 1 mSv, compared to 88% less than 1 mSv in 2017. There was no result at or above 4 mSv in 2018. Whole body dose is a component of effective dose.

Table 3

2018 Whole Body Dose Distribution	
Dose Range in mSv	% of Individuals
0 – 1	81.1
1 – 2	13.5
2 – 3	4.1
3 – 4	1.4
4 – 5	0
>5	0

Figure 3

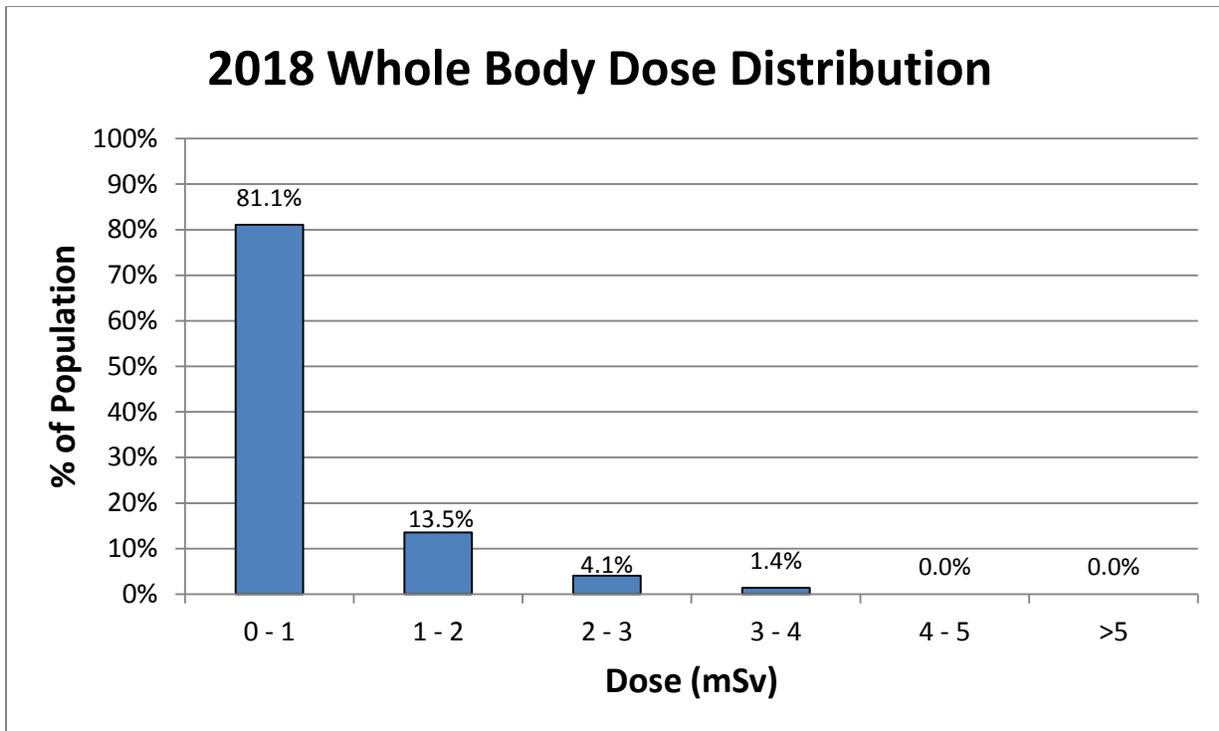


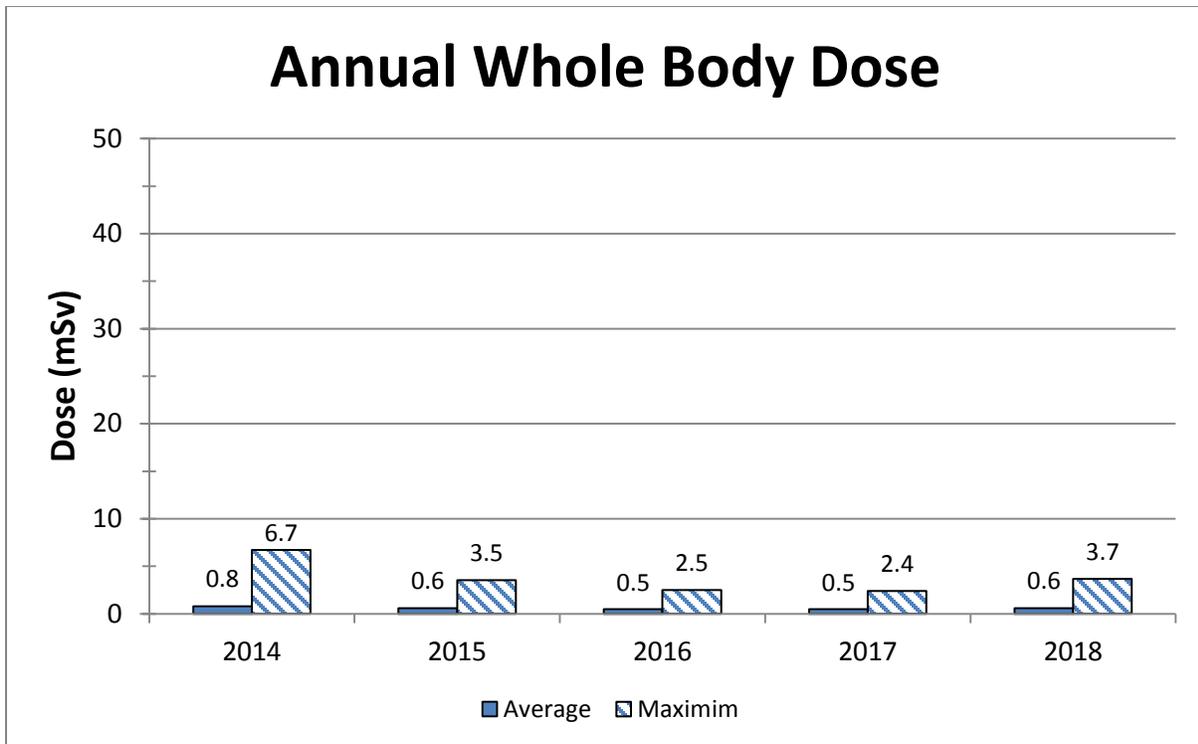
Table 4 and Figure 4 show the average, minimum and maximum individual external whole body dose for the five year period from 2014 – 2018. The average whole body dose has not exceeded 1.0 mSv in the five year period and has remained relatively stable over that time.

The highest individual whole body exposure was 3.7 mSv, received by a S&FP operator, slightly higher than the highest individual result in 2017 and 2016. Production levels in 2018 were significantly higher than in 2016 and 2017. Higher production levels correspond to an increase in operating days in a given year.

Table 4

2014 – 2018 Whole Body Dose					
Result (mSv)	2014	2015	2016	2017	2018
Minimum	0	0	0	0	0
Average	0.8	0.6	0.5	0.5	0.6
Maximum	6.7	3.5	2.5	2.4	3.7

Figure 4



Site visitors and non-NEW contractors may also be issued dosimeter badges. The average and maximum whole body results for these individuals were <0.1 mSv and 0.4 mSv, respectively.

Skin Dose

Table 5 and Figure 5 illustrate that over 87% of individual skin doses in 2018 were less than or equal to 10 mSv, with no skin dose result above 30 mSv. Last year there were no employees with a skin dose result greater than 30 mSv as well. All results remain less than 10% of the regulatory limit of 500 mSv.

Table 5

2018 Skin Dose Distribution	
Dose Range in mSv	% of Individuals
0 – 10	87.2
10 – 20	10.8
20 – 30	2.0
30 – 40	0
40 – 50	0
>50	0

Figure 5

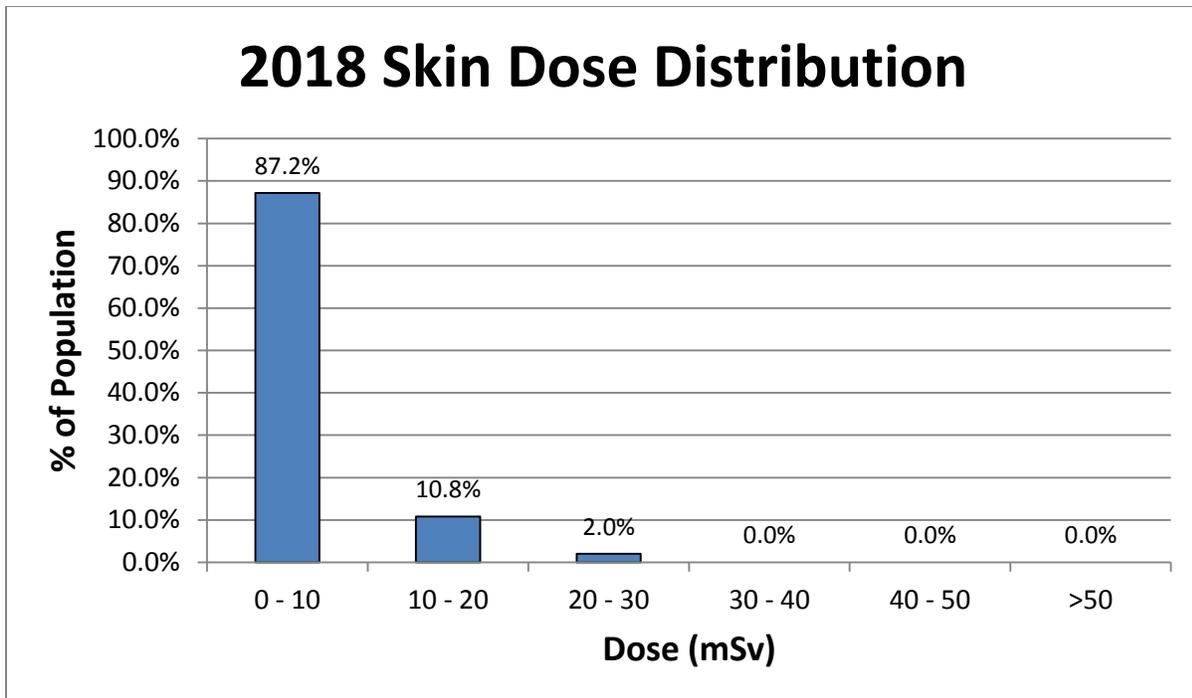


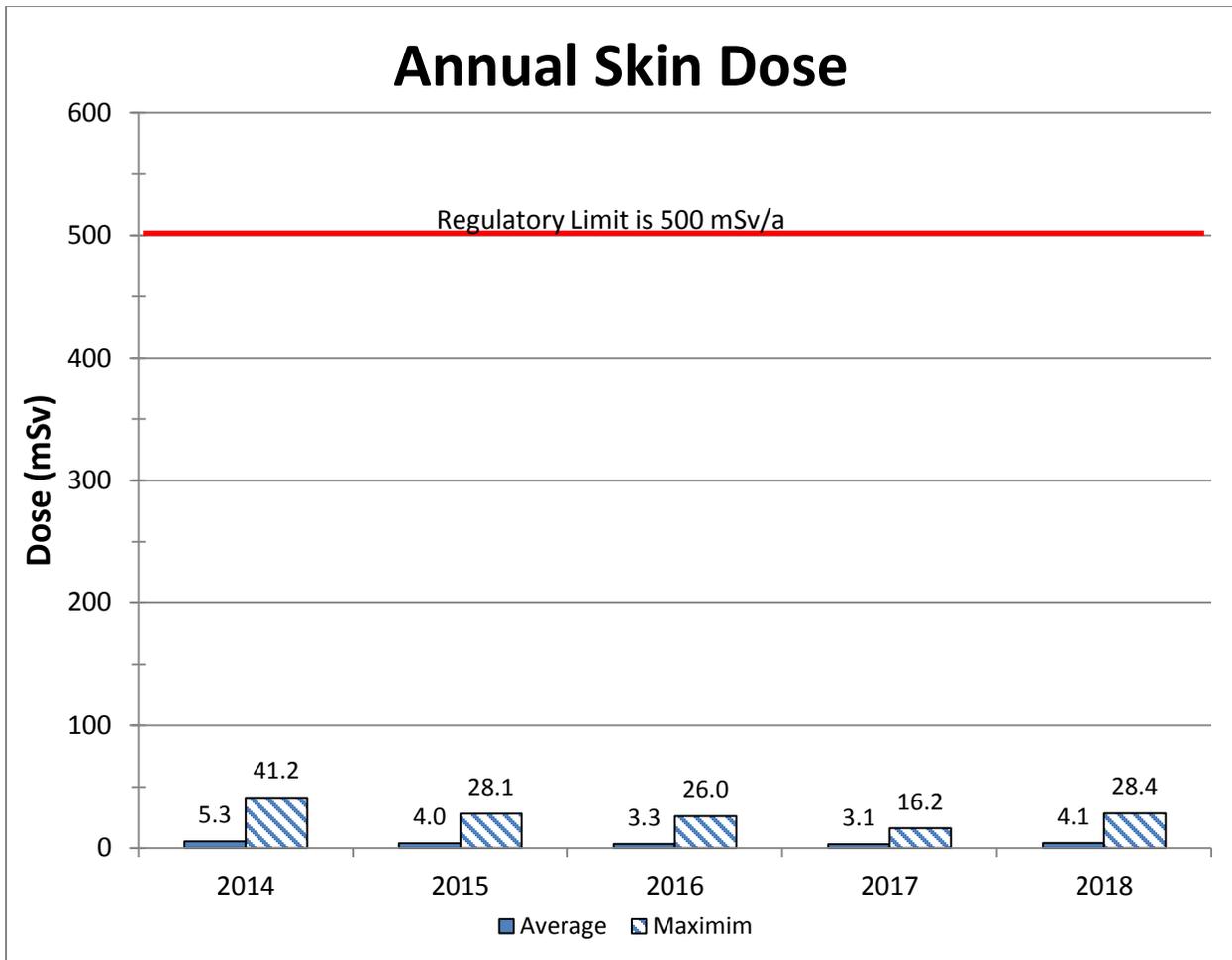
Table 6 and Figure 6 show the average, minimum and maximum individual skin doses for the five year period from 2014 – 2018. The average individual skin dose increased slightly in 2018 compared to 2017, likely due to increased UO₃ production last year. The average result also remained within the range of average results in the last five years. The refinery average result of 4.1 mSv is less than 1% of the CNSC annual regulatory limit.

