2018 Fourth Quarter Compliance Monitoring
&
Operational Performance Report

Reporting Period October 1 – December 31, 2018

Cameco Fuel Manufacturing Inc.
Fuel Facility Operating Licence
FFOL-3641.00/2022

200 Dorset Street East
Port Hope, Ontario
L1A 3V4

Submitted to:
The Canadian Nuclear Safety Commission
P.O. Box 1046, Station B
280 Slater Street
Ottawa, Ontario
K1P 5S9

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 Fuel Services Divisional (FSD) head office.

CFM operates a Class IB nuclear facility in Port Hope, Ontario and employs approximately 145 workers. In addition, approximately 130 employees work at a metal manufacturing plant located in Cobourg, Ontario, which does not handle uranium products. In the fourth quarter of 2018, CFM operated under the licence FFOL-3641.00/2022 issued by the Canadian Nuclear Safety Commission (CNSC), which took effect on March 1, 2012. On August 18, 2015, CNSC staff issued CFM Revision 1 of the Licence Conditions Handbook (LCH) which remains in effect.

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, local residents, and the environment. Corporate policies and programs, including the Safety, Health, Environment and Quality (SHEQ) policy provided guidance and direction for the development of site-based programs and procedures that are defined in CFM's Management System manual (CFM-MS).

As a result of the programs, plans and procedures, environmental emissions are being controlled to levels that are a fraction of the regulatory limits, and radiation exposures for workers and the public are also well below the regulatory limits. There were also no exceedances of the action levels in the radiation protection and the environmental protection program.

Table Of Contents

1. INTRODUCTION

1.1 General Introduction

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

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

CFM operates a Class IB nuclear fuel manufacturing facility in Port Hope, Ontario and employs approximately 145 workers. In addition, approximately 130 employees work at a metal manufacturing plant located in Cobourg, Ontario, which does not handle uranium products. CFM operates under licence #FFOL-3641.00/2022 issued by the Canadian Nuclear Safety Commission (CNSC), which took effect on March 1, 2012 and is valid until February 28, 2022. The facility is licensed to produce nuclear fuel bundles using uranium dioxide (UO_2) primarily for CANDU reactors used by both domestic and international customers. The licence also provides continued authorization to process and store depleted and enriched UO_2.

On August 18, 2015, CNSC staff issued to CFM Revision 1 of the Licence Conditions Handbook (LCH). CFM's LCH-Cameco-CFM-R001 is issued as part of the licensee's operating licence. The purpose of this handbook is to establish and consolidate into one document the compliance framework related to CFM's operating licence. The LCH specifies the CNSC expectations by defining the licensing basis and explaining the regulatory context related to each licence condition.

The submission of this report fulfills the requirement of Section 2.3 in the operating licence FFOL-3641.00/2022 and references the requirements in the LCH. The purpose of this report is to summarize the operating performance and provide a summary of the Safety and Control Areas for the fourth quarter of 2018.

There were no reportable events as detailed in the Nuclear Safety and Control Act during the quarter. There were no action level exceedances in the radiation protection or the environmental protection program during the quarter.

In addition to the CNSC, CFM is regulated by other federal and provincial agencies, such as the Ontario Ministry of the Environment and Climate Change (MOECC), Environment Canada, Human Resources and Skills Development Canada, and Transport Canada.

The following table provides a list of acronyms, and the corresponding descriptions, that are typically used in Cameco reports.

Table 1

Acronyms Used In This Report	
Acronym	**Description**
ACL	Administrative Control Limit
ACMOPR	Annual Compliance Monitoring & Operational Performance Report
ALARA	As Low As Reasonably Achievable
BMS	Bundle Manufacturing System
BRR	Blind River Refinery
Cameco	Cameco Corporation
CFM	Cameco Fuel Manufacturing
CIRS	Cameco Incident Reporting System
CCM	Contaminated Combustible Material
CCME	Canadian Council of Ministers of the Environment
CNC	Contaminated Non-combustible Material
CNSC	Canadian Nuclear Safety Commission
DRL	Derived Release Limit
E/OH&S	Environmental Occupational Health & Safety
FHA	Fire Hazard Analysis
FPP	Fire Protection Program
FSD	Fuel Services Division
IAEA	International Atomic Energy Agency
IMS	Integrated Management System
JH&SC	Joint Health & Safety Committee
kg	kilogram
KPI	Key Performance Indicator
LCH	Licence Conditions Handbook (LCH-Cameco-CFM-R000)
LTI	Lost Time Injury

Mg	mega gram
µg/L	micrograms per Litre
µg/m³	micrograms per meter cubed
µSv/hr	microsievert per hour
mg	milligram
mSv	millisievert
mSv/yr	millisievert per year
MOECC	Ministry of the Environment & Climate Change
NCSPM	Nuclear Criticality Safety Program Manual
NEW	Nuclear Energy Worker
NFPA	National Fire Protection Agency
OSL	Optically Stimulated Luminescence
PDP	Preliminary Decommissioning Program
PHCF	Port Hope Conversion Facility
PHFES	Port Hope Fire and Emergency Services
QA	Quality Assurance
R&EPM	Radiation and Environmental Protection Manual
SAR	Safety Analysis Report
SAT	Systematic Approach to Training
SHEQ	Safety/Health/Environment & Quality
TLD	Thermo Luminescent Dosimeters
UO_2	Uranium Dioxide
WSIB	Workplace Safety Insurance Board

* Not all acronyms listed above appear in every quarterly report.

1.2 Facility Operation

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

In addition to Cameco requirements regarding management systems, CFM has created a Management System Program Manual (CFM-MS) to replace the previous Integrated Management System (IMS) manual. The program manual CFM-MS was designed to meet the requirements of CSA N286-12 *Management System Requirements for Nuclear Facilities* for a quality program. The CFM-MS has been organized to align directly with the requirements of N286-12, with corporate and site-specific information incorporated where applicable to demonstrate how CFM meets each requirement of the standard.

CNSC quality requirements and other regulatory requirements. The application of the quality requirements is scaled according to the safety significance (frequency and consequence) of a particular activity.

Changes to the physical design of equipment, processes and the facility with the potential to impact safety are evaluated using an internal change and design control process from project planning through to completion of the project. This process is used to help identify impacts and potential impacts to radiation protection, the environment, health and safety and fire protection.

In the fourth quarter of 2018 CFM maintained its registration to the ISO 14001:2015 Environmental Management System standard, which is an internationally recognized standard for environmental management. As part of the management system program, CFM schedules and conducts audits during the course of a year to assess the level of conformance to these management systems. In addition, independent third-party experts conduct compliance audits in the areas of health, safety, environmental, and radiation protection legislation to help ensure that CFM continues to meet all applicable legal requirements. Cameco's corporate office performs periodic audits of the site management systems programs as well to help ensure the site complies with corporate expectations.

The performance of the facility in the fourth quarter of 2018 demonstrates that CFM is qualified to carry out the activities permitted under the operating licence. CFM 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 as well as the necessary measures to facilitate Canada's compliance with international safeguard obligations.

CFM 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, CFM'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 worker and public radiation exposures are well below the established limits.

1.3 Production or Utilization

CFM's operating licence permits the production of up to 125 Mg of UO_2 as pellets contained in finished fuel bundles, during any calendar month. Production rates during the fourth quarter were within the monthly limit.

1.4 Facility Modification

Modifications to facility buildings, processes, equipment, procedures, programs or organizational structure with the potential to impact safety are evaluated through the internal change and design control process from planning through to completion. This process is used to help identify impacts and potential impacts to the licensing basis, the environment as well as to the health and safety of employees and local residents.

In the fourth quarter of 2018 there were no modifications undertaken that required written approval from the Commission or a person authorized by the Commission. The commissioning of the graphite coating process continued in the fourth quarter. Upgrades to the old waste treatment area continued in the fourth quarter and will be continuing into 2019.

The LCH references core CFM documents that form the licensing basis of the facility in each safety and control area. In the fourth quarter of 2018 there was one document that was required to be submitted to the CNSC.

- Environmental Protection Manual (CFM-EP), version #2

CFM also submitted the 2017 annual Third Party Review as well as an updated Fire Hazard Analysis in the fourth quarter.

2. 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.

In addition to Cameco requirements regarding management systems, CFM has a Management System Program Manual (CFM-MS). The program manual CFM-MS was designed to meet the requirements of CSA N286-12 Management System Requirements for Nuclear Facilities for a quality program. The manual has been organized to align directly with the requirements of N286-12, with corporate and site-specific information incorporated where applicable to demonstrate how CFM meets each requirement of the standard.

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

In the fourth quarter of 2018, CFM maintained its registration to the internationally recognized ISO 14001:2015 Environmental Management System standards.

As part of the management system program, CFM schedules and conducts internal and external audits throughout the year to assess the level of conformance to these management systems.

In the fourth quarter there were two audits performed as outlined below:

- Combined Safety Health Environment and Quality (SHEQ) and compliance audit conducted by Cameco Corporation and Arcadis Canada; and.
- CNSC compliance inspection in December focusing on the elements from the Waste Management Safety and Control Area.

All audits and their respective findings are entered into the Cameco Incident Reporting System (CIRS) with the Corrective Actions or Activities being assigned to the appropriate personnel.

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 there is a sufficient number of employees in all relevant job areas and that they have the necessary knowledge, skills and tools to safely carry out their duties.

CFM has a number of programs, procedures and processes that establish the framework for a safe environment and foster a sustainable safety culture at the site. All employees are encouraged to build and maintain a questioning attitude with respect to health, safety, radiation protection and environmental issues.

CFM has a sufficient number of qualified workers as well as the minimum number of responsible people to carry on the licensed activities safely and in accordance with the *Nuclear Safety and Control Act* and its Regulations. Mandatory federal, provincial and/or Cameco-required training is tracked and trended at CFM.

CFM continues to enhance communication between facility management and employees through the use of regular (daily) tool box meetings and monthly safety presentations. In addition, daily production meetings are held to discuss safety, environmental, quality, and production concerns. The above communication processes were continued in the fourth quarter of 2018 along with the use of a tool to improve the process for employees to raise concerns.

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 the quarter, CFM continued to operate in a manner that supports safe, clean and reliable production in compliance with applicable acts and regulations. CFM operated in accordance with site programs and procedures and did not exceed any CNSC regulatory limits.

In the fourth quarter there was a planned shutdown of the facility over the winter holidays in December. The planned shutdown provides an opportunity to complete maintenance activities, complete any scheduled facility and equipment upgrades as well as allows employees an opportunity to use vacation time.

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

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. The 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.

To operate in a safe, clean and reliable manner CFM has programs and procedures including the Safety Analysis Report (SAR), Fire Hazard Analysis (FHA), environmental aspects registry, chemical hazard assessment and other assessments for safety and/or risk. The SAR summarizes the systematic review of the site operations to identify and assess hazards and potential risks to the public and the environment. The report uses the Process Hazard Assessment technique for risk evaluation. This report is updated at a minimum of every five years to ensure that it is updated as necessary to reflect current plant conditions. The facility also has a nuclear criticality program to address the handling and processing of enriched uranium that meets the CNSC regulatory document RD-327 *Nuclear Criticality Safety*.

There were no modifications made in the quarter that affected the safety case for CFM. 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 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.

Changes to the physical design of equipment, processes and the facility with the potential to impact safety are evaluated using an internal change control process from project planning through to the completion of the project. This process is used to help identify impacts and potential impacts to the environment and to the health and safety of employees and local residents. Site design control is incorporated in the change control and project management processes and this 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 member of the public.

During the fourth quarter of 2018, CFM did not make any significant changes to processes that would have impacted the licensing basis.

The commissioning of the graphite coating process continued in the fourth quarter as did planned upgrades to the old waste treatment area.

2.2.3 Fitness for Service

This safety and control area cover activities that impact on the physical conditions of systems, structures and components to ensure that they remain effective over time. This includes programs that ensure all equipment is available to perform its intended design function.

CFM has programs and procedures that ensure that the facility is operated in a safe, clean and reliable manner. CFM has an established Planned Maintenance program as defined in the site management system document (CFM-MS). Maintenance plans are issued, reviewed and updated periodically to ensure the routines developed continue to be effective and adequate.

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*. The program must ensure that contamination and radiation doses are monitored and controlled.

