2016 Annual Compliance Monitoring
&
Operational Performance Report

Reporting Period January 1 – December 31, 2016

Port Hope Conversion Facility
Operating Licence
FFOL-3631.00/2017

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I 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.

Cameco operates a Class IB nuclear facility in Port Hope, Ontario under Canadian Nuclear Safety Commission (CNSC) Operating Licence FFOL-3631.00/2017 (the Licence) and employs approximately 335 workers. PHCF was granted a new operating license on March 1, 2012 for a five year period, expiring on February 28, 2017.

The previous and current licences allow for the production of uranium as uranium dioxide (UO_2), uranium as uranium hexafluoride (UF_6) and uranium metal as depleted or natural uranium metal and alloy. The facility currently processes and/or stores various natural, depleted and enriched uranium compounds.

Cameco is committed to the safe, clean and reliable operation 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. PHCF maintains the required programs, plans and procedures in the areas of health and safety, radiation protection, environment, emergency response, fire protection, waste management, and training. As a result of these actions, PHCF's operations have maintained employee radiation exposures well below the regulatory dose limits. Environmental emissions and public radiation exposures are being controlled to levels that are a fraction of the regulatory limits.

The PHCF's Quality Assurance (QA) 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 QA and other regulatory requirements. There were no significant issues identified during the internal or external audits completed in 2016.

Both UF_6 and UO_2 plant operations training focused on continuous learning, with planned job task observations and learning moments, presented by area engineers. Operators in both plants participated in area specific qualification training or re-training, as per individual and plant requirements.

Many UF_6 operators were transferred to support the site clean-up initiative (SuperCUP), during a planned UF_6 plant shut down, and training was provided to ensure all transferred operators had the skills necessary to perform assigned tasks in a safe and efficient manner. A few UF_6 operators were transferred to the UO_2 plant in support of the UO_2

ramped up production schedule. As these activities ended, UF_6 operators (Level 2 and 3) completed start-up evaluations in all their respective qualified/training areas, prior to assuming normal duties.

A wide range of mandatory legislative and other job specific training activities were also carried out in 2016. This training ensures that all personnel have the level of training related to radiation safety, fire safety, chemical safety, on site-emergency arrangements, environmental protection, and conventional health and safety, appropriate for their duties.

To operate in a safe, clean and reliable manner PHCF has programs and procedures that comprise the safety analysis for the site including the safety report, a fire hazard analysis (FHA), an environmental aspects registry, a chemical hazard assessment and other assessments for safety and/or risk. The safety report is a licence requirement that summarizes the systematic review of the site operations to identify and assess hazards and potential risks to the public and environment from PHCF.

PHCF has conducted specific assessments to ensure the safety of its operations. These studies have included, but are not limited to, an environmental risk assessment, a flood study, a harbour wall study, and screening level risk assessments for UF_6 and anhydrous hydrogen fluoride (AHF) service. There were no modifications made in 2016 that affected the safety case for the PHCF. 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.

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. A site 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. In 2016, PHCF made no significant changes to processes used to ensure that the physical design of the site is maintained.

The Operational Reliability program, which was introduced in late 2010, consists of four focus areas deemed key to improving and maintaining reliable operations. They include materials management, work management, reliability engineering, and operations improvement. Work continued in 2016 in all four focus areas.

The radiation protection program at the PHCF is well established, with detailed procedures outlining the processes under each element of the program. Review of the 2016 dose data indicates that the program is effective in the prevention of unreasonable risk to the health and safety of workers. Though the radiation protection and as low as

reasonably achievable (ALARA) programs have been demonstrated to be effective, the PHCF has also made improvements as part of its continual improvement program.

The health and safety management program fosters and promotes a strong sustainable safety culture. Under the Operational Excellence initiative, PHCF strives for a safe, healthy and rewarding workplace. The effectiveness of the conventional Occupational Health and Safety (OH&S) system can be evaluated by the responsiveness of the site to leading safety activities such as the Conversion Safety Steering Committee (CSSC), audits, inspections, evaluations, reviews, benchmarking, training and employee participation and engagement. The PHCF was successful in meeting the expectations of these various initiatives. Occupational health and safety efforts at PHCF are supported by one joint committee, the CSSC. The CSSC, created in 2013, incorporates the previously-existing Policy Health and Safety Committee (PHSC) and Workplace Health and Safety Committee (WHSC) into one committee.

In 2016, PHCF advanced several improvements to the environmental protection program. The Environmental Risk Assessment was updated to align with CSA standard N288.6 Environmental risk assessments at Class I nuclear facilities and uranium mines and mills. The review of CSA standards N288.4 Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills and N288.5 Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills was completed and work continues to come into full compliance with the standards by 2017. Waste management projects were deployed, as part of the long-term waste management plan, to dispose of contaminated materials at appropriately licensed hazardous waste facilities.

PHCF maintained its emergency preparedness and response program while looking for opportunities to further improve. As a result, there was significant activity in 2016. This activity and associated records are subject to various audits and are incorporated into the PHCF annual management review. In 2016, third party verifications were conducted in order to confirm the effectiveness of the Fire Protection Program.

PHCF has a waste management plan in place at the facility in compliance with applicable regulatory and licence requirements. The most recent revision of the preliminary decommissioning plan was submitted to the CNSC in May 2016 and has been accepted by the CNSC.

PHCF maintains a comprehensive security program which meets the requirements of the General Nuclear Safety and Control Regulations, the Nuclear Security Regulations and other CNSC requirements.

A comprehensive uranium inventory system to demonstrate compliance with safeguards requirements is maintained. PHCF participated in nine safeguard inspections in 2016.

The scope of transportation activities at the PHCF includes the transport of Class 7 radioactive materials outlined in the Transportation of Dangerous Goods Act SOR/2008-34. There was one reportable transportation event which occurred at the PHCF in the fourth quarter regarding the misclassification of empty drums.

Cameco works to build and sustain the trust of local communities by acting as a good corporate citizen in the communities 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 environmental practices and performance. Cameco continued its comprehensive approach to community outreach in 2016 with the continuation of community forums, newsletters, and other information initiatives.

The nuclear criticality safety program at the PHCF follows the criticality control principles as described in Radiation Protection Program Manual. The PHCF met all site-specific reporting requirements.

Vision in Motion is Cameco's plan to clean up and renew the PHCF. The project builds on work now under way through the Port Hope Area Initiative (PHAI) to address historic low-level radioactive waste issues in the Municipality of Port Hope.

In conclusion, in 2016, the PHCF continued to operate within the framework of the Nuclear Safety and Control Act (NSCA) and met all requirements as per its operating licence.

II Table of Contents

1.0 INTRODUCTION

1.1 General Introduction

Cameco Corporation (Cameco) is a major supplier of uranium processing services required to produce 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.

Cameco operates a Class IB nuclear facility in Port Hope, Ontario under Canadian Nuclear Safety Commission (CNSC) operating Licence FFOL-3631.00/2017 (the Licence) and employs approximately 335 workers.

PHCF is situated on the north shore of Lake Ontario in Ward 1 of the Municipality of Port Hope, Ontario. Site 1 is bounded by Hayward Street to the north, the Port Hope harbour to the east, Lake Ontario to the south, and Choate Street, Marsh Street and municipal land associated with the Port Hope Water Treatment Plant to the west. Eldorado Place bisects the southern portion of the site, with the employee parking lot located further to the west. Site 1 also includes the centre pier property, which is bounded by Hayward Street to the north, the Port Hope Harbour to the west, Lake Ontario to the south and the Ganaraska River to the east. Site 2 is a storage facility situated in the Nelson Street and Dorset Street East area.

Vision in Motion (VIM) is Cameco's plan to clean up and renew the PHCF. The project builds on work now under way through the Port Hope Area Initiative (PHAI) to address historic low-level waste issues in the Municipality of Port Hope. It provides Cameco with an opportunity to deliver an allowance of qualifying waste materials to the Long-Term Waste Management Facility (LTWMF) that will be constructed by the PHAI on the site of the licensed Welcome Waste Management Facility. Demolition of Building 42 and 43A on the Centre Pier, which began in late 2015, was concluded in March 2016, reducing financial liabilities and other risk associated with these aging structures which were no longer in use. The 2016 SuperCUP campaign, which focused on equipment removal from buildings 2, 27 and 31 was successfully completed. There were no recordable environmental or safety incidents associated with these activities. VIM planning activities were also progressed. Work is focused on refining the design scope that has previously been presented to regulators, Municipality of Port Hope and the local community. The project is now ready to begin detailed design.

Figure 1 – Site 1, Port Hope Conversion Facility

Figure 2 – Site 2, Storage Facility

Cameco is committed to the safe, clean and reliable operation 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.

PHCF maintains the required programs, plans and procedures in the areas of health and safety, radiation protection, environment, emergency response, fire protection, waste management, and training.

As a result of these actions, PHCF has continued to produce uranium products for the Canadian and international nuclear industry while at the same time maintaining radiation exposures to the workforce well below the dose limits. Environmental emissions and public radiation exposures are being controlled to levels that are a fraction of the regulatory limits.

The submission of this report fulfills the requirement of Section 2.2 of the operating licence for PHCF (FFOL-3631.00/2017). The annual compliance report was prepared in accordance with the CNSC document *Annual Compliance Monitoring and Operational Performance Reporting Requirements for Class 1 A & B Nuclear Facilities* (March, 2011). This report describes the facility operations and provides a summary of the Safety and Control Areas for 2016.

Cameco is committed to reducing the frequency and significance of all events at site, including loss of primary containment (LOPC) events. Therefore, all events ranked level two or higher are investigated and resulting actions are tracked through the Cameco Incident Reporting System (CIRS).

During 2016 PHCF experienced the following reportable incidents. All these events were thoroughly investigated with corrective action plans developed. There was no risk to the public related to any of these incidents. Cameco is confident that through the corrective actions implemented, the review of the incidents that occurred and robust management systems the PHCF will continue to operate in a safe, clean and reliable manner.

On January 5, 2016, an employee was cutting a piece of steel in the cutting booth. Their left hand was placed on the ground clip that was installed on the cutting table. A cut to the final piece of steel caused it to fall over, crushing the end of the employee's finger between the ground clip and the piece of steel leading to a Lost Time Incident.

On January 12, 2016, a gasket failure in the drop line room in the UF_6 plant led to a UF_6 leak within the plant.

On January 26, 2016 at approximately 9 a.m. it was discovered that a tote bin inverter assembly that was stored in the yard outside of building 27 was leaking hydraulic fluid from a sheared off valve and hose. Due to the snow melt and precipitation, a small

portion of the hydraulic fluid was carried from the leak point to the nearby storm catch basin which releases directly into the Port Hope harbour.

On February 4, there was a small unplanned release of fluorine gas within the UF_6 plant as a result of a compressor failure. The release was quickly detected, stopped and emergency ventilation was activated.

On April 1, 2016, a flange failure on a stainless steel tank in the UO_2 plant led to the release of an estimated 1,850L of dilute nitric acid into secondary containment within the plant. At the time of the incident, the tank was undergoing routine, regularly scheduled cleaning. The solution contained nitric acid at a diluted concentration of about 25 to 30% with water. Minor nitric acid fuming was detected within the plant.

On April 22, 2016, an employee working in the UF_6 plant rolled their ankle and required medical attention. A medical assessment confirmed that the employee broke a bone in their leg. The event resulted in a lost-time incident.

On July 13, 2016, PHCF personnel identified a dented pressure pipe in the UF_6 plant. The dented pipe is connected to the final refrigeration system and typically contains Freon. As part of the scheduled maintenance shutdown the refrigeration unit and associated piping was drained and isolated. While the system was empty and maintenance was being conducted, the pipe received an impact, resulting in the dent. When the system underwent its pressure test using nitrogen, a standard practice before restarting the refrigeration unit, the system was walked down to check for any potential leaks. During this walk down it was discovered that the pipe was dented, however no material was released as a result of this damage. A pressure boundary deformation is a reportable event as per PHCF's Licence Conditions Handbook.

On September 4, 2016, a cooling water pump house pump burnt out, resulting in light smoke. The emergency response team (ERT) was activated to investigate and the powerhouse switched over to an alternate cooling water pump. There were no impacts to safety or the environment as a result of this event. The CNSC duty officer was contacted as result of the ERT activation.

On November 20, 2016, an employee required medical treatment for a sprained left ankle. The employee was working in the cylinder filling area standing on the cylinder trolley. When the employee turned to complete a task, the employee rolled their ankle and fell. The event resulted in a lost-time incident.

In addition to the CNSC, the PHCF is regulated by other federal and provincial regulators, such as the Ontario MOECC, Environment and Climate Change Canada (ECCC), Employment and Social Development Canada (ESDC), and Transport Canada (TC).

The acronyms in the following table are used in this report.

Table 1

ACRONYMS USED WITHIN THIS REPORT	
ACRONYM	**DESCRIPTION**
AAQC	Ambient Air Quality Criteria
AEMS	Air Emission Management Strategy
AHF	Anhydrous Hydrogen
ALARA	As Low As Reasonably Achievable
BRR	Blind River Refinery
Bq/cm^2	Becquerel per Square Centimeter
Cameco	Cameco Corporation
CaO	Calcium Oxide
CBT	Computer Based Training
CCC	Criticality Control Committee
CCM	Contaminated Combustible Material
CCME	Canadian Council of Ministers of the Environment
CFM	Cameco Fuel Manufacturing
Charter	The Safety Charter
CIRS	Cameco Incident Reporting System
CNC	Contaminated Non-Combustible Material
CNSC	Canadian Nuclear Safety Commission
CofA	Certificate of Approval
COC	Contaminants of Concern
CSSC	Conversion Safety Steering Committee

C-TPAT	Customs-Trade Partnership Against Terrorism
CTI-RC	Cameco Technology and Innovation Research Centre
DRD	Direct Reading Dosimeter
ECCC	Environment and Climate Change Canada
ECA	Environmental Compliance Approval
EHS	Environmental Health and Safety
EMP	Environmental Monitoring Program
ERP	Emergency Response Plan
ERT	Emergency Response Team
ESDC	Employment and Social Development Canada
FHA	Fire Hazard Analysis
FBW	Filter Backwash
FFI	Facility Fire Inspections
FPP	Fire Protection Program
FSD	Fuel Services Division
gU/h	Grams of Uranium per hour
HAZOP	Hazard and Operability Analysis
HEPA	High Efficiency Particulate Absorption
HIRAC	Hazard Identification, Risk Assessment and Control
I&E	Impingement and Entrainment
IAEA	International Atomic Energy Agency
ITM	Inspection, Testing and Maintenance
JTA	Job Task Analysis
KPI	Key Performance Indicator
LCH	Licence Conditions Handbook
Licence	Licence FFOL-3631.00/2017

LIMS	Laboratory Information Management System
LOPC	Loss of Primary Containment
LTWMF	Long Term Waste Management Facility
MISA	Municipal/Industrial Strategy for Abatement
MOECC	Ontario Ministry of the Environment and Climate Change
mSv	Millisievert
NEW	Nuclear Energy Worker
NO_x	Nitrogen Oxides
NO_2	Nitrogen Dioxide
NO_3	Nitrate
NSCA	Nuclear Safety Control Act
NUO_2	North UO_2 Plant
OH&S	Occupational Health and Safety
OJT	On the job training
PDP	Preliminary Decommissioning Plan
PHAI	Port Hope Area Initiative
PHCF	Port Hope Conversion Facility
PHFES	Port Hope Fire and Emergency Services
PM	Planned Maintenance
PTTW	Permit to Take Water
QA	Quality Assurance
SAP	SAP is a corporate wide enterprise application software for asset management, maintenance management, accounting and purchasing functions
SAT	Systematic Approach to Training
SCBA	Self-Contained Breathing Apparatus
SCR	Selective Catalytic Reduction

SEU	Slightly Enriched Uranium
SHEQ	Safety Health Environment and Quality
SPOC	Single Point of Contact
SSC	Systems Structures and Components
SWCS	Storm Water Control Study
SWEMP	Site-Wide Environmental Management Plan
SWRA	Site-Wide Risk Assessment
TC	Transport Canada
UF_6	Uranium Hexafluoride
µgU/L	Micrograms of Uranium per Litre
ULN	Upper Limit of Normal
UO_2	Uranium Dioxide
UO_2N	Combined Effluent
UO_2S	UO_2 plant cooling water
UO_3	Uranium Trioxide
µR/h	Microroentgen per Hour
µSv	Microsievert
WSIB	Workplace Safety and Insurance Board

1.2 Facility Operation

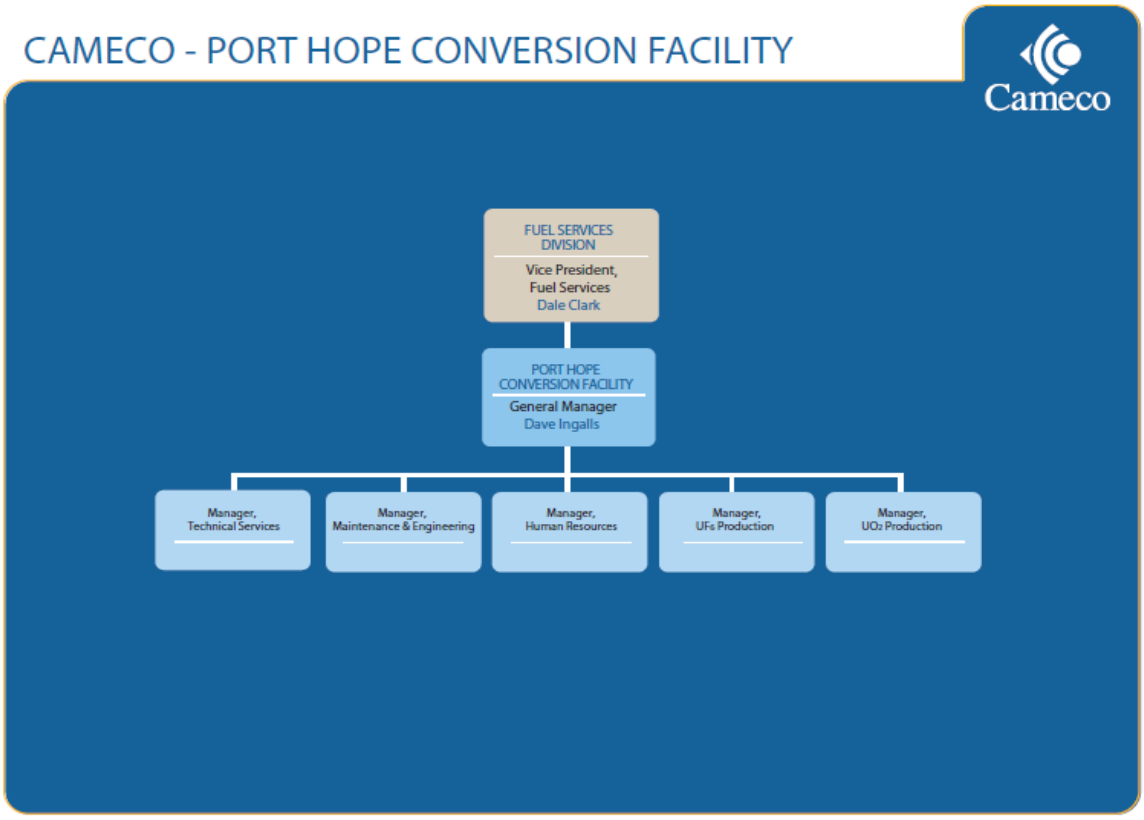
Cameco continues to strive for operational excellence at all of its facilities through consistent application of management systems across its operations to ensure that they operate in a safe, clean and reliable manner. Corporate policies and programs, including that for safety, health, environment and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

The general manager 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 PHCF and their respective personnel. All members of the site's management team are held accountable for the roles and responsibilities that they hold.

The Science and Technology group is located at PHCF, under the direction of the director, science and technology.

An organizational chart for PHCF for 2016 is shown in Figure 3.

Figure 3 - PHCF Organizational Chart



The manager, technical services reports directly to the general manager and has delegated day-to-day communications with CNSC staff related to specific activities to the senior specialist, quality, regulatory compliance and licensing. This position is responsible for coordinating and tracking compliance actions, maintenance of the facility's safety report and serves as the single point of contact (SPOC) with the CNSC for licensed activities at the site.

PHCF has a Licence Conditions Handbook (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 PHCF licence. The LCH outlines 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.

In addition to Cameco requirements regarding management systems, the facility's quality program has been designed to meet section 3(d) of the *Class I Nuclear Facilities Regulations*. This program provides the controls to ensure all processes are conducted in a safe manner and that processes applying to licensed activities are conducted in accordance with applicable CNSC quality requirements and other regulatory requirements. The application of the quality requirements is scaled according to the safety significance (complexity and hazard potential) of a particular activity.

PHCF was the first site in Cameco registered to the ISO 14001 Environmental Management System Standard, which is an internationally recognized standard for environmental management. As part of the management system programs, the facility conducts audits during the course of a year to assess the level of conformance to these management systems. In addition, the facility also conducts compliance audits in the areas of health safety and environmental legislation to ensure PHCF continues to meet all applicable regulatory requirements. Lastly, corporate technical experts perform periodic audits of the site management systems programs to ensure the site complies with corporate expectations.

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, radiation protection, health and safety and fire protection. A site 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.

In 2016, the PHCF made no significant changes to processes used to ensure that the physical design of the site is maintained.

Production targets were achieved for both UF_6 and UO_2 operations during the year. Both UF_6 and UO_2 plants resumed operations in January after a Christmas shutdown period.

There were scheduled shutdowns of both the UO_2 and UF_6 plants in the summer of 2016. The summer shutdown allowed for planned maintenance activities and for employees to utilize vacation time. The start-up of the plants after the extended shutdown periods was routine.

During periods of shutdown in the UF_6 operations, a minimum crew was maintained in the UF_6 plant, while remaining operators were deployed to Super CUP activities. The 2016 Super CUP campaign was focused on equipment removal from buildings 2, 27 and 31.

The UO_2 and UF_6 plants were safely shutdown in December 2016 after achieving their annual production targets.

The depleted uranium production circuit in the UO_2 plant was not operated in 2016.

As discussed in the previous section, PHCF experienced nine reportable events in 2016 related to site operations.

On January 5, 2016, an employee was cutting a piece of steel in the cutting booth. Their left hand was placed on the ground clip that was installed on the cutting table. A cut to the final piece of steel caused it to fall over, crushing the end of the employee's finger between the ground clip and the piece of steel leading to a Lost Time Incident.

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PHCF maintains the required programs, plans and procedures in the areas of health and safety, radiation protection, environment, emergency response, fire protection, waste management, and training. As a result of these actions, PHCF’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 well below the established limits.

The performance of the facility in 2016 demonstrates that Cameco is qualified to carry out the activities permitted under the Licence. All activities on the defined site in the licence are subject to the Nuclear Safety and Control Act (NSCA). Cameco is committed to take all reasonable precautions to protect the environment and the health and safety of employees and the public, to maintain the security of the facility and the nuclear substances associated with the facility, and the necessary measures to facilitate Canada’s compliance with international safeguards obligations.

1.3 Production or Utilization

The maximum daily production rate for the UF_6 plant did not exceed the licensed limit of 45 tonnes uranium as UF_6. The annual production of uranium in the UF_6 plant did not exceed the limit of 12,500 tonnes uranium as UF_6.

The annual production of uranium as UO_2 did not exceed the licensed limit of 2,800 tonnes uranium.

Detailed plant production information is considered “Protected Proprietary” and is submitted to the CNSC on an annual basis under a separate cover.

1.4 Facility Modification

There were no modifications affecting the safety analysis of the licensed facility made in 2015 that required written approval of the Commission or a person authorized by the Commission.

The following PHCF documents referenced in the LCH were updated and reissued in 2016:

- Criticality Safety Program Manual;
- Occupational Health and Safety Management Program Manual;
- UF_6 Plant Supervisor Training Procedure;
- Environmental Risk Assessment;
- Preliminary Decommissioning Plan;
- Port Hope Training Plan;
- Facility Licensing Manual;
- Quality Management Program Manual;
- Derived Release Limit and Operating Release Level Reports;
- Clean-Up Program;
- Fire Safety Plan;
- Fire Protection Plan;
- Waste Management Plan;
- Process and Design Change Control Procedure
- Emergency Response Plan; and,
- UF_6 Plant Operations Training Procedure.