The maximum individual skin dose in 2018 was 28.4 mSv compared to 16.2 mSv in 2017. This result is approximately 6% of the CNSC annual limit. The individual with the highest skin dose is a process operator. The average and maximum non-NEW contractor/visitor skin dose results were <0.1 mSv and 0.4 mSv, respectively.

Table 6

2014 – 2018 Skin Dose					
Result (mSv)	2014	2015	2016	2017	2018
Minimum	0	0	0	0	<0.1
Average	5.3	3.9	3.3	3.1	4.1
Maximum	41.2	28.1	26.0	16.2	28.4

Figure 6



Extremity Dose

Process operators working in the DRaff area and certain maintenance workers have historically been issued ring dosimeters. These dosimeters are only required to be worn when working in the DRaff area of the refinery but may be worn in other areas of the refinery as well. Table 7 shows the average, minimum and maximum ring dosimeter result for employees over the last five years. The average extremity dose increased in 2018 compared to the last few years. This is attributable to increased production levels in 2018. However, the average result of 3.5 mSv is still less than 1% of the CNSC annual limit of 500 mSv, with the maximum extremity dose just under 3% of the regulatory limit. The highest extremity dose was to a process operator.

Table 7

2014 – 2018 Extremity Dose					
Result (mSv)	2014	2015	2016	2017	2018
Minimum	0	0	0	0	0.2
Average	5.4	1.5	1.2	1.0	3.5
Maximum	48.2	15.3	10.6	13.6	14.5

Urine Dose

Table 8 shows the distribution of urine results for 2018. The majority of results (99%) are less than or equal to 5 µg U/l, and <0.1% of the results are greater than 25 µg U/l. These percentages are the same as reported in 2017. The highest urinalysis result in 2018 was 54 µg/L, from a non-routine sample submitted by a process operator.

Table 8

2018 Urinalysis Results	
Distribution of Results	Number of Results
Number of Samples ≤ 5 µg U/l	3397
Number of Samples >5 to ≤ 25 µg U/l	33
Number of Samples >25 to ≤ 50 µg U/l	1
Number of Samples ≥ 50 µg U/l	1
Number of Samples Analyzed	3432

The 2018 urine dose distribution is shown in Table 9 and Figure 7. About 74% of individuals were assigned a urine dose of 0.2 mSv or less, similar to the 78% in 2017. Also in 2018 approximately 96% of the urine dose results were less than 1 mSv, compared to 98% in 2017. Cameco’s Fuel Services Division has an Internal Dosimetry Licence (#11010-16-24.0) for both urinalysis and lung counting.

Table 9

2018 Urine Dose Distribution	
Dose Range in mSv	% of Individuals
0 – 0.2	73.9
0.2 – 0.4	8.7
0.4 – 0.6	5.1
0.6 – 0.8	6.5
0.8 – 1.0	2.2
>1.0	3.6

Figure 7

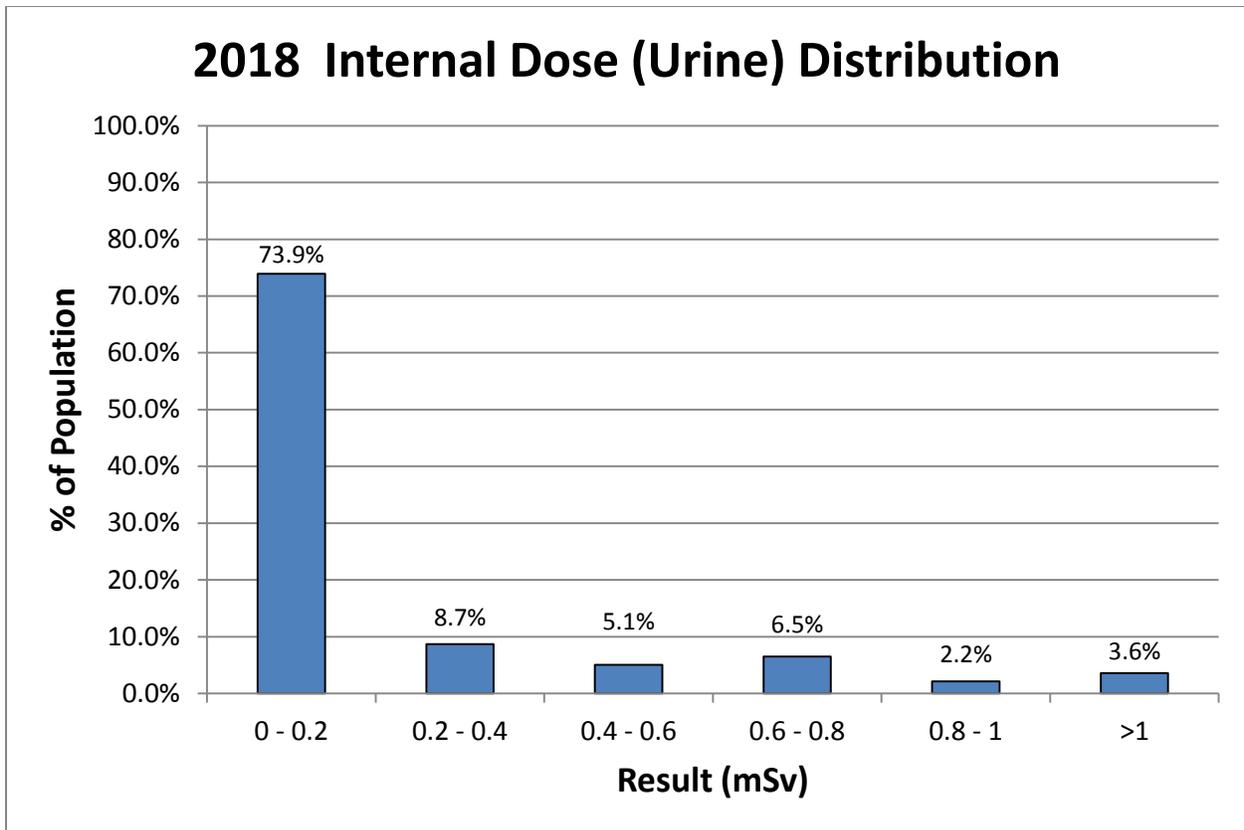


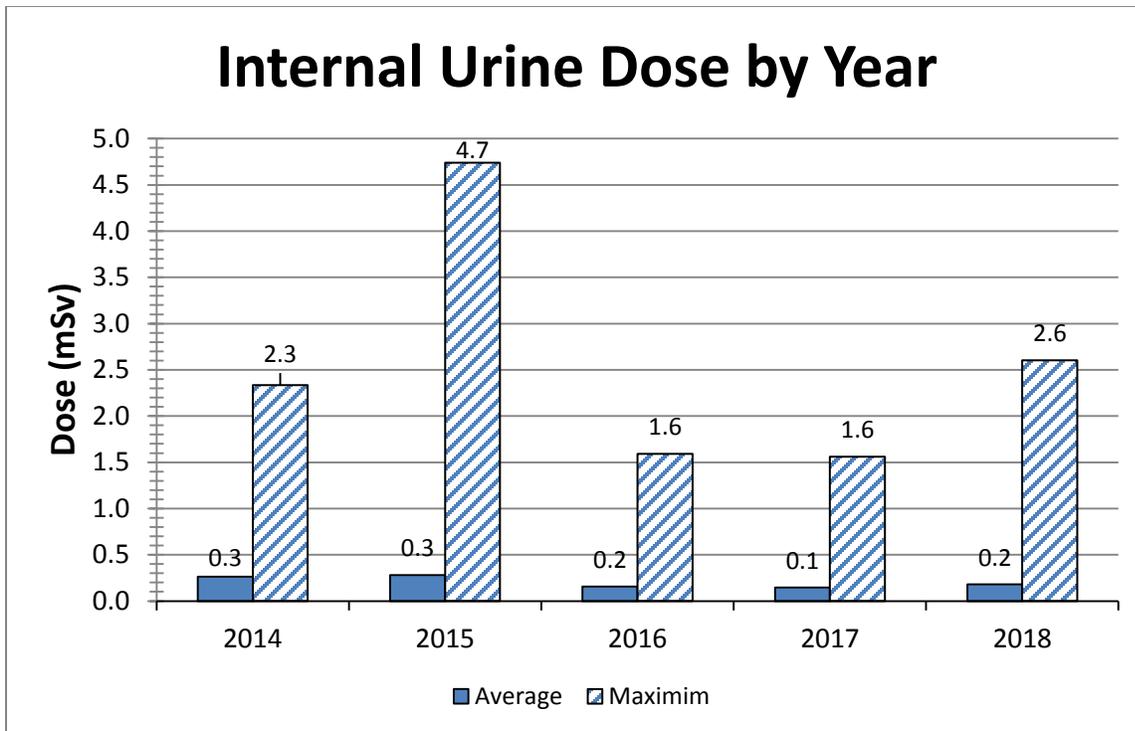
Table 10 and Figure 8 show the minimum, average and maximum individual assigned urine dose for the 2014 – 2018 periods. Overall refinery average urine dose results have been stable over the last five years. The individual with the highest maximum individual urine dose in 2018 was an S&FP operator. The maximum dose in 2018 is slightly higher than the highest individual result in 2017 and 2016 when production levels were lower.

Urine dose is a component of effective dose.

Table 10

2014 – 2018 Internal Dose (Urine)				
Year	Number of Individuals	Minimum Dose (mSv)	Average Dose (mSv)	Maximum Dose (mSv)
2014	150	0	0.3	2.3
2015	147	0	0.3	4.7
2016	141	0	0.2	1.6
2017	134	0	0.1	1.6
2018	138	0	0.2	2.6

Figure 8



Lung Dose

Table 11 and Figure 9 show the breakdown of the internal lung dose for individuals in 2018. This data includes both employees and contractor NEWS. Approximately 65% of individuals had an assigned lung dose less than or equal to 1 mSv and no one had an assigned lung dose greater than 3 mSv. The two individuals with the highest lung dose are both process operators. Due to the nature of the lung dose assessment methodology, there can be some year-to-year variation in dose group assignments, which impacts directly on the percentage of individuals in each dose range.