CFM 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 to ensure exposures are kept to levels ALARA. The program includes the following components:

- external radiation dosimetry – personal monitoring;
- internal dosimetry – urine analysis program;
- workplace air sampling program;
- respirator program;
- contamination surveys; and
- gamma surveys.

At CFM all employees and contractors working more than 80 hours per year are considered NEWs and are provided dedicated dosimeters to measure external radiation exposure. CFM uses Landauer's Optically Stimulated Luminescence (OSL) dosimeters, a CNSC licensed dosimetry service provider, to monitor whole body, skin, and eye dose and Thermal Luminescent Dosimeters (TLD) extremity rings to monitor extremity dose. Dosimeters are changed monthly for production related employees and quarterly for all other employees. The provider sends the dosimeter results to the National Dose Registry (NDR) and provides a copy to CFM.

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 specified five year periods.

For various radiological parameters, CFM has established action levels, approved by the CNSC that may be indicative of a potential loss of control for that specific parameter. Action levels pertaining to radiation protection are listed in section 8.2 of CFM's LCH. These action levels serve as an early warning of a condition that warrants further investigation. A result above an action level is investigated and remedial actions taken if necessary.

CFM continued the use of a number of ALARA initiatives during the quarter as part of its continual improvement program, including:

- collection of dose rate data throughout the facility;

- collection and review of the in-plant air, surface readings, surface contamination on lung counts as well as urine non-submissions by the Radiation Protection committee, and
- ongoing oversight for compliance to hand and foot monitoring requirement as well as urine submissions.

The following tables and graphs summarize the quarterly dose results for external and internal dosimetry as well as contamination control measures.

Whole Body Dose

The action levels for whole body dose for NEWs are 1.6 mSv per month and 1.0 mSv per quarter. The monthly action level applies to NEWs who are monitored on a monthly basis (primarily production employees). The quarterly action level pertains to NEWs who are monitored on a quarterly basis (i.e. office staff, contractors, etc.). These individuals receive lower radiation exposure and; therefore, a lower action level has been established. There were no action level exceedances in the radiation protection program during the fourth quarter.

Table 2 shows the fourth quarter whole body dose for three work groups: employees in the operations group, employees in administration/support roles, and outside contractors/visitors. The highest exposures are from the operations work group, consisting of production, inspection, and maintenance personnel.

Table 2

2018 Fourth Quarter Whole Body Dose Results				
Work Group	**Number of Individuals**	**Average (mSv)**	**Minimum (mSv)**	**Maximum (mSv)**
Operations	108	0.27	0.00	1.26
Administration / Support	88	0.01	0.00	0.20
Contractors/Visitors	20	0.01	0.00	0.10

Figure 1 displays the distribution, in 1 mSv increments, of whole body dose for all NEWs during the quarter. Note that figures with ranges on the horizontal axis identify results that are greater than or equal to the first number and less than the second value. For example 1 – 2 on the horizontal axis in figure 1 means all results in that range are greater than or equal to 1 mSv ($\geq$ 1 mSv) and less than 2 mSv (< 2 mSv).

As can be seen from Figure 1, 98% of employee external whole body exposures were 1 mSv or less.

Figure 1

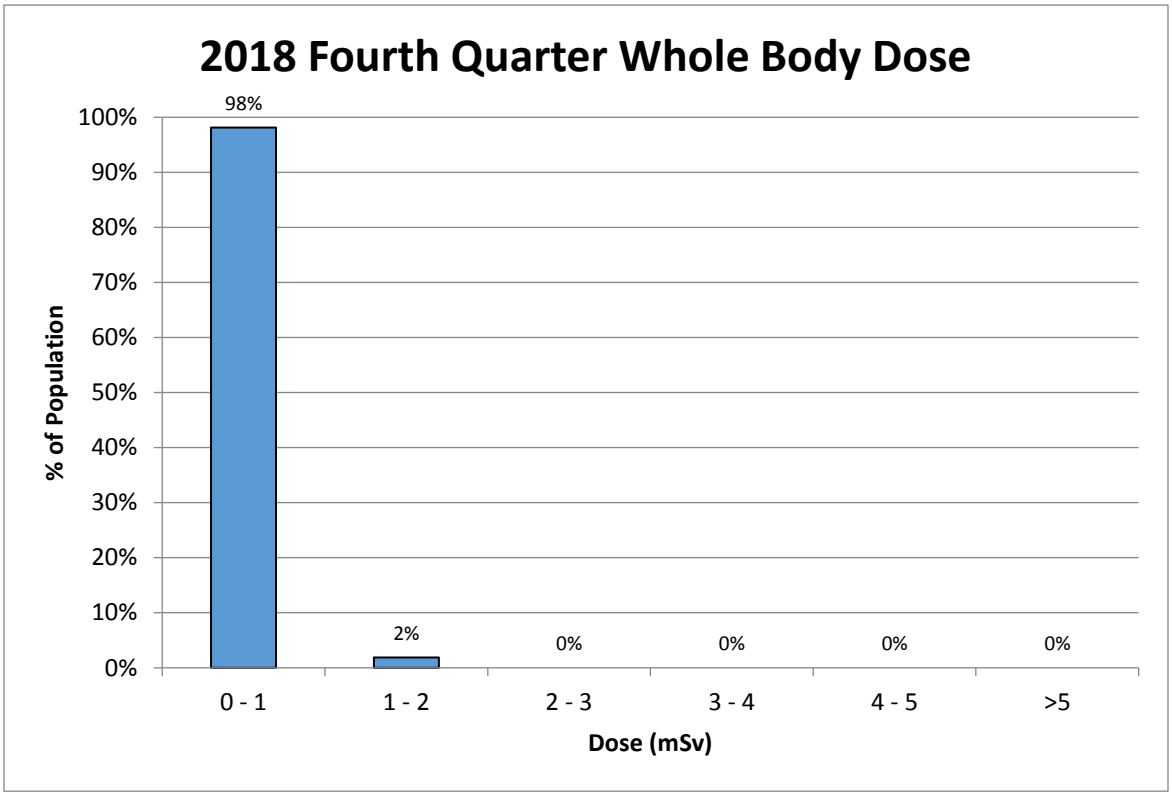
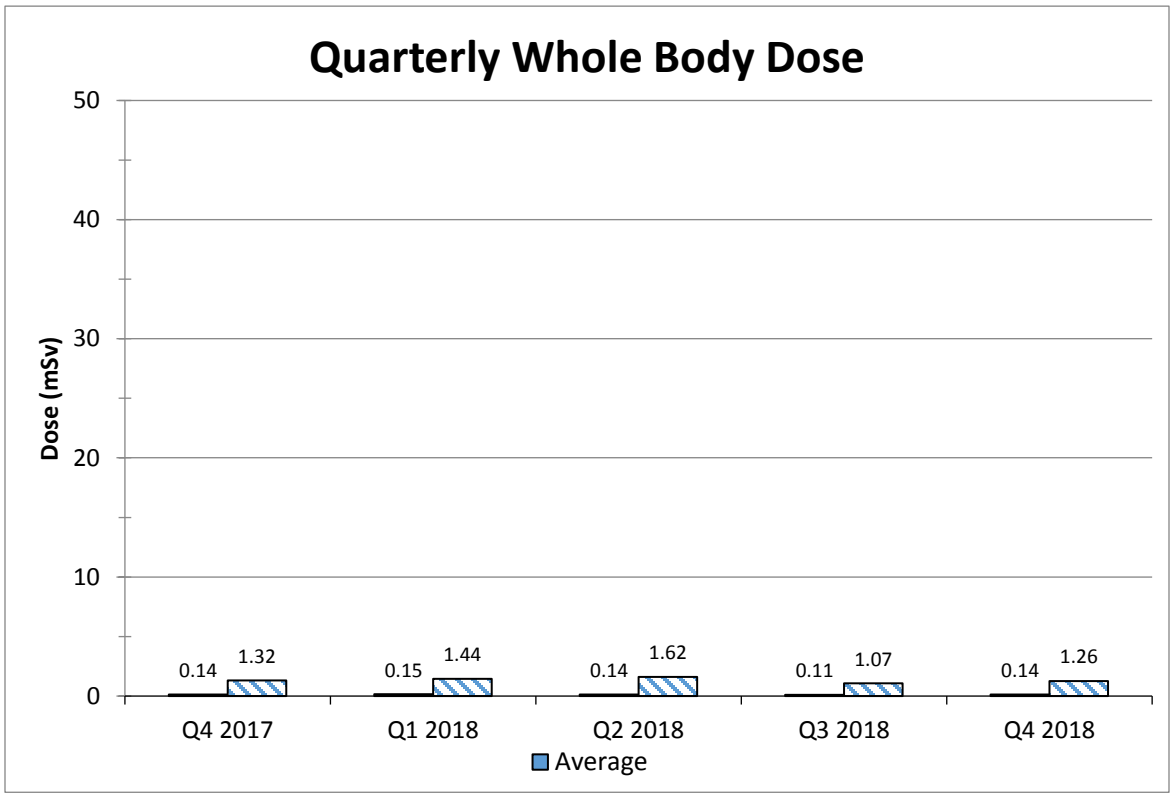


Table 3 and Figure 2 shows the quarterly average and maximum individual external whole body exposure for all NEWs from the fourth quarter of 2017 to the fourth quarter of 2018 (five monitoring periods). The average whole body dose in the fourth quarter for all NEWs was 0.14 mSv and the maximum dose was 1.26 mSv. It is most accurate to compare the fourth quarter result in 2018 to the previous fourth quarter result in 2017 due to production rates. A review of the production rates indicate the same amount of uranium was processed in the fourth quarter of 2017 and the fourth quarter of 2018. When these two quarters are compared the average dose is the same and the maximum dose was lower in 2018. The individual with the highest exposure in the fourth quarter was a Pelleting Area employee.

Table 3

Whole Body Dose by Quarter				
Monitoring Period	**Number of Employees**	**Average Dose (mSv)**	**Minimum Dose (mSv)**	**Maximum Dose (mSv)**
Q4 2017	234	0.14	0.00	1.32
Q1 2018	233	0.15	0.00	1.44
Q2 2018	232	0.14	0.00	1.62
Q3 2018	226	0.11	0.00	1.07
Q4 2018	216	0.14	0.00	1.26

Figure 2



Skin Dose

CFM's action levels are 20 mSv per month for production employees and 5 mSv per quarter for support staff and contractors. The action levels for skin dose were not exceeded in the quarter.

Table 4 shows the fourth quarter skin exposure results for three work groups, employees in operations (monitored monthly), employees in administration and/or support roles and outside contractors/visitors (both monitored on a quarterly basis). The highest exposures are from the operations work group, consisting of production and maintenance personnel. The maximum skin dose was 12.77 mSv in the fourth quarter. The average skin dose for all NEWs was 0.98 mSv. The action levels for skin dose were not exceeded in the quarter.

Table 4

2018 Fourth Quarter Skin Dose				
Work Group	**Number of Individuals**	**Average (mSv)**	**Minimum (mSv)**	**Maximum (mSv)**
Operations	108	1.95	0.00	12.77
Administration / Support	88	0.02	0.00	0.67
Contractors/Visitors	20	0.02	0.00	0.10

Figure 3 displays the distribution of skin dose received by NEWs in 10 mSv increments during the quarter. As shown in the figure, the majority of NEWs received a skin dose below 10 mSv (approximately 96%).