On November 20, 2015, Cameco submitted its application to renew its operating Licence FFOL-3631.00/2017 for a 10-year term. The hearing was held November 8 and 9, 2016 in Port Hope, Ontario.

2.0 SAFETY AND CONTROL AREAS

2.1 Management

2.1.1 Management System

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.

The PHCF's quality management 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 quality assurance (QA) requirements and other regulatory requirements. The application of QA requirements is scaled according to the complexity and hazard potential of a particular activity.

The annual site management review meeting was held January 12 to 13, 2017 to review the suitability, adequacy and effectiveness of the SHEQ policy during 2016. The site management systems, which cover all of our site programs, were reviewed and sufficient information was provided to demonstrate effectiveness. Specific areas reviewed included, but were not limited to, policy, legal requirements, process identification, risk assessment, site objectives, training, communications, information management, security, environmental programs, occupational health & safety programs, radiation protection programs, audits, and corrective actions.

In 2016, internal SHEQ and compliance audits (legal and other requirements) were conducted and all results have been reported in CIRS to ensure that findings, opportunities for improvement and areas of concern are reviewed by site management and processed accordingly.

As part of its management system the PHCF has a site audit program that routinely looks at various aspects of site operations related to the licensed activities. In addition to internal SHEQ and compliance audits, PHCF also had a number of external audits completed in 2016 as shown below. It should be noted that the list does not include inspections completed by CNSC staff as part of their oversight of licence activities.

- A second party audit of the Fire Protection Program was completed and results were received in the fall.
- A second party audit of the FSD Internal Dosimetry Program was completed in the fall. This audit is a requirement under the quality assurance program developed for the Internal Dosimetry Services Licence issued to BRR, CFM and PHCF.
- Five customer product audits were completed in 2016.

There were no significant issues identified during the internal or external audits completed in 2016. With respect to compliance audits, they are conducted each year against applicable federal and provincial environmental legislation. All regulations are audited at least once every three years. Audits will not be discussed elsewhere in this report. Details and findings related to the audit program will be submitted under separate cover due to the confidential nature of the information.

All procedures that support licensed activity are subject to the site document control process as described in the various site document control procedures. Procedures that support the licensed activity 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, all environmental health and safety procedures, radiation protection and QA.

PHCF follows a systematic evaluation method for its safety culture self-assessments which are generally completed every five years. The most recent self-assessment was completed in 2015. Cameco uses these assessments to shape the safety program improvements at each site.

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 licensee 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.

This safety and control area covers activities that enable effective human performance through the development and implementation of processes that ensure that licensee 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.

PHCF operations focused on continuous improvement, which provided the organization with many efficiencies on deployment and standardization. The Learning Management System (LMS) is being utilized by all end-users for viewing and tracking positional requirements, with adherence and compliance to requirements being tracked throughout 2016. New LMS initiatives continue to be explored, while divisional collaboration continued through the use of a common training calendar, standardized qualifications and shared use of internal trainers.

Mandatory, legislated, and other job specific training activities were carried out in 2016. This training ensures that all personnel have the level of training related to radiation safety, fire safety, chemical safety, on site-emergency arrangements, environmental protection, and conventional health and safety, appropriate for their duties. Mandatory, federal, provincial, and Cameco required training is tracked and trended with 97% compliance achieved in 2016. Systems are in place to ensure employees only perform functions for which they are qualified.

UF_6 plant operations training continued as required, with operators completing new or re-qualification area specific training. UF_6 operators (Level 2 and 3) working outside of the UF_6 plant in support of SuperCUP operations, completed start-up evaluations in all their respective qualified/training areas, prior to assuming normal duties. Engineer reviews were also conducted for any changes to areas during shut-down. Self-check (stop, think, act, review) safety training was successfully introduced in the UF_6 plant, towards the end of the year, with plans to roll out this safety initiative site-wide in 2017.

The UO_2 plant continued to train operators in specific areas, as required, including transferred UF_6 operators supporting the UO_2 ramped up schedule. These operators returned to the UF_6, once UF_6 operations resumed. Continuous improvement efforts included training and conducting job task observations, learning moments conducted by area engineers and the identification of critical tasks on area tests.

Procedural (work instruction) updates and revisions continue in both the UF_6 and UO_2 plants.

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 2016, the PHCF continued to operate in a manner that supports safe, clean and reliable production and in compliance with applicable acts and regulations.

Production targets were achieved for both UF_6 and UO_2 operations during the year. Both UF_6 and UO_2 plants resumed operations in January after a Christmas shutdown period.

There were scheduled shutdowns of both the UO_2 and UF_6 plants in the summer of 2016. The summer shutdown allowed for planned maintenance activities and for employees to utilize vacation time. The start-up of the plants after the extended shutdown periods was routine.

During periods of shutdown in the UF_6 operations, a minimum crew was maintained in the UF_6 plant, while remaining operators were deployed to Super CUP activities. The 2016 Super CUP campaign was focused on equipment removal from buildings 2, 27 and 31.

The UO_2 and UF_6 plants were safely shutdown in December 2016 after achieving their annual production targets.

The depleted uranium production circuit in the UO_2 plant was not operated in 2016.

PHCF's operating performance is tracked using a comprehensive set of key performance indicators (KPIs) and objectives. In addition, the CNSC and other regulatory agencies have conducted facility inspections to verify compliance with applicable acts and regulations.

As part of its management system, the PHCF has a site audit program that routinely looks at various aspects of site operations related to the licensed activities. This is discussed in detail in the Management System section.

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.

PHCF has a safety report that documents the detailed safety analysis carried out for the facility. The safety report summarizes the systematic review of the site operations to identify and assess hazards and potential risks to the public and environment from PHCF operations. Cameco uses a hazards and operability (HAZOP) approach to assess new processes or equipment. This focuses on equipment, instrumentation, human actions and other factors that impact on the process. HAZOPs are conducted prior to making any plant modifications that may affect the safety case for the facility, with the site safety report updated at least every five years to include the findings from any HAZOP's completed since the last revision to the report. The safety report was most recently updated in 2015 and accepted by CNSC staff in 2016.

There were no modifications made in 2016 that affected the safety case for PHCF. 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. A Stage Gate process is used at PHCF to review capital projects at up to four points in the design process. This process includes sign-off by site management (or designate), to ensure that these requirements are addressed in every capital project.

PHCF contains numerous types of conventional industrial equipment including storage tanks, conveyors and associated piping, as well as specialized equipment for the uranium conversion processes. The plant equipment is designed, installed, operated and modified with materials suitable for the service and hazards of each area.

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

PHCF has a contractual arrangement with the provincial Technical Standards and Safety Authority (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, PHCF utilizes 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.

The following significant changes to systems, structures and components occurred at the PHCF in 2016:

- Demolition of two unused buildings on the Centre Pier concluded in March 2016. The objective of the project was to eliminate the need to maintain buildings 42 and 43A, which were no longer in use, thereby reducing financial liabilities and other risk associated with these aging structures. The work included removal of the entirety of the Building 42 and 43A structures above the foundation and closing of openings in adjoining buildings that remain (buildings 41 and 43).

Floor slab and grade beams were left in-place and sealed with a fixative to control contamination.

In 2016, the PHCF made no significant changes to processes used to ensure that the physical design of the site is maintained.

2.2.3 Fitness for Service

This safety and control area covers activities that impact on the physical condition of 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.

Critical requirements for maintaining a safe facility are effective maintenance and QA programs. This is to ensure any changes to plant equipment are adequately controlled and authorized, and do not adversely affect the safety of the facility.

Work continued in 2016 in all areas of the Operational Reliability program that was launched in late 2010. Highlights by focus area include:

- Work Management
  - Began to expand work management to other functional areas of the facility, such as engineering work.
  - Continued working on aspects of work management opportunities.
- Materials Management
  - Master Data Governance improvement project continued
  - Improvement teams were established for kitting and repair/replace processes.
- Reliability Engineering
  - Continued focus on preventive maintenance (PM) reviews to ensure high asset importance ranked and production related PMs take priority.
  - Asset management plan development was completed for reliability centered maintenance (RCM) analyses that were conducted on the powerhouse deaerator and UO_2 blender.
  - Software tool Isograph V3.0 RCM has been acquired and will be used to focus on PM optimization in 2017.
- Operations Improvement
  - Testing continued for Operator Care Rounds (OCRs) on electronic hand-held mobile devices (currently paper-based).
  - A project to track mobile equipment uptime was started.
  - Piping and instrumentation drawing verification and valve tagging continued.
- General
  - A number of associated procedures were revised as a result of new business processes.

The effectiveness of the program, as it pertains to reliability of equipment and systems, continues to be measured through a number of leading and lagging metrics. Program effectiveness is defined by upward trends of these indicators to reach world class standards for chemical manufacturing industries.

Testing and verification activities are integrated into the preventive maintenance strategy for any SSCs. Compliance to the activities is measured on a weekly basis.

The asset management program accounts for ageing through a number of processes designed to detect early warning signs and to prescribe rehabilitation programs or pro-active replacement strategies. The effectiveness of the program is measured by the same means as the overall maintenance program and is considered to be effective.

PHCF has an established Planned Maintenance (PM) program whereby all tasks are initiated and documented through the work notification system in SAP (SAP is a corporate wide enterprise application software for asset management, maintenance management, accounting and purchasing functions). PM plans are issued reviewed and updated periodically to ensure the PM routines continue to be effective and adequate. KPIs are in place to monitor the effectiveness of the program.

Fire protection systems are tested according to an established schedule as outlined in the Fire Protection Program. 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.

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

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.

PHCF 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 monitoring;
- Internal dosimetry – urine analysis & lung counting programs;
- Workplace air sampling program;
- Respirator program; and
- Radiation & contamination surveys.

The CNSC regulatory limits for effective dose for Nuclear Energy Workers (NEWs) are 50 millisievert (mSv) per year and no more than 100 mSv over a specified five year period.

For various radiological parameters, Cameco has established action levels, which are well below regulatory limits 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, 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.

Radiation protection objectives and targets are established jointly by the site management team, site specialists and FSD specialists, including the health physicist, to ensure there is agreement, commitment and awareness of these objectives and targets. 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.

Audits and inspections were performed in accordance with licence conditions. Refer to the Management Systems section of this report for further details.

The performance of the Radiation Protection Program is tracked using KPIs. The KPIs for this program include but are not limited to risk control, training, objectives and targets, operational controls, and monitoring.

The radiation protection program at PHCF is well established, with detailed procedures outlining the processes under each element of the program. Review of the 2016 dose data indicates that the program is effective in the prevention of unreasonable risk to the health and safety of workers.

Though the radiation protection and ALARA programs have been demonstrated to be effective, PHCF has also made significant improvements as part of its continual improvement program, including:

Program Improvements

- New requirement to scan all bags for contamination at the whole body monitors prior to leaving site.
- Specific tools have been purchased and are controlled for use only in zone 1 areas only to prevent cross-contamination.
- Eight new beta-gamma contamination survey meters have been provided to the CUP crew.
- A hand and foot monitor has been placed outside of the UF_6 lunch room for employees to monitor prior to entering the lunch room.
- With the support of the HIRAC and Fall Protection subcommittees, improvements have been made to the operational safety of the Lung Count Trailer.
- The alpha and beta alarm limits on the whole body monitors have been set below the free release limit of $0.4 Bq/cm^2$.
- As per CNSC recommendations, the External Dosimetry Administrative and Regulatory Action Levels for monthly whole body exposure has changed to 1.2 mSv and 2.0 mSv. The PHCF Radiation Protection Program Manual is in the process of being updated to reflect this change.
- The lung counter detector hardware was upgraded to Lynx digital signal analyzers and the discontinued Nuclear Instrumentation Module (NIM) based electronics were eliminated. Calibration of the new system was completed after install.
- The 2016 in-vivo lung counting performance test- evaluation of the counting configuration was successfully performed under the supervision of Health Canada Human Monitoring Laboratory Radiation Protection Bureau.

- Approval has been obtained to purchase a hand and foot monitor to be placed outside of the UO_2 lunch room in building 24.
- To improve the continuous in-plant air sampling in the UF_6 plant, three real time continuous air monitors (CAM) were purchased during the third quarter and installation began in the fourth quarter. The CAM system is intended to provide early warning to plant personnel in the event of increased airborne uranium as quantified by the derived air concentration (DAC).
- A routine protocol has been created for frequent urinalysis investigations for the same individual due to procedural non-compliances to decrease occurrences.
- A new monitoring booth has been placed at Gate 1.

Procedural Improvements

- Updated the Nuclear Criticality Safety Program Manual;
- Updated CAP:RAD:13 Radioisotope Source Control;
- Updated CAP:RAD:14 Contamination Monitoring of Plant Clothing and Boots;
- Updated CAP:RAD:16 Performing Check for Loose Contamination Using the Swipe Check Method;
- Updated CAP:RAD:18 External Dosimetry – Optically Stimulated Luminescence Badge Program;
- Updated CAP:RAD:28 Room Surveys;
- Updated CAP:RAD:34 Operating Plant Beta Radiation Surveys; and,
- Updated CAP:RAD:53 Relocating the Lung Count Trailer to the Blind River Refinery.

PHCF's performance in 2016 regarding the ALARA targets is summarized below:

- Maintain employee maximum radiation exposures to ALARA levels or below:
    - The 5 mSv for external whole body dose was met. The maximum dose of 4.1 mSv in 2016 was received by a Materials Handling operator
    - The 20 mSv for external skin dose was met. The maximum dose of 16.9 mSv was received by a UF_6 operator.
    - The 1 mSv for internal dose – urine analysis was met. The maximum dose of 0.72 mSv was received by a maintenance employee.
    - The 4 mSv for internal dose – lung counting was met. The maximum dose of 2.4 mSv was received by a maintenance employee.

- Utilized the 'top five' approach in order to follow up on the five workers with the highest year-to-date doses in each dose component. Results were tracked monthly and the approach was found to be effective in meeting the ALARA targets for internal urine analysis and external whole body dose.
- Achieved over 99.0% compliance to scheduled urine sample submissions.
- Implementation of contamination controls and monitoring for zone 2 and yard areas continued in 2016.
- Upgraded MGP/DMC/3000 direct reading dosimeters to monitor daily exposure to beta radiation were provided to operators and maintenance workers in the UF_6 plant.
- Supported the production team with improving engineering and administrative controls to address radiation issues associated with operation of flame reactors and management of ash cans.

The 2017 ALARA targets are following:

- Dose targets: Whole body dose < 5 mSv;
- Skin dose < 20 mSv;
- Urine analysis dose < 1 mSv; and,
- Lung dose < 4 mSv.

Radiation protection initiatives planned for 2017 include:

- Continue to utilize the 'top five' approach in order to follow up on the five workers with the highest year-to-date (YTD) doses in each dose component;
- Achieve 98% compliance to scheduled urine sample submissions;
- Improve the site's contamination and zone control programs; and,
- Continue to support the production team to develop and implement a plan for engineering and administrative controls to address radiation issues associated with operation of flame reactors and management of ash cans.

PHCF uses a licensed dosimetry service provider that is accredited by the CNSC. The dosimetry service provides optically stimulated luminescence (OSL) dosimeters to PHCF for use by employees, contractors, and visitors. An OSL badge is used to monitor whole body and skin dose. Dosimeters are changed monthly for production, maintenance and support services and quarterly for all other employees. The provider reports the OSL results to the National Dose Registry (NDR) as well as provides a copy to PHCF.

In 2016, PHCF did not exceed any CNSC licensed limits or action levels with respect to radiation protection.

NEW training is conducted for each employee or contractor, who is likely to receive dose above 1 mSv or requires unlimited access to Zone 3 areas. All employees and contractors receive annual refresher training in the form of a monthly safety meeting presentation which includes a competency assessment. In 2016, PHCF recorded 99.5% compliance to Radiation Protection training requirements.

The radiation monitoring instrumentation was maintained as per regular calibration and maintenance schedules.

Inventory of sealed and unsealed sources that are used or possessed on site are listed in the radioisotope source control procedure. Regular inspection and leak tests of the sealed sources were carried out in 2016 according to this procedure. Results showed that sources are in a state of safe operation and pose no undue risk to workers. Control of sealed sources was maintained throughout the year.

Internal doses are assigned through urine analysis and lung counting programs which are part of Cameco's licensed internal dosimetry service.

The following tables and graphs summarize employee dose results. Note that in figures with ranges on the horizontal axis, a range of 1 – 2, for example, means all results are greater than 1 and less than or equal to 2.

Whole Body Dose

Distributions of 2016 external whole body dose are shown in Table 2 and Figure 4. More than 93% of the whole body exposures were below 1 mSv with a total of 19 workers receiving a whole body dose greater than 2 mSv.

Table 2

2016 Whole Body Dose Distribution	
Dose Range (mSv)	**Percentage of Individuals (%)**
0 – 1	93.06
1 – 2	4.50
2 – 3	2.06
3 – 4	0.13
4 – 5	0.26
> 5	0

Figure 4

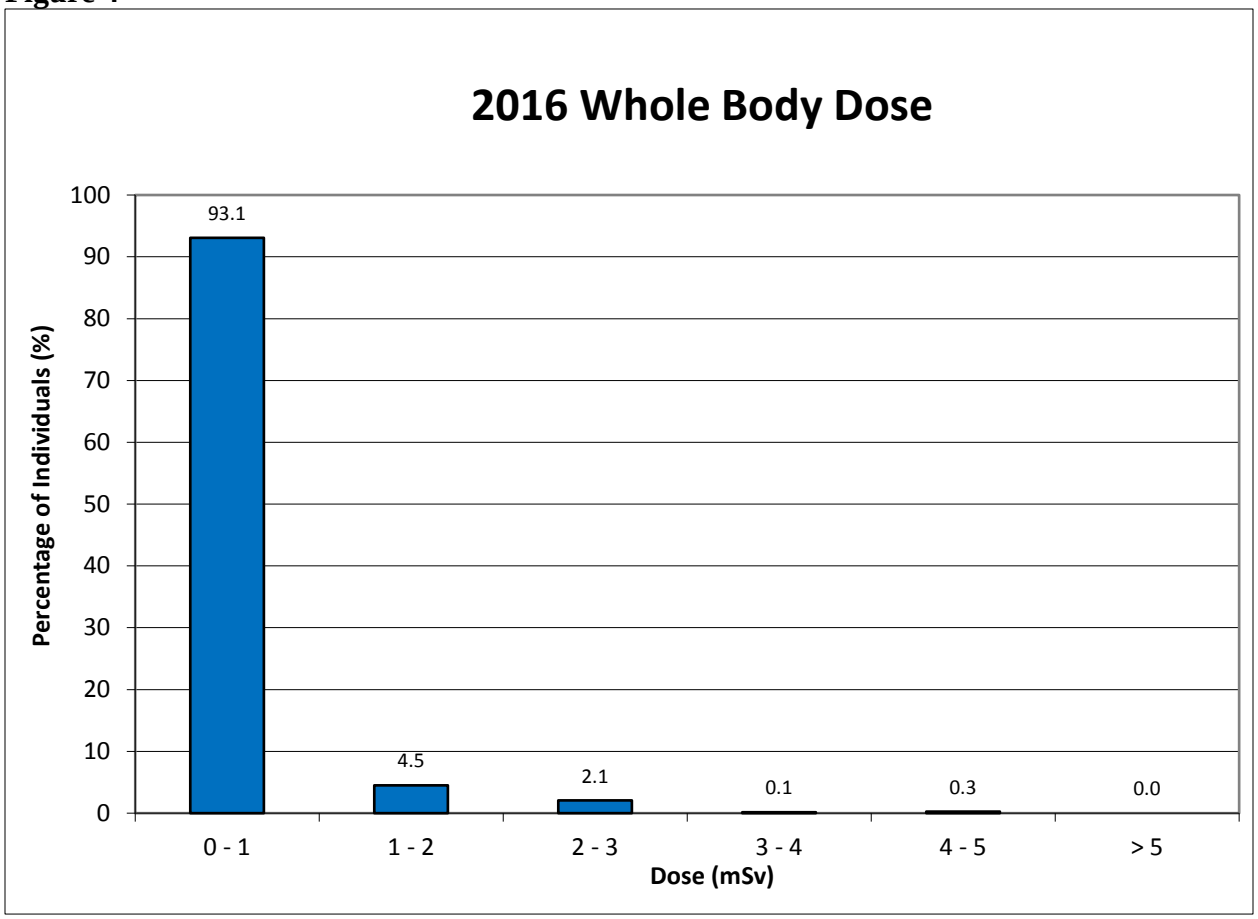
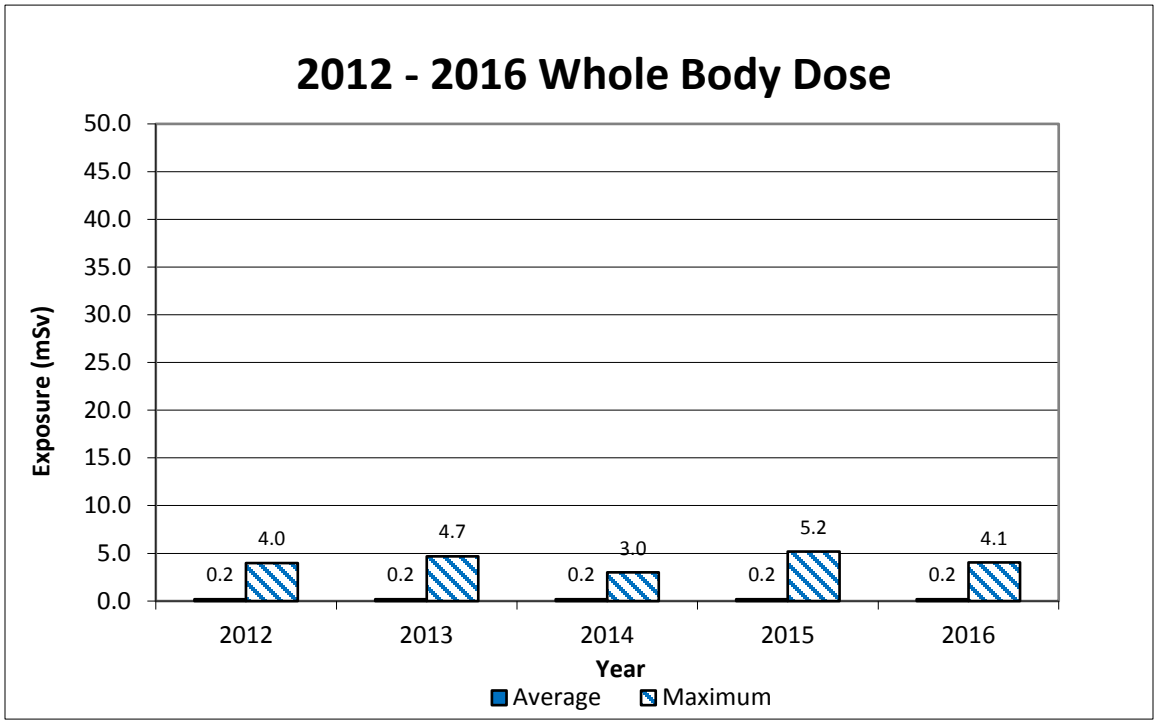


Table 3 and Figure 5 show the employee average and maximum individual external whole body dose for the five year period from 2012 – 2016. This data includes contractors with NEW status. The average dose in 2016 was comparable to the average dose from 2012 through 2015. The maximum individual external whole body dose was 4.1 mSv received by a Materials Handling operator.

Table 3

2012 – 2016 Whole Body Dose				
Year	**Number of Individuals**	**Average (mSv)**	**Minimum (mSv)**	**Maximum (mSv)**
2012	943	0.2	0.0	4.0
2013	809	0.2	0.0	4.7
2014	798	0.2	0.0	3.0
2015	880	0.2	0.0	5.2
2016	778	0.2	0.0	4.1

Figure 5



Skin Dose

Distributions of 2016 external skin doses are shown in Table 4 and Figure 6. Over 98% of the external skin doses were below 10 mSv.

