

The information contained in this report concerns the performance and operation of BWXT Nuclear Energy Canada Inc.'s (BWXT NEC) Class IB nuclear facilities located in Peterborough and Toronto, Ontario. This report is prepared to meet fuel fabrication operating licence FFOL-3620.01/2020 condition 2.4. The content shows adherence to the BWXT NEC commitment to operate safe Class IB nuclear facilities, as well as demonstrate compliance with applicable regulations and licence conditions specified by the Canadian Nuclear Safety Commission.

Peterborough &  
Toronto

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**Submitted to:**

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## 1 EXECUTIVE SUMMARY

BWXT Nuclear Energy Canada Inc. (BWXT NEC) has been involved with the Canada Deuterium Uranium (CANDU®) industry from its earliest years. BWXT NEC produces nuclear fuel bundles used by the CANDU fleet to generate clean electricity that powers homes, business and the Canadian economy. BWXT NEC operates in three plant locations: Arnprior, Toronto and Peterborough, Ontario. BWXT NEC's Toronto and Peterborough facilities are Class IB nuclear facility operations. The operating licence issued by the Canadian Nuclear Safety Commission (CNSC) authorizes BWXT NEC to operate and modify its nuclear fuel facility to produce natural and depleted uranium dioxide (UO<sub>2</sub>) pellets in Toronto at 1025 Lansdowne Ave., and produce and test fuel bundles in Peterborough at 1160 Monaghan Rd. The Peterborough facility is additionally authorized to receive, repair, modify and return contaminated equipment from off-site nuclear facilities.

The purpose of this compliance report is to demonstrate that BWXT NEC has successfully met the requirements of the Nuclear Safety and Control Act, associated regulations and the Class IB Nuclear Fuel Facility Operating Licence FFOL-3620.01/2020 revised by the CNSC on December 16, 2016, and expiring December 31, 2020. This report is prepared based on the CNSC's *Annual Compliance Monitoring and Operational Performance Reporting Requirements for Class I A & B Nuclear Facilities*. It has been divided into two parts to separate worker protection from public and environmental protection. Appendices containing confidential and proprietary information are submitted to the CNSC separately.

BWXT NEC is committed to continuously improve systems to protect employees, the environment and our communities against environment, health and safety hazards. We work to implement programs and objectives to conserve natural resources, prevent pollution and minimize waste. Maintaining a safe and healthy work environment for our employees is a top business priority. To demonstrate commitment and ensure compliance, BWXT NEC maintained the following external registrations:

- International Standards Organization (ISO) 9001:2015 Quality Management System
- Canadian Standards Association (CSA) Z299.1-1985 Quality Management System
- ISO 14001:2004 or 2015 Environmental Management System

No significant operational changes occurred at either facility. Upgrades were made to programs with the objective of achieving continuous improvement and environmental health and safety excellence. Details are provided in the main sections of this report.

Changes made to the physical facilities, equipment, processes, procedures or practices that could impact employee health and safety, the environment or the public as a result of the operation of BWXT NEC's facilities are assessed through the business-wide Change Control program.

BWXT NEC has established facility specific CNSC approved *Action Levels* for various radiological and environmental parameters. An Action Level is defined in the *Radiation Protection Regulations* "as specific dose of radiation or other parameter that, if reached, may indicate a loss of control of part of a licensee's radiation protection program, and triggers a requirement for specific action to be taken." Action Levels are also applied to environmental protection. Action Levels are set below regulatory limits; however, they are CNSC reportable events. Accordingly, BWXT NEC has established *Internal Control Levels* for various radiological and environmental parameters that are set even lower than Action Levels to act as an early warning system. Internal Control Level exceedances result in internal investigation and correction and are not CNSC reportable events.

Employee workplace radiation exposures are measured by CNSC approved methods and systems. Overall, dose trends are favourable and consistent with an effective application of the ALARA (As Low as Reasonably Achievable - Social and Economic Factors considered) principle. All measured radiation

exposures received by personnel in the reporting period were within regulatory limits and below Action Levels.