Figure 3

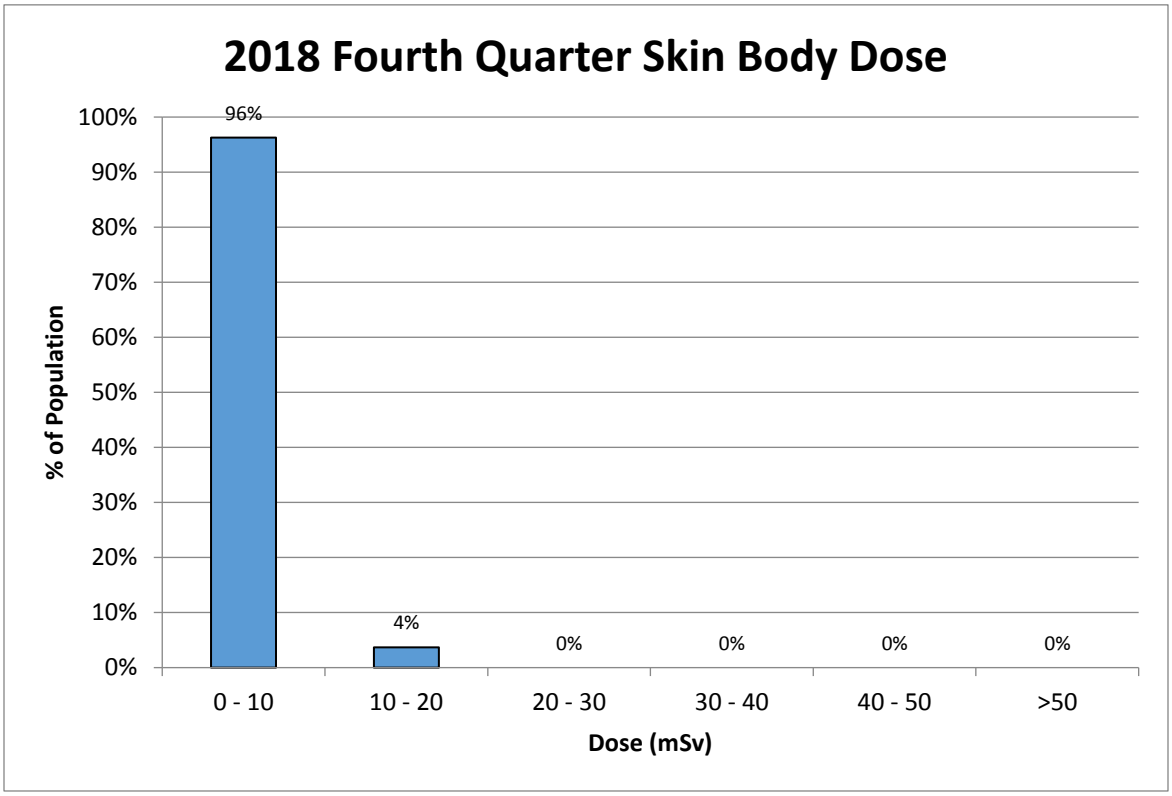


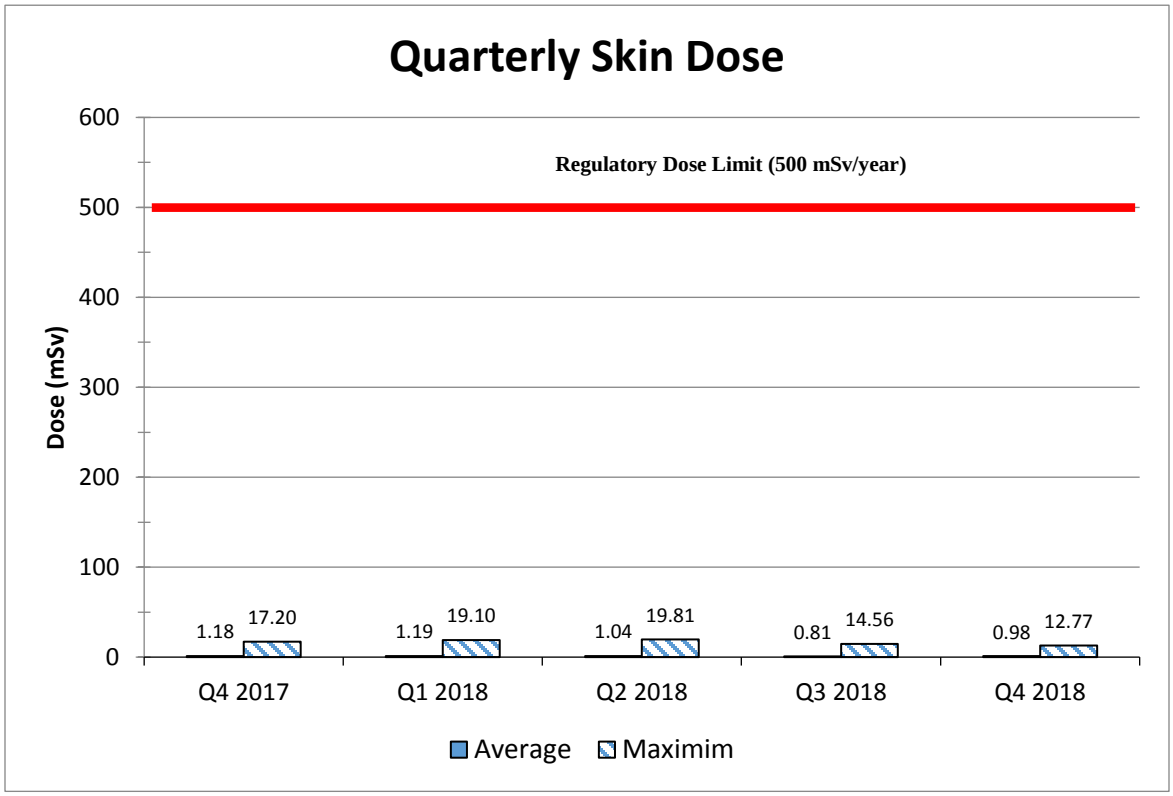
Table 5 and Figure 4 show the employee quarterly average and maximum individual skin exposure from the fourth quarter of 2017 to the fourth quarter of 2018. It is most accurate to compare the fourth quarter result in 2018 to the previous fourth quarter result in 2017 due to production rates.

When these two quarters are compared the average and maximum dose were lower in 2018 than the average and maximum dose in 2017. A review of the production rates indicate there was more uranium processed in the third quarter of 2017. It is possible there was an impact on the average dose due to the lower quantity of uranium processed in 2018. The individual who received the maximum skin dose was the same individual with the maximum whole body dose.

Table 5

Skin Dose by Quarter				
Monitoring Period	**Number of Employees**	**Average Dose (mSv)**	**Minimum Dose (mSv)**	**Maximum Dose (mSv)**
Q4 2017	234	1.18	0.00	17.20
Q1 2018	233	1.19	0.00	19.10
Q2 2018	232	1.04	0.00	19.81
Q3 2018	226	0.81	0.00	14.56
Q4 2018	216	0.98	0.00	12.77

Figure 4



Eye Dose

Cameco notified the CNSC in a letter dated April 30, 2018 that CFM had decided to discontinue reporting lens of the eye doses in the quarterly compliance reports, beginning in the first quarter of 2018. The eye doses reported by the dosimetry service provider was determined based on an algorithm to prorate eye doses using the OSL dosimeters. Cameco's review of the existing dosimeter providers and their use of the algorithm and the beta dose is an uncalibrated method and likely results in overestimation of the actual eye dose. Due to this uncertainty Cameco does not feel these estimated doses should be submitted to the National Dose Registry. Cameco continues to investigate commercially-available dosimeters that would meet the appropriate requirements for eye dosimetry.

Extremity Dose

The action level for extremity dose at CFM is 55 mSv per quarter. The quarterly action level applies to production NEWs who regularly handle product as part of their daily task. The extremity ring dosimeters are worn for one week per quarter (40 hours) and an adjustment factor is applied to take into account the average hours worked by the employees for the quarter to calculate the exposure. CFM calculates the factor for each NEW, who wears rings, using the hours worked in the quarter divided by the 40 hours the rings are worn. The average factor for all employees is then provided to the dosimetry provider who applies the factor to the dose obtained when the rings are analyzed. The resultant dose is representative of the quarterly result which is then provided to CFM and the NDR.

The maximum individual extremity dose in the fourth quarter for the left hand extremity was 19.17 mSv and for the right hand the maximum dose was 29.20 mSv. The average extremity dose was 5.10 mSv and 5.22 mSv for the left and right extremity respectively.

Figure 6 displays the distribution of the quarterly extremity dose for NEWs in 20 mSv increments. In the fourth quarter the majority of NEWs received an extremity dose below 20 mSv for both the left and right hand extremity.

Figure 5

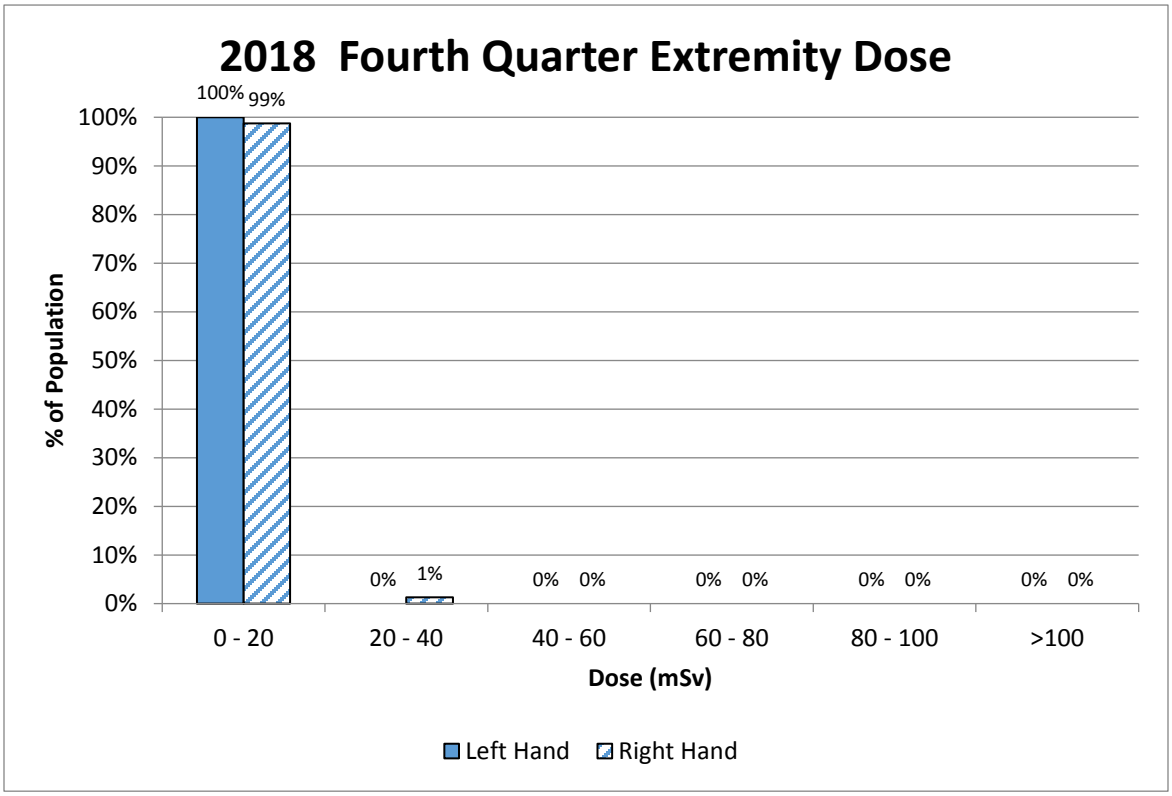


Table 6 and Figure 6 show the average and maximum extremity dose for NEWs over the period from the fourth quarter of 2017 to the fourth quarter of 2018. It is most accurate to compare the fourth quarter result in 2018 to the previous fourth quarter result in 2017 due to production rates. When these two quarters are compared the average and maximum dose was lower in 2018 when production rates are considered.