Table 11

2018 Lung Dose Distribution	
Dose Range in mSv	% of Individuals
0 – 1	64.7
1 – 2	22.0
2 – 3	13.3
3 – 4	0
4 – 5	0
>5	0

Figure 9

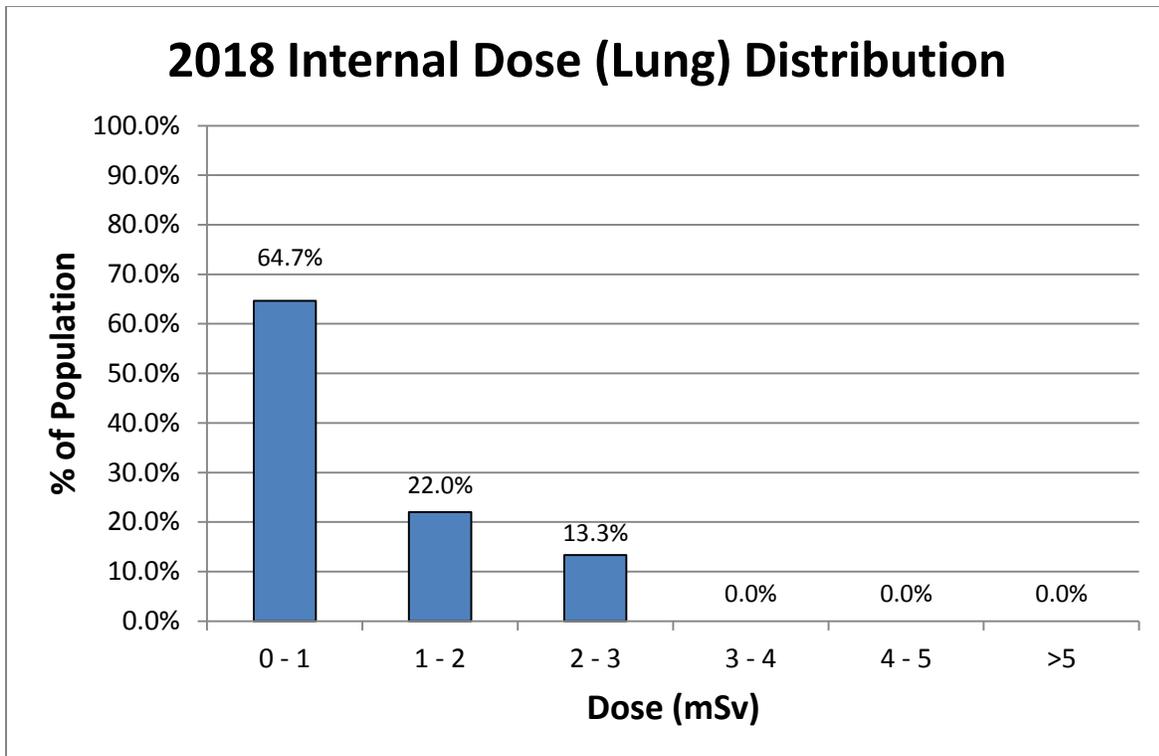


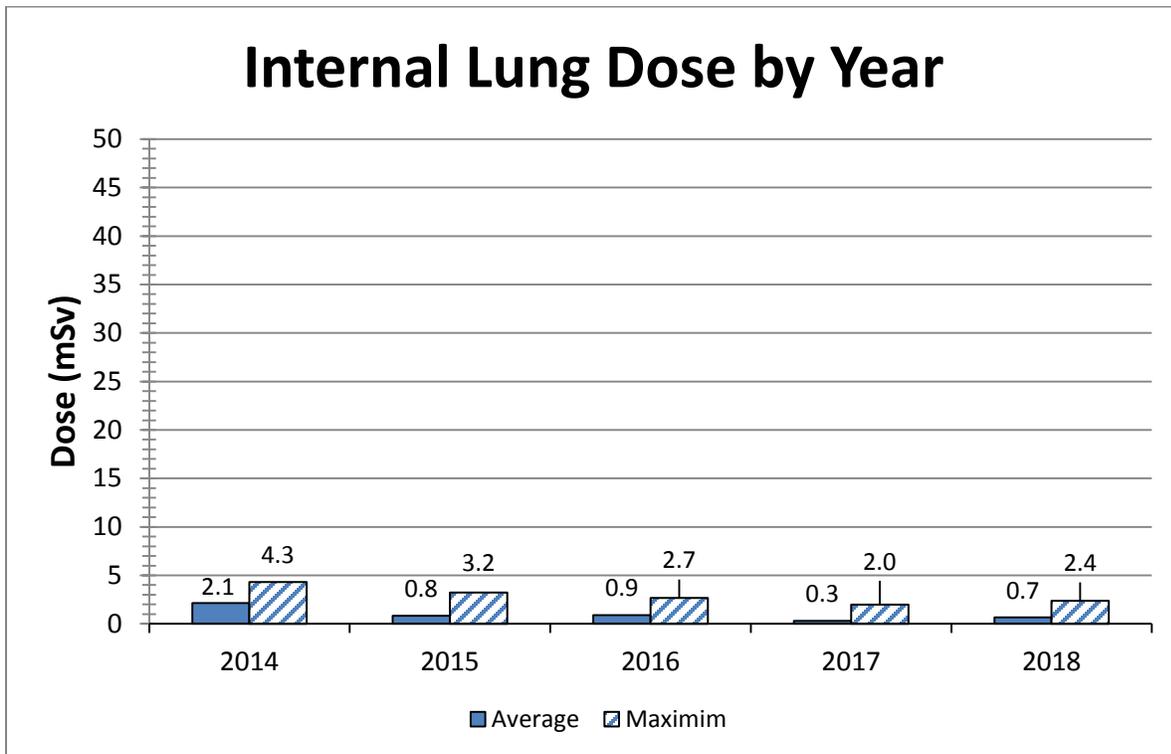
Table 12 and Figure 10 show the minimum, average and maximum individual assigned lung dose for the 2014 – 2018 period. The average individual lung dose in 2018 is slightly higher than in 2017, attributable to increased production levels, but is comparable to results in prior years. The highest individual lung dose in 2018 was 2.4 mSv, again up slightly from the maximum dose reported in the previous year. Overall, individual lung dose has shown a decreasing trend over the last five years.

Lung dose is a component of effective dose.

Table 12

2014 – 2018 Internal Dose (Lung)				
Year	Number of Individuals	Minimum Dose (mSv)	Average Dose (mSv)	Maximum Dose (mSv)
2014	162	0	2.1	4.3
2015	154	0	0.8	3.2
2016	154	0	0.9	2.7
2017	145	0	0.3	2.0
2018	150	0	0.7	2.4

Figure 10



Total Effective Dose

Table 13 and Figure 11 show the breakdown of the total effective dose for individuals in 2018. This data includes both employees and contractor NEWs. All individuals had an effective dose of less than 7 mSv.

Table 13

2018 Total Effective Dose Distribution	
Dose Range in mSv	% of Individuals
0 – 2	71.3
2 – 4	18.0
4 – 6	9.3
6 – 8	1.3
8 – 10	0
>10	0

Figure 11

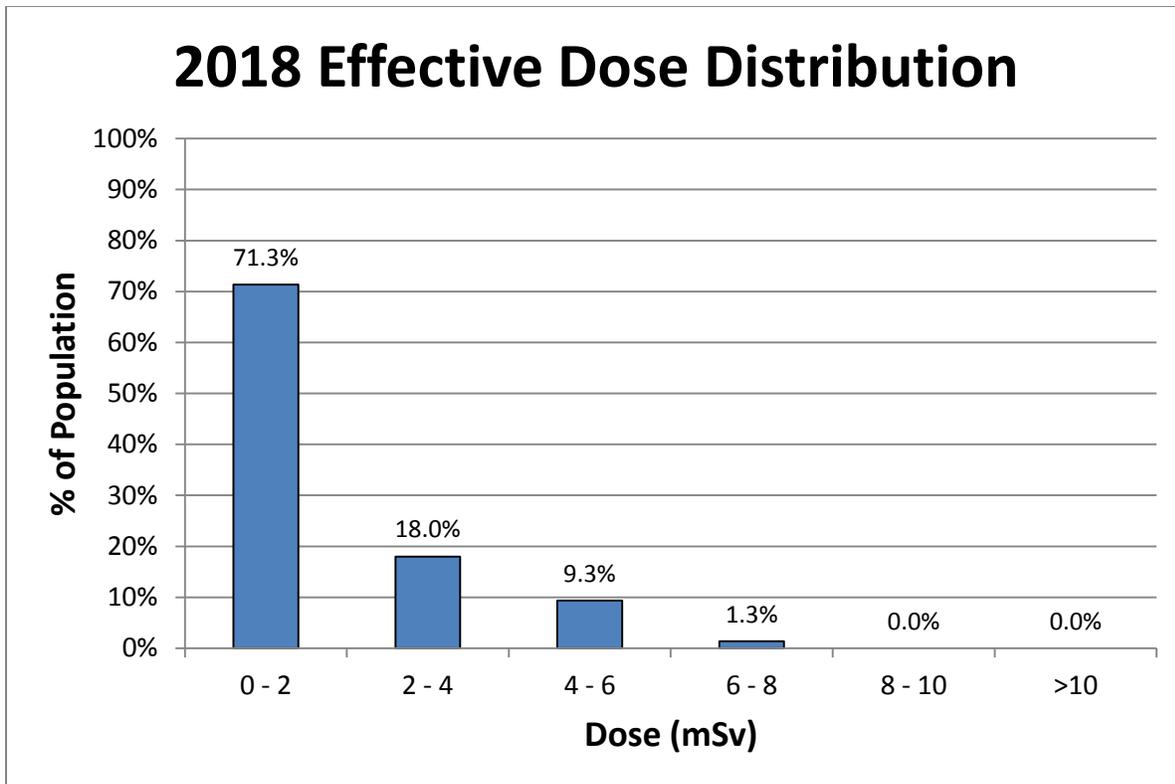


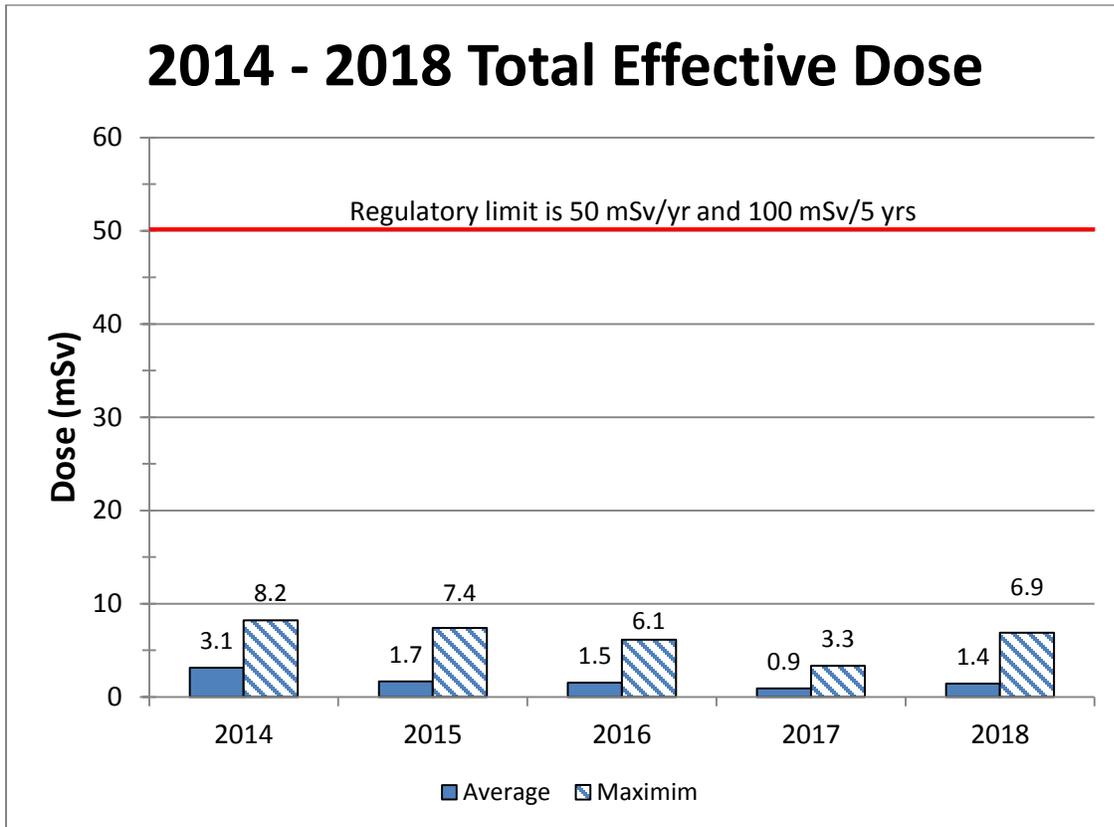
Table 14 and Figure 12 show the total effective dose results for the 2014 – 2018 period. The average total effective dose in 2018 was slightly higher than the average effective dose in the previous year but comparable to prior years. Similarly, the maximum individual total effective dose in 2018 was slightly higher than in 2017 but comparable to prior years. The annual regulatory limit for total effective dose is 50 mSv; therefore the highest individual result in 2018 was just under 14% of the annual regulatory limit.

With respect to the regulatory limit of 100 mSv total effective dose over five years, the highest individual result for the current five-year dosimetry period (January 1, 2016 to December 31, 2020) is 16.4 mSv to an S&FP operator.

Table 14

2014 – 2018 Total Effective Dose				
Year	Number of Individuals	Minimum Dose (mSv)	Average Dose (mSv)	Maximum Dose (mSv)
2014	162	0	3.1	8.2
2015	154	0	1.7	7.4
2016	154	0	1.5	6.1
2017	145	0	0.9	3.3
2018	150	0	1.4	6.9

Figure 12



As indicated in Table 15, the individual with the highest effective dose in 2018 is an S&FP operator. Historically, S&FP operators have been one of the work groups that receive the highest effective dose at the refinery. Four of the five highest individual doses in 2018 were to S&FP operators.

Table 15

2018 Five Highest Total Effective Dose Individuals				
Occupation	Urine Dose (mSv)	Lung Dose (mSv)	External Whole Body Dose (mSv)	Effective Dose ¹ (mSv)
S&FP Operator	2.6	1.8	2.5	6.9
S&FP Operator	1.1	1.8	3.7	6.5
S&FP Operator	1.2	2.1	2.2	5.6
Process Operator	<0.1	2.2	3.2	5.5
S&FP Operator	1.4	1.9	1.8	5.1

¹ Note that the effective dose value may not match the combined urine + lung + whole body dose value due to rounding.