BWXT NEC has established conventional health and safety programs to manage the non-radiological workplace safety hazards to protect personnel. Key performance indicators are used to measure the success of the programs throughout the year. The Toronto site was injury-free in 2017 and achieved a BWXT President and Chief Executive Officer Safety Award as recognition for their excellent safety performance.

BWXT NEC recognizes that an effective way of maintaining public trust is to maintain environmental excellence. This requires a demonstrated commitment to operating in accordance with the highest environment, health and safety standards. The facilities are ISO 14001 registered to ensure effective environmental management systems are in place to achieve environmental goals and objectives and keep all environmental impacts well within applicable standards and as low as reasonably achievable. These programs demonstrate compliance to relevant federal and provincial legislation. Environmental protection programs are also compliant with the following standards:

- CSA N288.4-10, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills*, CSA N288.5-11
- *Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills*
- CSA N288.6-12, *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills*

Air and water emissions are routinely measured from both facilities to demonstrate compliance with the CNSC's environmental protection requirements and the ALARA principle. All measurements were below Action Levels and annual releases were a very small fraction of regulatory limits.

Established emergency response plans are in place that describe the actions to be taken to minimize health and environmental hazards, which may result from fires, explosions, or the release of hazardous materials. This includes effects to the local area and members of the public. The plans intend to reduce the risk of emergencies such as fires, and assist emergency staff and plant personnel in understanding key emergency response issues, and assist the facilities in protecting employees, the local community and the environment through sound emergency management practices. The emergency response plans were developed in accordance with federal laws and standards as follows and fulfils the CNSC operating licence requirements.

1. CAD/CSA-Z731-03, *Emergency Planning for Industry Standard*
2. CNSC Regulatory Guide G-225, *Emergency Planning at Class I Nuclear Facilities and Uranium Mines and Mills*
3. The Province of Ontario Nuclear Emergency Plan Part VIII
4. Canada Labour Code
5. CNSC Regulatory Document REGDOC 2.10.1, *Nuclear Emergency Preparedness and Response*
6. NFPA 801, *Fire Protection for Facilities Handling Radioactive Materials*
7. CSA N393-13, *Fire Protection for Facilities that Process, Handle, or Store Nuclear Substances*

BWXT NEC has implemented and maintains a safeguards program and undertakes all required measures to ensure safeguards implementation in accordance with International Atomic Energy Agency (IAEA) commitments and CNSC regulatory document RD-336 *Accounting and Reporting of Nuclear Material*. Movement (inventory changes) of natural and depleted uranium are documented and reported to the CNSC as required. The IAEA and the CNSC jointly conduct annual verifications.

BWXT NEC safely transports dangerous goods, including Class 7 radioactive material shipments as defined by the *Transportation of Dangerous Goods (TDG) Act and Regulations*. Shipments occur routinely between suppliers and the Toronto and Peterborough facilities, customers and waste vendors.

BWXT NEC places great importance on its relationships with all levels of local government and residents in the communities in which it operates and works to ensure there is open communication and awareness of BWXT NEC's operating activities. The public information program defines the process for providing information about BWXT NEC operations. Public interest in both facilities was low during the reporting period. Enquiries were tracked and responded to in a timely manner. The Community Liaison Committee (Toronto), whose mandate is to provide a forum for a cross-section of neighbours and other community stakeholders to share information and ideas, continued to meet regularly.

This compliance report demonstrates that BWXT NEC has successfully met the requirements of the Nuclear Safety and Control Act, Regulations and CNSC Class I B nuclear facility operating licence requirements.