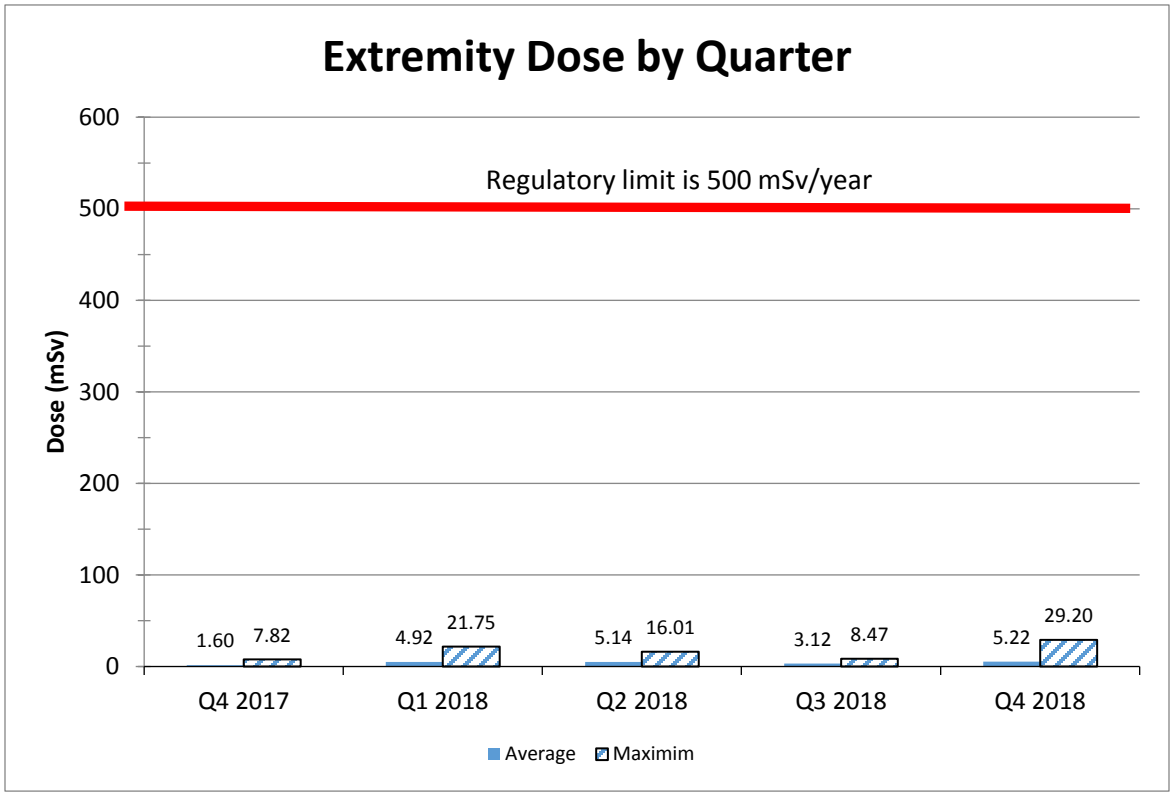
The individual with the highest exposure was the same Pelleting Area employee with the highest whole body and skin dose.

Table 6

Extremity Dose by Quarter				
Monitoring Period	**Number of Employees**	**Average Dose (mSv)**	**Minimum Dose (mSv)**	**Maximum Dose (mSv)**
Q4 2017	83	1.60	0.00	7.82
Q1 2018	84	4.92	2.01*	21.75
Q2 2018	81	5.14	1.75*	16.01
Q3 2018	77	3.12	1.42	8.47
Q4 2018	79	5.22	2.26	29.20

*Minimum doses for Q1 and Q2 2018 were incorrectly reported as 0.0 mSv. The above table has been updated to reflect the actual minimum dose for the quarters as reported to the National Dose Registry. This change did not affect the average dose reported and represents less than half a percent of the annual dose limit. Therefore, the change is not expected to lead to a situation in which the environment, the health and safety of persons or national security is adversely affected.

Figure 6



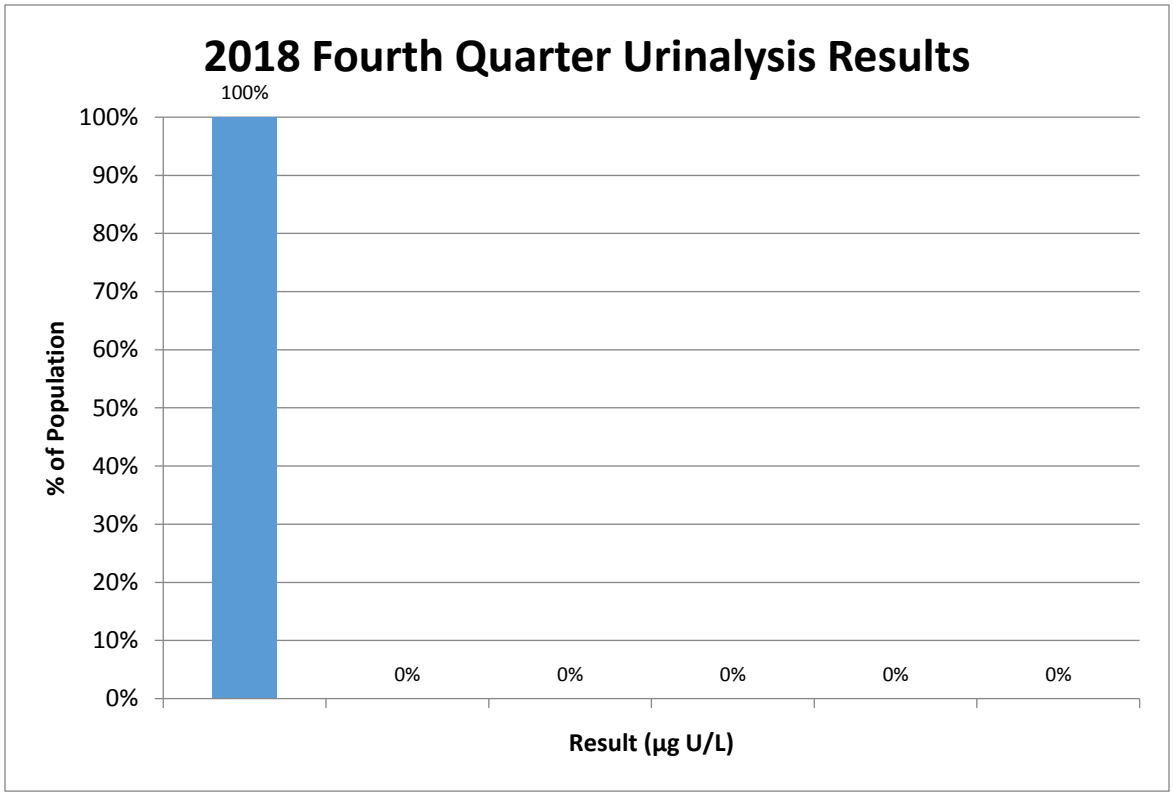
Urine Analysis

CFM collects bi-weekly urine samples from NEW's who work in the Pelleting Area. The samples are sent off site and are analyzed for uranium content using mass spectroscopy. The action level for a single routine urine sample is 10 µg/L of uranium concentration.

Of the 418 urine samples analyzed during the fourth quarter most the samples were below 2.0 µg/L. The maximum result was 2.0 µg/L and the average was 0.33 µg/L. During the quarter there was no exceedance of the urine analysis action level.

The following figure shows the distribution of urine analysis results in 2 µg/L increments for NEWs during the quarter. In the fourth quarter the all NEWs who participate in the internal dosimetry program had urine samples with uranium concentrations below 2 µg/L.

Figure 7



Internal Dose

CFM assigns internal dose using lung counting with annual results provided in the Annual Compliance Monitoring and Operational Performance Report (ACMOPR). Routine urine analysis samples are collected on a biweekly basis for trending purposes; if an acute uptake is noted it will be verified using lung counting and dose assigned if required. This process is described in CFM's *Internal Radiation Monitoring* procedure (HSI-039).

In the fourth quarter, there were no routine urine sample results that were above the internal administrative level of 4.0 µgU/L.

Contamination Control

CFM has other programs to ensure radiation exposure levels remain low. An extensive contamination control program at CFM is zone control. The facility is divided into four zones for contamination control purposes. Zone 1 areas are designated as clean areas with no contamination permitted. Food and drink can be consumed in these areas and include the lunch room and office areas. Zone 2 areas contain no open sources of radioactivity but have the potential for contamination. These areas include the assembly area, change rooms and the machine shop. Zone 3 areas are the access points to Zone 4. Zone 4 areas contain open sources of radioactivity and include the Pelleting Area. Consumption of food and drink are restricted in Zones 2, 3, and 4.

The administrative limits are provided in Table 7 as well as the routine contamination monitoring results for the fourth quarter. Of the 599 samples taken none exceeded the internal administrative control limits (ACL).

Table 7

2018 Fourth Quarter Alpha Contamination Monitoring Results			
Area	**# of Samples Taken**	**Administrative Limits (Bq/cm^2)**	**# of Samples Above Limits**
Zone 1	85	0.4	0
Zone 2	148	4.0	0
Zone 3	31	4.0	0
Zone 4	335	40	0

In-Plant Air

Routine air sampling is conducted at workstations throughout the plant continuously during operations to monitor airborne uranium dioxide in the work environment. To ensure exposures to airborne uranium are well below the regulatory dose limits, the ACL for any daily air sampling result has been set at 595 µg/m³ (15 Bq/m³) which is less than half the recommended concentration for an 80 hour monitoring period (urine bioassay schedule). The 2000 hour ACL represents an annual monitoring period and has been set at 52 µg/m³ (1.3 Bq/m³).

In addition, continuous air monitors in the PP2 and the Waste Treatment area measure in-plant air concentrations. The monitors are equipped with visual and audible local and panel alarms. If the uranium concentration in the area exceeds 52 µg U/m³ the alarm sound and the CAMhead alarm procedure is initiated. If this occurs the procedure requires employees to leave the area, notify the supervisor, don a respirator until the monitor indicates the air concentration has returned to below the ACL and perform an initial survey to identify the cause. An incident/accident investigation is also required (similar to an exceedance of the fixed air samplers).

The results for the fourth quarter of 2018 taken in each area, including the CAMheads in the PP2 and Waste Treatment area, are shown in Table 8 below. Of the 2648 monitoring results, 4 (less than 1%) exceeded the 2000 hour ACL of 52 µg/m³ with no result exceeding the 80 hour ACL.

Table 8

2018 Fourth Quarter Uranium In-plant Air Sampling Results					
Plant Area	**# of Samples**	**Average (µg U/m³)**	**Maximum (µg U/m³)**	**# Samples > ACL$^{2000\ hr}$**	**# Samples > ACL$^{80\ hr}$**
Ceramics Lab	341	1	8	0	0
Compaction Room	230	1	5	0	0
End Cap Welders	114	1	4	0	0
Load Room	269	2	7	0	0
Pangborn Room	172	3	24	0	0
Pelleting Area	344	2	7	0	0
UO_2 Grinders	230	9	103	3	0
Waste Treatment	57	8	62	1	0
PP2 Area	648	2	15	0	0
New Waste Treatment	243	1	6	0	0
TOTAL	**2648**	**3**	**103**	**4**	**0**

Note: During normal operations some processes in the Pangborn Room, the PP2 area as well as the Waste Treatment Area, require the use of respiratory protection. Therefore, procedures are in place instructing CFM staff to wear respirators in these areas when performing specific job tasks to minimize internal exposure (in addition to local extraction). Local extraction is sufficient in other areas where uranium dioxide powder is used; therefore, respirators are not required in these areas unless there is an upset condition.

For results above the ACL an incident/accident investigation is required. The information collected during the investigation is provided to the Radiation Protection committee who reviews the corrective actions and evaluates the effectiveness of the action. If additional actions are required the committee follows up with the operator or supervisor involved.

The maximum result occurred in the UO_2 Grinder area and occurred as a group of exceedances. The group of exceedances were identified as an adverse trend and entered into CIRS to start an investigation into the elevated readings. The investigation determined water from the grinders was splashing back onto the samplers due to inaccurate or poor control of the required water flow rates. Additional flow control was added to address the issue. The elevated result in the Waste Treatment area occurred when bowls of recycled uranium powder are emptied into a drum. Empty bowls fell over causing residual uranium to become airborne. The operators were wearing respirators and cleaned the area before proceeding with the required task.

Gamma Surveys

An ongoing ALARA initiative involves posting OSL's around the facility to determine areas of elevated gamma radiation. The site locations which have been tracked on a quarterly basis are numbered 13 through 59.

The result for each location in the fourth quarter is summarized in Table 9. The results illustrate that the Fuel Storage Area had the highest gamma fields (5.1 µSv/hr), which is expected due to the amount of product stored in the area. There is a sign posted instructing workers to limit the time spent in this area. The next highest reading (3.9 µSv/hr) was in the PP2 Receiving area. This is expected due to the amount of raw material stored in this area. Employees limit their time in this area. The next highest result (1.9 µSv/hr) was in the Dry Waste Treatment area. This area processes scrap product which varies in quantity from time to time.