Contamination Control

An extensive contamination control program is in place at the refinery. The refinery is divided into three zones for contamination control purposes. Zone 1 areas are designated as clean areas, with no dispersible radioactive material allowed, while Zone 3 areas are production areas. Zone 2 areas are considered buffer zones where small amount of radioactive material may be present. Routine contamination monitoring is done in Zone 1 and 2 areas, with a focus on employee lunchrooms, change rooms and hallways. Table 16 summarizes 2018 alpha monitoring results from both areas and includes both swipe samples and direct contact surface measurements. There were ten results above the internal administration level (IAL) in 2018, compared to six results above the IAL in 2017. For any results over the IAL, the affected area is cleaned and re-monitored to verify the contamination has been removed. Contamination readings above the IAL pose no significant risk to people or to the environment. There were no adverse trends noted during routine contamination monitoring activities.

Table 16

2018 Alpha Contamination Monitoring Results				
Area	Number of Readings Above IAL	Total Number of Measurements	Action Level – Swipes (Bq/cm ²)	Action Level – Contact Readings (Bq/cm ²)
Zone 1	0	1,190	0.15	0.4
Zone 2	10	14,659		

All plant clothing is laundered on site and clothing and work boots are routinely monitored for contamination; with items contaminated above administrative levels disposed of via the on-site incinerator. There were no contamination issues identified related to vehicles leaving the refinery.

Three whole body monitors are in routine service at the front entrance to the facility. All employees and visitors are required to pass through a whole body monitor prior to exiting the refinery. Any contamination issues identified are addressed promptly prior to individuals leaving site.

In-plant Air

A summary of in-plant air sampling results for 2018 is provided in Tables 17 and 18. Approximately 0.1% of the samples were above the uranium-in-air respirator level (RL). There were only 2 samples above the RL in 2018 compared to 11 samples above in 2017. Average results for each of the four plant areas identified in the table were very similar to 2017 area average results, with the average result being $1 \mu\text{g U/m}^3$, or approximately 1% of the RL. The highest result for the year was from the warehouse area. The UO_3 processing areas consist of the plant areas necessary for the production of UO_3 , from calcination through to denitration. The UO_3 ancillary areas include raffinate/DRaff, sump treatment, equipment decontamination and the maintenance shop.

Table 17

2018 Uranium In-plant Air Sampling Results				
Plant Area	# of Samples	Average ($\mu\text{g U/m}^3$)	Maximum ($\mu\text{g U/m}^3$)	# of Samples above RL¹
Warehouse	1,975	1	172	1
UOC and UO_3 Labs	20	0	0	0
UO_3 Processing Areas	3,703	2	113	1
UO_3 Ancillary Areas	3,521	<1	55	0
TOTAL	9,219	1	172	2

¹ Respirator Level (RL) is $90 \mu\text{g U/m}^3$

As shown in Table 18, there were a total of 1,373 samples from the raffinate/DRaff area analyzed for thorium-in-air in 2018. This number represents approximately 47% of the total number of samples collected from the area. Just under 5% of the samples analyzed for thorium-in-air were actually above the thorium-in-air RL, roughly double the percentage in 2017. The number of RL samples increased from 20 the previous year to 66 in 2018. An increase in area operating days due to higher production in 2018 resulted in increased maintenance in the area, compared to the previous year. The highest result for the year occurred during maintenance activities. All personnel wear the proper PPE during maintenance activities.

Table 18

2018 Thorium-in-air Air Sampling Results from Raffinate/DRaff Area			
# of Samples¹	Average Th-230 (Bq/m³)	Maximum Th-230 (Bq/m³)	# of Samples above RL²
1,373	0.02	1.55	66

¹Represents the number of samples actually analyzed for thorium-in-air.

² Respirator Level (RL) is 0.15 Bq/m³ Th-230.

Gamma Surveys

Plant gamma surveys using hand-held meters are done on a routine basis throughout the refinery. The frequency of the readings and the number of readings taken in each area varies based on the area of the refinery and the historical results from that area. Measurement frequencies can vary from monthly to semi-annually. Table 19 summarizes the results from general area readings taken in 2018. The results indicate that the raffinate/DRaff area has the highest gamma fields of all refinery areas. This is consistent with results from prior years, with the average and maximum results from this area in 2018 slightly higher than in the previous year. There were no other adverse trends noted. Appropriate signage is posted at areas or locations where there is a reasonable probability that a person may be exposed to a dose rate greater than 25 µSv/h.

Table 19

2018 Summary of Plant Gamma Readings by Area (µSv/h)			
Location	Average Result	Maximum Result	Range
UOC Warehouse	5	11	<1 – 11
UOC Sub-sampling Lab	6	9	4 – 9
Calcination Area	6	23	<1 – 23
Digestion	2	2	1 – 2
Solvent Extraction	1	1	<1 – 1
UO ₃ Sub-sampling Lab	4	8	1 – 8
Scrap Recovery	1	4	<1 – 4
Raffinate/DRaff	33	202	1 – 202
Boildown	1	1	<1 – 1
Equipment Decontamination	5	16	<1 – 16
Sump Treatment	1	1	<1 – 1
Denitration	1	2	<1 – 2
Nitric Acid Recovery	1	1	<1 - 1

2.3.2 Conventional Health and Safety

This safety and control area covers the implementation of a program to manage non-radiological workplace safety hazards and to protect personnel and equipment.

A key element of a safe, clean and reliable operation is a comprehensive and well-established worker protection program which has been in place for many years at the BRR. The foundation of the program is based on the Nuclear Safety and Control Act and its regulations as well as Part II of the *Canada Labour Code*. The regulations made pursuant to the *Nuclear Safety and Control Act* and the *Canada Labour Code* prescribe specific health and safety requirements that are met by the BRR.

Non-radiological safety hazards are managed through a comprehensive Occupational Health and Safety program as prescribed by the Cameco Health and Safety Management Program. This program set out the requirements for management of health and safety aspects of the operation consistent with Cameco's corporate SHEQ policy. Key components of the program include:

- compliance with all safety and health-related legal and regulatory requirements;
- the setting of site safety and health objectives;
- the implementation of corporate safety standards;
- the development and maintenance of a formal hazard recognition, risk assessment and change control processes; and
- the documentation of health and safety significant incidents from the start through to the verification of completion of corrective actions via the CIRS database.

The BRR site program undergoes several review processes, including scheduled procedure reviews, program audits, and annual management review. Conformance to the program is also tested through various inspection programs, incident investigations, and ongoing analysis by the joint workplace committees.

The health and safety management program fosters and promotes a strong sustainable safety culture. Cameco has five key principles in the area of safety that form the framework for how safety is managed. These are:

- safety is our first priority;
- we are all accountable for safety;
- safety is part of everything that we do;
- safety leadership is critical to Cameco Corporation; and
- we are a learning organization.

The effectiveness of the conventional OHS system can be evaluated by the responsiveness of the site to leading safety activities such as audits, inspections, evaluations, reviews, benchmarking, training and employee participation and engagement. There is a site joint workplace health and safety committee, known as the Facility Health and Safety Committee (FHSC), which meets monthly to discuss safety-related issues. Committee members also participate in site FHSC inspections which are carried out on a weekly basis during operations. A schedule is followed to ensure the entire facility is inspected annually. Inspection results are distributed and published and are also entered into the CIRS database for recording and tracking purposes. Departmental inspections are also conducted on a monthly basis. A total of 40 FHSC inspections were conducted in 2018, along with 100 department inspections.

BRR has tracked leading and lagging safety indicators for many years. These consist of, but are not limited to, tracking safety meeting attendance, tracking the percentage of safety inspections completed and safety statistics. This data is reviewed by site and divisional management and has helped improve the overall safety performance at the refinery. Table 20 presents the safety statistics for the refinery over the last five years.

Table 20 – Safety Statistics

Year / Parameter	2014	2015	2016	2017	2018
First Aid Injuries	12	12	12	5	9
Medical Diagnostic Procedures	2	6	0	1	1
Medical Treatment Injuries	1	0	1	0	1
Lost Time Injuries	0	0	0	0	0
Lost Time Injury Frequency	0	0	0	0	0
Lost Time Injury Severity	0	0	0	0	0

All reported Occupational Health and Safety incidents are documented in CIRS for tracking and management. The CIRS system defines five categories of incidents based on actual and potential outcome, with Category 1 incidents being minor in scope and Category 5 incidents having the highest actual and potential consequences.

There were 143 health safety related incidents recorded in the CIRS database in 2018. Of these, 12 were related to injury or illness, one was operational-related, one was industrial hygiene related and 129 were identified as near misses. A significance rating system is built into the CIRS database and used to assess all events and near misses. The significance ratings range from I (lowest significance or minor) to V (highest significance or major). The health safety industrial

hygiene related event was assigned a significance rating of III. There were no level IV or V health safety related events. All other incidents were classified as Level I or II. In addition, 11 use of experience events were created in CIRS as learning opportunities based on incidents that happened at other locations, both within Cameco and external to the company.

There was one injury reportable to ESDC in 2018, compared to no reportable injuries in 2017.

In June 2018 BRR achieved eleven years without a lost-time injury and continues to be a leader in conventional safety within Cameco. BRR's total recordable injury rate (TRIR) at the end of 2018 was 0.87, which met Cameco's corporate TRIR target for the year. The refinery also received the Cameco Mary-Jean Mitchell Green award for safety performance for the ninth time.

The refinery has an effective orientation program for contractors, utilizing health and safety orientation handbooks and classroom training.

BRR has a safety charter (the Charter) in place detailing our employee's commitment to safety. Each employee is asked to sign the Charter to demonstrate their personal commitment to safety. As new employees are hired, Cameco explains the Charter to them and requests they sign the Charter. A copy of the Charter, with all employee signatures, is posted at the front entrance to the refinery.

Several activities to improve occupational health and safety were undertaken in 2018, including the following:

- Completion of a grid area noise level survey for the entire refinery;
- Completion of welding fume sampling;
- Transitioning to WHMIS 2015;
- A hazard assessment was completed for 25 new chemicals prior to their use on site;
- Completed an ergonomic assessment for modification of a work station;
- The sodium hydroxide powerhouse pumps and piping were upgraded;
- Removed unused conveyors at the drum cutter;
- Removed two nuclear gauges no longer required from site via a qualified vendor; and
- Held a "safety stand down" upon return to work after the summer and Christmas shutdown periods.

At the start of 2018 six health and safety objectives were created, four of which have been completed. The closed objectives were a training promotion, STOP Observation refresher training, an isolation list refresher and promotion and the development of a pre-incident plan for excavation rescue. The two 2018 objectives that remain open are related to completion of a refinery noise survey and updating of the site hearing conservation procedure and a review and update to the site contractor management program. Both objectives are expected to be

completed in the second quarter. Five new health and safety objectives have been created in 2019 related to the following activities/topics: review of personal protective equipment, review of the job hazard analysis (JHA) program, completion of a lighting survey, review of safety data sheets (SDS) against the chemical inventory, and promotion of job task observations (JTO).

2.3.3 Environmental Protection

This safety and control area covers the programs that monitor and control all releases of nuclear and hazardous substances into the environment, as well as their effects on the environment, as the result of licensed activities.

There are both federal and provincial regulatory authorities that have legislative jurisdiction over environmental protection at the facility. Cameco monitors air and liquid effluents discharges to ensure that they meet applicable provincial and federal requirements.

The refinery's Environmental Protection Program (EPP) is comprised of the following components:

- sampling of water and air emissions;
- high-volume sampling of ambient air, both near the refinery and in the Town of Blind River; and
- additional ambient sampling, including soil, surface water and groundwater monitoring

For key emission parameters, Cameco has established action levels accepted by the CNSC that may be indicative of a potential loss of control for that specific parameter. As noted previously, these action levels serve as an early warning of a condition that warrants further investigation. In addition, as a continual improvement tool, Cameco has established some lower-tier internal administrative levels, which are set below the action levels and provide very early warning of a potential concern. A result above an internal administrative level is also investigated and remedial actions taken if necessary.

The key characteristics of the operation and activities that can have a significant environmental impact are monitored and measured and are described in the Environmental Protection Program and associated procedures. These documents identify the emissions to the air, water and land, the programs that are in place to monitor them, what is measured, the legal requirements and the reporting requirements. Fourteen environmental related documents and four forms were updated in 2018.

Environmental objectives and targets are established jointly by the site management team and site specialists, including the environmental specialist, to ensure there is agreement, commitment and awareness of these objectives and targets across all areas of the refinery's operation. These objectives and targets can address, among other things, planned environmental improvements or enhancements in the field, purchase of new monitoring equipment and procedural and data management improvements. The status of these objectives and targets is reviewed by the site management team and resources are allocated as required to achieve the targets. Update reports

on the objectives and targets are posted on the EMS bulletin board outside the employee change rooms so that employees are aware of and can review the status of the objectives and targets.

Three of the four environmental objectives set at the start of 2018 have been completed. These objectives were related to updating the site DRL report, implementing the CSA waste management standards and reviewing uranium in liquid effluent loadings. There was also an objective related to the purchase and installation of a new NO_x analyzer for the nitric acid absorbers off-gas line. The analyzer has been ordered and is on site but not yet installed. Installation is expected to occur in the second quarter of 2019.

Three new environmental objectives were established at the start of 2019. The objectives are related to a review of incinerator operations, ambient water sampling for tri-butyl phosphate (TBP), and a review of regulatory compliance report requirements.

As part of the joint workplace health and safety committee, updates on the status of the environmental protection program at the refinery are discussed at the monthly meetings and employees are encouraged to bring any questions or concerns forward.