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## 2 GENERAL INTRODUCTION

BWXT Nuclear Energy Canada Inc. (BWXT NEC) has been involved with the Canada Deuterium Uranium (CANDU®) industry from its earliest years. BWXT NEC produces nuclear fuel bundles used by the CANDU fleet to generate clean electricity that powers homes, business and the Canadian economy. BWXT NEC operates in three plant locations: Arnprior, Toronto and Peterborough, Ontario. BWXT NEC's Toronto and Peterborough facilities are Class IB nuclear facility operations. The CNSC operating licence authorizes BWXT NEC to operate and modify its nuclear fuel facility to produce natural and depleted uranium dioxide (UO<sub>2</sub>) pellets in Toronto at 1025 Lansdowne Avenue (Figure 1), and produce and test fuel bundles in Peterborough at 1160 Monaghan Road (Figure 2). Finished bundles are then shipped to various customers. The Peterborough facility is additionally authorized to receive, repair, modify and return contaminated equipment from off-site nuclear facilities.



Figure 1: BWXT NEC Toronto

BWXT NEC is federally regulated for health and safety. The federal health and safety legislation is the Canada Labour Code Part II and the Canada Occupational Health and Safety Regulations. The Canada Labour Code is enforced by Employment and Social Development Canada. The purpose of Part II of the Canada Labour Code is to prevent accidents and injury to health arising out of, linked with or occurring in the course of employment. BWXT NEC facilities are also regulated federally by Transport Canada. BWXT NEC is additionally regulated provincially by the Ontario Ministry of the Environment and Climate Change (MOECC). Compliance to these agency requirements is ensured through company policies, management systems, and the following external registrations:

1. International Standards Organization (ISO) 9001:2008 Quality Management System
2. Canadian Standards Association (CSA) Z299.1-1985 Quality Management System
3. ISO 14001:2004 or 2015 Environmental Management System



**Figure 2: BWXT NEC Peterborough**

BWXT NEC is committed to the establishment and continuous improvement of a healthy Safety Culture. Safety Culture refers to the core values and behaviours resulting from a collective commitment by our company's leaders and individuals to emphasize safety, quality, ethics, and security over competing goals to ensure protection of people and the environment. The Environment, Health and Safety (EHS) Mission Statement defines it as a top business priority to continuously improve our EHS systems to protect fellow employees, the environment, and our communities against known and potential environmental, health and safety hazards. The BWXT NEC management team reviews, prioritizes and controls workplace hazards and ensures compliance with the pertinent regulatory requirements, applicable codes and company policies.

The primary facility potential radiological hazard is the inhalation of airborne  $UO_2$  particles. Measurements are performed for airborne and surface traces of uranium as an indicator of process containment efficiency. Urine samples provided by employees are used to indicate if inhalation may have occurred. A lesser potential hazard exists in the form of low-level external gamma and beta radiation exposure to employees.

Whole body, skin and extremity dose measurements are conducted to demonstrate compliance with the dose limits specified in the *Radiation Protection Regulations* and the ALARA principle. All dose measurement results for employees were below Action Levels and regulatory limits.

Air and water emissions are routinely measured to demonstrate regulatory compliance and the ALARA principle. All measurements were below *Action Levels* and annual releases were a small fraction of regulatory limits.

Table 1 defines the acronyms used in this report.

Acronym	Definition
AED	Automated External Defibrillator
ALARA	As Low as Reasonably Achievable (social and economic factors considered)
ATS	Action Tracking System
BWXT NEC	BWXT Nuclear Energy Canada Inc.
CANDU	CANadian Deuterium Uranium
CCME	Canadian Council of Ministers of the Environment
CLC	Community Liaison Committee
CNSC	Canadian Nuclear Safety Commission
CPR	Cardiopulmonary Resuscitation
CSA	Canadian Standards Association
CTS	Critical-to-Safety
dpm	Disintegrations per minute
EHS	Environment, Health and Safety
EMS	Environmental Management System
ERAP	Emergency Response Assistance Plan
IAEA	International Atomic Energy Agency
ISO	International Standards Organization
MOECC	Ministry of the Environment and Climate Change
MP	Member of Parliament
MPP	Member of Provincial Parliament
mSv	milliSievert – unit of measure for radiation dose 1 mSv = 0.001 Sv
NEW	Nuclear Energy Worker
NFPA	National Fire Protection Association
ppm	Parts per million
QA	Quality Assurance
RSI	Radiation Safety Instruction
SAT	Systematic Approach to Training
SSC	Systems, structures and components