Table 9

Fourth Quarter 2018 Gamma Survey Results						
Location #	**Area**	**Result (µSv/hr)**		**Location #**	**Area**	**Result (µSv/hr)**
13	Kitting	0.2		37	PP2 Powder Rec. N.	1.2
14	S Stacking	1.4		38	Powder Receipt	0.0
15	Stacking	0.1		39	U_3O_8 Add-back	0.7
16	Pelleting Entry	0.5		40	S End Cap	0.2
17	Pelleting Lab	0.1		41	End Cap	0.3
18	S Grinding	0.9		42	N End Cap	0.1
19	Grinding	0.9		43	E Offices	0.0
20	N Grinding	0.7		44	S End Plate	0.0
21	S Wall	0.0		45	End Plate	0.0
22	S Furnace	0.5		46	N End Plate	0.0
23	Furnace	0.7		47	W Offices	0.0
24	N Furnace	0.0		48	S Inspection	0.1
25	SE Wall	0.2		49	Inspection	0.1
26	E Wall Furnace	0.7		50	N Inspection	0.8
27	NE Wall	0.3		51	W Inspection	0.0
28	N Corridor	0.2		52	Strapping Bay	0.4
29	Ceramics Lab	0.0		53	Packing	0.4
30	R7#1 East Wall	1.3		54	Fuel Storage Area	5.1
31	PP2 West Wall	0.1		55	Graphite East	0.1
32	S Pressing	0.9		56	BMS Loading	1.0
33	N Pressing	1.1		57	PP2 Receiving	3.9
34	Pangborn	0.7		58	PP2 Press R53-1	1.1
35	S. Waste Treat	1.9		59	PP2 East Wall	0.5
36	N. Waste Treat	0.5				

2.3.2 Conventional Health and Safety

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

A key element of a safe, clean and reliable operation is a comprehensive and well-established worker protection program. The foundation of the program is based on the *Nuclear Safety and Control Act* and its regulations as well as Part II of the *Canada Labour Code*.

Cameco has five key principles in the area of safety that form the framework for how safety is managed. These are:

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

CFM manages non-radiological health and safety through a comprehensive E/OH&S program as prescribed by the Cameco Health and Safety Management Program. CFM maintains a series of detailed health and safety procedures and instructions, and our safety program is further supported by monthly safety meetings on a wide variety of safety topics, regular safety audits and monthly inspections conducted by employees from all levels of the organization.

Table 10 shows the safety statistics for the Port Hope facility for the fourth quarter.

Table 10

2018 Safety Statistics					
Year / Parameter	**Q1**	**Q2**	**Q3**	**Q4**	**Year To Date**
First Aid Injuries	7	2*	3	2	14
Medical Diagnostic Injuries	0	1*	0	0	1
Medical Treatment Injuries	0	2	0	0	2
Lost Time Injuries	0	0	0	0	0
Lost Time Injury Frequency	0.0	0.0	0.0	0.0	0.0
Lost Time Injury Severity	0.0	0.0	0.0	0.0	0.0

*Statistics adjusted due to changes in classification

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 CFM. CFM's Environmental Monitoring Program (EMP) is comprised of monitoring the following components:

- water and air emissions;
- gamma levels
- ambient air; and
- soil, vegetation; and groundwater

The key characteristics of the operation and activities that can have a significant environmental impact are monitored and measured and are described in the Radiation and Environmental Protection Manual (R&EPM) and associated procedures. Cameco has established action levels, which have been accepted by the CNSC, for key environmental parameters. These action levels serve as an early warning of a condition that warrants further investigation. An exceedance of an action level does not pose a risk to people or the environment. A result above an action level is investigated and remedial actions taken if necessary.

Public Dose

The *Nuclear Safety and Control Act* require that no member of the public shall receive from a neighboring nuclear facility a radiation dose in one year in excess of the regulatory limit of 1 mSv. To ensure compliance with this regulation, explicit limits are placed on the quantities of radioactive materials that may be released from licensed facilities in gaseous and liquid effluents, and on the gamma radiation levels emitted from the facility. These "Derived Released Limits" (DRLs) take into account all significant physical pathways and are calculated based on the average member of the site specific critical group receiving an annual dose of 1 mSv from each of the pathways. Since the pathways are site specific, different release limits apply to different facilities.

The public dose calculated below includes potential dose from all realistic pathways at the CFM facility. Liquid effluent is not used to calculate public dose as liquid emitted from the facility goes to the municipal sewer system and is not used for drinking purposes.

Air effluent calculations include the assessment of releases of particulate uranium dioxide to air from process stacks and building ventilation from the facility. Process stacks are sampled and analyzed daily for uranium emissions. The total amount of uranium dioxide released to the environment during the quarter in gaseous effluent from stacks was 0.001 kg.

Emissions from the building ventilation system in the main Pelleting Area are determined using in-plant air sampling data and exhaust discharge rates. Conversely in the powder receiving and powder preparation area building ventilation is calculated using the daily average of the continuous air monitors in the area. As the exhaust in this area uses HEPA filtration, a 90% efficiency factor is used in the calculation. The estimated release of uranium dioxide in building ventilation during the quarter was 0.267 kg. Therefore, the total amount of uranium dioxide released to air from stack emissions as well as exhaust ventilation in the quarter is estimated to be 0.268 kg.

The gamma component of public dose is calculated using the closest residence to the CFM facility which is located outside the fence line on the west side of the site. The closest gamma monitoring TLD at the fence line is at location #1 and represents the critical receptor location for the site (location that was used when the DRL was derived). To determine the effective dose in this location the natural background dose rate of 0.08 µSv/hr for the Port Hope area is subtracted from the result. The dose rate to the critical receptor was 0.005 µSv/hr in the fourth quarter. To calculate the public dose the total

amount of uranium dioxide released to air is added to the dose rate to the critical receptor as demonstrated in the following formula:

$$\text{public dose} = \frac{\text{total air emissions of } UO_2}{\text{Air Effluent DRL}} + \frac{\text{direct gamma dose rate}}{\text{Dose Rate DRL for location 1}}$$

$$\text{public dose} = \frac{0.268 \text{ kg}}{70 \text{ kg/qtr (1/4 of 280 kg /1 mSv/yr)}} + \frac{0.005 \text{ µSv/hr}}{0.35 \text{ µSv/hr/1 mSv}}$$

public dose = 0.004 mSv + 0.014 mSv

public dose = 0.018 mSv

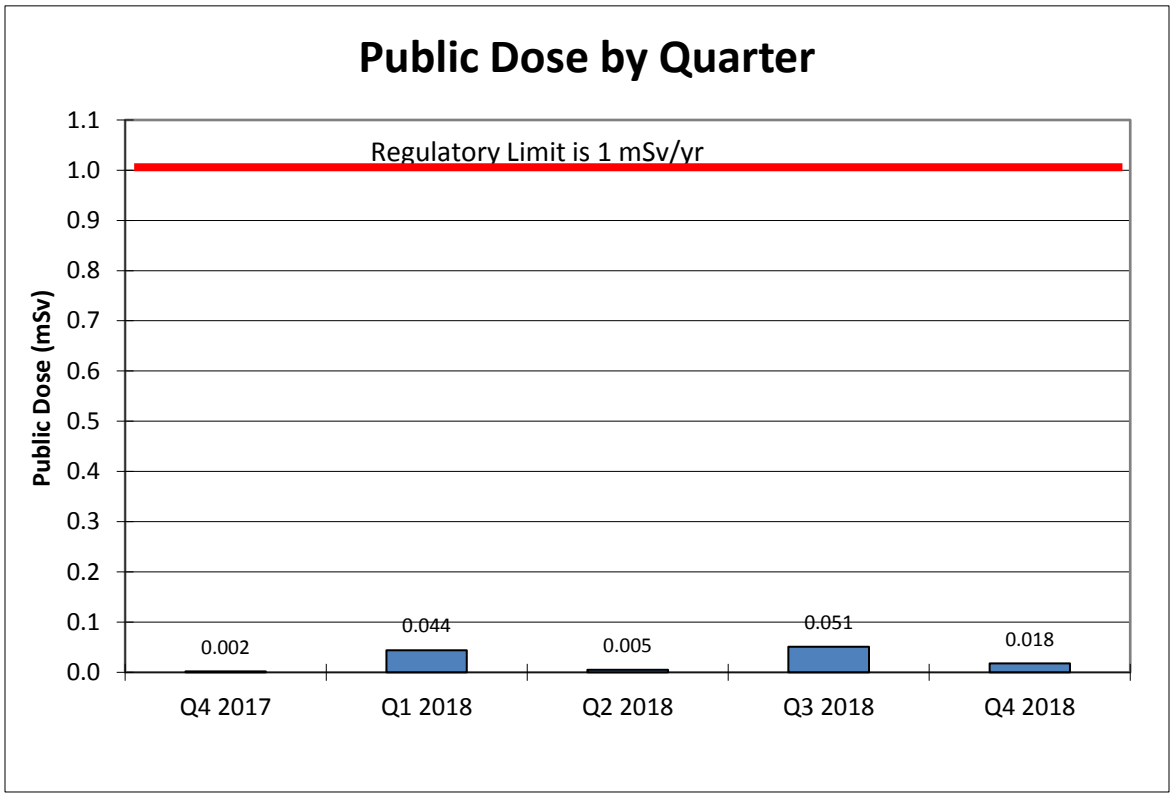
Therefore the total dose to the member of the public from air emissions and gamma levels for the quarter is calculated to be 0.018 mSv.

The estimated dose to the public from the fourth quarter of 2017 to the fourth quarter of 2018 is shown in Table 11 and Figure 8. The table provides the total dose to the critical receptor as well as the individual contributions from air and gamma converted into mSv/qtr units for comparison. Total dose to the critical receptor continues to be a fraction of the public dose limits. The result in the fourth quarter of 2018 is lower than the first and third quarter of 2018 and is higher than the fourth quarter of 2017 and the second quarter of 2018. Gamma is the major contributor to public dose; therefore, when the dose rate to the critical receptor is above background the public dose will also be elevated. The air component of public dose has been consistent during the last five quarters. Since the fourth quarter of 2017 the public dose range has been between 0.002 mSv and 0.051 mSv.

Table 11

Public Dose by Quarter (mSv/qtr)					
DRL Component	**Q4 2017**	**Q1 2018**	**Q2 2018**	**Q3 2018**	**Q4 2018**
Air	0.002	0.004	0.005	0.005	0.004
Gamma	0.000	0.040	0.000	0.046	0.014
Total dose to Critical Receptor	0.002	0.044	0.005	0.051	0.018

Figure 8



Gamma Monitoring

In order to ensure that local residents are not exceeding the member of the public dose limit of 1 mSv as defined in the *Radiation Protection Regulations*, environmental TLDs are strategically placed (at chest height) around the exterior perimeter of the licensed facility. The TLDs are deployed on a quarterly basis and measure gamma levels in µSv/hr. Twelve locations have been selected around the licensed facility's fenced perimeter.

The perimeter gamma DRL and the action level for the critical receptor are 0.35 µSv/hr and 0.2 µSv/hr respectively. The DRL for all other locations is 1.18 µSv/hr with an action level of 1.0 µSv/hr. There were no exceedances of the DRL's or the action levels during the fourth quarter.

Table 12 provides the quarterly gamma levels in µSv/hr for all fence line monitoring locations (i.e. 1-12) for the quarter.