Table 4

2016 Skin Dose Distribution	
Dose Range (mSv)	**Percentage of Individuals (%)**
0 – 10	98.5
10 – 20	1.5
20 – 30	0
30 – 40	0
40 – 50	0
> 50	0

Figure 6

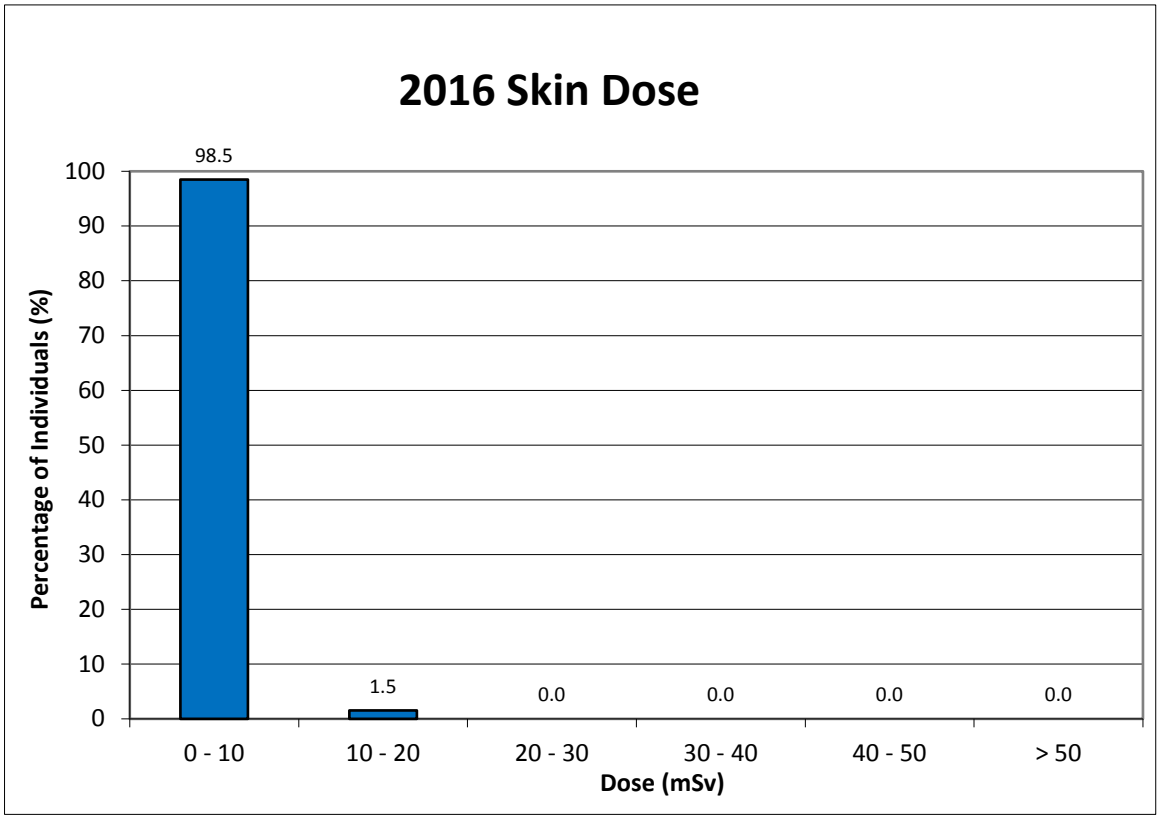
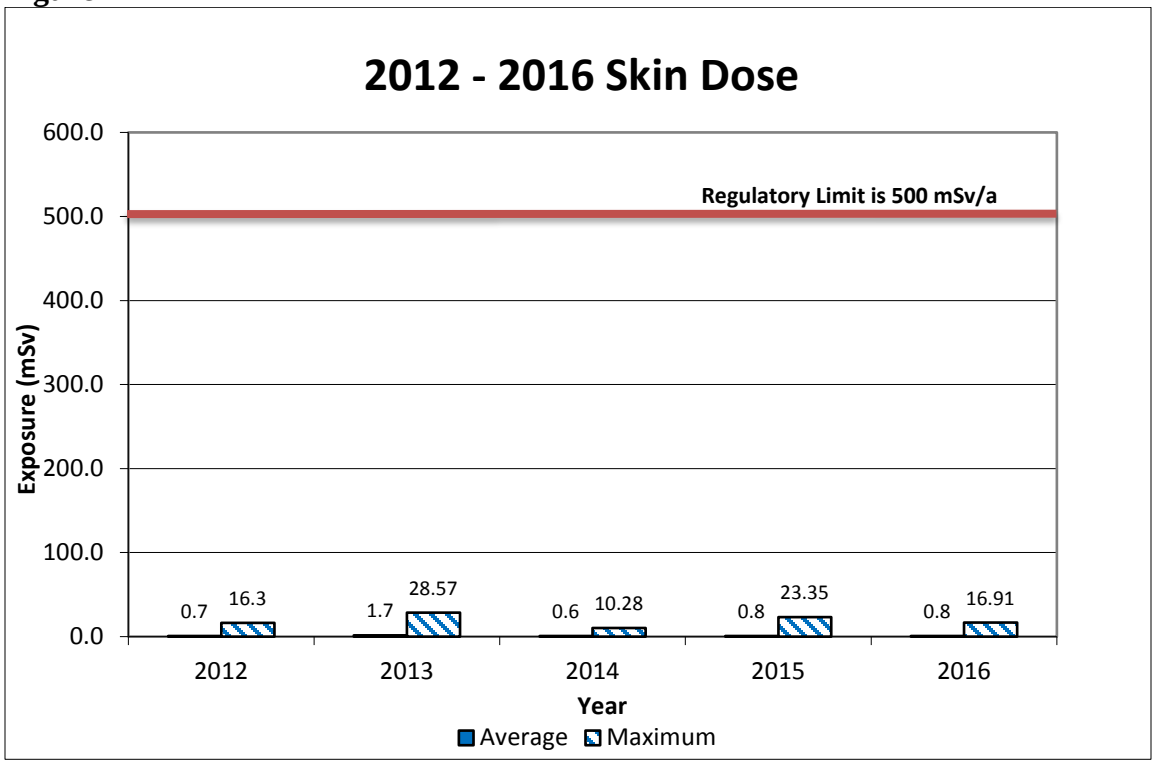


Table 5 and Figure 7 show the employee average and maximum individual skin dose for the five-year period from 2012 – 2016 including contractors (NEW). Average dose remained the same over the period. The maximum individual skin dose was lower than the previous year. The maximum individual dose in 2016 was 16.9 mSv, which is below 5% of the CNSC annual limit of 500 mSv for skin dose. The individual with the highest exposure was a UF_6 operator.

Table 5

2012 – 2016 Skin Dose				
Year	**Number of Individuals**	**Average**	**Minimum**	**Maximum**
2012	943	0.7	0.0	16.3
2013	809	1.7	0.0	28.6
2014	798	0.6	0.0	10.3
2015	880	0.8	0.0	23.4
2016	778	0.8	0.0	16.9

Figure 7



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 0.21 mSv, respectively. The average and maximum non-NEW contractor/visitor skin dose results were < 0.1 mSv and 0.20 mSv, respectively.

Urine Analysis

Table 6 shows the distribution of urine results for 2016. A total of 30,616 urine samples were collected and analyzed for uranium and/or fluorides during 2016. The majority of uranium in urine results (> 97%) were less than 5 µg U/L in 2016.

Table 6

2016 Urine Analysis Results	
Distribution of Results	**2016**
Number of Samples ≤ 5 µg U/l	28,836
Number of Samples >5 to ≤ 25 µg U/l	605
Number of Samples >25 to ≤ 50 µg U/l	34
Number of Samples > 50 µg U/l	20
Number of Uranium in Urine Samples Analyzed	29,494

The distribution of 2016 internal urine dose for employees is shown in Table 7 and Figure 8. Approximately 93% of the individual assigned doses were below 0.2 mSv.

Table 7

2016 Internal Dose Distribution (Urine Analysis)	
Dose Range (mSv)	**Percentage of Individuals (%)**
0.0 – 0.2	93.82
0.2 – 0.4	5.01
0.4 – 0.6	1.00
0.6 – 0.8	0.17
0.8 – 1.0	0.00
> 1.0	0.00

Figure 8

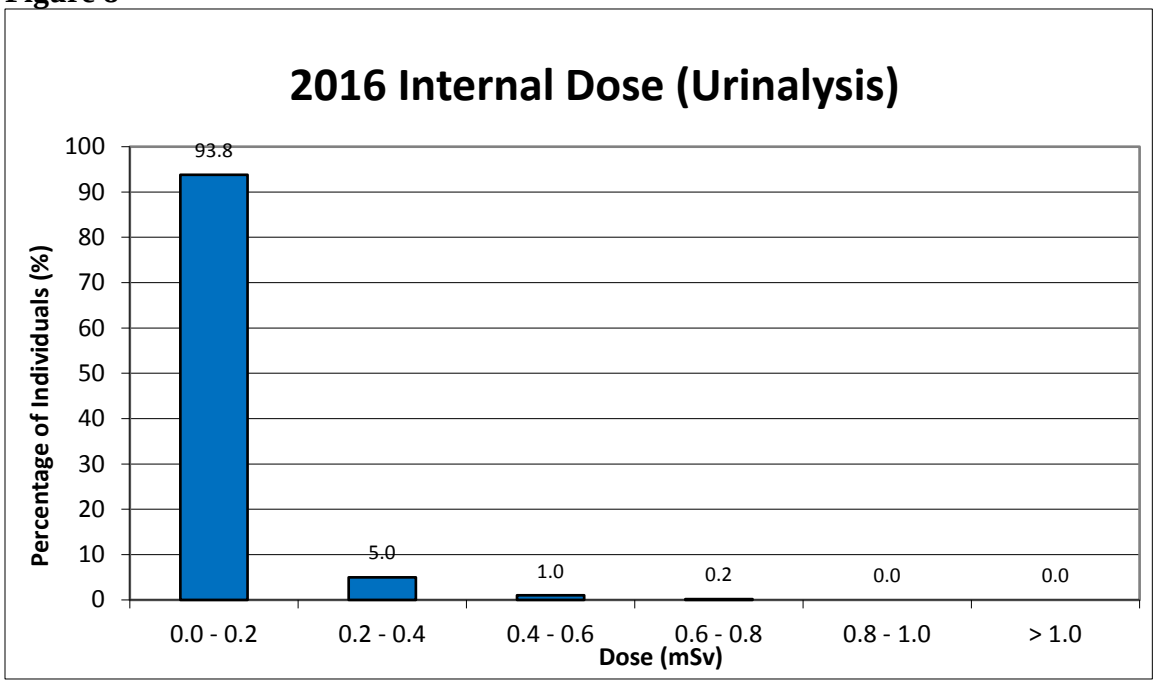


Table 8 and Figure 9 present the average and maximum internal urine analysis doses for the 2012 through 2016 period. A total of 599 employees, contractors and visitors were monitored by the urine analysis program during 2016. The average and maximum internal urine analysis doses in 2016 (including contractors) were 0.05 mSv and 0.72 mSv respectively which were comparable to 2015. The maximum dose of 0.72 mSv was received by a maintenance employee.

The annual ALARA target for internal urine analysis exposure of 1 mSv was not exceeded in 2016.

Table 8

2012 – 2016 Internal Dose (Urine Analysis)				
Year	**Number of Individuals (Includes Contractors)**	**Average Dose (mSv)**	**Minimum Dose (mSv)**	**Maximum Dose (mSv)**
2012	1,073	0.03	0.00	1.14
2013	897	0.03	0.00	0.58
2014	666	0.04	0.00	0.59
2015	665	0.04	0.00	0.64
2016	599	0.05	0.00	0.72

Figure 9

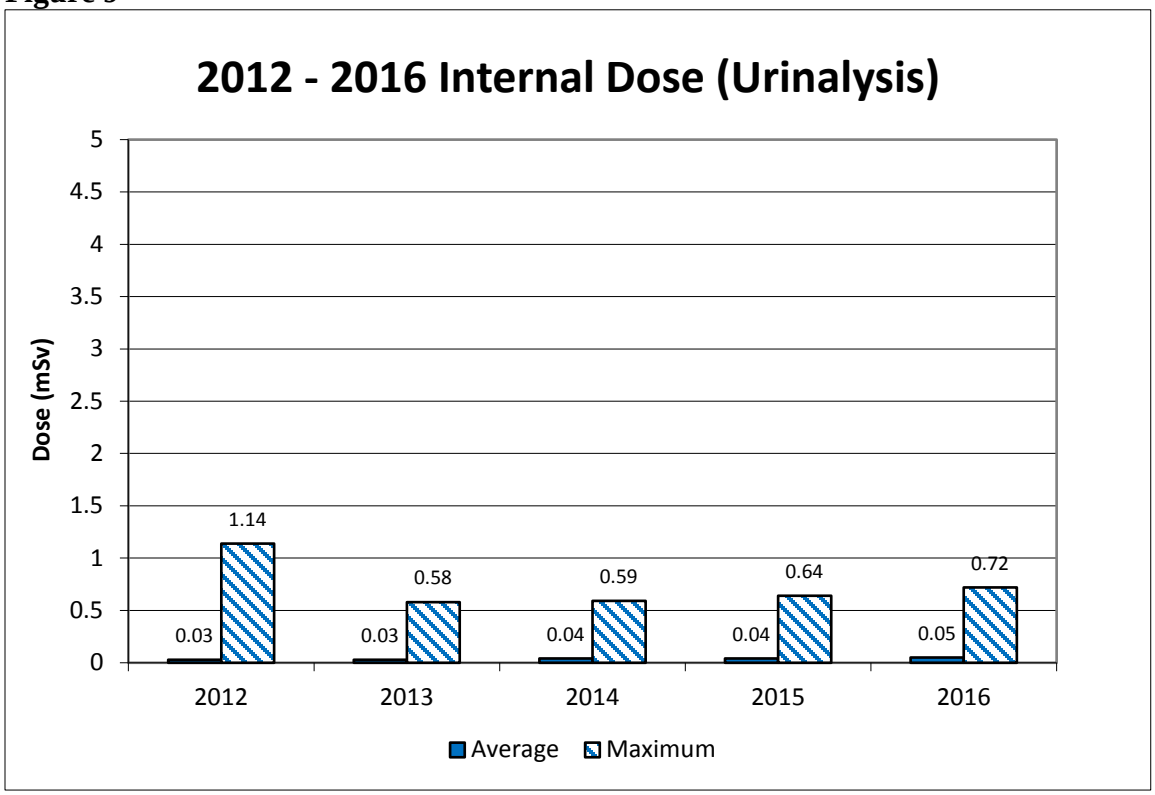


Table 9 shows a comparison of the annual exposure results for whole body dose, skin dose and urine analysis broken down by work group. The highest doses are from the operations work group, consisting of production, materials handling, waste management and maintenance personnel.

Table 9

Work Group	Whole Body (mSv)			Skin Exposure (mSv)			Urine Analysis (mSv)		
	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
UF_6 Plant	0.52	0.00	4.00	2.76	0.00	16.91	0.12	0.00	0.54
UO_2 Plant	0.68	0.00	1.33	2.44	0.00	5.48	0.08	0.01	0.25
Maintenance	0.45	0.00	2.95	2.84	0.00	13.32	0.13	0.00	0.72
Technical Support [1]	0.11	0.00	4.05	0.18	0.00	4.12	0.01	0.00	0.21
Administration[2]	0.01	0.00	0.18	0.03	0.00	1.09	0.01	0.00	0.14
Total (Max)	**0.19**	**0.00**	**4.05**	**0.72**	**0.00**	**16.91**	**0.05**	**0.00**	**0.72**

[1] Includes contractors (NEWs)
[2] Includes outside contractors

Lung Counting

As part of the licensed internal dosimetry program Cameco employs the use of a lung counter to monitor and assess exposure of uranium in the lungs of its employees and contractors (NEW) at PHCF. This equipment is capable of measuring extremely low levels of contamination to the point where an employee's exposure could be stopped well before it could become an issue.

A total of 824 internal lung count doses were assigned at the PHCF in 2016. There were no investigations triggered by the lung counting program during the year and no regulatory action level was exceeded for lung count measurements. An intercomparison (independent test) was completed in May 2016 by Health Canada to validate, test and certify the lung counting system. A second intercomparison was completed in November 2016 by Health Canada to validate all data collected from May to November. In November, the Lung Counter detector hardware was upgraded to Lynx digital signal analyzers and the discontinued NIM based electronics were removed from the system. Calibration of the new system was completed after install of the new hardware, after which, an intercomparison was completed in November by Health Canada to validate, test and certify the new system.

The estimates of 2016 internal exposures, based on the lung counting program, were assigned for 245 employees and the prorated actuals of 2016 internal exposures were calculated for 579 contractors (NEW) and administrative employees. The 2016 average internal lung counting dose assigned was 0.36 mSv. The maximum dose of 2.4 mSv, received by a maintenance employee, was similar to the 2015 value of 2.7 mSv. The annual ALARA target for lung counting of 4 mSv was not exceeded in 2016.

Taking into consideration counting statistics and the minimum detectable activity (MDA) of the lung counter, six basic dosimetry groups were created with a greater number of workers in each to increase the accuracy of dose assessment. These dosimetry groups are: the UF_6 plant; UO_2 plant; maintenance; technical support; administration; and NEW contractors. The technical support dosimetry group includes materials handling, science & technology, environmental and radiation safety personnel, and engineering work groups.

Table 10 and Figure 10 show the distribution of assigned lung counting doses. All assigned lung doses were below 4 mSv.

Table 10

2016 Internal Dose Distribution (Lung)	
Dose Range (mSv)	**Percentage of Individuals (%)**
0 – 1	82.4
1 – 2	17.0
2 – 3	0.6
3 – 4	0
4 – 5	0
> 5	0

Figure 10

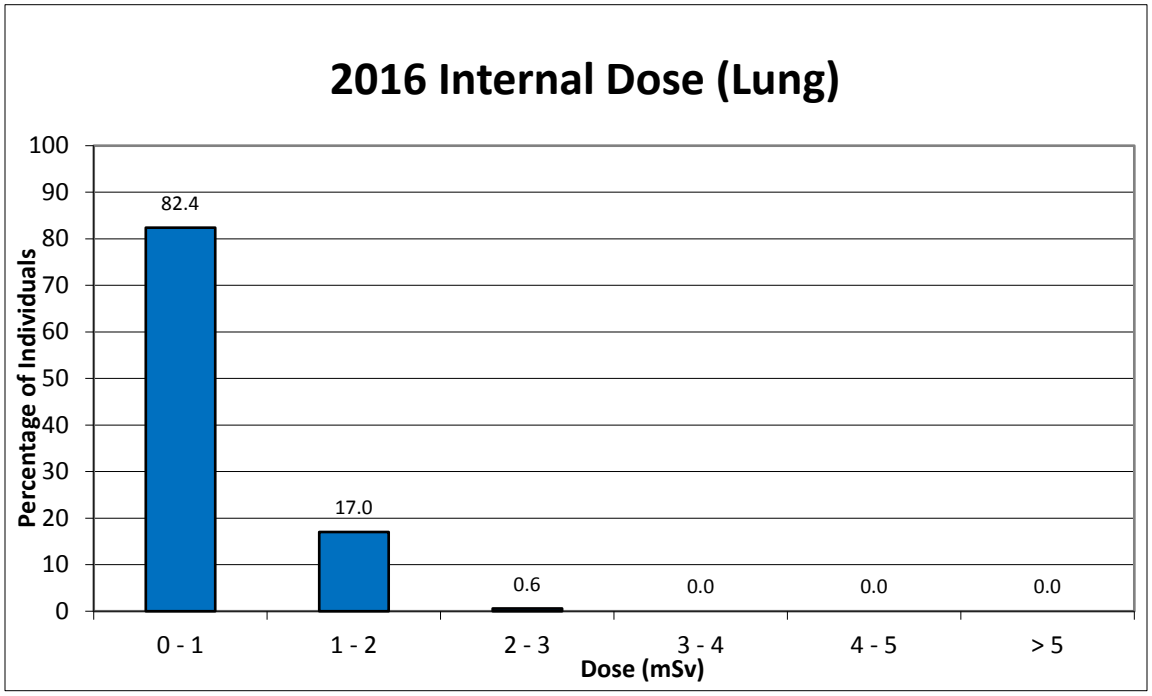


Table 11 presents the internal lung counting dose indicators for 2012-2016 period.

Table 11

Internal Lung Count Exposures 2012 - 2016				
Year	**Number of Individuals**	**Average (mSv)**	**Minimum (mSv)**	**Maximum[1] (mSv)**
2012	450	1.6	0.0	3.7
2013	823	0.5	0.0	3.4
2014	840	0.5	0.0	2.7
2015	857	0.4	0.0	2.7
2016	824	0.4	0.0	2.4
[1]Maximum annual dose to an individual				

Table 12 shows the assigned internal lung count doses for 2016.

Table 12

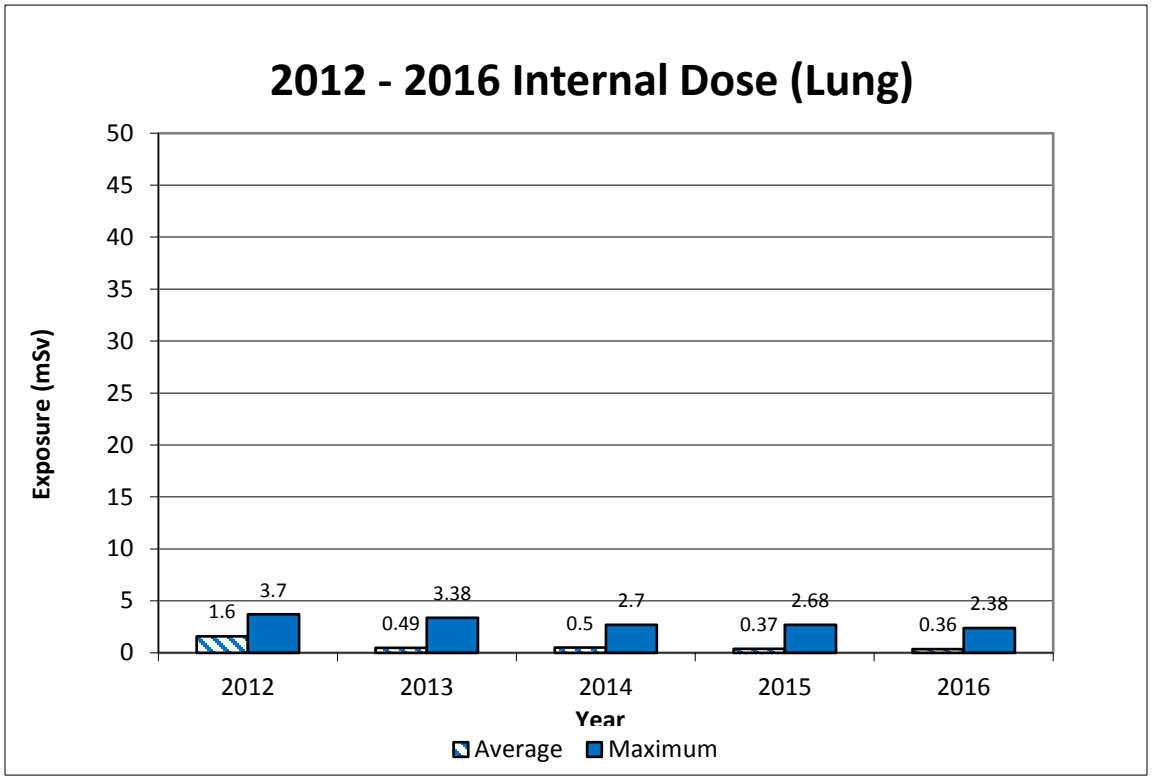
Assigned Internal Lung Count Doses 2016				
Dosimetry Group	**Number of Individuals**	**Average (mSv)**	**Minimum (mSv)**	**Maximum[1] (mSv)**
UF_6 Plant	74	1.11	0.14	1.46
UO_2 Plant	22	1.27	0.73	1.38
Maintenance	71	1.78	0.41	2.38
Technical Support	83	0.39	0.00	0.63
Administration[2]	177	0.03	0.00	0.48
Contractors[2] (NEW)	397	0.05	0.00	1.04
Regulatory Limit - annual (5 years)		50 (100)		
[1]Maximum annual dose to an individual				
[2]Includes prorated doses				

In 2016, no lung count measurements exceeded the MDA of the lung counter; therefore, lung doses for all individuals were based and assigned on group averages. Differences in individual lung doses within the same group are due to different fractions of the group average being applied to the individual's annual dose, based on the date the individual's lung count occurred.