Acronym	Definition
TDG	Transportation of Dangerous Goods
TLD	Thermoluminescent Dosimeter
UO <sub>2</sub>	Uranium Dioxide
μSv	microSievert – unit of measure of radiation dose 1 μSv = 0.001 mSv = 0.000001 Sv
WSC	Workplace Safety Committee

**Table 1: Definition of Acronyms**



## **PART I: WORKER PROTECTION**

### 3 FACILITY OPERATIONS

Facility operations continued routinely and safely without any significant challenges. During the reporting period, there were no significant modifications made to either facility. Uranium dioxide pellets were shipped to BWXT NEC's Peterborough facility without incident. The pellets were assembled into CANDU reactor fuel bundles and were then safely shipped to customers. Plant personnel followed procedures satisfactorily, as reflected in internal and external audits, self-assessments, radiation surveys, contamination monitoring and air sampling measurements. Details are provided in subsequent sections of this report.

The President of BWXT NEC is responsible for all activities within the company. The various functional groups, such as Human Resources, EHS, Quality Assurance (QA), Information Technology, Sales and Commercial Operations report directly or indirectly to the President.

Senior Management accountability for the effectiveness of the management systems is defined. The Director, OpEx and Quality has been assigned the responsibility for monitoring and assessing the effectiveness of the business Licensed Activity management system. The Director, OpEx and Quality is responsible and has the freedom to identify problems, initiate or recommend solutions, and confirm their implementation and effectiveness.

The following key position changes occurred:

- In March 2017, the Toronto Quality Leader, Mark Beaudon assumed the role of Manager Shop Operations. Mark is responsible for all of Manufacturing and Engineers and is the Site Leader of the Toronto plant. As a result, Jack Chong transitioned to the Shop Supervisor role.
- In May 2017, John MacQuarrie assumed the role of President having overall responsibility for BWXT NEC.

During the reporting period, the following pertinent modifications to the company organization structure occurred:

- In June 2017, Ted Richardson assumed the new role of Director, Fuel Operations. Ted oversees all aspects of the fuel operations in Toronto, Peterborough and Arnprior.

BWXT NEC maintains five EHS related committees that review activities including proposed changes to ensure safe plant operations. They are:

- Health and Safety Policy Committee - comprised of unionized workers and management to contribute to making the company as safe as possible by promoting health and safety awareness, making recommendations to workers and management regarding policies and procedures for safe working practices
- Workplace Safety Committee (WSC) - comprised of unionized workers and management to prevent accidents and occupational illness by promoting health and safety awareness, making recommendations to workers and management regarding safe work practices and monitoring health and safety issues until resolved
- As Low as Reasonably Achievable (ALARA) Committee - comprised of unionized workers and management to continuously improve the radiation safety program and implement ALARA practices where practical to ensure that radiation doses are as low as reasonably achievable.
- Beryllium Safety Committee – comprised of unionized workers and management to continuously improve the beryllium safety program and reduce potential beryllium hazards to workers at the Peterborough site.

- Ergonomics Committee - comprised of unionized workers and management to develop, monitor and administer the ergonomic procedure and recognize, reduce and where possible eliminate physical and cognitive ergonomic risk factors.

In accordance with EHS program requirements, registrations and certifications, internal audits are conducted annually to assess conformance to internal and external requirements. A total of 28 internal audits were conducted. Details on the scope and findings are provided in subsequent sections of this report. No licensed activity related formal external audits were conducted by BWXT NEC during the review period.