Table 12

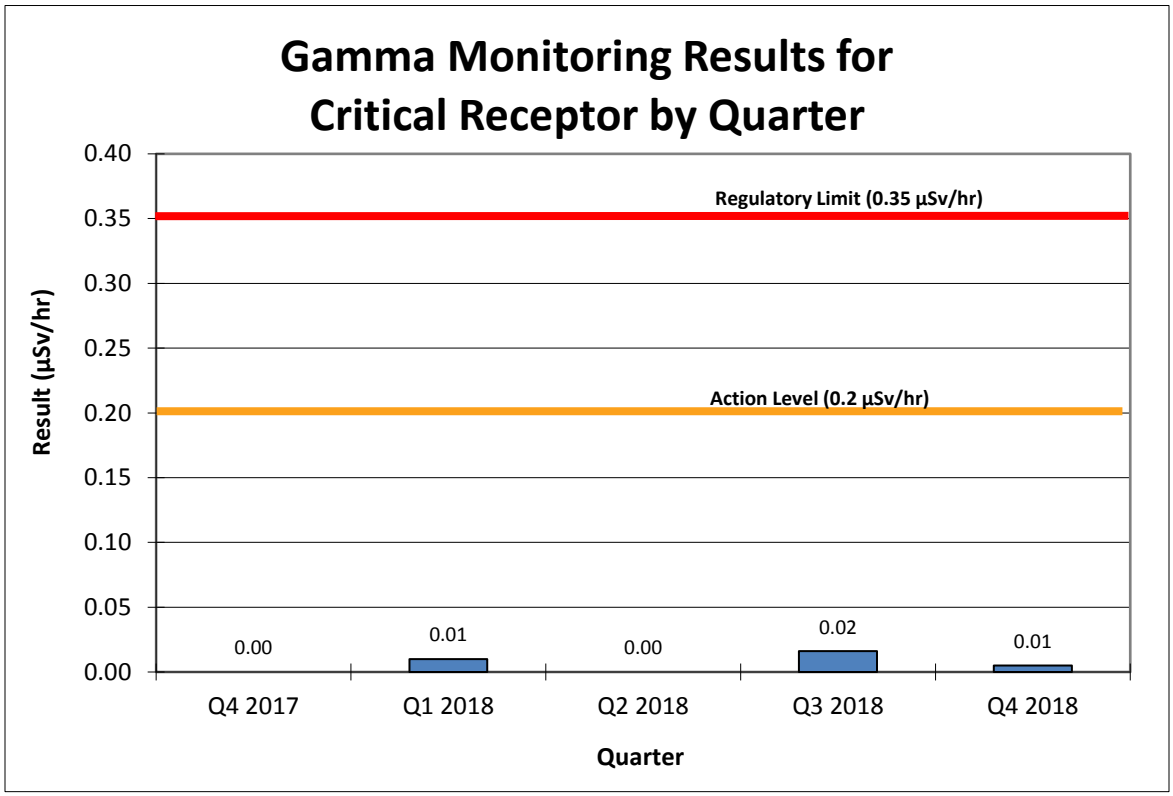
2018 Fourth Quarter Gamma Monitoring Results (µSv/hr)			
Location	**Regulatory Limit (DRL)**	**Action Level**	**DRL Contribution**
1	0.35	0.2	0.01
2	1.18	1.0	0.02
3	1.18	1.0	0.00
4	1.18	1.0	0.00
5	1.18	1.0	0.00
6	1.18	1.0	0.00
7	1.18	1.0	0.00
8	1.18	1.0	0.00
9	1.18	1.0	0.03
10	1.18	1.0	0.00
11	1.18	1.0	0.18
12	1.18	1.0	0.22

The monitoring results for location 1 (closest location to the critical receptor) from the fourth quarter in 2017 to the fourth quarter of 2018 are provided in Table 13 and Figure 9. Results have been corrected to take into account background gamma levels by subtracting 0.08 µSv/hr. The gamma levels at location 1 in the fourth quarter of 2018 continue to be low when compared to the action level.

Table 13

Gamma Monitoring Results at Critical Receptor by Quarter (µSv/hr)			
Period	**Regulatory Limit (DRL)**	**Action Level**	**DRL Contribution**
Q4 2017	0.35	0.20	0.00
Q1 2018	0.35	0.20	0.01
Q2 2018	0.35	0.20	0.00
Q3 2018	0.35	0.20	0.02
Q4 2018	0.35	0.20	0.01

Figure 9



Stack Emissions

Samples of the gaseous effluent released from the plant are obtained by isokinetic stack sampling which has been designed to meet the requirements of ANSI N13.1 *Guide to Sampling Airborne Radioactive Materials at Nuclear Facilities*. The samples are analyzed by alpha counting and the average uranium concentration of the effluent is determined.

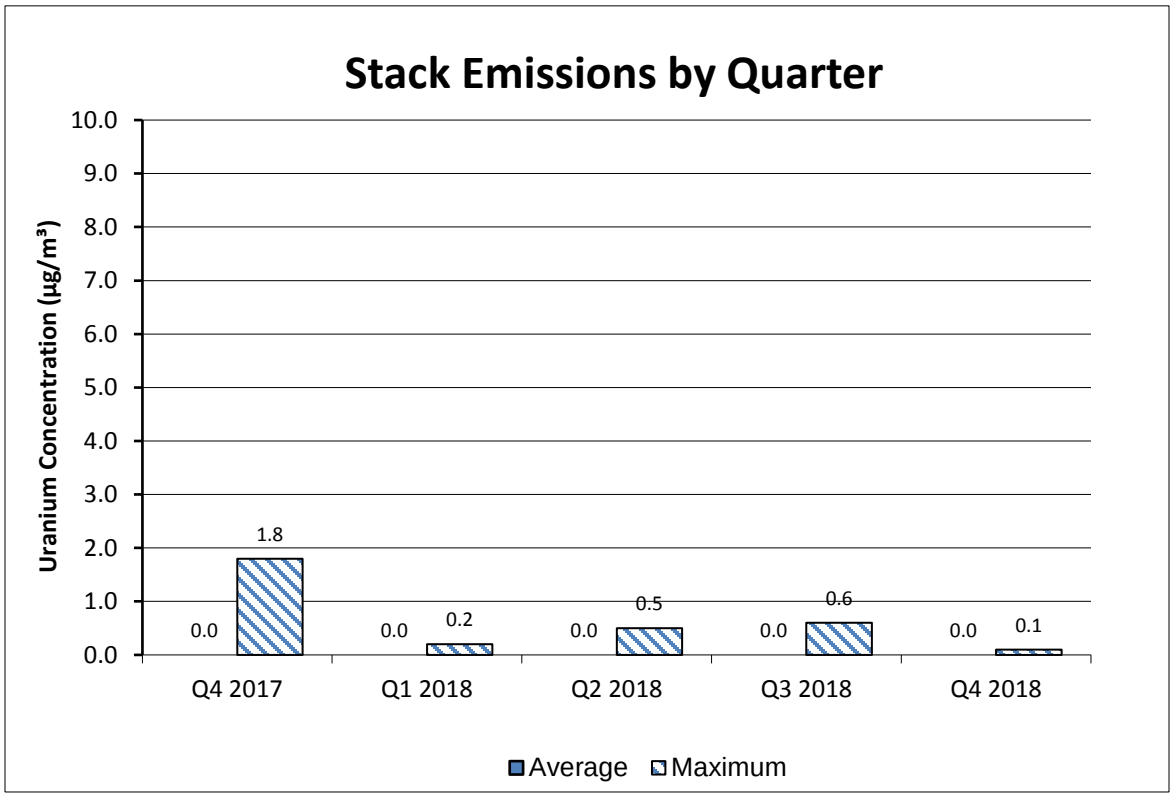
The release limit for air emissions is 14 kg per year as outlined in the operating licence issued by the CNSC. The action level for stack emissions is 2.0 µg/m³ uranium concentration for a daily stack reading. The total amount of uranium dioxide released to the environment during the quarter in gaseous effluent from stacks was 0.001 kg. There were no exceedances of the release limit or action levels with respect to air emissions during the quarter. Table 14 and Figure 10 provide the average and maximum uranium concentration for all stacks in µg/m³ from the fourth quarter of 2017 to the fourth quarter of 2018. The average and maximum concentrations measured in stack emissions in the fourth quarter were lower than previous quarters.

Table 14

Stack Emissions by Quarter (µg/m³)

Source	Action Level	Avg./Max.	2017 Q4	2018 Q1	2018 Q2	2018 Q3	2018 Q4
PP2 West		Avg.	0.0	0.0	0.0	0.0	0.0
	2.0	Max.	0.0	0.1	0.1	0.1	0.0
PP2 East		Avg.	0.0	0.0	0.0	0.0	0.0
	2.0	Max.	0.1	0.1	0.1	0.0	0.0
Waste Treatment Area Absolute		Avg.	0.0	0.0	0.1	0.1	0.0
	2.0	Max.	0.2	0.1	0.3	0.6	0.1
BMS Extraction		Avg.	0.0	0.0	0.0	0.0	0.0
	2.0	Max.	0.1	0.1	0.2	0.2	0.1
Hoffman Vacuum		Avg.	0.0	0.0	0.0	0.0	0.0
	2.0	Max.	0.1	0.0	0.0	0.0	0.0
Pangborn North Dust Collector		Avg.	0.0	0.0	0.0	0.0	0.0
	2.0	Max.	0.1	0.1	0.5	0.2	0.1
Pangborn South Dust Collector		Avg.	0.1	0.0	0.0	0.0	0.0
	2.0	Max.	1.8	0.1	0.2	0.1	0.1
Waste Treatment Dust Collector		Avg.	0.0	0.0	0.0	0.0	0.0
	2.0	Max.	0.1	0.1	0.2	0.0	0.1
DeVilbiss Mist Collector		Avg.	0.0	0.0	0.0	0.0	0.0
	2.0	Max.	0.1	0.2	0.2	0.2	0.1
Furnace Burn-off		Avg.	0.0	0.0	0.0	0.0	0.0
	2.0	Max.	0.1	0.1	0.2	0.0	0.1
Overall Average & Maximum	2.0	Avg	0.0	0.0	0.0	0.0	0.0
		Max	1.8	0.2	0.5	0.6	0.1

Figure 10



Building Ventilation Emissions

Emissions from the building ventilation system are determined using in-plant air sampling data and exhaust discharge rates. The release limit for air emissions is 14 kg per year as outlined in the operating licence issued by the CNSC. Building ventilation emissions are calculated in the PP2 area using the daily average of the continuous air monitors and the exhaust discharge rates for the area. As the exhaust in this area uses HEPA filtration, a 90% efficiency factor is also applied in the calculation. The general ventilation in the Pelleting Area is calculated using the in-plant air data in the areas surrounding the furnaces.

The action level for building ventilation is 1.0 g/hr monitored on a daily basis. In the first quarter of 2018 CFM, after approval from the CNSC, implemented a second action level for the PP2 area at a lower criteria of 0.5 g/hr. This was recommended after a review of the results indicated a lower concentration in the PP2 area. There were no exceedances of either action level in the fourth quarter. The estimated release of uranium dioxide in exhaust ventilation from both areas during the quarter was 0.267 kg (0.240 kg from the Pelleting Area and 0.027 kg from the PP2 area).

Table 15 provides the average and maximum uranium concentration emitted through the building ventilation system in g/hr from the fourth quarter of 2017 to the fourth quarter of 2018. Figure 11 provides the average and maximum uranium concentration emitted through the existing Pelleting Area and Figure 12 provides the average and maximum uranium concentration emitted through the PP2 area.

The table and figures demonstrate that the PP2 area has much lower emissions through building ventilation than the Pelleting Area. In the fourth quarter of 2018 the building ventilation average emission rates for the Pelleting Area were lower when compared to previous quarters. The maximum emission rate in the Pelleting area in the fourth quarter of 2018 was comparable to two previous quarters and lower than the remaining two quarters.