Differences in individual lung doses from year to year are due to correction factors. The 2016 lung doses assigned in March 2017 are estimates. The actual doses for 2016 will be produced in March 2018 (once lung counts for every individual have been completed in 2016) and the difference between 2016 estimates and actuals will be applied to 2017 estimates.

Figure 11 shows the average and maximum internal lung dose for PHCF employees for the 2012 through 2016 period. These trends, prior to 2013, do not include the outside contractors work group, whose internal lung doses were not assigned at this point in time. Beginning in 2013, due to improvements in the lung counting program, lung dose data has been assigned to outside contractors (NEWs).

Figure 11



Total Effective Dose

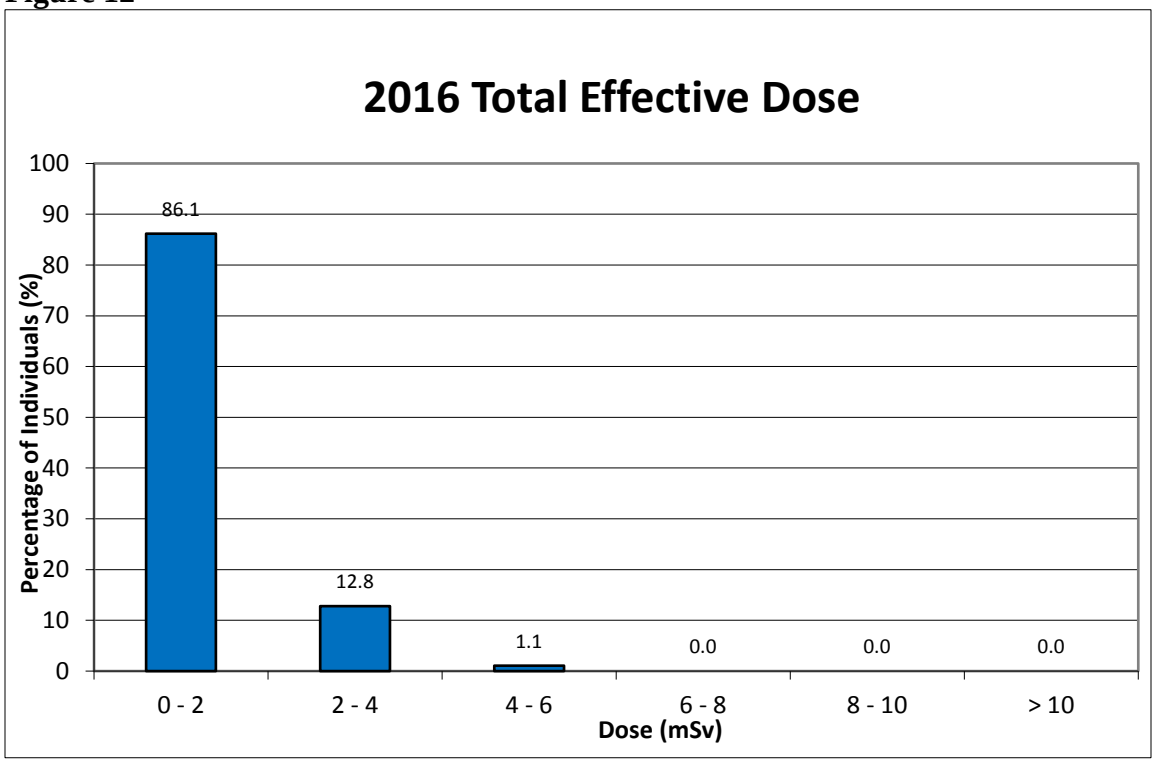
The total effective dose (TED) was assessed for 433 employees and 397 contractors. It should be noted that the internal lung dose component was assessed using the estimating function of the lung counting program management. The site average and maximum total effective dose for 2016 were 0.60 mSv and 5.60 mSv, respectively.

Table 13 and Figure 12 show the breakdown of the total effective dose for employees in 2016. 98.9 percent of employees or contractors (NEWs) had an effective dose of 4 mSv or less, while 1.1 percent of employees or contractors (NEWs) had an effective dose greater than 4 mSv.

Table 13

2016 Total Effective Dose Distribution	
Dose Range (mSv)	**Percentage of Individuals (%)**
0 – 2	86.1
2 – 4	12.8
4 – 6	1.1
6 – 8	0.0
8 – 10	0.0
> 10	0.0

Figure 12



The average employee effective dose in 2016 was similar to the average effective dose recorded in 2015.

Table 14 and Figure 13 present the total effective dose for employees during the 2016-2020 periods.

The five year regulatory limits established in the Radiation Protection Regulations (SOR/2000-203) apply to unique five year periods of time. The current period extends

from January 1, 2016 to December 31, 2020. The maximum individual effective dose for the current five year dosimetry period is 5.60 mSv which is well below the regulatory limits of 50 mSv/year and 100 mSv/5 years.

Table 14

Total Effective Dose 2016 - 2020				
Year	**Number of Individuals**	**Average (mSv)**	**Minimum (mSv)**	**Maximum[1] (mSv)**
2016	830	0.6	0.0	5.6
2017	-	-	-	-
2018	-	-	-	-
2019	-	-	-	-
2020	-	-	-	-
[1]Maximum annual dose to an individual				

Figure 13

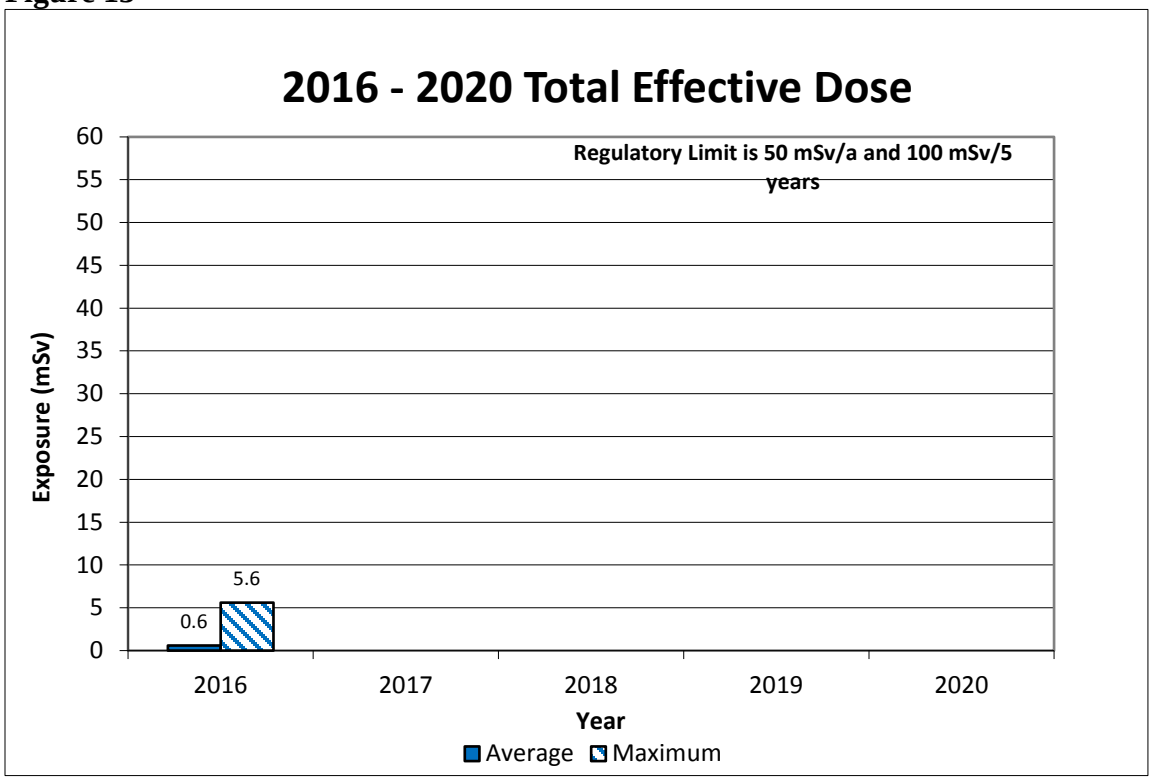


Table 15 shows the total effective dose broken down into urine analysis dose, lung count dose and external whole body dose for 2016.

Table 15

Dose Components & Total Effective Dose 2016												
Dosimetry Group	**Urine Analysis Dose (mSv)**			**Lung Counting Dose[1] (mSv)**			**External Whole Body Dose (mSv)**			**Total Effective Dose (mSv)**		
	Avg	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**
UF_6 Plant	0.12	0.00	0.54	0.95	0.00	1.46	0.52	0.00	4.00	1.60	0.00	5.60
UO_2 Plant	0.08	0.01	0.25	1.23	0.50	1.38	0.68	0.00	1.33	1.90	0.10	2.90
Maintenance	0.13	0.00	0.72	1.59	0.00	2.38	0.45	0.00	2.95	2.20	0.00	5.00
Technical Support	0.01	0.00	0.21	0.12	0.00	1.86	0.11	0.00	4.05	0.20	0.00	4.50
Administration	0.01	0.00	0.14	0.01	0.00	0.43	0.01	0.00	0.18	0.00	0.00	0.60
PHCF Average	**0.05**	**0.00**	**0.72**	**0.36**	**0.00**	**2.38**	**0.19**	**0.00**	**4.05**	**0.60**	**0.00**	**5.60**

[1]Based on estimated individual lung doses

Doses assigned by the urine analysis program continue to be minimal. No employee has exceeded the minimum detectable activity in the lung counting program since 2004 and all lung doses were assigned using a group average method. As with the previous year's data, the group averages for external whole body dose are low compared to maximally exposed individuals. This indicates that workplace controls are adequately controlling exposure for the group as a whole but the actions of specific employees are causing those individuals to receive unnecessary dose.

As indicated in Table 16, the individuals with the highest effective doses at the PHCF include operators in the UF_6 plant, a maintenance pipefitter/welder, and a material handling operator.

Table 16

2016 Five Highest Effective Dose Individuals				
Occupation	**Urine Dose (mSv)**	**Lung Dose (mSv)**	**External Whole Body Dose (mSv)**	**Effective Dose (mSv)**
UF_6 Operator	0.19	1.44	4.00	5.60
Pipefitter / Welder	0.28	1.77	2.95	5.00
UF_6 Operator	0.22	1.38	3.22	4.80
UF_6 Operator	0.31	1.39	2.81	4.50
Material Handling Operator	0.02	0.45	4.05	4.50

Contamination Control

PHCF is divided into three zones for contamination control purposes. Zone 1 areas (clean areas - no radioactive sources other than monitoring equipment) are clearly delineated. Whole body monitors are located at the Zone 1 boundary in the main lobby and at the Gate 12 vehicle port. A hand and foot monitor is located at the Gate 1 exit. In Zone 2 areas (transition areas – may contain limited amounts of uranium compounds), no visible contamination should exist and, when detected, loose contamination is promptly isolated, monitored, cleaned and monitored again to ensure the contamination has been removed. Zone 3 areas are production areas where uranium products are expected. Zone 1 and 2 areas are monitored on a weekly schedule (lunchrooms and change houses) and rotating monthly schedule (offices) so that each office area is monitored at least once annually. Additional monitoring is done on an as-needed basis (i.e. during an investigation, when requested or where contamination is suspected). The contamination readings above the internal administration level posed no significant risk to people or to the environment.

Table 17

Summary of PHCF Internal Administration Levels and Events in 2016				
Area	Levels (Bq/cm^2)		Contamination Events	
	Alpha	Beta/Gamma	Number of Samples above Levels	Number of Samples Taken
Zone 1	0.4	0.4	0	2,831
Zone 2	0.4	3.7	47	27,835

Contamination in Zone 2 was primarily detected in close proximity to production areas. Identified contamination is flagged and promptly cleaned up. Contaminated items that were unable to be cleaned were disposed of.

Vehicle contamination check verification forms are used to record contamination checks on vehicles leaving the site. Tires, seats, floors and pedals are checked for contamination. If necessary, vehicles are directed to the site truck wash booth to be decontaminated prior to leaving the site.

In-plant Air

The in-plant air monitoring program covers over 100 permanent monitoring stations across PHCF. Filters are changed and analyzed on a daily basis. Portable stations are also used on an as required basis.

Monthly averages of the airborne uranium activity concentration for each plant/area are reported as a fraction of the administrative level (AL) or derived air concentration (DAC). The DAC is based on the solubility class and particle size of uranium compounds found in the various plants.

Table 19 shows the average annual derived air concentration per work area for the 2012 through 2016 period. Air sampling data from the UF_6 plant enclosures that are permanently posted for respiratory protection has been omitted. As such, Table 18 values may not match data reported previously. The reduced number of air samples corresponding to a DAC greater than one may be attributed to the use of live-time air monitoring in the UF_6 and UO_2 plants which provides instant feedback and prompts immediate action.

It is important to note that in addition to the two plants having very different processes, there are several reasons for the differences in the total number of 1 DAC exceedances in the UF_6 and the UO_2 plants. The UF_6 plant is a larger building (10 floors versus 4 floors) which requires more fixed air monitoring locations (55 versus 25) than the UO_2 plant,

and the UF_6 plant operates continually, while the UO_2 plant operates 5 days a week, with samples collected daily during production. This results in a total number of data points for DAC in the UF_6 plant being approximately three times the number of data points in the UO_2 plant.

The DAC is based on the solubility class and particle size of uranium compounds found in the operating plants. The latest studies summarized in the "Internal Dosimetry Program – Technical Basis Document", show the average DAC values of 340 µgU/m^3 and 100 µgU/m^3 for the UF_6 and UO_2 plants, respectively. PHCF is taking a conservative approach by using the 100 µgU/m^3 as the DAC value across the site which means that for the UF_6 plant, PHCF is being more conservative than is required by the Technical Basis Document.

Table 18

Airborne Activity Concentration								
Year	**Annual Average (DAC) and Number of Samples >DAC**							
	UF_6		**UO_2**		**Waste Recovery**		**CUP**	
	Average	**>DAC[1]**	**Average**	**>DAC[1]**	**Average**	**>DAC[1]**	**Average**	**>DAC[1]**
2012	0.08	84	0.03	2	0.02	0	0.01	0
2013	0.06	66	0.03	4	0.01	0	0.02	0
2014	0.06	94	0.03	3	0.02	1	0.01	0
2015	0.06	60	0.03	2	0.02	0	0.01	0
2016	0.05	60	0.04	2	0.05	11	0.01	0
[1]Number of air samples greater than 1 DAC								

Gamma Surveys

Plant gamma surveys using hand-held meters are done on a routine basis throughout the site. The frequency of the readings and the number of readings taken in each area varies based on the area and the historical results from that area. Table 19 summarizes the results taken in each area in 2016.

The general processes and operations at the PHCF are well defined and stable, and the external gamma radiation levels were fairly constant in 2016. Gamma readings in the flame reactor areas and the drop line filter areas are highly variable and strongly dependent on the operational conditions of the UF_6 plant. Results in Table 19 were higher than reported in 2015 due to operational conditions.

Areas with elevated gamma dose rates (i.e. flame reactors) require additional controls such as wearing direct reading dosimeters (DRDs) for routine work or radiation work permits for non-routine and project work to ensure worker's exposures are kept as low as reasonably achievable (ALARA).

Table 19

Summary of Plant Gamma Readings by Area (µSv/h)				
Building Number	**Location**	**Average**	**Minimum**	**Maximum**
2	1st Floor	1.82	0.68	4.48
	2nd Floor	1.11	0.50	1.71
	3rd Floor	4.41	0.15	29.8
5B	1st Floor	0.31	0.09	0.99
5C	1st Floor	0.77	0.19	2.85
7	1st Floor	0.48	0.29	0.60
12	1st Floor	8.46	0.37	26.2
24	1st Floor	4.11	0.31	17.4
	2nd Floor	3.58	0.05	13.8
	2nd Floor/Mezzanine	2.00	1.30	2.47
	3rd Floor	1.19	0.30	5.33
	4th Floor	6.51	0.47	35.6
50	1st Floor Flame Reactor Area	211.3	12.8	838
	1st Floor Tote Bin Area	3.95	1.74	8.13
	1st Floor Drop Line Filter Area	40.0	7.6	96.6
	1st Floor Cylinder Filling Area	0.60	0.55	0.65
	1st Floor Effluent Area	0.50	0.36	0.61
	2nd Floor Tower	3.47	0.08	7.26
	2nd Floor Flame Reactor Area	115.7	10.8	301.0
	2nd Floor Effluent Area	0.07	0.04	0.10
	3rd Floor Tower	8.82	1.19	26.1
	3rd Floor Flame Reactor Area	34.5	13.7	56.1
	3rd Floor Effluent Area	0.24	0.07	0.30
	3rd Floor Cold Trap Area	0.13	0.13	0.13
	4th Floor Tower	5.16	2.72	8.02
	4th Floor Flame Reactor Area	15.6	6.35	38.3
	5th Floor Tower	7.90	2.80	24.9
	5th Floor Flame Reactor Area	10.8	2.72	34.2
	6th Floor Tower	4.41	0.11	11.3
	7th Floor Tower	4.44	0.22	17.0
	8th Floor Tower	3.61	0.81	10.4
	9th Floor Tower	2.63	0.24	6.67

2.3.2 Conventional Health and Safety

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

The health and safety management program fosters and promotes a strong sustainable safety culture. Under the Operational Excellence initiative we strive for a safe, healthy and rewarding workplace. Cameco has five key principles in the area of safety that form the framework of 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.

Occupational health and safety (OH&S) efforts at PHCF are supported by one joint committee, the Conversion Safety Steering Committee (CSSC). The CSSC, created in 2013, incorporates the previously-existing Policy Health and Safety Committee (PHSC) and Workplace Health and Safety Committee (WHSC) into one committee. Time is allotted, actions are reviewed, issues discussed and minutes are maintained separately to address interests of both the WHSC and PHSC. The CSSC reviews and discusses matters involving OH&S policies, procedures and programs (composition of PHSC committee), safety performance, safety program performance, work refusals, safety related projects, and joint union/management OH&S issues that may arise from time to time (composition of WHSC committee). The CSSC meets three days per month in an effort to improve safety performance on site and creating a sustainable safety culture. Each member of the CSSC dedicates a fourth day a month for safety dedicated duties. This far exceeds the Canada Labour Code requirement of nine meetings per year. The CSSC is active in promoting continuous improvement and is effectively meeting the expectations of its mandate.

The health and safety of workers at PHCF is assured through site-specific safety and health management programs. These programs set out the requirements for management of health and safety aspects of the operation consistent with Cameco's corporate SHEQ policy, which is modeled on the OHSAS 18001 standard. 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 PHCF 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 CSSC. Refer to the Management Systems section of this report for further details.

The effectiveness of the conventional OH&S 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. The PHCF was successful in meeting the expectations of these various initiatives.

Audits and inspections are conducted at PHCF to ensure regulatory compliance and compliance to Cameco's policies and procedures. Audit and inspection results are discussed with the managers responsible for the areas inspected and entered CIRS for resolution or management.

The PHCF 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 facility.

The PHCF follows a systematic evaluation method for its safety culture self-assessments which are generally completed every five years. The most recent self-assessment was completed in 2015. Cameco uses these assessments to shape the safety program improvements at each site.

Table 20 compares the safety statistics for the PHCF over the past five years. The number of first aid injuries, medical diagnostic procedures, medical treatment injuries, lost time injuries, lost time frequency and lost time injury severity were consistent with previous years.

Table 20

2012 – 2016 Safety Statistics					
Year / Parameter	**2012**	**2013**	**2014**	**2015**	**2016**
First Aid Injuries	94	67	69	71	84
Medical Diagnostic Procedures	12	5	11	7	6
Medical Treatment Injuries	19	4	12	3	12
Lost Time Injuries	1	0	1	1	3
Lost Time Injury Frequency	0.24	0.00	0.27	0.26	0.80
Lost Time Injury Severity	22.05	0.00	0.00	7.64	2.40

All reported Occupational Health and Safety incidents are registered in CIRS for tracking and management. The CIRS system defines five categories of incidents based on actual and potential outcome, with Category I incidents being minor in scope and Category V incidents having the highest actual and potential consequences. Incidents captured by the Canada Labour Code (Part II) definition of hazardous occurrences fall under Categories III-V of the CIRS system.

Several initiatives to improve OH&S were progressed in 2016, including:

- The CSSC steering committee completed all 3 targets outlined in their plan on schedule:
    - The CSSC performed 8 Hazard assessments;
    - Worked with supervisors to determine the best method for providing safety related information and support, in order to provide consistency regarding safety expectations;
    - Continue support of the subcommittee process by:
        - Strengthening communication and expectations for subcommittees.
        - Ergonomics sub-committee has been established.
        - New training has been developed and deployed to the Ergonomic subcommittee. Training to continually support the other subcommittees will be ongoing.
        - Attendance at each sub-committee meeting was calculated and reviewed on a monthly basis.
        - Each subcommittee identified and shared one primary target for 2016; Ongoing bi-monthly updates to the CSSC completed.
- The site asbestos survey commenced in the second quarter, the new database is expected to be available in 2017;
- Job Hazard Analysis (JHA) training completed to align the site with the revised corporate JHA standard;

- The CSSC participated in NAOSH week by hosting a two day safety event with several games that tested employees' safety knowledge;
- A new vendor for managing Safety Data Sheets was established and the transition to the new database was seamless;
- Completed implementation of the revised Control of Hazardous Energy standard in December;
- A new draft corporate standard for error prevention and self-checking was piloted in the UF_6 plant, with full facility roll out scheduled for 2017;
- The CSSC conducted monthly inspections to ensure that the entire site was inspected by year-end;
- The CSSC steering committee participated in an annual review led by the Quality department;
- 152 safety wins were implemented in 2016;

Future OH&S initiatives include:

- Full facility roll out of corporate error prevention and self-checking standard in 2017;
- Develop a process for 100% employee involvement in safety by the end of the third quarter;
- Implement improvements for sub-committee communication to the site;
- Make significant improvements towards hand, eye and ergonomic injuries;
- Increase site resources for carrying out the completion of Hazard Identification Risk Assessment and Controls (HIRACs);
- Develop a process to efficiently follow up on injuries and HIRAC assessments;
- Develop a CSSC three year plan;
- Increase safe accessibility to permanent fall prevention tie off points and hoisting and rigging points to improve compliance with the regulations; and,
- Support ALARA by decreasing the number of worker uranium uptakes.

A key element of a safe, clean and reliable operation is a comprehensive and well-established worker protection program, which is in place at PHCF. The regulations made pursuant to the NSCA and the *Canada Labour Code Part* II prescribe specific health and safety requirements that are met by the PHCF.

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. The PHCF's environmental monitoring program is comprised of the following components:

- water and air emissions;
- gamma levels;
- groundwater; and
- soil and vegetation.

The program ensures that applicable provincial and federal requirements are met.

The key characteristics of the operation and activities that can have a significant environmental impact are monitored and measured and are described in the EMP and associated procedures. These documents identify all of 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.

The performance of the Environmental Protection Program is tracked using KPIs. The KPIs for this program include but are not limited to risk control, training and awareness, objectives and targets, operational controls, certification, and monitoring.

Audits and inspections were performed in accordance with licence conditions. Refer to the Management Systems section of this report for further details.

Cameco has established action levels, which have been accepted by the CNSC, for key environmental parameters. An exceedance of an action level does not pose a risk to people or the environment.

Though the environmental programs have been demonstrated to be effective, the PHCF advanced several improvements to the environmental protection program in 2016.

Program Improvements included:

- The PHCF has completed a review of CSA standards N288.4 Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills and N288.5 Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills and is continuing work to come into full compliance with the standards by 2017;

- The Environmental Risk Assessment was updated to align with CSA standard N288.6 Environmental risk assessments at Class I nuclear facilities and uranium mines and mills; and,
- Waste management projects were deployed, as part of the long-term waste management plan, to dispose of contaminated materials at appropriately licensed hazardous waste facilities.