Any issues identified during either regulatory or internal audits are documented in the CIRS database so that corrective actions can be identified and implemented.

The site Environmental Protection Program was accepted by CNSC staff in 2018 and implemented and the site Waste Management Plan also updated and re-issued. The FSD Environmental Management System program and FSD Waste Management program documents were also updated and re-issued in 2018.

Dose to the Public

The derived release limit (DRL) for a given radionuclide is defined as the release rate that would cause an individual of the most highly exposed group to receive and be committed to a dose equal to the regulatory annual dose limit due to release of the radionuclide to air or surface water during normal operation of a nuclear facility over the period of a calendar year.

The DRL for the facility is based on three components: dose to the public from air emissions, dose from water discharges and dose from gamma radiation. For the refinery, dose to the public from air and water emissions is a very small fraction of the public dose limit (<0.001 mSv). Therefore, the gamma component represents virtually all the estimated public dose.

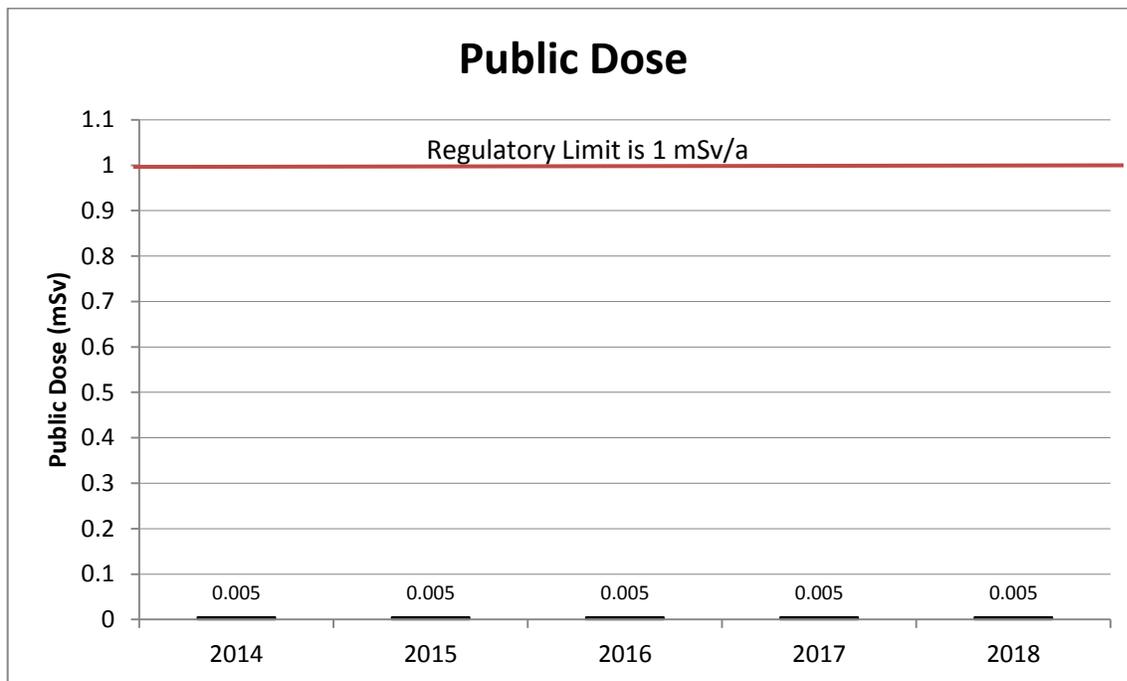
The critical receptor is the hi-vol station at the golf course. An environmental dosimeter is placed at the hi-vol station and changed out on a quarterly basis. In 2018, the estimated dose to the public based on results from the dosimeters located at the golf course hi-vol station is 0.5% of the public dose limit, or 0.005 mSv.

The annual estimated dose to the public for the 2014 – 2018 periods is shown in Table 21 and Figure 13. The annual estimated dose remains unchanged from previous years.

Table 21

Dose to the Public						
Dose in mSv	Regulatory Limit	2014	2015	2016	2017	2018
Critical receptor	1 mSv/year	0.005	0.005	0.005	0.005	0.005

Figure 13



Environmental dosimeters are also being placed along each of the four perimeter fence lines; north, south, east and west. The perimeter fence line surrounds the refinery and defines the boundary of the CNSC licensed facility. The dosimeters are collected and replaced in the field monthly. Results from the fence line dosimeters are being reported in the CNSC quarterly reports.

Gamma levels along the fence line can vary as the inventory of uranium materials in the yard area does change through the course of a year based on concentrate receipts, production

requirements and shipping schedules. Table 22 below summarizes the 2018 results from each fence line.

Table 22

2018 Measured Fence Line Gamma Levels ($\mu\text{Sv/h}$)			
Fence Line	Monthly Average Result	Monthly Maximum Result	Range
East	0.39	0.42	0.35 – 0.42
North	0.24	0.26	0.20 – 0.26
South	0.41	0.46	0.33 – 0.46
West	0.88	1.12	0.74 – 1.12

A CNSC action level of 1.0 $\mu\text{Sv/h}$ is currently in effect at the north fence only. All north fence results in 2018 were below this action level value. On average results along the east, north and south fence lines were very similar to 2017 results, while results at the west fence line were slightly lower when compared to the previous year. This is likely due to changes in inventory levels in the west yard.

Despite the fact that environmental dosimeters are now being used along the fence line, the critical receptor for the gamma component of dose to the public remains the hi-vol station at the neighboring golf course; as the land immediately outside the perimeter fence continues to be owned and controlled by Cameco. The golf course is the closest location where members of the public can reasonably be expected to be in proximity to the refinery for any significant period of time.

Air Emissions

The refinery has two process stacks and an incinerator stack that are routinely monitored for uranium and particulate emissions. TSI samplers are used in the stack for the measurement of uranium and total particulate. These isokinetic dust samplers use electrostatic precipitation to collect a sample from the stack gas stream. The absorber stack also has an on-line NO_x analyzer. Each process area also has its own separate ventilation system. Uranium emissions from each of the individual process area ventilation systems are determined through calculation and verified periodically by third-party sampling of some of the ventilation systems. A variety of pollution control equipment including bag houses, scrubbers and activated carbon beds are used at the facility to control and reduce emissions to air. Total uranium releases to the environment are shown in Table 23 and Figure 14 below.

Total uranium loadings to the environment increased slightly in 2018 compared to previous years due to increased production. However, the total uranium loadings in 2018 were still the third

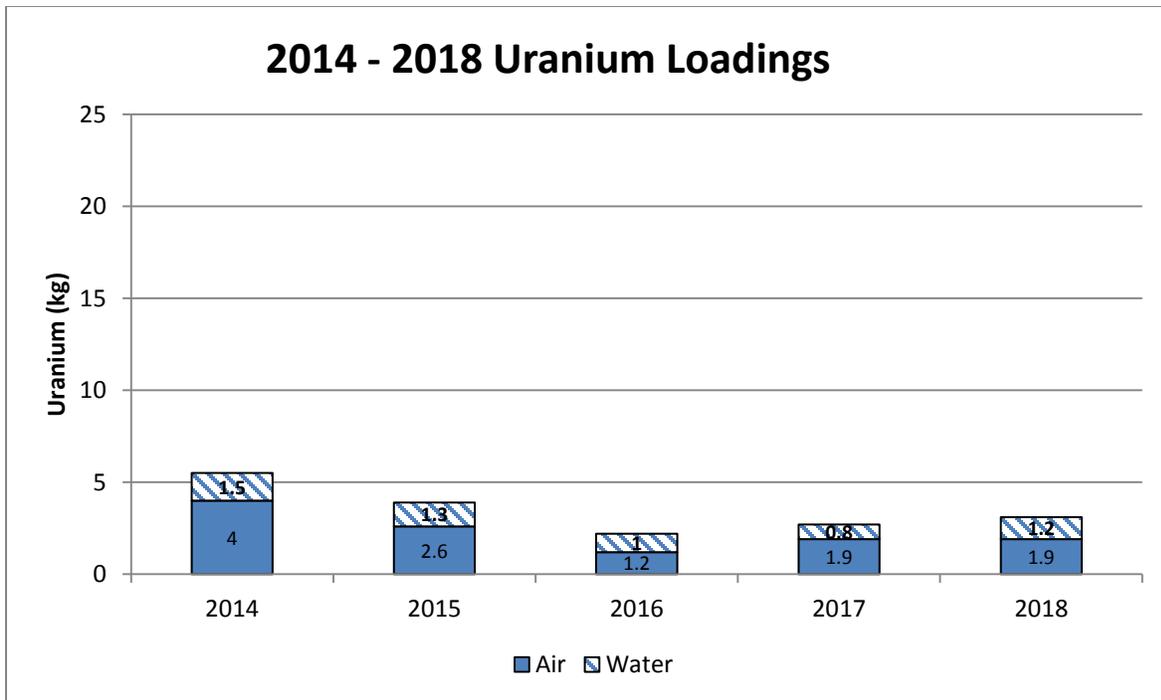
lowest annual total in the 35 year history of refinery operations, indicating continued excellent environmental performance. The only two years with lower total uranium emissions were 2016 and 2017.

Emissions to air represent a combination of uranium loadings from the two process stacks and the incinerator stack, as determined from the routine stack sampling program, and uranium loadings from the various process area ventilation exhaust systems, as determined by in-plant air sampling data and exhaust discharge rates. Approximately 60% of emissions to air in 2018 were from process ventilation exhaust systems, with the other 40% attributable to stack emissions. Just over 80% of the stack emissions were from the DCEV, with emissions from the absorber stack and the incinerator stack combining for the remainder. The variation in uranium loadings to water from year-to-year is attributable to changes in annual production levels and also to the volume of wastewater discharged in a given year. This volume will vary with annual precipitation received, as storm water run-off on site is collected, combined with and discharged simultaneously with other refinery liquid effluent streams.

Table 23

2014 – 2018 Total Uranium Emissions to the Environment (kg U)					
Emission	2014	2015	2016	2017	2018
Air	1.5	1.3	1.0	0.8	1.2
Water	4.0	2.6	1.2	1.9	1.9
Total	5.5	3.9	2.2	2.7	3.1

Figure 14



There were no exceedances of CNSC regulatory limits or action levels with respect to air emissions in 2018. As indicated in Table 24 stack emissions for the key regulatory parameters remain low and well below CNSC licensed limits and action levels.

Table 24

2014 - 2018 Daily Main Stack Emissions									
Source	Parameter	CNSC Limit	CNSC Action Level	Value	2014	2015	2016	2017	2018
DCEV	Uranium (g U/h)	100	10	Average	0.05	0.05	0.05	0.04	0.05
				Max.	0.60	0.38	1.09	0.31	0.24
Absorber	Uranium (g U/h)	100	1	Average	<0.01	0.01	0.01	0.01	0.01
				Max.	0.05	0.03	0.04	0.10	0.18
	Nitrogen Oxides (kg NO ₂ /h)	56	12	Average	2.0	2.5	1.6	1.7	2.3
				Max.	4.8	5.6	4.8	5.0	5.4
Incinerator	Uranium (g U/h)	10	1.5	Average	<0.01	<0.01	<0.01	<0.01	<0.01
				Max.	0.01	0.01	0.02	0.01	0.01
All stacks	Particulate (g/h)	11,000	-	Average	9	6	6	8	10
				Max.	41	59	45	31	137

Results less than the detection limit are denoted as “<”.

In addition to BRR's routine monitoring, stack sampling for uranium and other parameters of interest from the process stacks was also completed in 2018 by an independent third-party.

Stack sampling of the incinerator was also carried out by an independent third-party to demonstrate that emissions from the incinerator meet provincial MECP limits as specified in the Environmental Compliance Approval (ECA) for the incinerator. Results from annual testing are shown in Table 25. Results from most parameters are generally comparable to the 2017 levels, though there was a notable decrease in total suspended particulate emissions. There was also an increase in emissions of dioxins and furans, though results were still well below the applicable regulatory criteria. Year-to-year results for the other parameters are not indicating any adverse trends, with all results well below their respective limits. Copies of the stack testing reports have been submitted to CNSC staff.

Table 25

Incinerator Stack Sampling Results for Air Pollution Control Circuit (APC)						
Parameter	2014	2015	2106	2017	2018	% of Limit (for 2018)
Total Suspended Particulate (mg/s)	0.61	1.3	7.18	6.50	1.25	10 ¹
Uranium (mg/s)	<0.001	0.001	0.003	0.001	<0.001	<1 ²
NO _x as NO ₂ (mg/s)	104	69	60	68	57	10 ¹
Mercury (µg/s)	0.12	0.17	0.42	0.11	0.14	<1 ¹
Cadmium (µg/s)	0.22	0.09	6.2	0.90	0.17	2 ¹
Lead (µg/s)	0.48	0.63	11.6	3.6	1.9	1 ¹
Dioxins & Furans (pg I-TEQ/Rm ³)	11	12	7.5	6.4	17	22 ¹
HCl (mg/s)	<2.8	<3.1	<1.35	<0.88	<0.87	<4 ¹
HF (mg/s)	<1.9	<0.63	<0.74	<0.50	<0.50	<3 ³
SO ₂ (mg/s)	<8.6	<3.8	<7.5	<7.7	<6.5	<15 ¹

¹ Limit as indicated in MOECC Amended Environmental Compliance Approval 7751-6PUNQV.