Table 15

Building Ventilation Rates by Quarter (g/hr)

Parameter	Action Level	Measure	2017 - Q4	2018 - Q1	2018 - Q2	2018 - Q3	2018 - Q4
Uranium Emissions from Pelleting Area	1.0	Average	0.20	0.19	0.19	0.23	0.18
		Maximum	0.29	0.40	0.30	0.86	0.31
		Minimum	0.10	0.10	0.08	0.09	0.05
Uranium Emissions from PP2 Area	0.5	Average	0.01	0.01	0.01	0.01	0.01
		Maximum	0.06	0.07	0.12	0.05	0.04
		Minimum	0.00	0.00	0.00	0.00	0.00

Figure 11

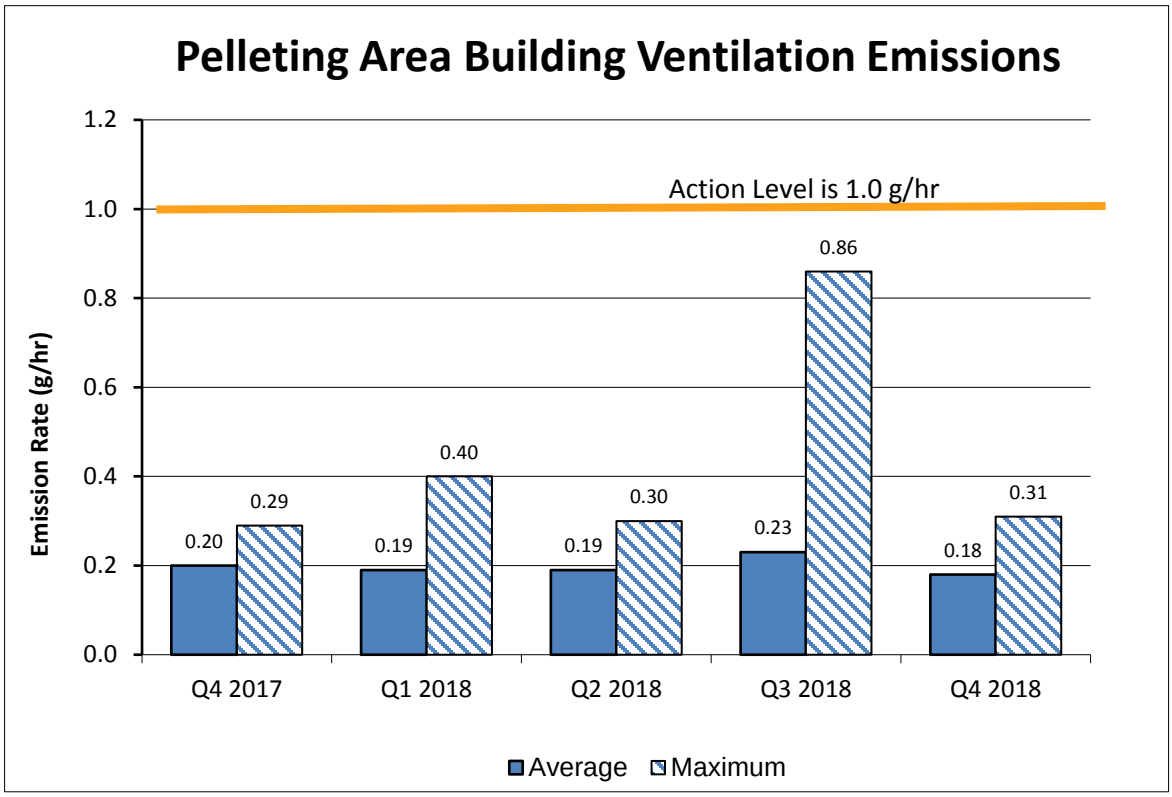
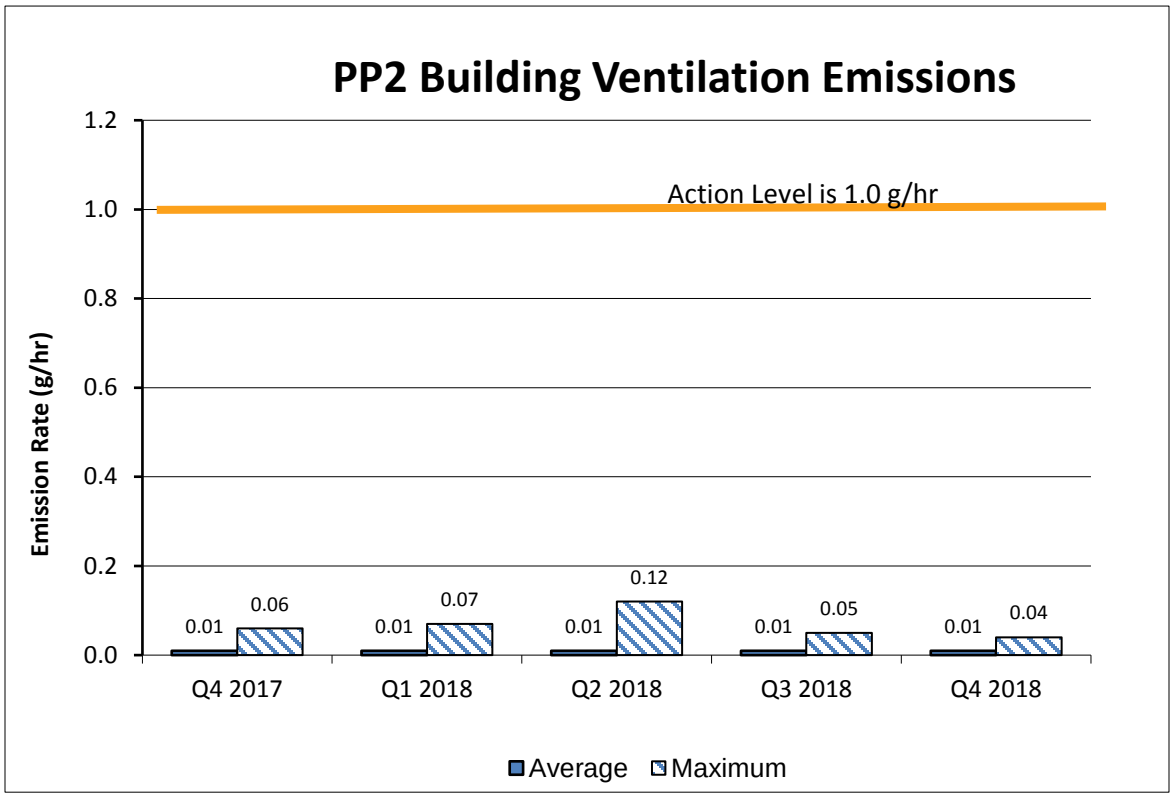

Pelleting Area Building Ventilation Emissions
Emission Rate (g/hr)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Action Level is 1.0 g/hr
0.20
0.29
0.19
0.40
0.19
0.30
0.23
0.86
0.18
0.31
Q4 2017
Q1 2018
Q2 2018
Q3 2018
Q4 2018
Average
Maximum

Figure 12



Liquid Emissions

Liquid effluent generated from production processes are collected and treated to remove the majority of the uranium dioxide using an evaporator process. The condensed liquid is monitored prior to a controlled release to the plant sewer line. Liquid effluent generated from sanitary sewer systems (i.e. showers and bathroom facilities, laundry facilities, etc.) are released directly to the plant sewer line.

Liquid effluent is monitored for uranium content to ensure compliance with various federal, provincial, and municipal regulations. Automated sampling takes a sewer sample from the plant sewer line every 15 minutes, 24 hours per day at the point of discharge to create a composite sample. A sample is taken from the composite twice a week and is analyzed for uranium concentration. The composite sample is representative of liquid effluent discharged to the sanitary sewer from the facility.

The release limit for liquid releases to the sewer is 475 kg per year as outlined in the operating licence issued by the CNSC. The action level for a composite sample is 0.2 mgU/L. There was no exceedance of the action level in the fourth quarter.

The total amount of uranium released to the sanitary sewer in the fourth quarter of 2018 is estimated to be 0.22 kg. The average concentration of uranium in the sewer effluent for the quarter was 0.02 mg/L with a maximum result for a single composite sample of 0.03 mg/L. In the fourth quarter the water meter continued to misread the amount of water used. This information along with potable water usage and groundwater released to sewer is used to calculate the uranium emissions for the quarter. To ensure the emissions were not underreported the amount of potable water was estimated for the quarter using results from the fourth quarter of 2017. The equipment using the process water has not changed over the last year. The Municipality of Port Hope, who owns the equipment, has been contacted to repair the meter. The meter is scheduled to be repaired during the first quarter of 2019.

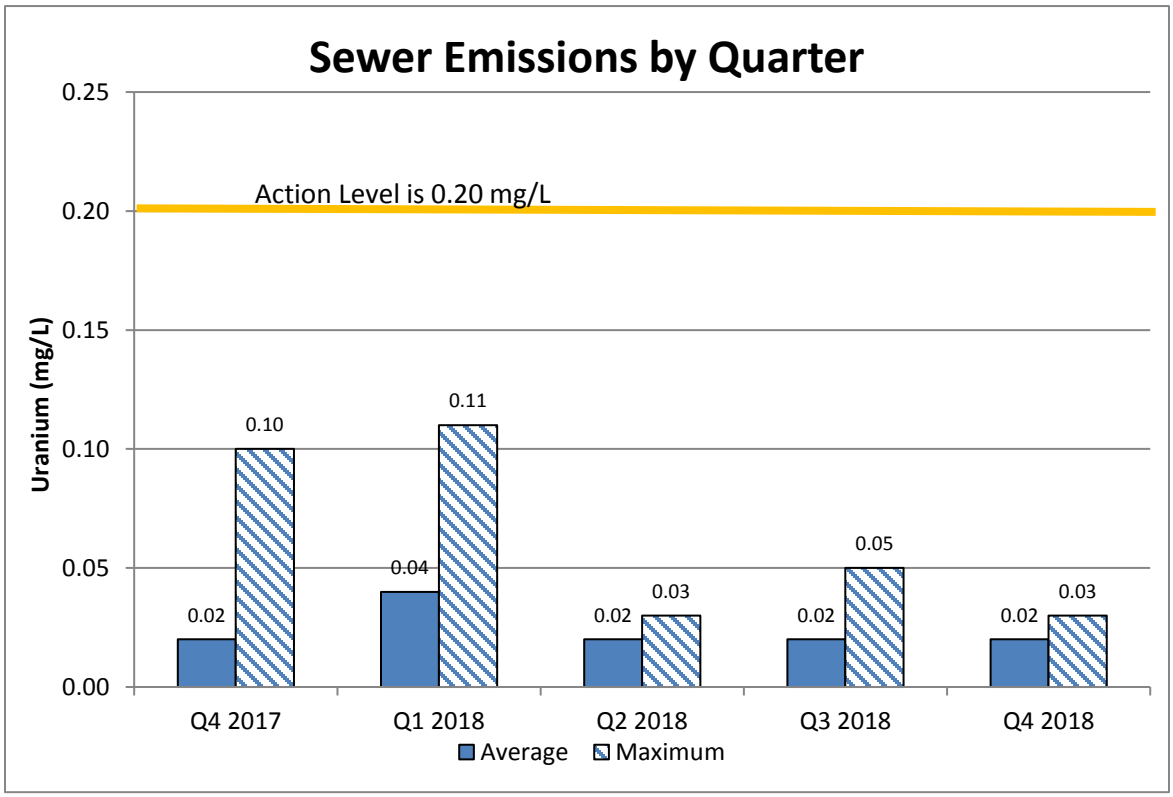
Table 16 and Figure 13 provide the average and maximum uranium concentration for a single composite sample from the fourth quarter of 2017 to the fourth quarter of 2018. The average and maximum concentration in the fourth quarter were equal to the second quarter and third quarter. Also provided in the table is the minimum and maximum pH measured in the samples. During the fourth quarter all sanitary sewer samples were collected, stored, and analyzed as scheduled.

Table 16

Sanitary Sewer Emissions by Quarter

Parameter	Action Level	Measure	2017 Q4	2018 Q1	2018 Q2	2018 Q3	2018 Q4
Uranium (mg/L)		Average	0.02	0.03	0.02	0.02	0.02
	0.2	Maximum	0.10	0.11	0.03	0.03	0.03
pH	6.5	Minimum	7.5	7.3	7.4	7.4	7.7
	9.0	Maximum	8.1	8.4	8.0	8.3	8.2
Volume of water		(m^3)	9951	8748	9726	6627	10921
Estimated Discharge		(kg)	0.17	0.30	0.19	0.12	0.22

Figure 13



*Action Level of 0.20 mgU/L was reinstated in second quarter of 2018

Ambient Air Monitoring

CFM uses hi-volume air samplers to measure the concentration of uranium dioxide that has been emitted from gaseous emissions (i.e. stack as well as fugitive emissions) at the plant boundary at ground level. The system provides information on the impact to the public as well as the environmental impact from facility operations.

In the first quarter of 2018 CFM elected to eliminate the hi-volume action level after obtaining approval from the CNSC. This was recommended after a review of the regulations indicated there was no requirement for an action level.

High volume air samples are collected in the four corners of the CFM property. The samplers are run for 24 hours per day on a continuous basis. The sample filter is changed once a week and analyzed for uranium concentration. In the fourth quarter the maximum concentration was 0.0003 µg/m and occurred in the Southwest and East locations.