## **4 PRODUCTION**

All possession and monthly processing limits, as specified in the CNSC facility operating licence were met. Production data is proprietary and is provided separately to the CNSC in Appendix C. There was a one-week production shutdown in the first quarter, a three-week production shutdown in the third quarter and a two-week production shutdown in the fourth quarter between both sites. Production shutdowns are for engineering projects and equipment maintenance.

## **5 FACILITY MODIFICATIONS**

Changes made to the physical facilities, equipment, processes, procedures or practices that could impact product quality, employee health and safety, the environment or the public as a result of the operation of BWXT NEC's facilities are assessed through the Change Control program. Physical changes that occurred during the reporting period are summarized in section 6.4.2. There were no modifications that affected the safety analysis of the facilities.

## **6 SAFETY AND CONTROL AREAS**

### **6.1 Management**

#### **6.1.1 Management System**

The "Management System" 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 management system defines the requirements of the quality assurance program for the licensed activity, which ensures applicable buildings and facilities, process equipment, and processes used in support of licensed activities are conducted in accordance with the Nuclear Safety Control Act and Regulations, applicable CNSC QA requirements, jurisdictional requirements and compliance best practices.

Management reviews for EHS program elements are conducted once annually before the end of April each year to review the previous calendar year activities. The EHS Management Reviews encompass the following items:

- Status of actions from previous management reviews;
- Follow-up actions from previous management reviews.
- Results of external agency audits where applicable;
- Open regulatory compliance obligations;
- Results of Reg Auditor (Gensuite®) compliance evaluations;
- Results of QA for licensed activity internal and external audits (where applicable);
- Results of QA for licensed activity management self-assessments;

- Trends in non-conformances (Gensuite Action Tracking System items) for closure metrics;
- EHS related Quality Assurance Actions;
- Trends in Incident and Measurement (Gensuite) items for root cause;
- Status of EHS training activities;
- Procurement process;
- Extent to which Environmental, Health and Safety and ALARA objectives and targets have been met;
- Radiation dose trends;
- Communications and changes in the needs and expectations of interested parties, including complaints;
- Changing external and internal issues, including compliance obligations;
- Changes in risks and opportunities;
- Opportunities for continual improvement;
- Evaluation of the effectiveness and continuing suitability of the EHS Mission Statement and the Environment, Health and Safety Program.

The above inputs are reviewed to ensure continuing suitability, adequacy and effectiveness of the management system. The criteria for these are:

**Suitable:** Does the system satisfy the requirements and represent the best way of doing things for our business?

**Adequate:** Is the system fit for its current purpose?

**Effective:** Does the system enable the right things to be done? Is it driving continuous improvement?

Formal meeting minutes are prepared. Actions are formally issued for follow-up by the applicable functional lead(s) and retained as a record.

The previous management review meeting resulted in seven actions that were formally issued for follow-up by the applicable functional lead(s), and tracked to closure in Action Tracking System (ATS). Overall, the implemented management system for the licensed activity program was considered suitable, adequate and effectively implemented at both facilities. Continuous improvement remains a priority.

#### 6.1.1.1 Licensed Activity Internal Audits

Internal auditing is an independent, objective activity designed to add value and continuously improve programs. Periodic assessment of program effectiveness is conducted through systematic internal audits that are planned and carried out on behalf of management to measure performance, the effectiveness of the program element processes and to promote continuous improvement. An audit schedule is prepared annually and ensures that each licensed activity program element is audited at least once every three years. Table 2 provides a summary of internal audits conducted in the reporting period. The summary does not include internal audits that form part of the International Standards Organization (ISO) 9001/Z299 system which have a product focus but do share some overlap with safety, e.g., management system, documentation, training etc.

BWXT NEC did not conduct any formal external audits of other facilities during the review period that relate to the licensed activities at the facility.