Procedural updates included:

- CAP:ENV:15 Collection and Measurement of Lime Candles; and,
- Spills Prevention and Contingency Plan.

The environmental initiatives planned for 2017 include the following:

- Implement CSA standards N288.4 Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills and N288.5 Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills;
- Implement CSA Standards N292.0 General principles for the management of radioactive waste and irradiated fuel and N292.3 Management of low- and intermediate radioactive waste;
- Continue to implement portions of the long-term waste management plan, to dispose of contaminated materials at appropriately licensed hazardous waste facilities; and,
- Continue to support Super CUP through onsite presence, data review/interpretation, troubleshooting support and event response/investigation. .

Dose to Public

The Operating Release Level (ORL) is the level resulting in an annual dose of 0.3 mSv to the critical receptor for the PHCF.

In accordance with the requirements of the CNSC, the ORL for the PHCF has been developed.

An ORL equation for Site 1 has been derived and is expressed in the form shown below.

Public Dose = $\text{Dose}_{\text{Air}} + \text{Dose}_{\text{Water}} + \text{Dose}_{\text{Gamma}} < 0.3$ mSv/y

To calculate the ORL, health physics experts have identified monitoring location 14 as the critical receptor in the ORL report for PHCF. A person located at this receptor, given their proximity to the facility and the theoretical length of time that could be spent at this location, would be expected to receive the highest possible radiation dose that any member of the public could receive. The radiation exposure from the air quality data, the

liquid effluent data and the gamma monitoring data are determined and added together. This number must be lower than the ORL accepted by the CNSC, which is well below the public dose limit of 1 mSv.

The 2016 annual dose to the critical receptor is shown in Table 21. This Table illustrates the site total as well as the individual contributions from water, air and gamma. The ORL of 0.3 mSv/year was not exceeded in 2016. The dose to the public critical receptor from Cameco's operation in 2016 was approximately 6% of the public dose limit of 1 mSv/year and approximately 19% of the licensed limit of 0.3 mSv/year.

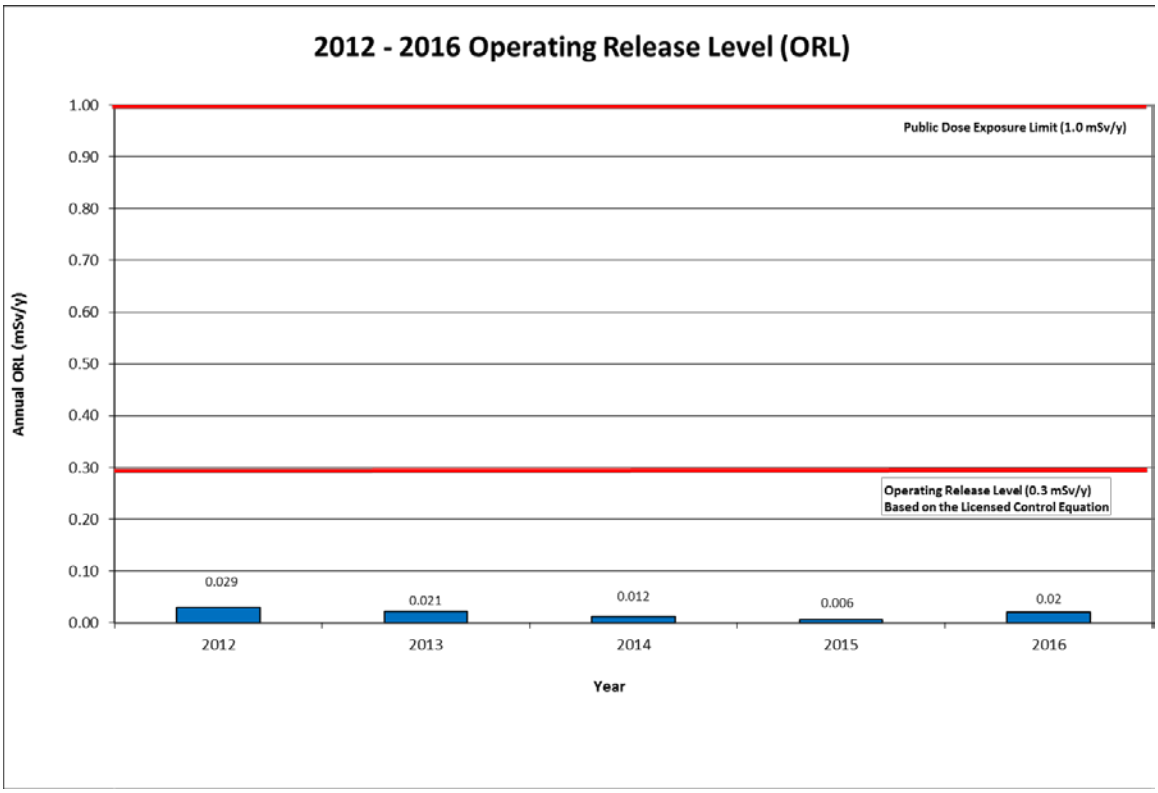
Increased gamma reading results were observed in 2016. Cameco investigated the increase and determined that the higher readings were attributed to material movement onsite.

The ORL contributions are also shown graphically in Figure 14.

Table 21

2012 - 2016 Public Dose (mSv/year)					
ORL Component	**2012**	**2013**	**2014**	**2015**	**2016**
Air	0.002	0.002	0.001	0.001	0.001
Water	<0.001	<0.001	<0.001	<0.001	<0.001
Gamma	0.028	0.020	0.012	0.004	0.020
Total ORL	0.029	0.021*	0.012*	0.006	0.020*
*Due to rounding, total ORL may vary from the sum of individual contributions.					

Figure 14



Gamma Monitoring

Fenceline gamma measurements are performed around the main facility (Site 1) as well as the Dorset Street warehouses (Site 2) on a monthly basis.

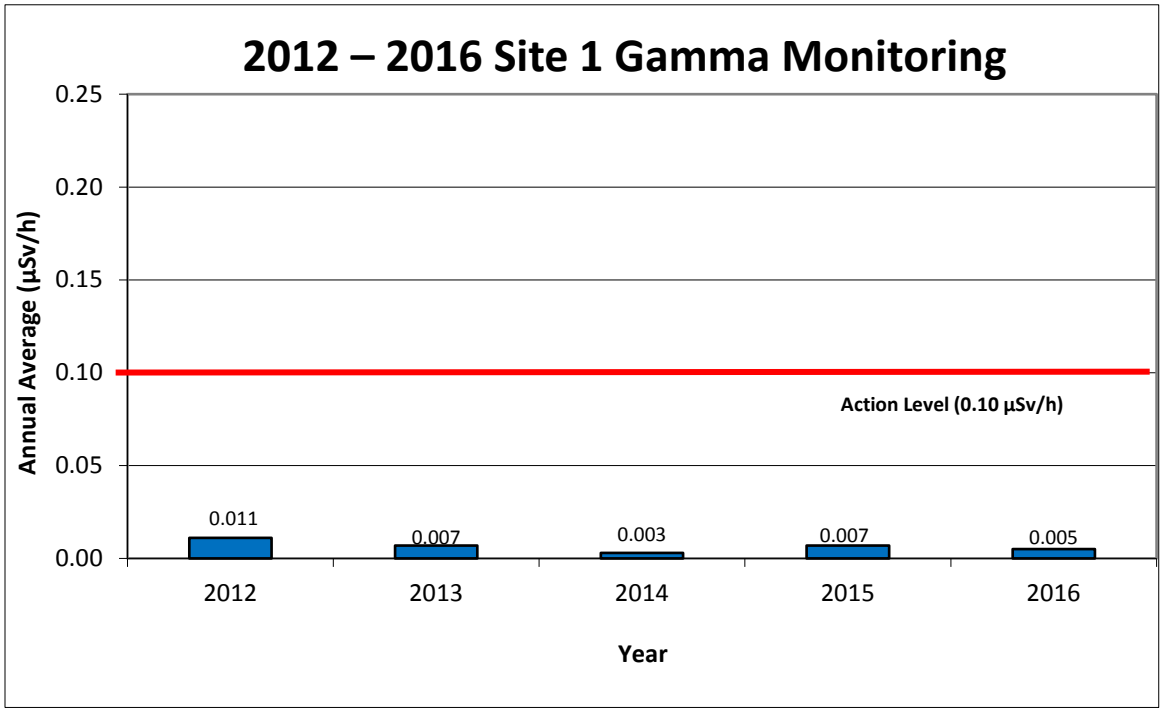
The annual monitoring results for Site 1, as measured at the critical receptor, are presented in Table 22 and Figure 15. The CNSC action level for this station is 0.10 µSv/h.

Table 22

2012 – 2016 Site 1 Gamma Monitoring Results		
Period	**Annual Average (µSv/h)**	**Annual ORL Contribution (mSv/y)**
2012	0.011	0.028
2013	0.007	0.020
2014	0.003	0.012
2015	0.007	0.004
2016	0.005	0.020

Fluctuations in the gamma results are expected given that the values are near background levels. No activities were conducted in 2016 which would have resulted in an increased gamma dose to the critical receptor. To reduce the fluctuation, Cameco uses a three month running average gamma dose rate for the ORL calculation.

Figure 15



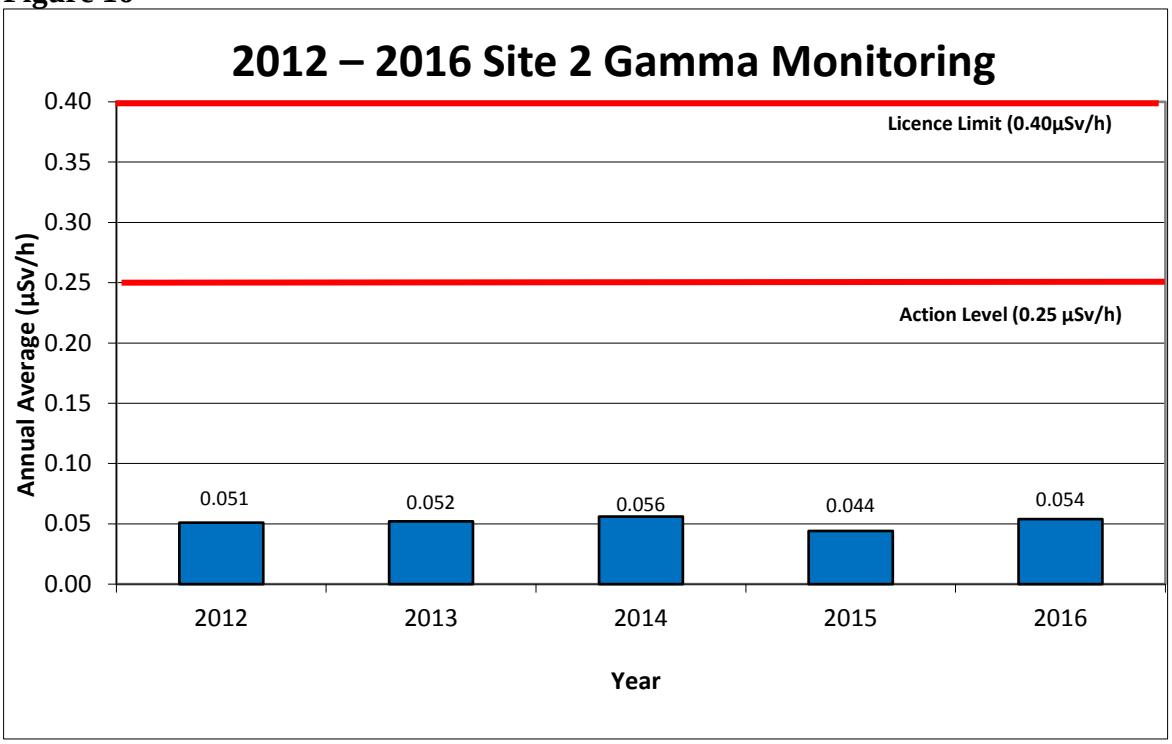
Fence line gamma measurements in 2016 were lower than measurements in 2012 through 2015 at the PHCF. Changes can be attributed to natural variations of gamma levels close to background and accuracy of the monitoring method. The 2016 results for the critical receptor at Site 1 were at 19% of the licence limit and at Site 2 were at 14% of the licence limit for the critical receptor.

The annual monitoring results for Site 2 are presented in Table 23 and Figure 16. The limit for Site 2 is 0.40 µSv/h at any station. Cameco developed performance based action levels for each fenceline gamma monitoring station at Site 1 and Site 2. These action levels were accepted by CNSC staff in July 2010.

Table 23

2012 – 2016 Site 2 Gamma Monitoring Results	
Period	**Annual Average (µSv/h)**
2012	0.056
2013	0.058
2014	0.054
2015	0.044
2016	0.054

Figure 16



Discharge to Air

The air quality monitoring program at PHCF is divided into source air monitoring and ambient air monitoring. The source air monitoring program collects and analyzes daily samples from the main stacks on the UF_6 and UO_2 operating plants. Both of these stacks are continuously sampled for uranium.

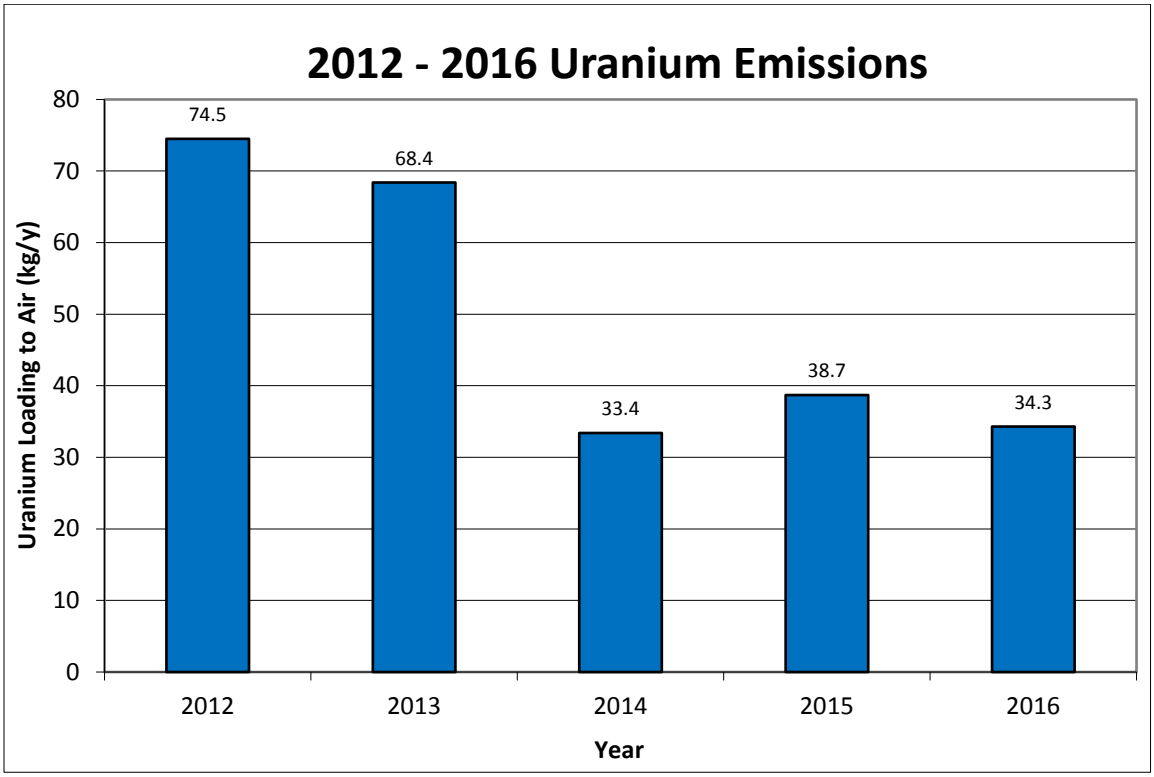
The total uranium emissions to air from PHCF in 2016 were approximately 34.3 kgU. These uranium loadings include both the UF_6 and UO_2 main stacks, plant building ventilation and facility point sources. Table 24 and Figure 17 illustrates PHCF uranium loading to air for the period of 2012 to 2016. The PHCF uranium loading to air decreased

significantly in 2014 due to the installation of a new tail gas Venturi scrubber in January 2014.

Table 24

Total Uranium Emissions					
Emission	**2012**	**2013**	**2014**	**2015**	**2016**
Air	74.5	68.4	33.4	38.7	34.3

Figure 17



A stack monitoring program is used to determine the airborne uranium emission rates on a daily basis from the main stacks of the UF_6 and UO_2 plants. The licensed action level for the UF_6 plant main stack is 40 g U/h. The licensed action level for the UO_2 plant main stack is 7 g U/h.

No licensed action levels were exceeded for uranium emissions from the UF_6 plant main stack in 2016. The annual average and maximum uranium emissions in 2016 were comparable to 2014 and 2015 levels.

No licensed action levels were exceeded for uranium emissions from the UO_2 plant main stack in 2016. The annual average uranium emissions from the UO_2 plant main stack for 2016 is comparable to levels observed in previous years.

Fluoride emissions from the UF_6 main stack are sampled and analyzed on a continuous basis using an on-line analyzer and the data is collected on the plant computer system. The UO_2 main stack is also continuously sampled for ammonia to determine the ammonia emission rate from the UO_2 plant main stack.

The depleted circuit was non-operational in the fourth quarter, therefore there are no reportable NO_x emissions.

All other stacks are sampled on an occasional or as requested basis. Source emission action levels and maximum limits are indicated in the appropriate Tables and Figures throughout this report.

The 2016 annual average and maximum stack emissions from the UF_6 plant main stack and the UO_2 main stack are presented in Table 25 and Figure 18 through to Figure 21.

Table 25

2012 - 2016 Daily Main Stack Emissions									
Plant	**Parameter**	**Licence Limit**	**Action Level**	**Value**	**2012**	**2013**	**2014**	**2015**	**2016**
UF_6	Uranium g U/h	290	40	Average	4.2	5.1	1.2	1.7	1.2
				Maximum	25.3	25.3	6.3	19.2	6.0
	Hydrogen Fluoride g HF/h	650	230	Average	16	19	13	17	10
				Maximum	160	143	99	146	122
UO_2	Uranium g U/h	150	7	Average	1.2	1.3	1.2	1.2	1.0
				Maximum	7.2	6.2	3.9	2.9	5.2
	Ammonia kg NH_3/h	58	13	Average	1.9	2.0	2.2	2.4	1.7
				Maximum	6.4	4.3	5.4	4.7	5.5

No regulatory action levels were exceeded for fluorides (as HF) for the UF_6 plant main stack in 2016. Air emissions observed in 2016 were comparable to levels observed in previous years. The total fluoride emissions to air (as HF) from the PHCF in 2016 were approximately 310 kg HF. These fluoride loadings include the UF_6 main stack, UF_6 plant building ventilation and facility point sources.

No regulatory action levels were exceeded for ammonia for the UO_2 plant main stack in 2016. The average annual ammonia emissions from the UO_2 plant main stack in 2016 are comparable to levels observed in previous years. The total ammonia emissions to air from PHCF in 2016 were approximately 44.0t NH_3. These ammonia loadings include the UO_2 plant main stack, the UO_2 plant point sources and facility point sources.