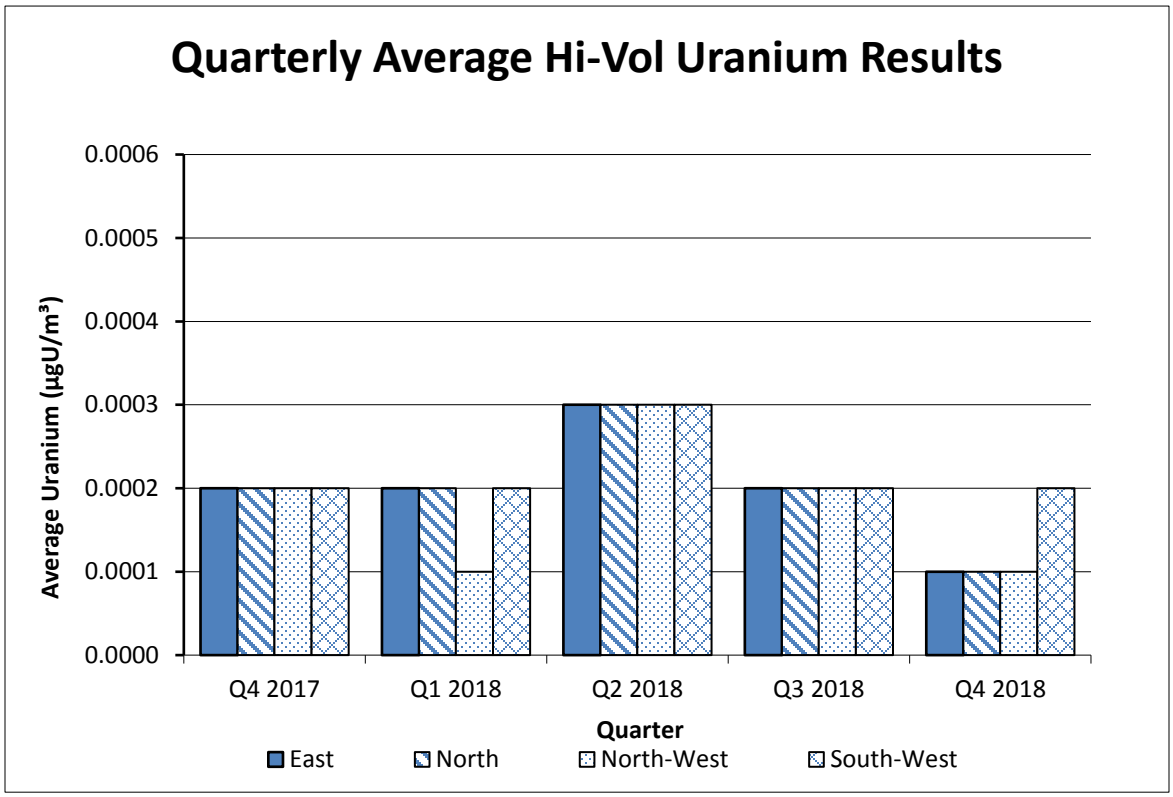
Table 17 and Figure 14 provide the quarterly average and maximum uranium-in-air concentrations for all locations from the fourth quarter of 2017 to the fourth quarter of 2018. The results for the fourth quarter are comparable when compared to previous quarters.

Table 17

Uranium-in-Air Concentration at Hi-Vol Stations by Quarter µg/m³

Quarter		Result	East	North	North West	South West
2017	Q4	Average	0.0002	0.0002	0.0002	0.0002
		Maximum	0.0004	0.0005	0.0003	0.0006
2018	Q1	Average	0.0002	0.0002	0.0001	0.0002
		Maximum	0.0003	0.0003	0.0002	0.0003
2018	Q2	Average	0.0003	0.0003	0.0003	0.0003
		Maximum	0.0005	0.0005	0.0006	0.0005
2018	Q3	Average	0.0002	0.0002	0.0002	0.0002
		Maximum	0.0004	0.0004	0.0004	0.0004
2018	Q4	Average	0.0001	0.0001	0.0001	0.0002
		Maximum	0.0003	0.0002	0.0002	0.0003

Figure 14


Quarterly Average Hi-Vol Uranium Results
Average Uranium (µgU/m³)
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
Q4 2017
Q1 2018
Q2 2018
Q3 2018
Q4 2018
Quarter
East
North
North-West
South-West

Soil Monitoring

As part of CFM's commitment to protecting the community and the environment, soil and vegetation samples are routinely collected from specific locations surrounding the CFM facility. The purpose of the survey is to measure and document uranium dioxide concentrations in the soil and vegetation to verify that no significant build up from emissions of uranium have been released from the facility.

Vegetation, ground level soil (surface), and core samples are each separately collected at 23 locations surrounding the Port Hope facility. In 2003 CFM elected to perform the analysis on an annual basis until 2010 when the decision was made to return to a three year sampling schedule. Soil sampling was completed in 2016 with the results reported in a supplemental to the 2016 ACMOPR. The next sampling campaign will be completed in 2019.

Groundwater Monitoring

CFM has an extensive groundwater monitoring program in place with a total of 75 groundwater monitoring locations. Groundwater wells are sampled semi-annually in the spring and fall of each year. Samples are collected by a consultant in accordance with uranium in ground water sampling protocols and are sent to an independent laboratory for uranium analysis. Results are reported in CFM's ACMOPR.

Effluent and Environmental Monitoring Program Performance

The facility Environmental Protection Program sets out the effluent and environmental monitoring requirements for the facility to ensure adequate environmental protection measures are in place. The performance criteria of these programs is that at least 90% of planned samples are collected and analyzed to meet the data acceptance criteria. Please find below the performance criteria for the data collected during the fourth quarter:

- Water samples (i.e. sanitary discharge) – 100% of planned samples were collected
- Air samples (i.e. stacks, in-plant air, CAMheads) – 100% of planned samples were collected
- Environmental Samples (i.e. surface water, groundwater, hivol, fenceline gamma, soil, vegetation) – 100% of planned samples were collected

In the quarter, all chemical analysis was completed external to CFM and only data meeting acceptance criteria was reported.

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.

As the primary response provider for the facility, the Port Hope Fire and Emergency Services (PHFES) have the resources in place to effectively respond to emergencies at the facility.

Effective emergency response is carried out through CFM's Emergency Preparedness and Response Procedure. The plan assigns specific accountabilities and sets out processes and procedures to protect the health and safety of employees, contractors, the public and the environment in the case of an emergency. The fire protection plan involves a number of areas which include fire prevention, fire protection and emergency response. The supporting documents define those elements which positively contribute to prevent fires, maintain fire safe conditions at the facility, maintain reliability of the fire protection systems and provide an effective emergency response to limit the effects of fire.

During the quarter CFM completed the following:

- Quarterly Emergency Call-In test was performed on Monday November 12, 2018 at 11:00 am. This was performed on a long weekend to represent a day when there are a limited number of employees on site. Rapid notify was used to initiate phone calls to immediate responders stating there was a test of CFM's emergency response capabilities. The test identified there were 5 responders who were available to respond to the site within 10 minutes. Therefore, the minimum complement required for the site was successfully achieved.
- Evacuation drill combined with an EOC activation drill was conducted in the fourth quarter. This drill is completed in order to ensure continued testing of CFM's emergency response plan and practice actions in different scenarios of CFM responders. The debrief meeting identified recommendations that were entered into CIRS for tracking and trending.
- Monthly facility inspections were completed for all areas of the plant. Non-conformances are addressed immediately if possible or if planning is required using two options; a work order notification or a CIRS event.

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

Wastes generated at CFM are segregated as either contaminated or non-contaminated at the point of generation. Non-contaminated waste is either recycled or transferred to an appropriate waste management facility. Contaminated waste is decontaminated and recycled or stored in appropriate containers pending assessment of recycling or disposal options.

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.

CFM 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.

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 (Internal Atomic Energy Agency (IAEA) Safeguards and Non-proliferation Agreement.

There was one short notice random inspection on October 12, 2018 with inspectors from the IAEA. No issues were identified during the inspection.

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.

UO_2 powder is transported by road from the PHCF to CFM. As well UO_2 in the form of finished fuel bundles is transported in shipping containers that meet the package requirements as specified in the CNSC *Packaging and Transport of Nuclear Substances Regulations.*

During the quarter, CFM maintained compliance with CNSC's *Packaging and Transport of Nuclear Substances Regulations and the Transportation of Dangerous Goods Act.*

3. OTHER MATTERS OF REGULATORY INTEREST

3.1.1 Public Information Program

Cameco works to build and sustain trust of local communities by acting as a good corporate citizen in the communities in which it operates. A key element of building and sustaining trust is a commitment to provide those in the community with accurate and transparent reporting of environmental practices and performance. These are central values for Cameco and it is these values that drive CFM's Public Information Program.

For the fourth quarter of 2018, CFM continued to meet the requirements of CNSC RD/GD 99.3, Public Information and Disclosure programs.

Public Engagement

Between October and December Cameco and its employees participated in a number of community events and activities intended to raise the profile of the organization and support the local community.

In October, Cameco joined with its industry partner, OPG Darlington at its Refurbishment Open House, setting up a booth and engaging with members of the public to explain CFM's role in refurbishment and the nuclear industry. In November, Cameco joined Scientists in School to take in a demonstration of the organization's Cameco-sponsored STEM workshops at Beatrice Strong Public School in Port Hope. As well that month, more than 20 Cameco employees and their family members participated in the Port Hope Christmas parade. In December, Cameco remained engaged in the community by continuing its annual support of the YMCA's Operation Red Nose campaign, a program which ensures local residents had a free, safe ride home during the holiday season. As well Cameco sponsored and participated in the Cameco Capitol Arts Centre's 21st Annual Capitol Christmas Festival of Lights and Trees.

Cameco provided free advertising to local charitable organizations with its sponsorship of MyFMs Community Partner Program. Through the quarter the Northumberland Hills Hospital, Salvation Army and Northumberland United Way benefitted from this sponsorship by receiving advertising.

The fall edition of Cameco's Energize newsletter was mailed to all mailing addresses in Port Hope (Wards 1 and 2) in December, was posted on Camecofuel.com, emailed out to subscribers and advertised on Cameco's social media pages. The issue presented an overview of the community outreach done throughout the year, an update on the corporation's most recent quarterly announcement as well as highlighting the Vision in Motion project as one of the key activities undertaken at the operations during 2018.

Public Disclosure

CFM did not disclose any unusual events to the public during the fourth quarter.

Social Media and Website

Our social media followers grew modestly in the fourth quarter and Facebook received 9 new followers. Cameco Ontario's 24 posts covered an array of topics. Posts varied including announcing alarm testing at the conversion facility as well as promoting events and announcements made by Cameco's community partners such as Cameco's participation at the Port Hope Christmas parade, the fundraising efforts of employees and the results of Cameco's annual employee giving fundraising campaign.

Media Analysis

Cameco received only minor mentions in media coverage related to the harbour wall collapse at PHCF. Coverage was generally neutral to positive in nature.

Communication Products

Communications products for the quarter included online advertising campaign, holiday season advertising as well as the publication, mail out and web posting of the Energize newsletter.

3.1.2 Site-Specific

CFM has the ability to handle enriched UO_2 in batch processes and in solid form. Nuclear criticality safety is achieved by employing engineered and administrative controls over batch size (Smallest Critical Mass) in processing and storage areas. CFM has a Nuclear Criticality Safety Program Manual (NCSPM) to address the handling and processing of enriched uranium. The NSCPM has been developed to guide generation and implementation of CFM's criticality prevention practices as they pertain to licensing and criticality prevention issues.

Processing of any amount of enriched material at CFM is governed by a criticality control committee (CCC) as described in the revised NSCPM.

There were no processing activities of enriched material conducted on site in the fourth quarter of 2018 and CFM met all site-specific reporting requirements.

3.1.3 Improvement Plan and Future Outlook

The 2017 improvement plans and future outlook for CFM are discussed in section 3.1.3 Improvement Plans and Future Outlook of the 2016 ACMOPR which was issued on March 30, 2017.

3.1.4 Safety Performance Objectives for Following Year

CFM 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.

The 2017 safety performance objectives for CFM are discussed in section 3.1.4 Safety Performance Objectives for Following Year in the 2016 ACMOPR which was issued on March 30, 2017.

4. CONCLUDING REMARKS

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

During the fourth quarter of 2018, CFM did not exceed any CNSC regulatory limits. CFM maintained environmental emissions and public radiation exposures to levels that are a fraction of the regulatory limits. There were no exceedances of the action levels in the radiation or environmental protection programs.

Cameco's relationship with local residents remains strong and we are committed to maintaining the strong support and trust we have developed over the past several years.