Audit Type	Peterborough		Toronto	
	Number of Audits	Number of Non-conformances	Number of Audits	Number of Non-conformances
Compliance (Regulation Audits)	10	6	10	11
QA for Licensed Activity	4	3	2	3
Environmental Management System (EMS)	1	3	1	3
<b>Total</b>	<b>15</b>	<b>12</b>	<b>13</b>	<b>17</b>

**Table 2: Summary of Internal Audits**

**6.1.1.2 Licensed Activity Related Self-Assessments**

The Self-Assessment Program governs a proactive process for self-critical, candid and objective evaluation of performance by a Functional Area measuring their process performance against goals established from business plans or external benchmarking standards. The Self-Assessment Program is a management tool used to engage the workforce in early and proactive detection of organizational weaknesses. It is a Functional Manager's opportunity to take a structured look at their own function. Self-Assessments help identify low level issues or trends for early resolution before more significant problems occur. A Self-Assessment schedule is prepared annually and ensures that each program element is reviewed periodically based on a risk-related approach. A summary of self-assessments conducted in the reporting period is provided in Table 3.

In the reporting period, minor continuous improvements were made to the Management Self-Assessments procedure and work instruction for clarity.

Program Element	Peterborough		Toronto	
	Number of Self-Assessments	Number of Findings	Number of Self-Assessments	Number of Findings
Non-Conformance & Corrective Action	1	0	1	3
Document Control & Records	1*	1	1	3
Personnel Capability (Training)	1*	0	1	0
Work Planning, Control & Verification	1	6	1	7
Use of Experience (OPEX)	1	0	0	0
Radiation Protection	1	2	1	3
Emergency Preparedness and Response	1	1	1	6
Environmental Protection	1	0	1	0
Waste Management	1	7	1	4
<b>Total</b>	<b>9</b>	<b>17</b>	<b>8</b>	<b>26</b>

**Table 3: Summary of Self-Assessments**

\*Product quality scope

**6.1.1.3 Management System Program Improvements**

All management system documentation required by operating licence condition 2.1 is in place. Continuous improvement is achieved through several review processes, including self-assessments and audits. The EHS Policy establishes the direction for the management system. In 2017, in addition to administrative edits, several minor continuous improvements were made to management system program elements as follows:

- The Non-Conformance & Corrective Action program was updated to require authorization for further work in the case of a non-conformance involving a high risk activity or process;
- The Change Control program was improved to include a pre-workflow Risk Analysis that determines the risk level of the intended change, the requirement for change control application for both temporary and permanent changes and clarification of what is involved in Conditional vs Final Change Notice Approval.
- The Critical-to-Safety (CTS) list was revised to include respirator filter/cartridges individually by part number.
- A written work instruction for new or changed CTS item masters was implemented and includes an approval process.

## 6.2 Human Performance Management

The "Human Performance Management" Safety and Control Area covers activities that enable effective human performance, through the development and implementation of processes that ensure that BWXT NEC staff members are sufficient in numbers in all relevant job areas, and have the necessary knowledge, skills and tools in place to safely carry out their duties.

The training program is outlined in the Licensed Activity QA Manual, and business-wide training procedures. Qualifications and training requirements are identified and personnel are given the appropriate training to ensure they are competent at the work they do. This training includes on-the-job training, radiation protection and safety risk assessment training. Workers only perform functions for which they are qualified. Both facilities achieved 100% regulatory training completion in the reporting period. Compliance to regulatory training completion is a key performance indicator that is tracked throughout the year.

From January 1 to June 25, 2017 the Training Tracker Tool in Gensuite was used to track EHS-related training. Gensuite is a suite of integrated applications enabling compliance and EHS excellence. On June 26, 2017 BWXT NEC transitioned to a new learning management system, SAP® SuccessFactors® Learning, for the tracking of training including EHS-related training. SAP SuccessFactors is a global provider of human resource software and fully integrated human capital management systems. Relevant course completion details are provided in subsequent sections of this report.