Figure 18

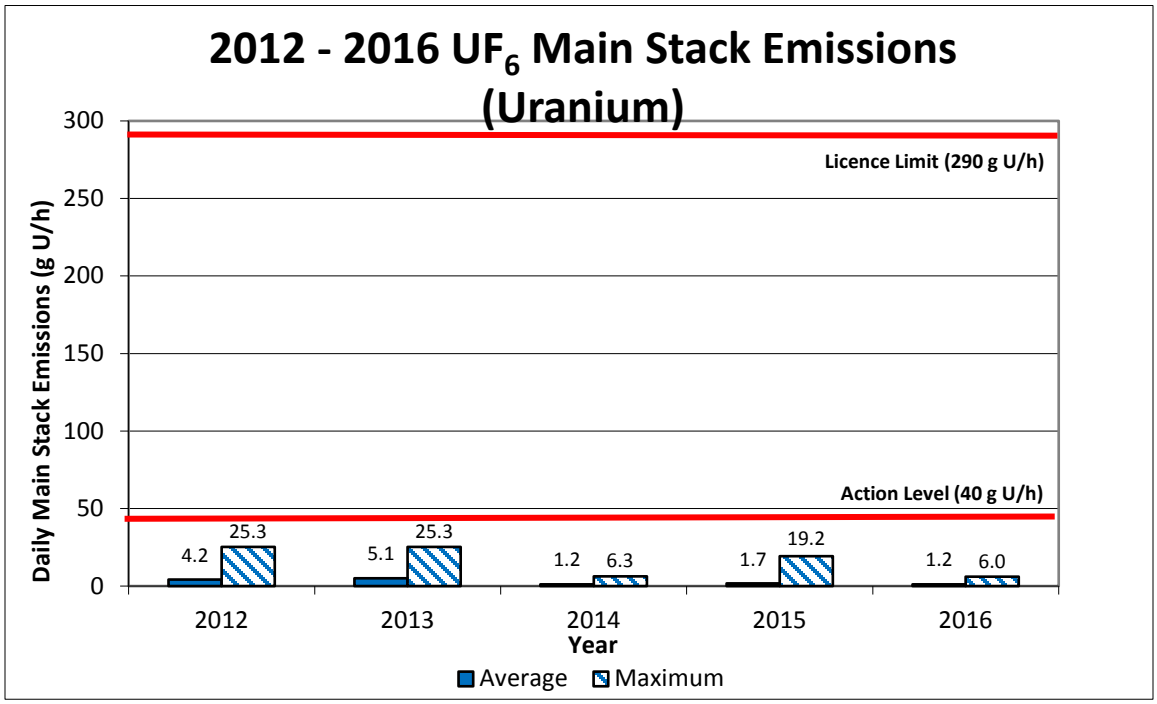


Figure 19

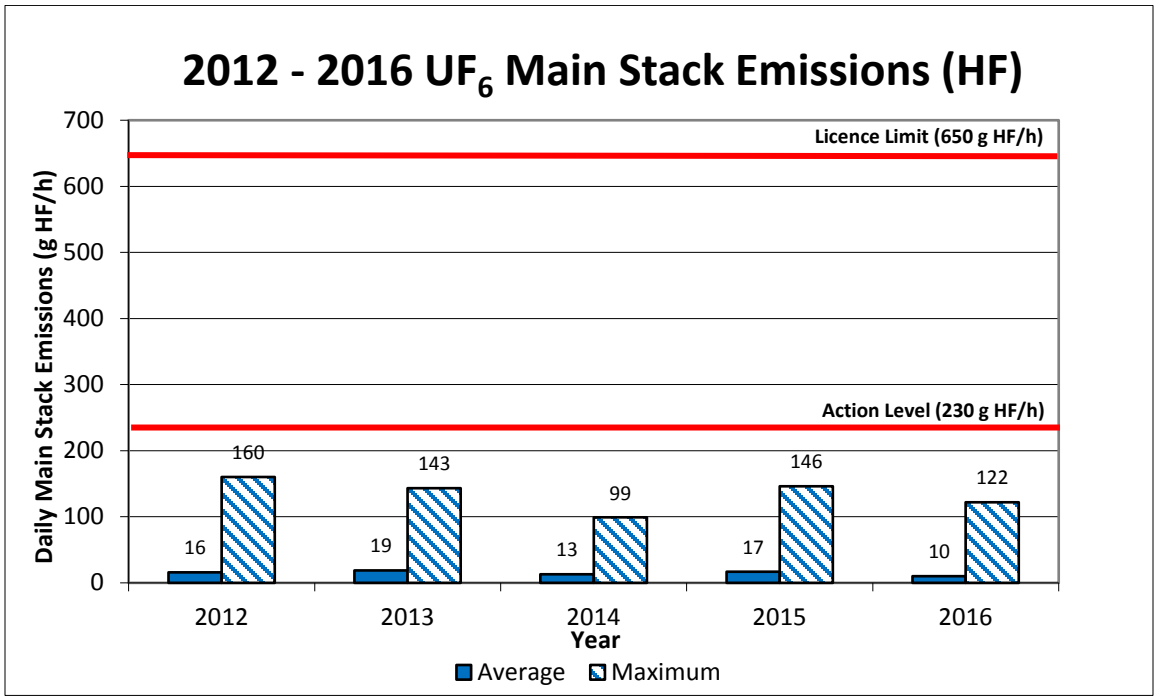


Figure 20

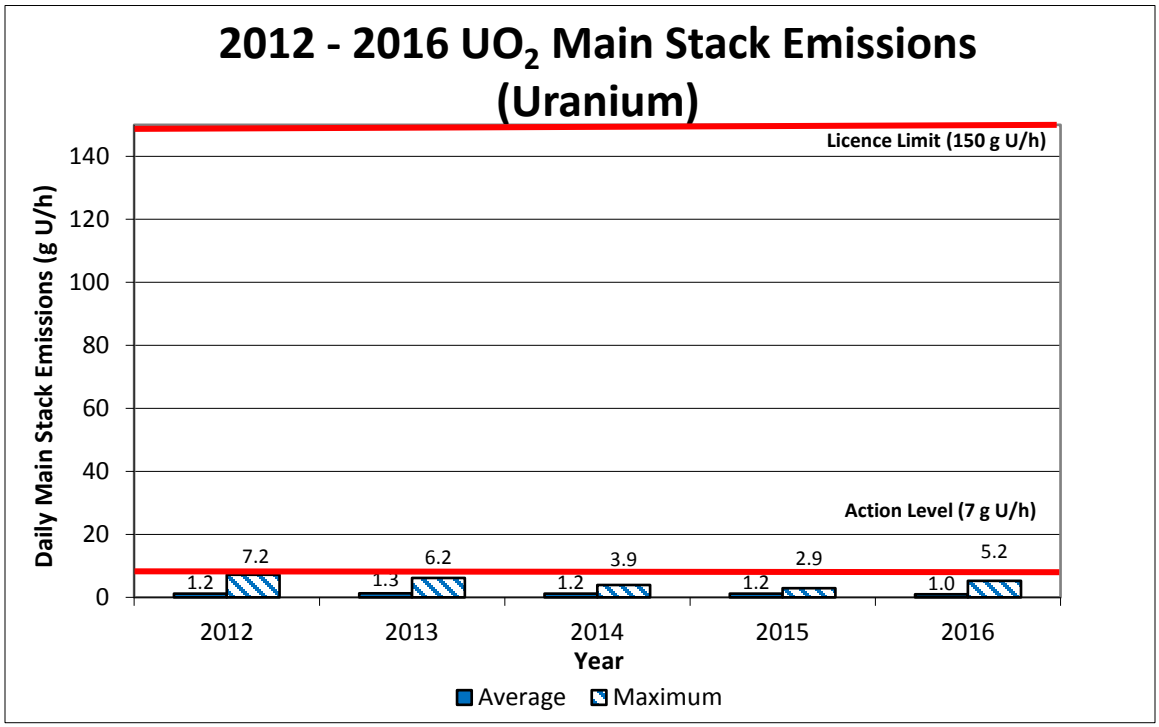
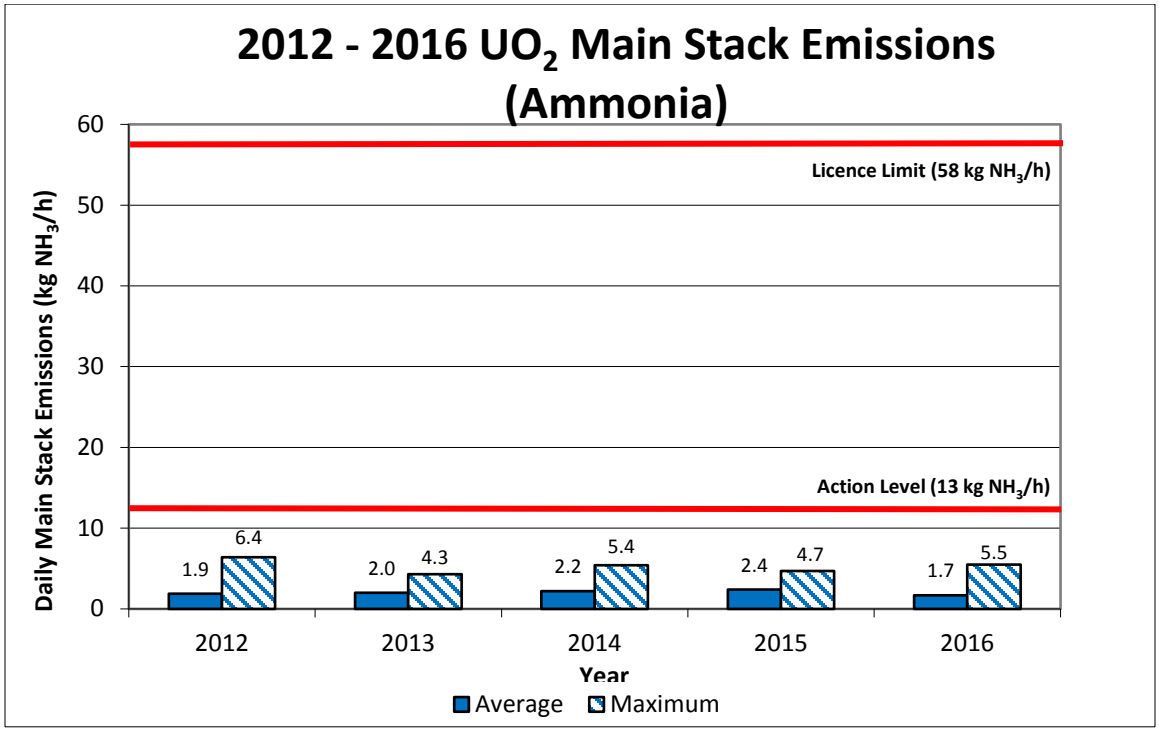


Figure 21



Ambient Air Monitoring

In support of the source sampling program, an ambient air program has been established to measure air quality near the PHCF. Samples from the site and the community are collected and analyzed for a variety of parameters. The facility's fluoride and uranium emissions have the greatest potential environmental impact and therefore are the primary focus of ambient air program.

Cameco monitors ambient uranium concentrations in the field using dustfall jars, high volume air samplers and soil samples. The results for these programs are provided below.

Dustfall monitoring is a measurement of deposition rate and is obtained by collecting particulate matter in a container, termed a dustfall jar. The particulate matter is collected over a one-month period, and analyzed to determine the uranium deposition rate. There is no regulated standard for uranium content in dustfall. Cameco has established an internal administrative screening level of 10 mg U/m^2/30 days that would be indicative of abnormal conditions.

No uranium dustfall results exceeded the internal administrative screening level in 2016. The facility uranium in dustfall results averaged 0.1 mg U/m^2/30 days in 2016, which is comparable to levels detected in previous years. It should be noted that dustfall uranium results observed from 2012 to 2016 are near method detection levels.

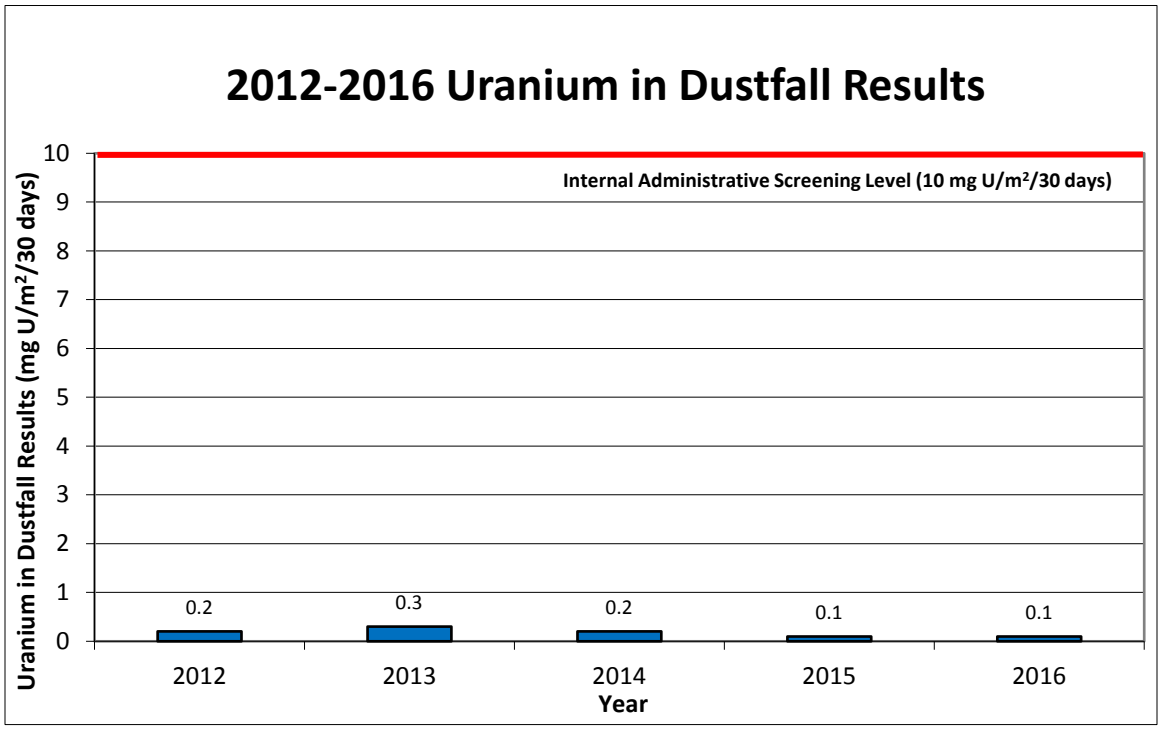
The annual all-station average uranium content in dustfall jars at and near the site in 2012 through 2016 is presented in Table 26.

Table 26

Comparison of Uranium in Dustfall Results (mg U/m^2/30 days)					
Period	**2012**	**2013**	**2014**	**2015**	**2016**
First Quarter	0.1	0.2	0.1	0.1	0.1
Second Quarter	0.3	0.2	0.4	0.2	0.1
Third Quarter	0.1	0.3	0.2	0.1	0.1
Fourth Quarter	0.2	0.4	0.2	0.1	0.1
Average	**0.2**	**0.3**	**0.2**	**0.1**	**0.1**
Cameco Internal Administrative Screening Level = 10 mg U/m^2/30 days					

Figure 22 shows the average uranium dustfall results from 2012 through 2016.

Figure 22



The high volume (hi-vol) air-sampling program monitors the concentration of uranium suspended in the air near the facility. There are four monitoring stations located at Marsh Street at the fence line just south of the UF_6 plant, east of the Port Hope Waterworks, Hayward Street and Shuter Street.

Approximately 40 cubic feet per minute of air is passed through and collects on a filter over a 24 hour period.

There is no regulated standard for uranium content in hi-vol monitoring. Cameco has established internal administrative screening levels of 1 µg U/m^3 24 h or 0.1 µg U/m^3 single station monthly average that would be indicative of abnormal conditions.

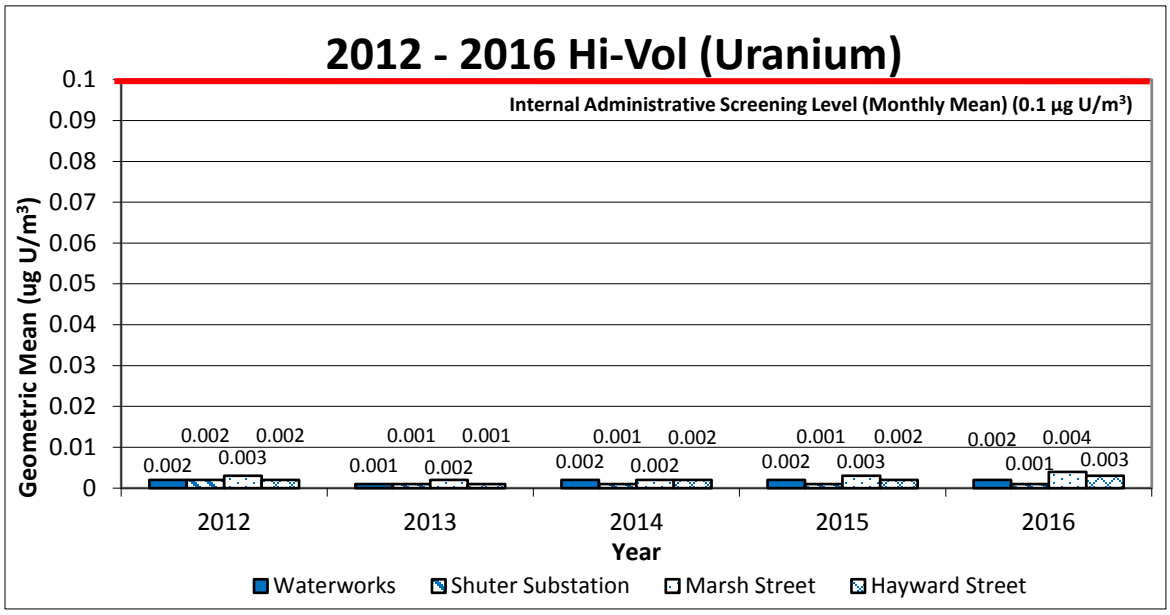
No uranium hi-vol exceeded the internal administrative screening level in 2016. Average hi-vol results for 2016 are comparable to levels observed in 2012 through 2015. Annual average results from all stations remain well below the new MOECC annual average POI standard of 0.03 µg/m^3 (PM_{10}), which took effect July 1, 2016.

Table 27 and Figure 23 show the average uranium hi-vol results from 2012 through 2016.

Table 27

2012 – 2016 Annual Uranium-in-Air Concentration at Hi-Vol Stations					
Year	**Result**	**Waterworks**	**Shuter Substation**	**Marsh Street**	**Hayward Street**
2012	Average	0.002	0.002	0.003	0.002
	Maximum	0.025	0.023	0.022	0.016
2013	Average	0.001	0.001	0.002	0.001
	Maximum	0.035	0.012	0.100	0.017
2014	Average	0.002	0.001	0.002	0.002
	Maximum	0.033	0.016	0.024	0.019
2015	Average	0.002	0.001	0.003	0.002
	Maximum	0.011	0.004	0.018	0.009
2016	Average	0.002	0.001	0.004	0.003
	Maximum	0.082	0.005	0.119	0.121
Cameco Internal Administrative Screening Level = 1 µg U/m^3 24h or 0.1 µg U/m^3 single station monthly average					

Figure 23



The concentration of fluoride emissions from Cameco in the ambient environment are monitored in the field using dustfall, lime candle and vegetation sampling. The results from these programs are provided below.

In addition to the uranium analysis discussed above, the fluoride content of the collected dust provides information of fluoride in air near the facility. There is no regulated

standard for fluoride content in dustfall. However, Cameco has established an internal administrative screening level of 20 mg F/m^2/30 days that would be indicative of abnormal conditions.

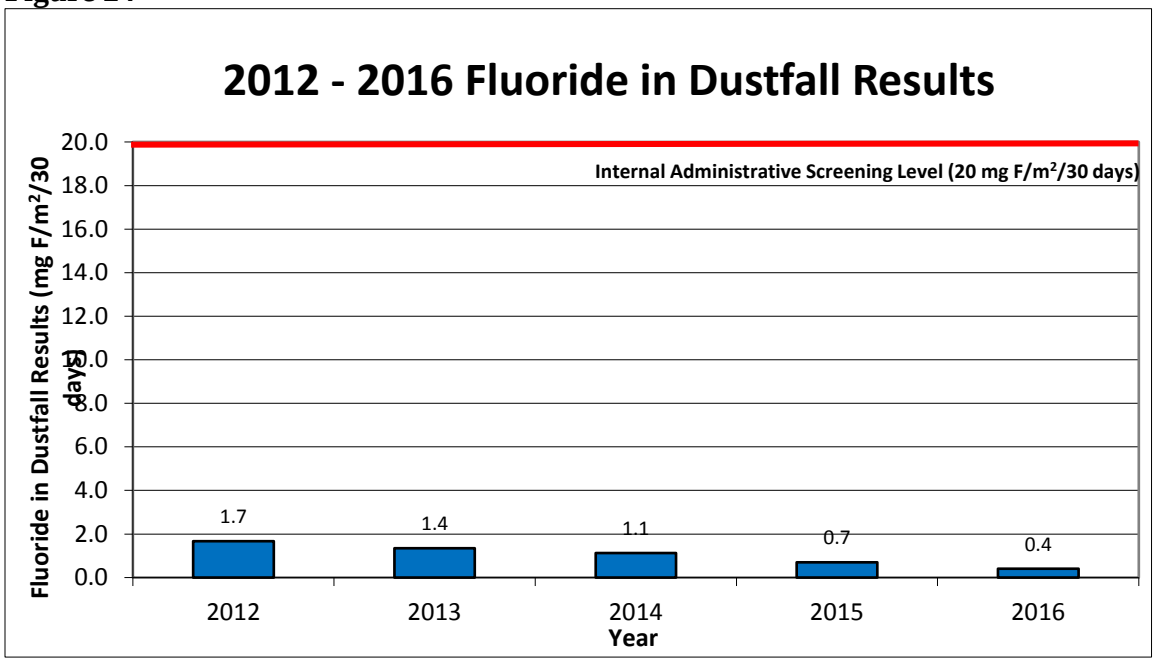
No fluoride dustfall exceeded the internal administrative screening level in 2016. The annual all-station average fluoride content in dustfall jars at and near the PHCF in 2012 through to 2016 is presented in Table 28. The dustfall fluoride levels observed are less than, but still comparable to levels observed in 2012 through 2015 and are within acceptable data range variation.

Table 28

Comparison of Fluoride in Dustfall Results (mg F/m^2/30 days)					
Period	**2012**	**2013**	**2014**	**2015**	**2016**
First Quarter	1.2	1.9	0.5	0.4	0.4
Second Quarter	2.0	1.2	1.0	0.8	0.7
Third Quarter	2.0	1.0	1.2	1.0	0.4
Fourth Quarter	1.5	1.3	1.8	0.6	0.2
Average	**1.7**	**1.4**	**1.1**	**0.7**	**0.4**
Cameco Internal Administrative Screening Level = 20 mg F/m^2/30 days					

Figure 24 shows the average fluoride dustfall results from 2012 through 2016.

Figure 24



Fluorination rate is an indirect measurement of the gaseous fluoride concentration in the ambient air. An established method for measuring the fluoride concentration in ambient

air is to expose lime coated filter papers, commonly called lime candles, for a fixed period of time. The fluoride reacts with the lime and the analysis of the lime candles provides a time-averaged fluoride concentration. Lime candles consist of a 10 cm x 10 cm filter paper that is soaked with a saturated calcium oxide (CaO) solution housed in a louvered shelter sampling station with a hinged top.

The lime candles are prepared, deployed and collected on a specified frequency and are analyzed. The period of time is normally 30 days; however, shorter terms of weekly periods are also used. These shorter-term results are used to assess impact in a timelier manner, and effect process changes to ensure that the monthly results are in compliance. Monthly and weekly lime candles are operated throughout the year. The MOECC Ambient Air Quality Criteria (AAQC) for fluoridation are 40 µg F/100 cm^2/30 days from April 1 to October 31 and 80 µg F/100 cm^2/30 days from November 1 to March 31. These criteria are based on the protection of foraging animals.

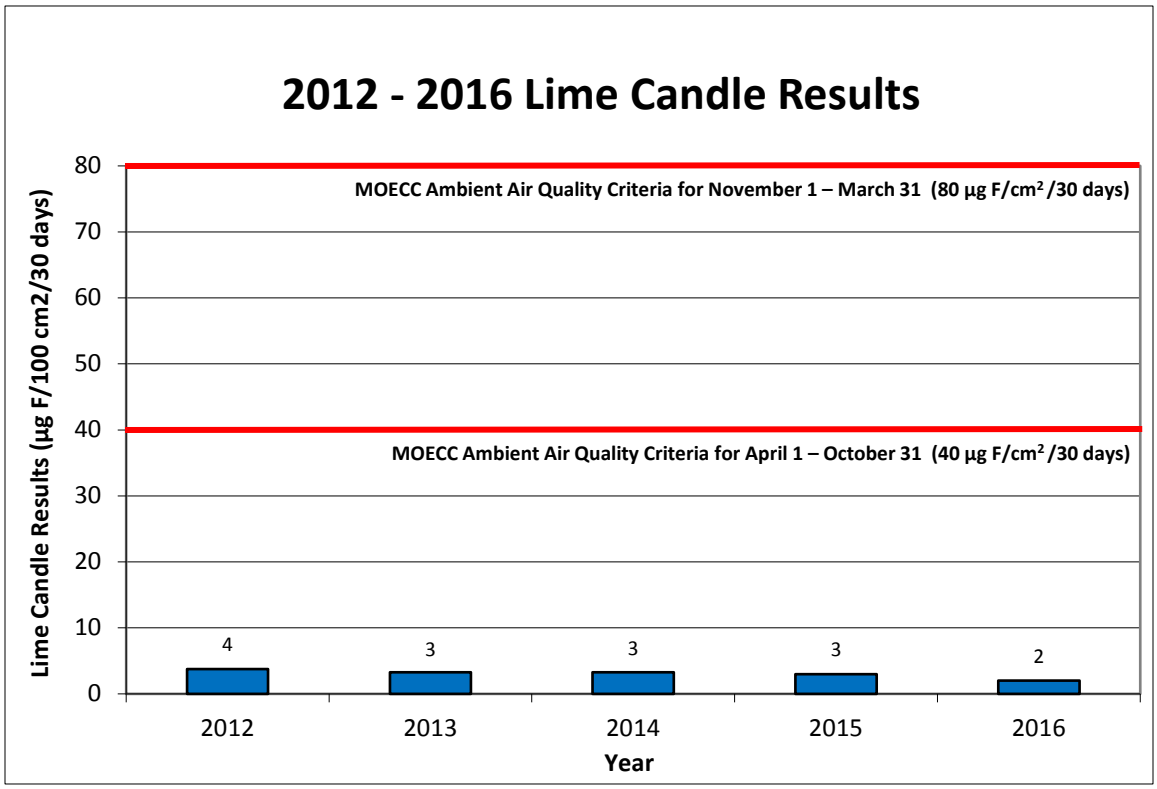
The quarterly average lime candle monitoring results are shown in Table 29 for 2012 through 2016. There were no lime candle results above the MOECC AAQC in 2016. The 2016 lime candle annual average is comparable to levels observed in previous years.

Table 29

Comparison of Monthly Lime Candle Results by Quarter (µg F/100 cm^2/30 days)					
Period	**2012**	**2013**	**2014**	**2015**	**2016**
First Quarter	4	4	3	3	2
Second Quarter	4	3	4	4	3
Third Quarter	4	4	3	3	3
Fourth Quarter	3	2	3	4	2
Average	**3**	**3**	**3**	**3**	**2**
The desirable ambient air quality criteria for lime candles are to protect forage crops consumed by livestock. During the summer growing season, the criteria is 40 µg F/100 cm^2/30 days, changing to 80 µg F/100 cm^2/30 days in winter.					

Figure 25 shows the average lime candle results from 2012 through 2016.

Figure 25



Soil Monitoring

The terrestrial sampling program, including soil and vegetation components, is carried out at frequencies specified in the individual procedures to supplement results from the PHCF air emissions monitoring programs and to monitor the long-term effects of facility air emissions, namely uranium and fluoride, in the areas surrounding the PHCF.

The soil monitoring program currently consists of five monitoring locations beyond the facility fence line. Three of these locations are within a 0 to 500 m radius zone from the facility, while the remaining two monitoring locations are within the 500 to 1000 m and 1000 to 1500 m radii. Only the clean fill soil plot data for the monitoring station located adjacent to the Port Hope Water Treatment Plant to the west of the facility is being reported herein.

The 2012 through 2016 uranium in soil in a clean fill soil plot data is provided in Table 30. The soil sampling approach was modified in 2015 to focus on the sampling of 15 cm cores and the collection of 0-5 cm, 5-10 cm and 10-15 cm core segments for compositing. Notwithstanding the above sampling approach updates, the five sampling locations were retained.