² Limit as per Appendix A of CNSC license FFOL-3632.00/2022

³ % of POI allowable limit as per O. Reg 419

Water Discharges

The refinery has one liquid effluent discharge location into Lake Huron. All liquid effluent is sampled and analyzed prior to discharge to ensure all federal and provincial regulatory discharge parameters are met. An effluent treatment circuit and supplementary pollution control equipment are installed in the UO₃ plant to control and reduce emissions to water.

As indicated in Table 26, concentrations of key parameters in liquid effluent emissions remain well below regulatory limits. Data for uranium, nitrate and radium-226 is reported as the monthly average of weekly composite results, while limits for pH are based on individual daily discharges. Results are comparable to previous years.

Effluent parameters are analyzed either in-house, using conventional and appropriate analytical instrumentation or completed by a qualified third-party contract laboratory.

Table 26

2014 – 2018 Liquid Effluent Discharges									
Parameter	Units of Measure	CNSC Licensed Limit	CNSC Action Level	Value	2014	2015	2016	2017	2018
Uranium	mg/l	2	0.2	Average	0.02	0.02	0.01	0.01	0.01
				Max.	0.05	0.05	0.01	0.02	0.03
Nitrate	mg/l as N	1000	80	Average	17	13	11	14	20
				Max.	32	23	19	25	32
Radium – 226	Bq/l	1	0.05	Average	0.01	<0.01	0.01	0.01	0.01
				Max.	0.02	0.01	0.01	0.01	0.01
pH		Min 6.0	Min. 6.5	Min.	7.1	7.2	7.3	7.3	7.3
		Max 9.5	Max. 9.0	Max.	8.4	8.4	8.6	8.2	8.5

Ambient Air Monitoring

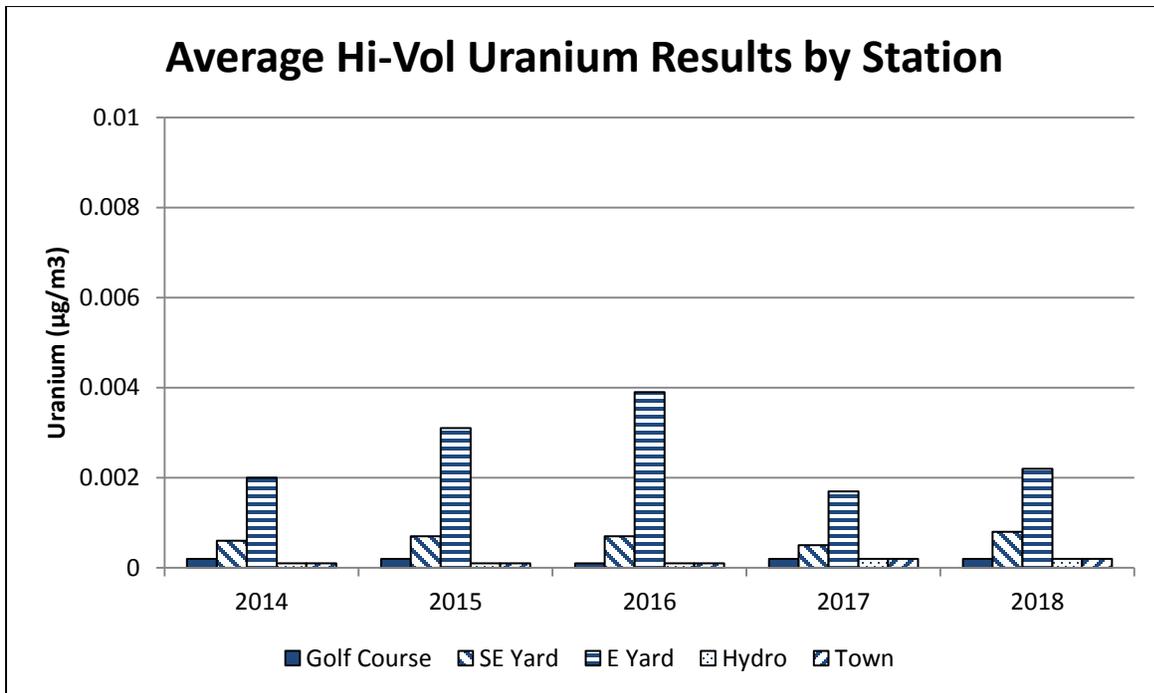
In addition to onsite monitoring of emissions, the refinery also has a comprehensive ambient air monitoring program. High volume air samplers (hi-vols) are used to collect uranium and particulates from the ambient air. Air is drawn into a covered housing and through a filter paper by means of a high flow rate blower. The hi-vol stations are operated continuously when the UO₃ plant is operating, with the filter papers normally being changed once every two weeks. The filter papers are measured before and after being placed in the field to determine particulate emissions and then analyzed for uranium to determine uranium emissions.

Table 27 and Figure 15 show the annual average uranium-in-air concentrations at each of the five hi-vol locations and the maximum individual result for each location. Two of the stations, the SE Yard and the East Yard, are located within the Cameco fence line, which defines the CNSC licensed area. The Golf Course location is also on Cameco property but located outside the fence line. The remaining stations, the Hydro yard and the Town location, are located approximately 1 and 5 km from the refinery respectively. Results in 2018 are comparable to previous years. For the three stations furthest away from the refinery, the year-to-year results are largely unchanged over the five year period. Annual results from all stations remain well below the MECP annual average criteria of 0.03 ug/m³, with the highest annual average location result in 2018 only at approximately 7% of this annual average criteria.

Table 27

2014 – 2018 Annual Uranium-in-Air Concentration at Hi-Vol Stations (µg/m³)						
Year	Result	Golf Course	SE Yard	East Yard	Hydro Yard	Town of Blind River
2014	Average	0.0002	0.0006	0.0020	0.0001	0.0001
	Maximum	0.0005	0.0014	0.0037	0.0003	0.0006
2015	Average	0.0002	0.0007	0.0031	0.0001	0.0001
	Maximum	0.0003	0.0015	0.0111	0.0003	0.0003
2016	Average	0.0001	0.0007	0.0039	0.0001	0.0001
	Maximum	0.0003	0.0016	0.0192	0.0002	0.0002
2017	Average	0.0002	0.0005	0.0017	0.0002	0.0002
	Maximum	0.0005	0.0016	0.0070	0.0005	0.0005
2018	Average	0.0002	0.0008	0.0022	0.0002	0.0002
	Maximum	0.0005	0.0020	0.0064	0.0005	0.0005

Figure 15



Soil Monitoring

Soil samples are collected from a number of sampling locations outside the perimeter fence, in the vicinity of the refinery. Starting in 2018, core samples are taken at a 0 to 5 cm depth annually and at a 5 to 15 cm depth at least once every five years. Samples are analyzed for uranium.

Table 28 shows the soil sampling results. The average uranium in soil result at the 0 – 5 cm depth for sample locations within 1000m of the refinery increased slightly compared to 2017 but was lower than in 2014 and 2015. The maximum individual result of 3.7 µg/g U in 2018 was from a sample location south-east of the perimeter fence and is slightly higher than the maximum individual result from 2017, which was also from the same sample location.

All results are well below the Canadian Council of Ministers of the Environment (CCME) guideline of 23 µg/g U for residential or parkland use, with the maximum result in 2018 at only 16% of this guideline value.

Table 28

2014 – 2018 Soil Uranium Results				
Location	Depth (cm)	Number of Samples	Average ($\mu\text{g/g U}$)	Range ($\mu\text{g/g U}$)
2018				
Sampling sites within 1000m	0 – 5	7	2.0	0.7 – 3.7
	5 – 15	0	-	-
Sampling sites outside 1000m	0 – 5	2	0.7	0.5 – 0.9
	5 – 15	0	-	-
2017				
Sampling sites within 1000m	0 – 5	7	1.6	0.7 – 2.8
	5 – 15	7	0.9	0.5 – 1.9
Sampling sites outside 1000m	0 – 5	2	0.6	0.3 – 0.9
	5 – 15	2	0.7	0.4 – 1.0
2016				
Sampling sites within 1000m	0 – 5	8	1.5	0.4 – 2.9
	5 – 15	8	0.6	0.2 – 1.0
Sampling sites outside 1000m	0 – 5	2	0.5	0.2 – 0.8
	5 – 15	2	0.6	0.2 – 1.0
2015				
Sampling sites within 1000m	0 – 5	17	3.8	0.5 – 9.7
	5 – 15	17	0.9	0.3 – 1.9
Sampling sites outside 1000m	0 – 5	2	1.4	0.2 – 2.6
	5 – 15	2	0.4	0.1 – 0.8
2014				
Sampling sites within 1000m	0 – 5	7	2.7	0.5 – 7.2
	5 – 15	7	1.4	0.3 – 2.8
Sampling sites outside 1000m	0 – 5	2	0.6	0.1 – 1.0
	5 – 15	2	0.3	0.1 – 0.5

Surface Water Monitoring

Table 29 and Figure 16 show surface water results for uranium at the location of the refinery outfall diffuser in Lake Huron. All uranium results are well below the CCME long-term exposure guideline value of 15 µg/L, with the maximum result at less than 5% of this guideline value.

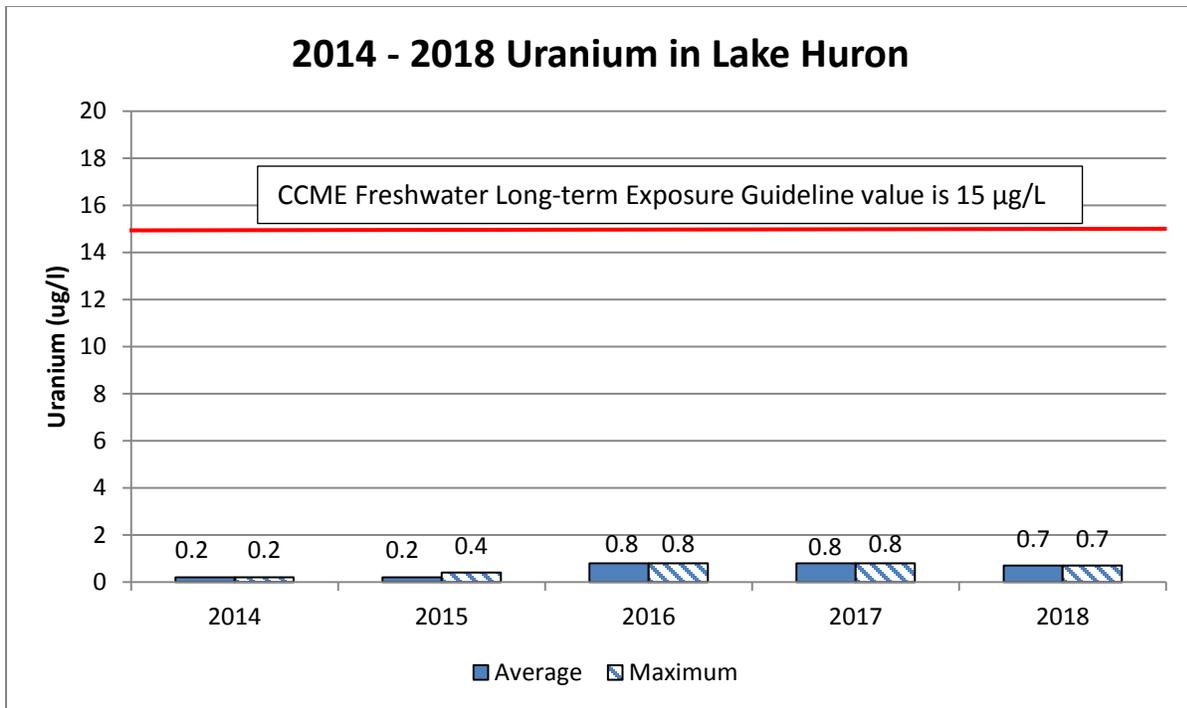
Nitrate and pH results are similar to previous years, while radium-226 results were reported as just above detection limits in 2018. No reason for the marginal increase in radium-226 results in 2018 could be identified. Further investigation may be carried out in 2019 dependent on the results obtained from the 2019 surface water sampling program.

Table 29

2014 – 2018 Lake Average and Maximum Results at Diffuser							
Parameter	Units	Value	2014	2015	2016	2017	2018
Uranium	µg/l	Average	<0.2	0.2	<0.8 ¹	<0.8	<0.7 ¹
		Maximum	<0.2	0.4	<0.8	<0.8	<0.7
Nitrate	mg/l as N	Average	0.2	0.2	0.2	0.2	0.2
		Maximum	0.3	0.2	0.2	0.2	0.2
Radium-226	Bq/l	Average	<0.005	<0.005	<0.005	<0.005	0.008
		Maximum	<0.005	<0.005	<0.005	<0.005	0.008
pH		Average	7.6	7.3	8.0	7.3	8.0
		Maximum	7.9	7.9	8.2	7.7	8.3

¹ The ambient water method detection limit for uranium was reassessed in 2016 and again in late 2017.