All individual sampling location values were below the Canadian Council of Ministers of the Environment (CCME) agricultural and residential/parkland land use soil quality guideline of 23 mg/kg (ppm). Moreover, all clean fill soil plot results were below the MOECC Table 1 full depth background site condition uranium standard of 2.5 µg/g (ppm) for residential/parkland/institutional/industrial/commercial/community land use.

Table 30

Clean Fill Soil Plot						
Depth (cm)	**2012**	**2013**	**2014**	**Depth (cm)**	**2015**	**2016**
0-2 cm depth	1.4	1.0	1.4	0-5 cm depth	1.0	1.2
2-6 cm depth	1.1	0.9	1.2			
6-10 cm depth	1.3	1.0	1.1	5-10 cm depth	1.0	1.1
10-15 cm depth	1.5	1.0	1.1	10-15 cm depth	1.2	1.0
70 cm composite	1.2	1.5	1.4			

Vegetation Sampling

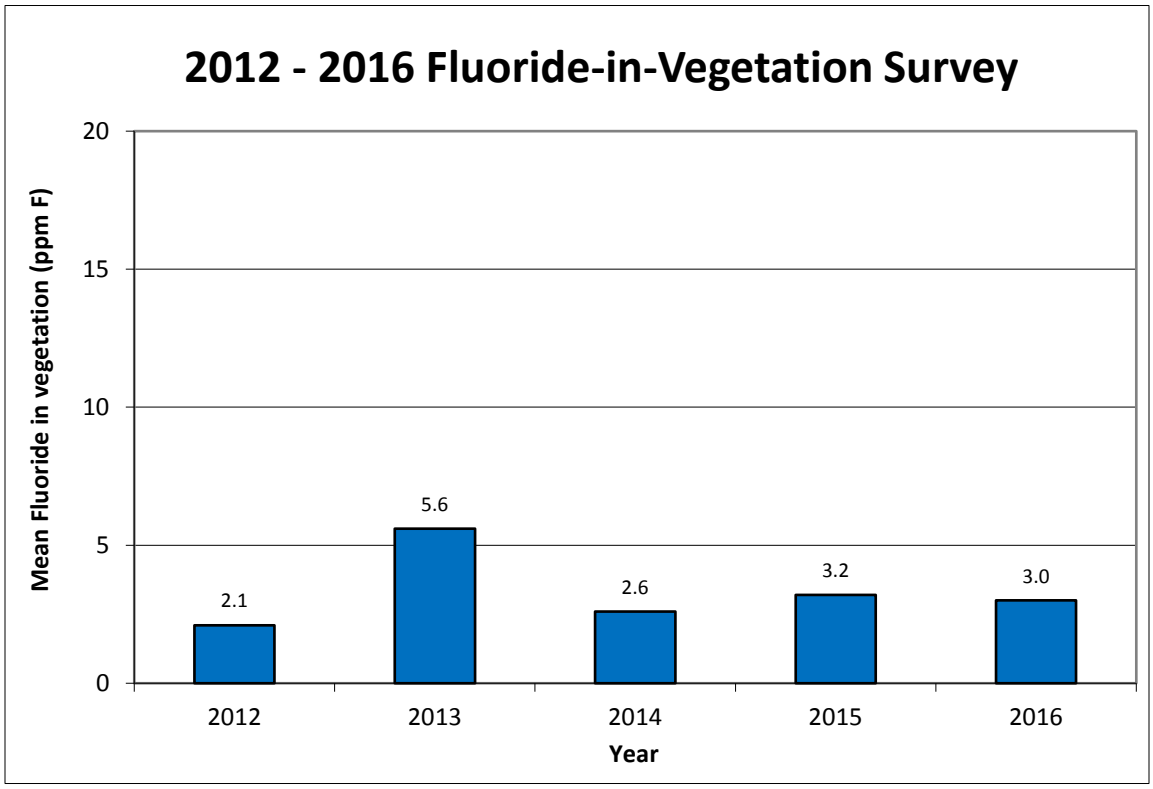
The focus of the vegetation monitoring program is foliar fluoride concentrations within the Municipality of Port Hope. Although the emissions control systems minimize the discharge of fluorides to the environment, the PHCF is an anthropogenic source of fluoride to the local environment.

Samples of fluoride-sensitive vegetation are collected in late-August or early September for fluoride analysis and assessed for visible foliar damage. The monitoring program is completed in conjunction with the MOECC and samples are obtained from locations adjacent to PHCF and throughout the surrounding community.

The 2016 vegetation survey was completed on September 2. All fluoride results were well below the MOECC's Upper Limit of Normal (ULN) guideline of 35 ppm.

Figure 26 illustrates the mean vegetation survey results for 2012 through 2016.

Figure 26



Discharge to Water

This section summarizes the PHCF liquid discharges and associated monitoring programs. Liquid discharge monitoring at the PHCF is divided into the following categories: Port Hope harbour water quality; liquid discharge monitoring; and sanitary sewage monitoring.

There are currently three types of point source discharges from the PHCF operations that are routinely monitored: cooling water returns, sanitary sewage discharge and a combined cooling water intake filter backwash (FBW) stream. Facility storm water discharge data is not summarized herein.

The FBW stream consists of harbour water used to back flush the travelling screens and downstream filters that comprise the facility cooling water intake mechanical pre-treatment operations.

Most of the PHCF cooling water requirements are met by the facility cooling water intake, located at the entrance to the Port Hope harbour. The remaining cooling water requirements are met by municipal potable water. A once-through cooling water system is used. The cooling water system takings, operations and discharges are regulated by MOECC via a Permit to Take Water (PTTW) and an ECA.

The municipal sewage treatment plant processes the sanitary sewer discharges from PHCF, including numerous on-site and some off-site contributions. A portion of the sanitary sewage discharge from PHCF originates upstream of the facility, primarily from the municipal water treatment facility. The principal facility sources are standard domestic contributions from facility washrooms and showering facilities, as well as Powerhouse effluent (i.e. boiler blowdown). All sanitary sewage sources merge into a common sanitary sewer line within PHCF prior to discharging to the municipal system.

A 2016 summary of select water quality data relating to the PHCF cooling water intake and discharges are shown in Table 31. The south cooling water intake (SCI), UF_6 plant + Building 2 cooling water return (UO_2N), and UO_2 plant cooling water return (UO_2S) have generally displayed consistent levels of uranium, fluoride, ammonia, nitrates and pH.

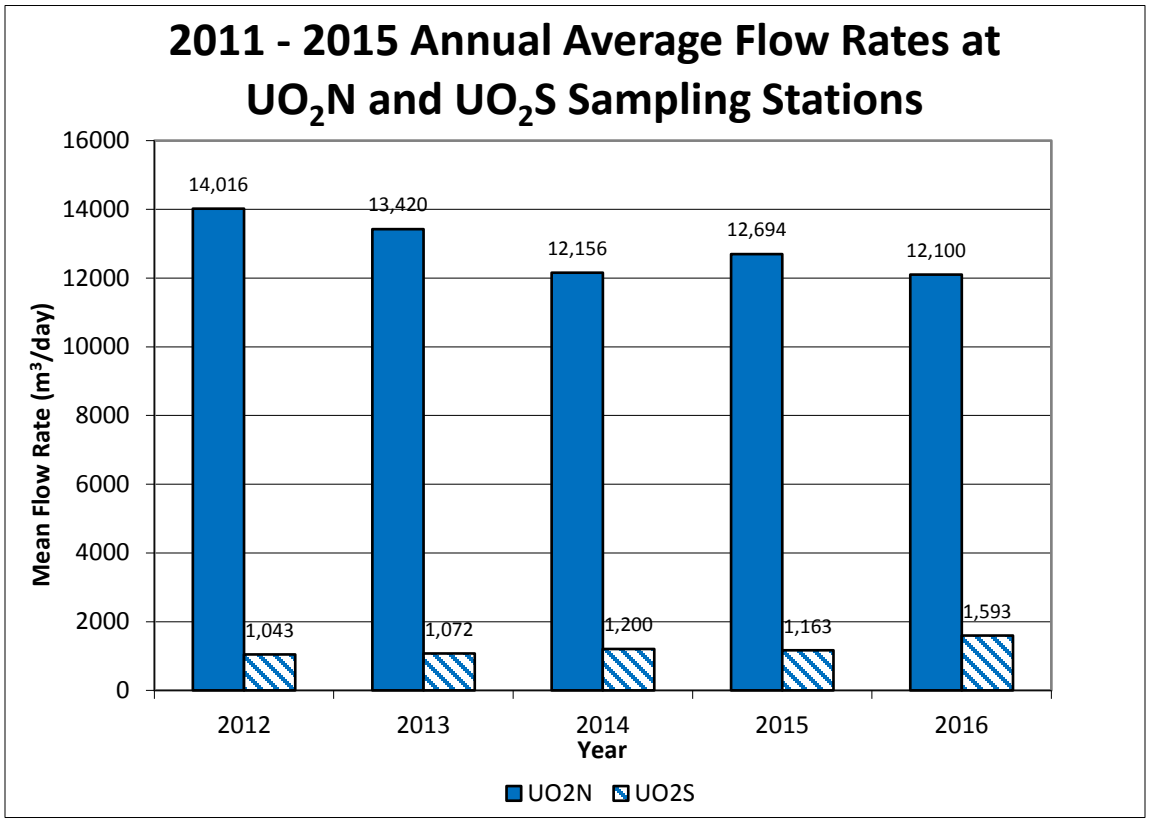
Table 31

Facility Water Quality Sampling Program										
Source	**Uranium (µg U/L)**		**Fluoride (mg F/L)**		**Ammonia + Ammonium (mg N/L)**		**Nitrate (mg N/L)**		**pH**	
	Avg	**Max**	**Avg**	**Max**	**Avg**	**Max**	**Avg**	**Max**	**Min**	**Max**
SCI	2.6	10	0.15	0.22	0.16	0.58	0.85	1.6	7.32	8.48
UO_2N	2.5	8.4	0.16	0.40	0.13	0.42	0.82	1.4	7.48	8.32
UO_2S	2.6	7.6	-	-	0.11	0.33	0.87	1.5	7.52	8.41
Note: Values are reported below the method detection limit, where applicable, to satisfy MOECC reporting requirements - indicates the parameter is not monitored										
SCI - Cooling Water Intake UO_2N – UF_6 plant + Building 2 Cooling Water Return UO_2S - UO_2 Plant Cooling Water Return										

Flow is monitored at both Port Hope harbour cooling water discharge points upstream of the respective discharges in accordance with MOECC MISA and ECA requirements. Flow rates observed at the UO_2N and UO_2S sampling points from 2012 through 2016 are presented in Figure 27.

In 2016, the average daily flow rates at the UO_2N and UO_2S sampling points were 12,100 m^3/day and 1,593 m^3/day respectively.

Figure 27



ECA 4998-9CKL7F requires specific sampling of the SCI, filtered cooling water supply (SCI-A) and cooling water discharge points UO_2N, UO_2S and FBW. The ECA requires the MISA cooling water sampling and flow monitoring requirements to be satisfied in addition to stipulating added sampling requirements.

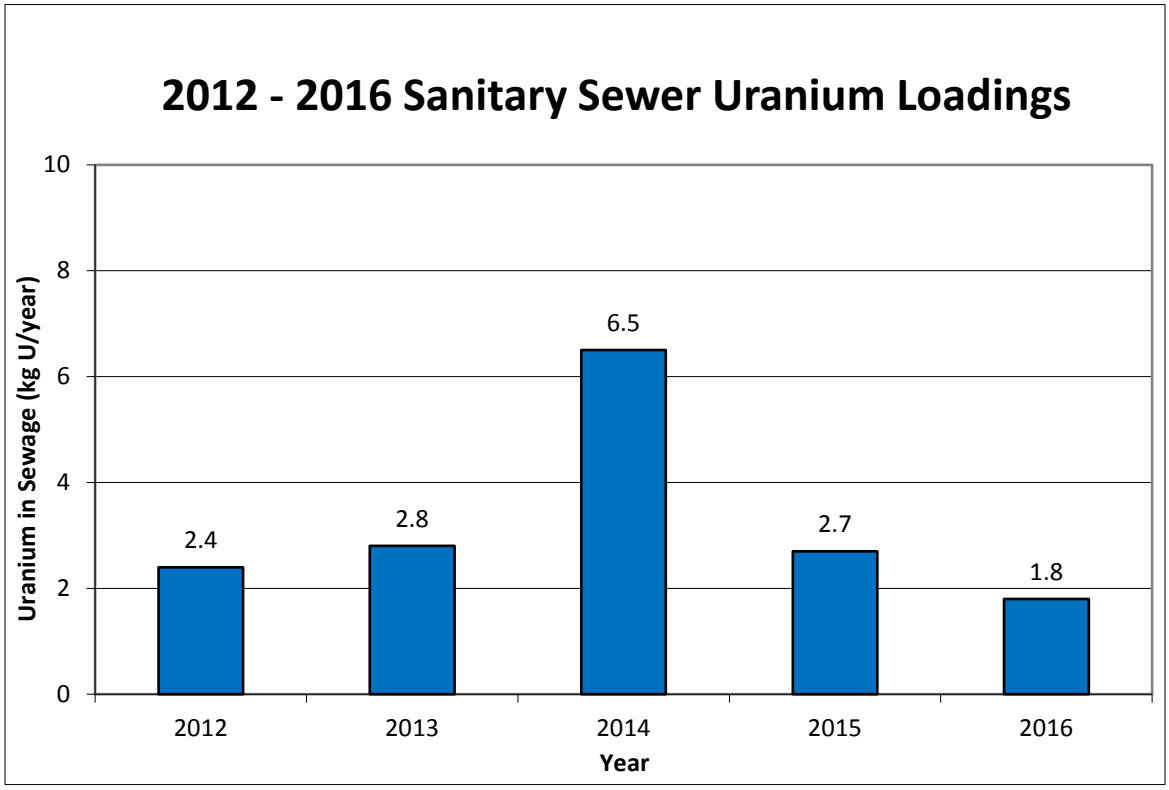
Overviews of ECA monitoring results with comparison to cooling water quality objectives and limits, among other items, are compiled in a separate annual performance report to fulfill additional CofA requirements. Annual performance reports are submitted to the MOECC within 90 days of the end of each calendar year.

The combined PHCF sanitary sewer return is sampled on a continuous basis using daily composite sampling. Table 32 summarizes the annual average uranium concentration and uranium loadings to the Municipality of Port Hope's sanitary sewer system. Uranium loadings are also illustrated in Figure 28. The mean sanitary sewer discharge rate and uranium loadings decreased significantly from 2014. The offset in flow is directly attributable to the 2014 implementation of Powerhouse effluent pH control system that displaced the need for effluent dilution.

Table 32

2012 – 2016 Sanitary Sewer Discharges			
Period	**Annual Average Flow (m^3/day)**	**Annual Average Uranium Concentration (µg/L)**	**Uranium Loadings (kg/year)**
2012	514	13	2.4
2013	826	10	2.8
2014	1,020	17	6.5
2015	379	19	2.7
2016	298	17	1.8

Figure 28



Harbour Water Monitoring

The ambient water quality program is concerned with monitoring the potential impacts of aqueous discharges into the receiving waters. Discharges to the harbour are from the three discharge points outlined previously as well as storm and groundwater flow through the facility. Given its proximity to the harbour outlet, the cooling water intake provides a reasonable indication of the overall water quality in the Port Hope harbour.

Water quality in the Port Hope harbour is sampled on a continuous basis by collecting daily composite samples from the facility's south cooling water intake (SCI). Table 33 provides a summary of select water quality parameters results for the SCI. The 2016 harbour water quality results were generally comparable to 2012 through 2015 results. Lastly, the 2014 maximum fluoride result should not be compared to the baseline monitoring data due to its association with the September 2014 UF_6 plant process effluent release to the Port Hope harbour.

Table 33

2012 - 2016 Harbour Water Quality						
Parameter	**Value**	**2012**	**2013**	**2014**	**2015**	**2016**
Uranium (µg U/L)	Average	3.7	3.3	3.3	2.9	2.6
	Maximum	10	8.3	7.6	6.6	10
Fluoride (mg F/L)	Average	0.099	0.10	0.11	0.13	0.15
	Maximum	0.14	0.18	0.39	0.17	0.22
Nitrate (mg N/L)	Average	0.83	0.84	0.86	0.89	0.85
	Maximum	1.5	1.6	1.5	1.7	1.6
Ammonia +Ammonium (mg N/L)	Average	0.10	0.11	0.23	0.20	0.16
	Maximum	0.40	0.35	0.52	0.66	0.58
Note :Values now reported below the method detection limit where applicable to satisfy MOECC reporting requirements						

The results of the harbour water quality for 2012 through 2016 are also illustrated in Figure 29 through to Figure 32. In accordance with the above feedback, the 2014 maximum fluoride result illustrated on Figure 30 should not be compared to the baseline monitoring data. Although slight increases in mean and maximum fluoride results are observed, all fluoride results were well below the Health Canada drinking water maximum acceptable concentration of 1.5 mg/L and the CCME aquatic biota toxicity benchmark (acute lethal endpoint) of 11.5 mg/L.

Figure 29

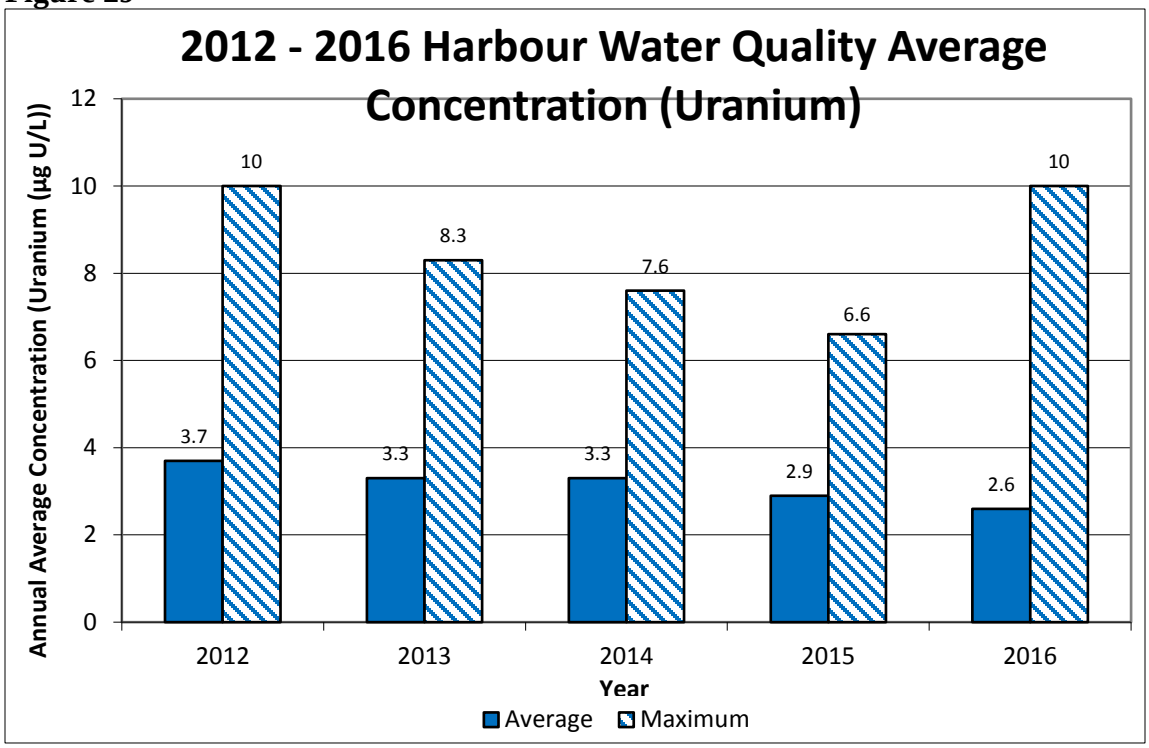


Figure 30

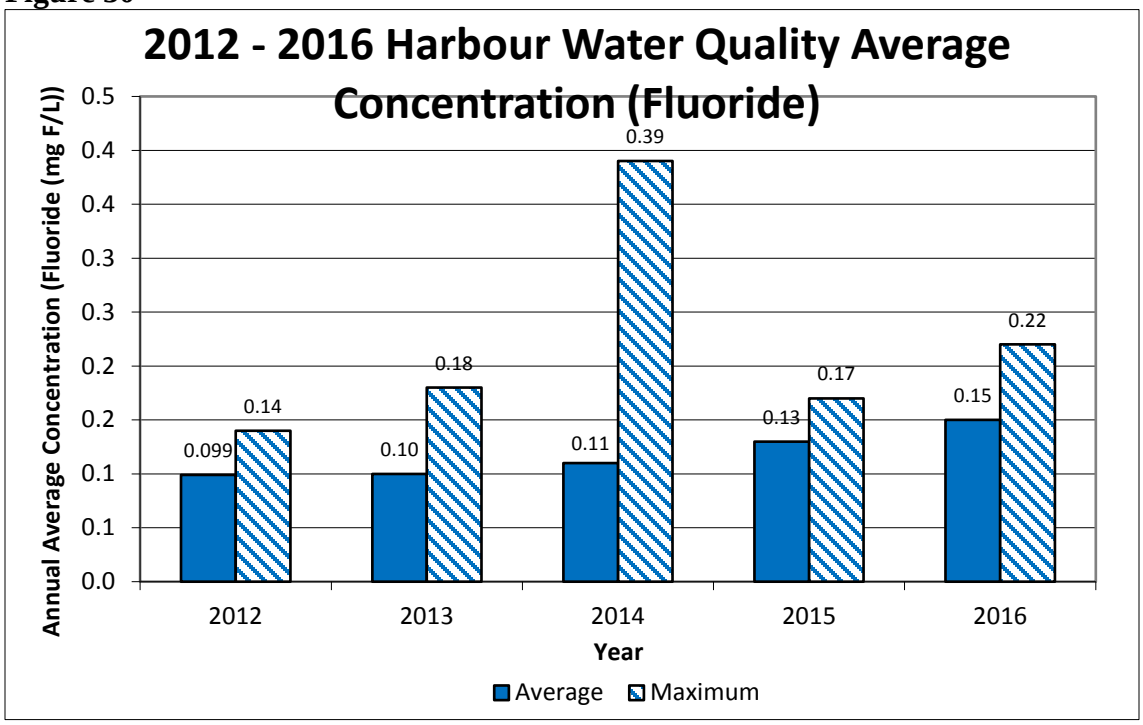


Figure 31

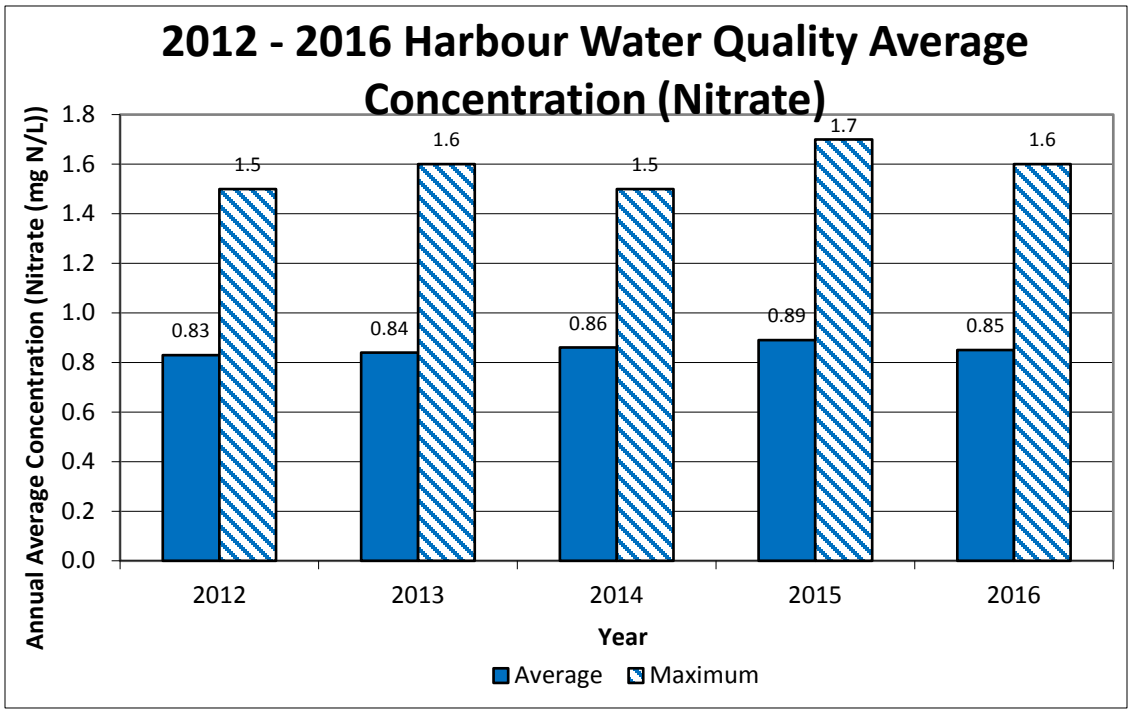
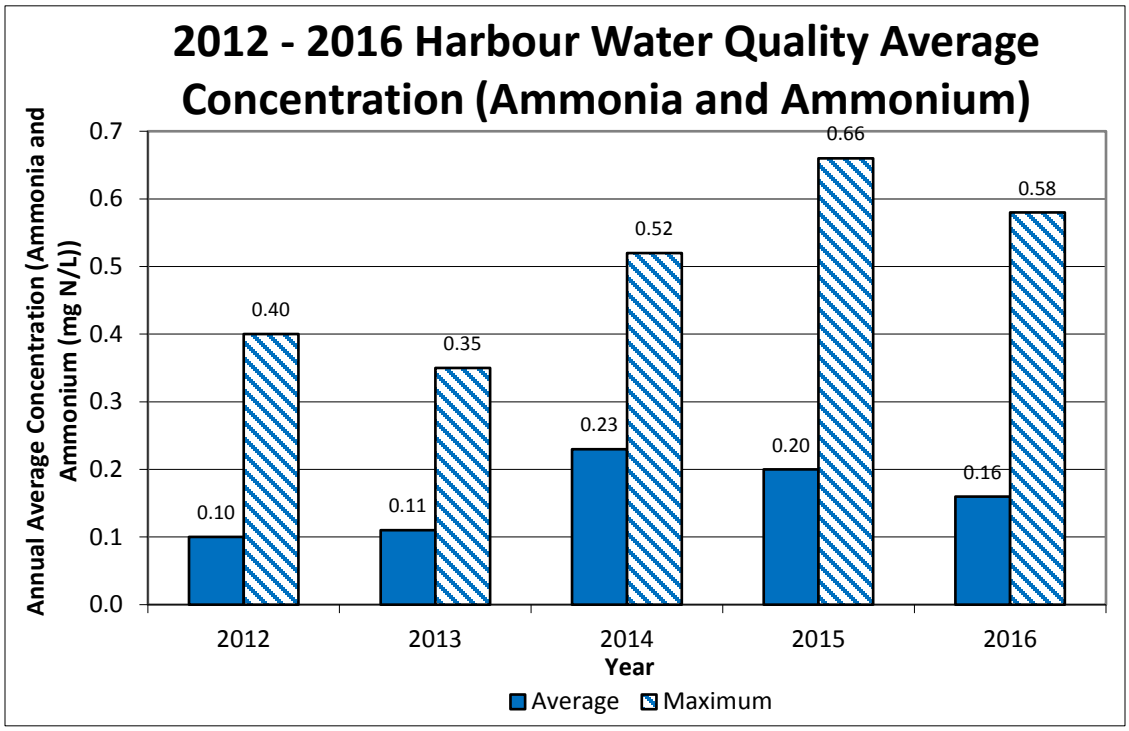