Figure 16



Groundwater Monitoring

Cameco has an extensive groundwater monitoring program in place around the refinery with a total of 35 monitoring wells: 14 inside the perimeter fence and 21 outside the fence line. Monitoring at each well location varies from once per year to three times per year depending on the location of the well relative to the refinery. Similarly, the parameters monitored and/or analyzed for at each location also varies. A map showing the location of all of the monitoring wells around the refinery is shown in Figure 18. The groundwater moves in a southwesterly direction towards the Mississagi River.

A summary of groundwater uranium results is shown in Table 30 and Figure 17. The average uranium result from all groundwater samples analyzed increased in 2018 compared to 2017. This increase is attributable to results obtained from monitoring well #22, located just south of the main UO₃ plant building outside the calcination area. Excluding monitoring well #22, the average uranium result in 2018 from samples collected from the remainder of the monitoring wells was 0.7 µg/L, comparable to the average uranium result (again excluding monitoring well #22) of 0.8 µg/L in 2017.

Eight samples were collected from monitoring well #22 in 2018, with results ranging from 27 µg/L to 6.5 µg/L. The average result was 14.8 µg/L. A seasonal trend appears to be developing with the highest uranium results at this location in recent years from samples collected in the spring and the lowest concentrations from samples collected in late summer or early fall. Slightly elevated results have previously been reported in the groundwater at this location, and have been attributed to historical activities. The 2018 results were higher than usual and further investigation and appropriate mitigation is planned for 2019.

Excluding monitoring well #22, the maximum average result from all other monitoring wells was 1.8 µg/L, from monitoring well #6B. This monitoring well is actually located upstream of the refinery relative to the local groundwater flow. Groundwater results, with the exception of three samples from monitoring well #22 collected over a two week period in late May/early June, remain below the Provincial Full Depth Generic Site Condition Standard in a Potable Groundwater Condition (Table 2) value of 20 µg/L uranium.

Table 30

2014 – 2018 Uranium in Groundwater Results							
Parameter	Units	Value	2014	2015	2016	2017	2018
Uranium	µg/l	Average	0.6	1.7	1.3	1.2	2.3
		Maximum	8.9	18.5	14.0	11.0	27.0

Figure 17

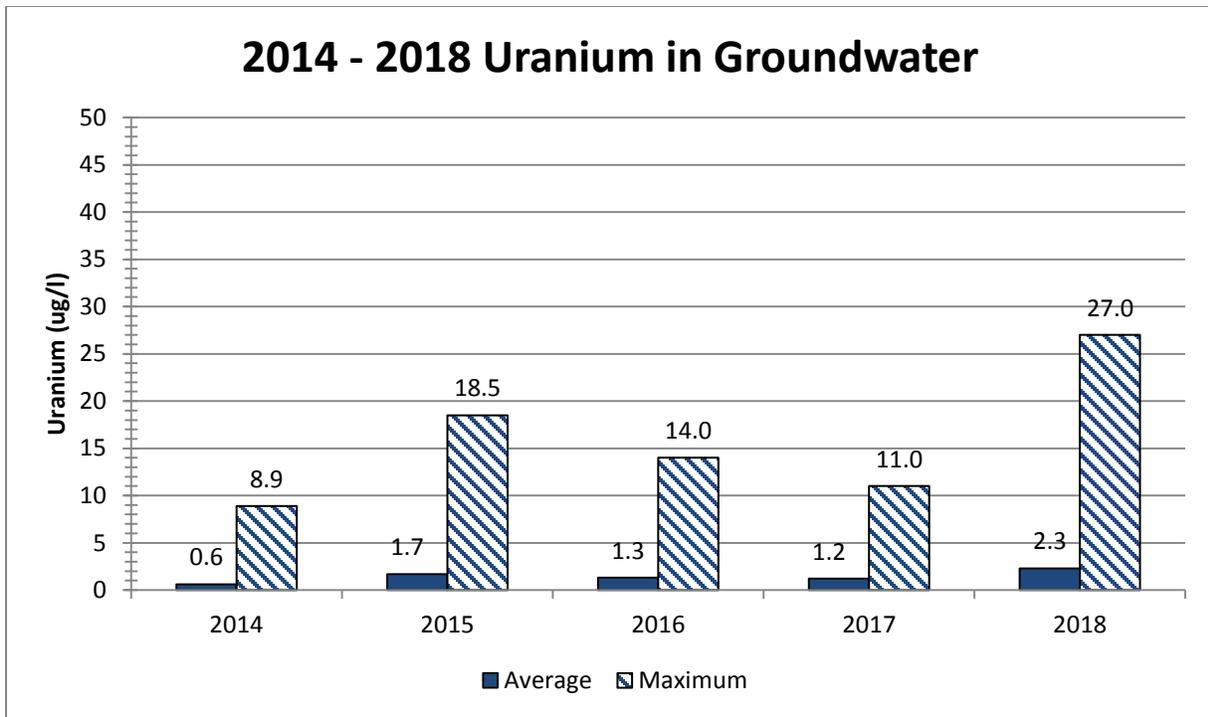
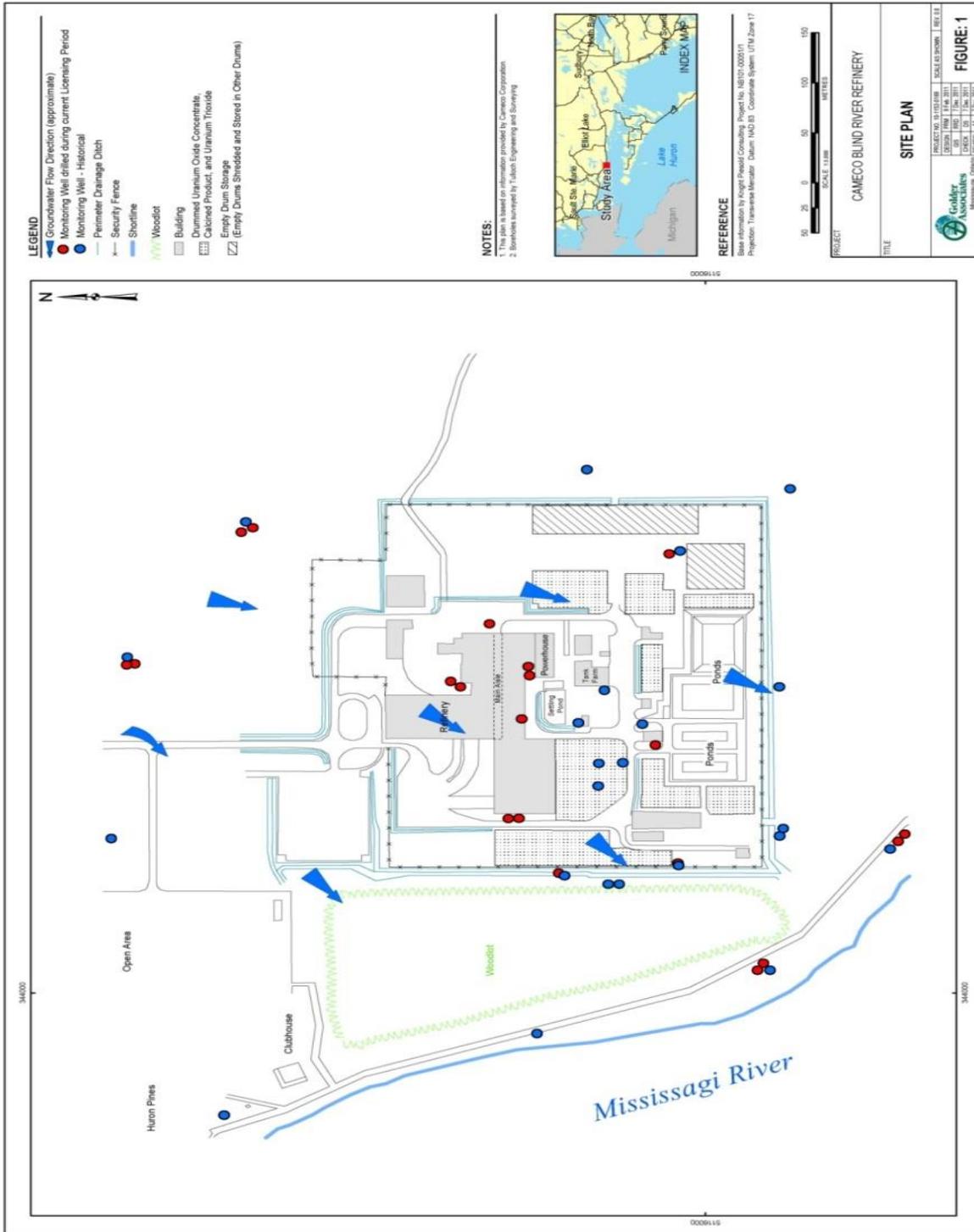


Figure 18



2.3.4 Emergency Management and Response

This safety and control area covers emergency plans and emergency preparedness programs. These procedures must exist for emergencies and for non-routine conditions. This also includes the fire protection program (FPP) and any results of emergency exercise participation.

Effective emergency response is carried out through the refinery Emergency Response Plan (ERP). The plan assigns specific accountabilities and sets out processes and procedures to protect the health and safety of employees, contractors, the public and the environment in the event of an emergency. The ERP was last updated and reissued in 2018. An emergency response needs analysis assessment was also completed and submitted to the CNSC in 2018. The site emergency management and response program meets the requirements of CNSC REGDOC-2.10.1: *Nuclear Emergency Preparedness and Response*.

As the primary response provider for the facility, the refinery's Emergency Response Team (ERT) consists of approximately forty-five designated members that are in place to respond to emergencies at the facility. In 2018 there were no incidents that required ERT activation and response.

ERT personnel are trained to NFPA 472 operations level for hazardous material response, and NFPA 600 for advanced internal/external firefighting. As part of the site Emergency Response Team (ERT), the refinery maintains first aid responders that are trained to respond to a variety of emergency medical situations, including chemical exposures and other site specific emergencies.

A mutual aid agreement has been signed by the Blind River Fire Department (BRFD) and Cameco. The commitment for assistance by the BRFD provides an additional layer of support to the refinery's emergency response capability. In addition, Cameco provides the BRFD with support, either financial or through the donation of equipment, and now conduct joint training exercises periodically with the BRFD so that in the event of an emergency at the refinery requiring off-site assistance, there will be a coordinated and effective response. It should also be noted that a number of the refinery's firefighters also belong to the town fire department.

To continually provide a high level of response capability, the refinery's ERT regularly engages in a number of training drills, exercises and courses. In 2018 these included:

- evacuation drills;
- regular crew ERT training;
- first aid attendant training;
- industrial rescue training;
- live fire training; and
- a joint training exercise with Town of Blind River Fire Department.

An off-shift drill was also carried out in 2018. Lastly, on an annual basis Cameco meets with the local contractor that delivers UO₃ tote bins to the PHCF to review practices and procedures related to the shipment of UO₃, including reporting protocols and how to respond to a transportation event involving a uranium spill.

All internal drills and exercises were assessed against pre-defined expectations and opportunities for improvement were recorded and tracked to completion. The emergency response program is also subject to Cameco internal audits. A full scale simulation emergency response exercise involving the local EMS and hospital, typically held once every three years, was carried out in the fall of 2018. CNSC staff were on site to observe the exercise. Corrective actions arising from the exercise were identified. The majority of the corrective actions have already been addressed, with the remainder on schedule to all be completed by the end of May 2019.

Emergency response is a key component of an effective Fire Protection Program (FPP). The FPP at the facility meets internal Cameco requirements and it also meets the requirements of the *National Fire Code of Canada*, the *National Building Code of Canada*, *NFPA 801 Standard for Fire Protection for Facilities Handling Radioactive Materials* and *CSA N393-13: Fire protection for facilities that process, handle or store nuclear substances*.

In developing the FPP, a defense-in-depth approach was used to ensure that the fire protection measures are adequate for the fire protection of the facility. The FPP is made up of the Fire Hazard Analysis (FHA) and fire protection supporting documents. The FHA identifies fire hazards and their potential impact related to life safety, radiation safety, environmental protection and asset protection and was last updated in 2018.

The fire protection supporting documents address a number of areas including fire prevention, fire protection and emergency response. The supporting documents define those elements which positively contribute to prevent fires, maintain fire safe conditions at the facility, maintain reliability of the fire protection systems and provide an effective emergency response to limit the effects of fire. These supporting documents are updated on a regular frequency.

As required by our CNSC operating License BRR is subject to annual third-party reviews for verification of the inspection requirements under the National Fire Code and NFPA 801. There were no significant items identified during the 2018 inspection review.

In addition to this third-party inspection, Cameco conducts routine monthly fire inspections of the facility to identify deficiencies in fire protection elements and fire protection systems. All identified issues are documented and tracked until they have been addressed. In addition to these specific fire protection inspections, routine inspections of the facility are done daily by site

security staff, who have been instructed to report any potential fire hazards noted during their rounds.

Cameco continues to utilize a divisional oversight role for the fire and emergency response organizations. This allows for alignment, consistency and sharing of best practices within the division.

2.3.5 Waste and By-product Management

This safety and control area covers internal waste and by-product-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 and by-product management facility. This also covers the ongoing decontamination and planning for decommissioning activities.

Solid wastes contaminated by uranium are reprocessed, recycled and re-used to the extent possible. Waste materials that cannot be reprocessed, recycled or re-used are safely stored on site until appropriate disposal options are available.

Wastes generated at BRR are segregated at the point of generation into contaminated and non-contaminated as appropriate. Non-contaminated waste can be recycled or disposed of at an appropriate facility. A portion of the non-contaminated waste generated is incinerated on site. While this increases the volume of contaminated ash generated marginally, it dramatically decreases the amount of material sent to the local landfill. Contaminated combustible materials are incinerated on site and the contaminated ash is recycled to recover uranium. Contaminated non-combustible waste is stored in appropriate containers pending assessment of recycling or other disposal options.

In 2018, a total of 4,095 kg of non-contaminated wastes were sent to a local landfill, similar to the amount sent in 2017. A total of 36,720 kg of non-contaminated materials were sent to appropriate recycling facilities, an increase compared to 2017.

BRR produces two secondary products at the facility; calcined and regeneration product, both of which are sent off-site to licensed facilities for uranium recovery. A uranium mill in the USA is licensed to receive both products, while Cameco's Key Lake operation is licensed to receive calcined product. A total of 3,112 drums of calcined product were generated at BRR in 2018, roughly a one-third increase compared to 2017. However, only 1,600 drums of calcined product were shipped off-site, compared to 5,000 drums shipped in 2017.

A total of 90 drums of regeneration product were generated in 2018, compared to 90 drums generated in 2017. There were 114 drums of regeneration product shipped, that same as in the previous year. The number of drums of calcined and regeneration product shipped in a given year will vary with annual production, site inventory levels, transportation schedules and end-user requirements.

In 2018, the BRR incinerated 86,953 kg of contaminated combustible materials (CCM), similar to the previous year. BRR receives CCM material from both Cameco operations in Port Hope, the PHCF and CFM. Approximately 45% of the CCM material generated in 2018 was from the two Port Hope sites, similar to 2017 levels.

A total of 845 drums of contaminated non-combustible materials (CNC) were generated in 2018, a slight decrease from 2017. Also, 194 drums of shredded metal were processed, compared to only 16 drums in the previous year.

BRR sent 1,620 drums back to various uranium mines for reuse, a decrease from 2017. In addition, a total of 26,889 drums were processed, decontaminated to unrestricted release criteria and sent to a local scrap metal dealer; a more that 50% increase compared to the previous year and reflective of higher production levels in 2018.

Lastly, a total of 2,292 drums containing shredded drum pieces and other miscellaneous contaminated non-combustible materials were shipped to a permitted waste disposal facility in the United States.

2.3.6 Nuclear Security

This safety and control area covers the programs required to implement and support the security requirements stipulated in the regulations, in *Nuclear Safety and Control Regulations*, the *Nuclear Security Regulations* and other CNSC requirements.

BRR's security plan provides the basis for security operations at the facility and identifies the systems and processes in place to meet security program objectives. Accordingly, the security plan and related procedures are considered prescribed information, subject to the requirements of the *Nuclear Safety and Control Regulations*.

Though the refinery's security program is well managed and developed, the facility continues to look for opportunities to enhance the existing program.

2.3.7 Safeguards and Non-proliferation

This safety and control area covers the programs required for the successful implementation of the obligations arising from the Canada/IAEA Safeguards and Non-proliferation Agreement.

There were three Short Notice Random Inspections (SNRI) conducted at the request of the IAEA in 2018. Also, at the end of the second quarter the IAEA conducted a physical inventory verification (PIV) and a design inventory verification (DIV).

The refinery is in compliance with the requirements in CNSC REGDOC-2.13.1: *Safeguards and Nuclear Material Accountancy*. REGDOC-2.13.1 supersedes RD 336: *Accounting and Reporting of Nuclear Material*, and will be incorporated into the next revision of the refinery License Conditions Handbook, replacing RD 336.

2.3.8 Packaging and Transport of Nuclear Substances

This safety and control area covers the packaging and transport of nuclear substances and other nuclear materials to and from the licensed facility.

UO₃ is produced and transported, in steel tote bins, by road from the refinery to Cameco's PHCF. As well, UO₃ is transported in drums via road, rail and/or marine transport to customers in the USA and on occasion, other countries around the world. The tote bins and drums meet the Type IP-1 package requirements as specified in the CNSC *Packaging and Transport of Nuclear Substances Regulations*.

In January 2018, members of the BRR Transportation Emergency Response Organization (TERO) responded to a highway incident near Montreal River involving a truck carrying uranium concentrate drums to the Blind River Refinery. There was only minor damage to the trailer, with no loss of containment or damage to any of the uranium concentrate drums. The truck was able to continue on to the BRR for unloading. Cameco prepared and submitted a transportation event report to the CNSC. There were no other transportation related-events involving the BRR.

In addition to the FSD Transportation Emergency Response Organization (TERO) organization, Cameco can also mobilize a hazardous materials response team with trained emergency response team members and dedicated HAZMAT equipment. An Emergency Response Assistance Plan (ERAP 2-0453) is on file with and has been approved by Transport Canada, pursuant to federal transportation of dangerous goods requirements, and applies to transportation emergencies. Transportation activities related to the shipping and receiving of goods at or from the refinery are included in the plan. Cameco reviews and updates the Emergency Response Assistance Plan as required.

In September 2018 a representative from Transport Canada was on site to conduct a transportation of dangerous goods (TDG) inspection. There were no issues identified.

3. OTHER MATTERS OF REGULATORY INTEREST

3.1.1 Public Information Program

In 2018, Cameco's Blind River refinery continued to fully meet the requirements of the Canadian Nuclear Safety Commission's (CNSC) RD/GD 99.3, Public Information and Disclosure.

For most of 2018, the communications team for Cameco's fuel services division was comprised of a director of public and government affairs, two communication specialists and a community relations liaison. The divisional communications team remains a part of Cameco's recently renamed corporate Sustainability and Stakeholder relations department.

Local media coverage of Cameco was light but generally positive in tone during 2018. Most media attention continues to focus on Cameco's sponsorship of and employee participation in local community events. Cameco celebrated 35 years of operation in Blind River with a centerfold story in the local newspaper.

Since establishing Cameco FSD's social media presence in 2013, use of both [Facebook](#) and [Twitter](#) have helped to augment Cameco's public information program and support efforts to engage youth, community members and employees. Throughout the year, Cameco's more than 150 social media posts covered an array of topics including its community investment announcements. Cameco's social media campaign continues to mature, with some posts garnering more than 2000 shares. Page Likes, or our Facebook audience, grew modestly, attracting approximately 30 more followers by the end of the year. These channels are used to share information about community investments, upcoming events and activities, employee volunteer activities and other matters of potential public interest.

Since 2006, Cameco's FSD has had its own dedicated website to supplement information found on the corporate website (www.cameco.com). Cameco Fuel Services Division's community website, camecofuel.com aligns visually with Cameco Corporation's various other community websites and is user-friendly with the ability to view on various devices such as smart phones, tablets and desktop computers. The camecofuel.com website continued to serve as a valuable tool to make information about the company easily accessible to members of the public. Quarterly environmental status reports, basic information about reportable incidents, articles on matters of public interest, external newsletter, news releases and announcements as well as presentations from community forums were posted to the new site as applicable.

For many years, Cameco has retained outside expertise to measure public opinion in Blind River to help determine the effectiveness of its public information program. The final report of the 2018 public opinion research conducted for Cameco by Fast Consulting was posted on Cameco's [FSD community website](#) in the fall of 2018. More than 200 Blind River residents were randomly

contacted and asked to respond to a series of questions about their perception of Cameco's operations in the community.

The survey results indicate that residents of Blind River continue to show strong support for local Cameco operations. 97% of local residents support Cameco's continued operations in Blind River. The results of the survey, which has been conducted three times in the past decade, remain consistent, with other significant findings including:

- Nearly all respondents (95%) agree Cameco does everything possible to protect people and the environment, up from 86% in 2013 and 84% in 2009.
- Nearly all (95%) agree Blind River is a safe, healthy place to live, including 75% who 'strongly agree'. This is in line with previous surveys.
- The large majority (87%) agree that various federal and provincial regulatory processes adequately ensure the safety of Blind River residents, up from 75% in 2013.

Cameco proactively created or took part in a number of public engagement and educational activities in 2018 designed to share information and receive feedback about its operations.

To engage the public and provide information about its operations Cameco hosted several events and published numerous information products in 2018. Cameco was once again a sponsor of the Canadian Nuclear Association conference in Ottawa and hosted booth in the main area and was able to engage other businesses and interest groups within the nuclear industry as well as students. Brochures on Cameco and general nuclear facts were available to attendees.

Cameco works to build and sustain the trust of local communities by acting as a good corporate citizen in the communities where we operate. A key element of building and sustaining that trust is a commitment to provide those in the community with accurate and transparent reporting of our environmental practices and performance. These are central values for Cameco and it is these values that drive the refinery's public information and disclosure program.

In addition to posting the quarterly and annual reports on the FSD website, BRR provides hard copies of these CNSC reports to the Town of the Blind River, to the MFN, to the Serpent River First Nation and to the Township of the North Shore.

The refinery continued its strategic approach to community outreach in 2018, meeting regularly with both the Mayor of the Town of Blind River and the Chief of the Mississauga First Nation to discuss issues of mutual concern and interest. Presentations to representative of both the Town of Blind River and MFN councils are typically made on an annual basis. There were no specific questions or concerns raised during the annual presentations in 2018, outside of requests for possible financial support for various community projects and queries regarding employment opportunities. There were no requests for presentations in other neighboring communities last year.

Cameco makes every effort to accommodate requests for tours, as production schedules permit, and typically welcomes a few hundred visitors per year. In 2018 BRR welcomed visitors from a number of groups and organizations, including representatives from College Boreal, the Greater Sudbury Fire Department, Tourism Excellence North and from the Penokean Hills Field Naturalists organization. A number of tours were also provided to individuals and groups from various Cameco supplier and customer organizations.

Cameco continued to develop partnerships and to provide financial and volunteer support to a number of events and organizations in Blind River and the surrounding area. Among those who received support in 2018 were:

- Town of Blind River Senior’s Christmas Luncheon;
- Town of Blind River, Mississauga First Nation, and Iron Bridge residents during Cameco Cares Day;
- Town of Bind River Festivals Committee;
- Regional theatre and art events;
- Mississauga First Nation “Little NHL” Tournament; and
- the Town of Blind River Community Day Events.

Information product examples

As requested below are web links to communications products referenced.

- Cameco’s community Website - <https://www.camecofuel.com/>

- Cameco’s community social media
 - Facebook <https://www.facebook.com/Cameco.Ontario/>
 - Twitter <https://twitter.com/CamecoOntario>

- Blind River Polling Results
 - Survey Report:
https://www.camecofuel.com/uploads/downloads/2018_Cameco_Blind_River_Survey_Final_Report.pdf

3.1.2 Site-Specific

The CNSC *Nuclear Criticality Program* is not applicable to the Blind River refinery operation.

Cameco has an approved PDP and financial guarantee for the refinery.

The refinery met all other site-specific reporting requirements.

3.1.3 Improvement Plans and Future Outlook

The following is a summary of improvement plans for 2018.

BRR completed a number of aging infrastructure related projects in 2018, including upgrading the service elevator, replacing a section of the fire water line, installing a new motor control center and replacing the diesel and electric fire water pumps. A new NO_x analyzer for the nitric acid absorbers off-gas line was ordered and received, but installation will not be completed until later in 2019.

BRR has no major improvement plans scheduled in 2019, but remains committed to continual improvement and will continue to look for opportunities to make the site operate more efficiently, while minimizing risk to employees, the public and the environment. With respect to environment and waste management Cameco is looking to continue reducing the historical inventory of waste management materials at the site. BRR also has additional capital projects planned in 2019 related to maintenance of aging infrastructure.

There are no major changes planned in 2019 that could require Commission approval.

3.1.4 Safety Performance Objectives for Following Year

The following is a summary of project facility operations and proposed or foreseen changes to equipment, procedures, production capacity, organization and licensing documents for 2019 that apply to the BRR site.

Cameco will continue to look at ways to continually improve the operation to ensure safe and reliable performance. Safety performance in 2018 and planned safety initiatives for 2019 were discussed earlier in Section 2.3.2. Minor changes, including the ones identified in the previous sections of this report, will continue to be made in 2019 to help improve the operation.

Cameco is not planning any other changes in 2019 that will impact the equipment, procedures, production capacity, organization and licensing documents of the facility.

4. CONCLUDING REMARKS

Cameco is committed to the safe, clean and reliable operations of all of its facilities and continually strives to improve safety performance and processes to ensure the safety of both its employees and the people in neighbouring communities.

In 2018 BRR did not exceed any CNSC regulatory limits. As a result of the effective programs, plans and procedures in place, the refinery was able to maintain individual radiation exposures well below all regulatory dose limits. In addition, environmental emissions continued to be controlled to levels that are a fraction of the regulatory limits, and public radiation exposures are also well below the regulatory limits.

Cameco's relationship with our neighboring communities remains strong and we are committed to maintaining these strong relationships.