Figure 32



Storm Water Monitoring

A revised stormwater monitoring program was implemented in 2012 as a follow-up to the the completion of an updated Storm Water Control Study (SWCS) in 2011. The revised monitoring program is carried out on a semi-annual schedule at six storm sewer outlets discharging to the Port Hope harbour.

Groundwater Monitoring

The PHCF long-term groundwater monitoring program includes groundwater level monitoring and groundwater sampling at select wells. Groundwater level monitoring is completed on a quarterly or annual basis.

Groundwater is sampled under three separate schedules: monthly sampling of the operating treatment wells; quarterly sampling of overburden wells covering five key areas of the site; and annual sampling of bedrock wells. The five keys areas of the site include: the refinery wells; area impacted to the east of the UF_6 plant; area impacted south of the UF_6 plant; the former UF_6 plant area; and the UO_2 plant area.

Recovery of contaminated groundwater for treatment from the south and east sides of the UF_6 plant began in the first quarter 2008, while recovery of contaminated groundwater for treatment from the pumping wells between the UF_6 plant and the harbour, as well as one pumping well to the east of the UO_2 plant (TW2A), began in the fourth quarter 2008.

Four additional pumping wells commenced operation during the fourth quarter of 2011. These installations are located to the east of the former UF_6 plant (TW27A and TW27B) and to the east/southeast of the UO_2 plant (TW2B and TW2C).

Twelve treatment (pumping) wells were in operation in during the 2016 calendar year. Pumping well TW7 to the south of the UF_6 plant is no longer operated under baseline conditions.

Figure 33 illustrates the groundwater monitoring program well locations and associated general groundwater flow directions, among other items.

Figure 33 – Onsite Well Locations

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 and any results of emergency exercise participation.

The fire protection and security group has focused efforts to refine training to site specific chemicals, needs and responses for both emergency and medical requirements.

This activity and associated records are subject to various audits and are incorporated into the PHCF annual management review.

There were a number of internal drills and exercises conducted, which tested the effectiveness of the site and the emergency response organization. The following is a general list of the internal drills and activities in which the emergency response organization participated in 2016:

- Hazardous materials response drills, to include polychlorinated biphenyl (PCB), natural gas, ammonia and hydrogen fire response;
- Fire alarm response drills;
- Medical assistance drills;
- Building evacuation drills; and,
- ERT recall drills.

All drills and exercises are documented and deficiencies are tracked to ensure that appropriate corrective actions are taken.

The emergency response and training assistance agreement between Cameco and the Municipality of Port Hope, continues to ensure that the two response organizations are provided the opportunity to train together in order to prepare for emergencies that could require a joint response. Also, as part of the agreement, Cameco continues to provide Port Hope Fire and Emergency Services (PHFES) with the necessary equipment and training to effectively respond to emergencies at the PHCF.

Cameco and PHFES continue to find opportunities to bring the organizations together for training and other activities. Additionally, Cameco has supported the PHFES for responses in the municipality and for non-emergency related initiatives. An example of the interactions in 2016 included:On November 24 and 25, the Emergency Response Team (ERT) conducted joint high angle rope rescue officer training and confined space training with PHFES at Rattle Snake point, Oakville Ontario.

Emergency preparedness and response training is provided on an ongoing basis to ensure that responders have the knowledge and skills necessary to provide for an effective emergency response. In 2015, there were 3924 hours of training conducted with 97% of responders successfully meeting the training criteria.

The PHCF Fire Protection program (FPP) has been designed to promote fire safety within the site and minimize the likelihood and frequency of fire as well as the potential impact on the health and safety of the employees, contractors, the public, the environment and Cameco's assets and continuity of operations. In order to confirm the effectiveness of the Fire Protection Program, the following third party verifications were conducted in 2016:

- Fire Protection Inspection, Testing and Maintenance Records Audit;
- Annual Plant Condition Inspection Audit;
- Fire Hazard Analysis for the UO_2 and UF_6 plant;
- Annual Sprinkler Inspections Testing and Maintenance; and
- Annual Alarm Inspection and Verification.

The third party verifications listed above are documented and deficiencies are tracked to ensure that appropriate corrective actions are taken.

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 at the facility are segregated at the point of generation into contaminated and non-contaminated. Non-contaminated waste is either recycled or transferred to a suitable facility. Contaminated waste is stored in appropriate containers pending assessment of recycling or disposal options.

In 2016, a total of 27.3 tonnes of non-contaminated wastes were sent to a local landfill. A total of 35.1 tonnes of non-contaminated materials were sent to a recycling facility for recovery.

PHCF produces two by-products at the facility. These include ammonium nitrate which is sold to a local fertilizer company and fluoride product which is sent for uranium recovery at a licensed facility. The amount of ammonium nitrate recycled in 2016 was 1,914 m^3. A total of 1,952 drums (243,926 kg) of fluoride product were generated in 2016.

In 2016, PHCF generated 306 totes of contaminated combustible materials (CCM) and shipped the totes to BRR for incineration. During the same period a total of 2286.9 tonnes of contaminated non-combustible materials (CNC) were generated. As a note, the large increase in CNC generated material in 2016 is related to VIM and Super CUP waste. There was a large inventory of VIM and Super CUP material generated in 2014 and 2015 but inventory records were not included until 2016.

PHCF recycled 76,850 kg of metal after decontamination to free release criteria.

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.

PHCF maintains a comprehensive security program which meets the requirements of the General Nuclear Safety and Control Regulations, the Nuclear Security Regulations and other CNSC requirements.

The 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, this document is considered prescribed information and is subject to the requirements of the General Nuclear Safety and Control Regulations.

PHCF ensures that security operations and procedures are reviewed (and revised as needed) in order to maintain compliance with General Nuclear Safety and Control Regulations, the Nuclear Security Regulations and other CNSC requirements.

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.

PHCF participated in ten safeguard inspections/activities in 2016:

- An international shipment verification was conducted on January 13.
- A Short Notice Random Inspection was carried out on March 1 and 2.
- A second international shipment verification was conducted on March 8.
- A UO_2 sampling campaign was conducted in the second quarter to support an IAEA investigation into the UO_2 ageing process. This was a voluntary activity to support ongoing improvements to Safeguards implementation within Canada.
- A Short Notice Random Inspection was carried out on June 2 and 3.
- A 3D laser modelling activity was conducted in the second quarter to support the CNSC's use of 3D laser and models to determine the contents of process tanks. This was a voluntary activity to support ongoing improvements to Safeguards implementation within Canada.
- A Physical Inventory Verification was carried out July 4 to 15.
- A Short Notice Random Inspection was completed November 3.
- A Design Information Verification was carried out December 6 to 8. This activity was not completed, additional time to complete this activity has been scheduled for the first quarter of 2017.
- On December 9, PHCF hosted an information meeting/tour with the CNSC regarding bulk density in powders and the impact on volume measurements in the UO_2 plant.

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.

Uranium dioxide (UO_2) is produced, packaged in drums and transported by road from the PHCF to Cameco's Fuel Manufacturing Facility in Port Hope and/or other domestic fuel manufacturing facilities. UO_2 is also packaged in drums and transported by road and marine overseas to Japan, South Korea, Romania and Argentina. There is also a small amount of material transported by air for customer evaluation purposes. The drums used for air transport meet the Type IP-3 packaging requirements; all other drums meet the Type IP-1 packaging requirements as specified in the CNSC *Packaging and Transport of Nuclear Substance Regulations*.

Uranium hexafluoride (UF_6) is produced and transported in Type H(M) and H(U) cylinders certified by the CNSC by road or marine from the PHCF to the USA or overseas, including but not limited to, the United Kingdom, France, Germany, Holland and Japan.

In addition to UO_2 and UF_6, uranium scraps and by-products are transported by road from the PHCF to Cameco's Key Lake operation or to the USA for uranium recovery.

There was one reportable transportation event which occurred at the PHCF in the fourth quarter regarding the misclassification of empty drums.

3.0 OTHER MATTERS OF REGULATORY INTEREST

3.1.1 Public Information Program

In 2016, PHCF continued to meet the requirements of CNSC RD/GD 99.3, Public Information and Disclosure programs.

The communications team for Cameco's fuel services division began the year with: a director of public and government affairs; a manager, external communications; a community relations liaison, and two communications specialist. Due to company-wide restructuring, the position of manager, external communications was eliminated. The divisional communications team is part of Cameco's corporate responsibility and communications department.

Cameco has retained outside expertise for the past 12 years to measure public opinion in Port Hope to help determine the effectiveness of its public information program. The final report of the 2016 public opinion research conducted for Cameco by Fast Consulting was posted on Cameco's FSD website in June 2016. More than 400 Port Hope residents were randomly contacted by telephone and asked to respond to a series of questions about their perception of Cameco's operations in the community.

Among the key findings:

- the large majority (89%) of respondents support the continuation of Cameco's operations in Port Hope including 60% who are 'strongly supportive' (vs. 53% in 2015). This high level of support is consistent with previous surveys.
- a majority of residents (71%) do not have any specific concerns with the presence of Cameco's operations in Port Hope;
- a majority of residents (85%) agree that Cameco does everything possible to ensure public safety;
- a majority of residents (80%) think that Cameco makes information about its operations in Port Hope readily available to residents, this is up from 2015;
- a majority of residents (91%) agree that Port Hope is a safe and healthy place to live; and
- a majority of residents (78%) agree that the regulatory process from various regulatory organizations adequately ensures their safety.

The results of this public opinion research confirm that Cameco's public information program is seen as effective and appropriate by the vast majority of Port Hope residents.

Results in most categories were consistent with surveys conducted over the past several years.

Local media coverage of Cameco was light and generally neutral in tone during 2016. Most media attention continues to focus on Cameco`s sponsorship of and employee participation in local community events. During 2016, while PHCF participated in its relicensing hearing, more stories appeared regarding the operations, but they remained neutral to positive. During relicensing the coverage focused a great deal on the hearing for the Port Hope Area Initiative (PHAI) and less attention focused directly on Cameco.

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. These channels are used to share information about community investments, upcoming events and activities, employee volunteer activities and other matters of potential public interest.

As social media outreach continues to mature and increase in frequency, the number of "followers" who have "liked" the Cameco page increased to 332. As well, our Twitter feed has grown to a lesser extent with 135 followers. With shares and retweets, several posts garnered larger audiences and resulted in many more people viewing our posts.

Cameco also continued to closely monitor social media channels focused on Port Hope. A review of postings on several Facebook pages dedicated to local political issues (Port Hope Politics, Friends of the Port Hope East Beach, Restore the Port Hope West Beach) demonstrated that interest in Cameco and nuclear issues ebbs and flows, based on what is being covered in the mainstream media as well as on other social media sites. There was little focus on Cameco in 2016 in the Port Hope Politics discussion forum. A few posts mentioned Cameco corporation's news releases and the local coverage of announcements. During the facility's relicensing hearings, few posts were made on this page, but comments remained largely neutral to positive mentioning interventions and the hearing process. As well, discussions mentioned the PHAI and cleanup efforts in the municipality. The Restore the West Beach Group posted information on several issues but primarily focused on Cameco's Vision in Motion project and the proposed municipal roadway to the west and south of the future property lines. Also during relicensing, an intervenor, Lake Ontario Waterkeeper, mentioned its involvement in Cameco's relicensing process on its blog page.

Since 2006, Cameco's FSD has had its own dedicated website to supplement information found on the corporate website (www.cameco.com). The FSD website provides more specific information about all three operations that comprise the division. Although the site can be accessed through a number of URLs, the primary access point is

www.camecoporthope.com. The website is promoted through a variety of methods, including advertisements and inclusion in all external newsletters. In 2016, a redesign of this website began. This new site will be launched in early 2017 and at this time the URL will change and a promotional campaign will ensure the local community is aware of this change.

The FSD 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, as well as presentations from community forums were posted in a timely manner.

Information about three environmental or operational incidents were posted to the website in 2016. There were no follow-up inquiries from either members of the public or the media.

As part of our commitment to keep residents informed about what is happening at our facilities, we also posted information about other types of events that could be of interest to the community. Of important note this year, a significant amount of information and documentation related to PHCFs relicensing was posted. In addition to posting all public licensing documents, for the first time summaries of several other technical documents were created and posted. This was done with the purpose of providing the public with the ability to learn more through less technical relicensing documentation.

Though traffic on the FSD website has shown a decline the past year with 3,681 unique page views in 2016, the landing page for PHCF was by far the most frequently visited of the three FSD licensed facilities with more than 5,100 hits. Analysis of unique page views indicate that most visitors are attracted to the pages providing information about contacting Cameco and careers, with more than 5,400 hits.

Cameco values the effective working relationship it has built with the Municipality of Port Hope (MPH) over the past several years. Cameco provides summaries of our quarterly environmental reporting to the Port Hope Council and offers to appear at council meetings in order to respond to any questions that might emerge from the quarterly results of the environmental monitoring program.

Cameco continued with the open community forum model introduced in 2006. An open, flexible, broadly-based forum model enables the company to improve its outreach program with all of its stakeholders, as well as to bring a common information base to all interested parties, both active special interest groups and passive community members. Question and answer sessions involving company representatives as well as guest speakers are an important part of the process. Participants have the opportunity to provide either written or oral questions.

Cameco promotes the forums in several ways. A database including more than 300 names has been developed. Individuals and organizations included in the database have specifically requested to be kept informed of Cameco's public events. Among those included are residents of Port Hope; municipal council members; local businesses and business organizations; special interest groups; non-governmental organizations; local and regional media; community service organizations; and other interested parties. Cameco also extends an invitation for every forum to the five First Nations bands in closest proximity to Port Hope. These are the Alderville First Nation, the Hiawatha First Nation, Mississaugas of Scugog Island, Mohawks of the Bay of Quinte and the Curve Lake First Nation. In addition, Cameco also sends a written invitation to the Metis Nation of Ontario.

To further encourage attendance at the forums, Cameco produces radio and print advertisements, posts an advisory on the FSD website and on its social media channels to ensure that as many people as possible are made aware of the event. Presentations made at the forums are posted on Cameco's community website.

In 2016, in addition to a regular Cameco community forum held in April and attended by approximately 50 local residents, for the first time Cameco also jointly hosted an information meeting with the PHAI. This meeting was held at the Cameco Capitol Theatre and attended by more than 90 people including several local media and members of the municipal council. Held in late September ahead of the facility's relicensing hearing, the information meeting provided the public with a coordinated perspective on the PHAI cleanup and Cameco activities related to its execution of Vision in Motion (VIM), Cameco's project to clean up and renew the Port Hope conversion facility. The information meeting was jointly hosted and included presentations from Cameco and PHAI's leaders as well as the senior project leaders from each project who provided detailed timelines of key activities as well as a description the activities conducted by PHAI and Cameco.

A range of questions were raised from the audience, primarily directed towards the PHAI with residents concerned about issues of property value, the dust and noise of the cleanup activities and the areas of the municipality selected for cleanup by the PHAI. These questions were largely raised in the context of the PHAI cleanup rather than related to Cameco's VIM related activities. The presentation from this evening was posted on the community website.

Throughout the year Cameco also hosted a number of meetings with representatives from interested groups. In particular ahead of relicensing, Cameco offered meetings with several special interest groups who intervened. A tour and meeting was hosted with the Lake Ontario Waterkeepers to provide them with a more perspective of the site and

address questions raised in their intervention. Letters were sent and phone calls made to the Mohawks of the Bay of Quinte, offering tours and / or further information related to their intervention with no response.

In 2016 any phone calls and emails came from individuals seeking either employment or community investment. There were no calls from citizens expressing environmental concerns.

Several hundred visitors were welcomed by more than 20 Cameco employees at the company's information tent at the 2016 Port Hope Fair. Colourful display boards provided information about the local operations, the role of nuclear in the province and the world as well as Cameco's community involvement. Two entire sections of the display were dedicated to providing details on the VIM project and the, then upcoming, Relicensing hearings for PHCF. Employee volunteers were on hand to welcome fair-goers and address questions. Most questions received focused on the Vision in Motion project or community investment opportunities.

In May, Cameco held its second annual career day at Port Hope High School. Approximately 25 employees holding a range of positions in the organization manned tables in the school's gymnasium to talk with students about their own personal education, training and work experience. Students from all four grades at the school attended.

Cameco provides tours of PHCF to a number of groups and individuals each year. Although most involve customers, nuclear industry representatives and regulators, several tours were provided to members of the public in 2016. They included:

- Durham College Chemical Engineer Students
- Ministry of Environment & Climate Control
- Northumberland Paramedics
- Lake Ontario Waterkeeper
- A group of grade nine students who were participating in "Take Your Kids to Work Day".

Cameco continued to develop partnerships with and provide financial and volunteer support to a number of events and organizations in Port Hope and the surrounding area. Cameco also continued efforts to increase the profile of local organizations by inviting more than 20 local charities to attend its second annual "Charity Fair" at the PHCF. Employees were provided information and introduced to members of the charities that benefit from the annual employee giving campaign.

Among the organizations that received from financial and/or volunteer support in 2016:

- Northumberland United Way;
- YMCA Northumberland's Swim to Survive Program
- Northumberland Hills Hospital;
- Habitat for Humanity Northumberland;
- Fare Share Food Bank;
- Canada Day celebrations in Port Hope and Cobourg;
- Float Your Fanny Down the Ganny;
- All-Canadian Jazz Festival;
- Junior Achievement;
- Scientists in School;
- Port Hope's Jack Burger Revitalization Project; and
- Northumberland Food for Thought.

Our employees remain our most trusted resource for information and we work to engage with the community as much as possible. In 2016, more than 300 Cameco employees volunteered at company-sponsored events in Northumberland County.

3.1.2 Site - Specific

The nuclear criticality safety program at the PHCF follows the criticality control principles as described in Radiation Protection Program Manual (section 8). In summary, processing of any amount of enriched material at the PHCF is governed by a criticality control committee (CCC) as described in the revised Nuclear Criticality Safety Program Manual. There were no processing activities of enriched material conducted on site in 2016.

Cameco has an accepted Preliminary Decommissioning Plan (PDP) and financial guarantee for the PHCF.

The PHCF met all other site-specific reporting requirements.

3.1.3 Improvement Plans and Future Outlook

The following is a summary of improvements planned to be implemented during 2016 at the PHCF.

Vision in Motion (VIM) is Cameco's plan to clean up and renew the PHCF. The project builds on work now under way through the Port Hope Area Initiative (PHAI) to address historic low-level waste issues in the Municipality of Port Hope. It provides Cameco with an opportunity to deliver an allowance of qualifying waste materials to the Long-Term Waste Management Facility (LTWMF) that will be constructed by the PHAI on the site of the licensed Welcome Waste Management Facility.

Demolition of Buildings 42 and 43A on the Centre Pier, which began in late 2015, was concluded in March 2016, reducing financial liabilities and other risk associated with these aging structures which were no longer in use. This work also provided information for VIM planning. Portions of the building that were contaminated or suspected to be contaminated were placed into storage on the center pier. There were no recordable environmental or safety incidents associated with the work.

The 2016 SuperCUP campaign, which focused on equipment removal from Buildings 2, 27 and 31 was successfully completed. There were no recordable safety or environmental events associated with the work.

VIM planning activities were progressed. Work is focused on refining the design scope that has previously been presented to regulators, Municipality of Port Hope and the local community. The project is now ready to begin detailed design. A joint regulators meeting was held to provide an overview of the PHCF Licence Renewal, Vision in Motion and Overall Environmental Performance to CNSC, ECCC and MOECC representatives. CNSC accepted the Supplementary Environmental Monitoring Plan for Vision in Motion and Other Clean-Up Program Projects.

Cameco and Canadian Nuclear Laboratories (CNL) working groups coordinated requirements for future activities. Topics of discussion have included Waste Acceptance Criteria, progression of activities on the Centre Pier and harmonization of environmental monitoring programs. Cameco and CNL issued joint letters to CNSC to clarify materials from Cameco that are eligible for placement into the Port Hope LTWMF and to clarify the approach to coordinating work at the Centre Pier property. Trilateral meetings were held with CNL, the Municipality of Port Hope and Cameco to exchange information and align planning.

Cameco and CNL held a joint community information meeting to outline the plans for coordinating remediation work in the area of the Port Hope waterfront. Coordinated efforts were described to the community, including a collaborative approach to dealing

with remediation of the harbour wall structures on the west side of the turning basin where Cameco and CNL remediation responsibilities abut one another. The planned approach has received positive feedback from the Municipality of Port Hope.

Cameco is not planning any other major changes in 2017 that could require the Commission's approval.

3.1.4 Safety Performance Objectives for Following Year

There are no major changes planned in 2017 that could require Commission approval.

PHCF 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.

4.0 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 2016, PHCF did not exceed any CNSC regulatory limits. As a result of the effective programs, plans and procedures in place, the PHCF 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.