Following the implementation of the Systematic Approach to Training (SAT) program in 2015, 2017 continued to have a focus on the application of SAT to new and legacy training. Programs that have been developed in compliance with SAT include:

- Training on knowledge areas such as Respiratory Protection Awareness, Transportation of Dangerous Goods, Security Awareness, Radiation Protection & Emergency Response for Class 7 Carriers, Uranium Emergency Response Assistance, Canada Labour Code Part II, and Radiation Safety
- Training on tasks such as External & Internal Radiation Hazard Monitoring, First Aid/Automated External Defibrillator/Cardiopulmonary Resuscitation, B3 Area Donning & Doffing
- Training for roles such as Material Handling – Shipping/Receiving, Material Handling – Janitorial, and Facilities Coordinator

Implementation of the SAT principles to existing and new training roles and programs continues into 2018 and 2019.

In response to a May 2017 CNSC Training Inspection and Report an action plan was developed and actions with 2017 due dates were closed as identified on the action plan.

The facilities are staffed with 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. EHS and other staff are available after business hours as needed.

## 6.3 Operating Performance

The "Operating Performance" Safety and Control Area covers an overall review of the operations licensed activities. Management conducts routine meetings to review operations at each facility including a discussion of health and safety concerns. Reporting of EHS-related concerns is encouraged. These are assigned and tracked to completion in the Gensuite software system and is a measure of employee engagement.

Operating performance is monitored with key performance indicators and program goals. In accordance with EHS program requirements, registrations and certifications, internal audits are conducted annually to

assess conformance to internal and external requirements. Related licensed activity audits are summarized in Table 2 and section 6.1.1.1 above.

## **6.4 Facility and Equipment**

### **6.4.1 Safety Analysis**

The "Safety Analysis" 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 an activity or facility, and considers the effectiveness of preventive measures and strategies in reducing the effects of such hazards.

The safety analyses utilized a combination of What-if Analysis, Hazards and Operability and Quantitative Risk Analysis and documents a systematic evaluation of hazards associated with the licensed facilities.

Modifications to the facilities are made in accordance with the business-wide Change Control program, which requires review of EHS parameters for new or modified facilities, processes, and new or relocated machinery, apparatus and equipment. Under this process, a proposed modification is screened for potential impact on the facility safety analysis. Where screening identifies a potential impact, a more detailed review of the proposed modification is conducted to identify if the change impacts a safety system, or the basis of the safety assessment (e.g. materials, quantities, locations, etc.). Third-party reviews or regulatory approvals are conducted as required. In this way, impacts on the safety analysis are identified and the safety analysis is validated and updated, where necessary.

During the reporting period, there were no changes that impacted the safety analysis for the facilities. As a result, there were no updates to the facility safety analysis reports at either site. Physical changes are described in the following section.

### **6.4.2 Physical Design**

The "Physical Design" Safety and Control Area relates to activities that impact on the ability of systems, structures and components (SSC) to meet and maintain their design basis, given new information arising over time and taking into account changes in the external environment.

Changes made to the physical facilities, equipment, processes, procedures or practices that could adversely affect product quality, employee health and safety, the environment or the public as a result of the operation of BWXT NEC's facilities are assessed through the Change Control program. Any changes to the design basis are identified and assessed through this program, including third-party reviews as required. Adequate mitigations are applied including modification of the proposed change, up to rejection of the proposed change.

The following significant improvements to the physical plants were implemented during the reporting period:

- Lighting replacements on fuel shop floor (Building 21-1 Peterborough)
- New floor in conference room (Building 21-2 Peterborough)
- Kit program relocation (Building 26 Peterborough)
- Union offices reconfiguration (Building 7 Toronto)
- Installation of an Emergency Operations Centre trailer outside Building 9 (Toronto)

### 6.4.3 Fitness for Service

The "Fitness for Service" 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 function when called upon to do so.

Both facilities are using an asset management and preventive maintenance software system. Maintenance Connection® is a web-based maintenance management software for work order and asset management. Maintenance Connection assists BWXT NEC in efficiently managing preventive maintenance tasks as well as to control and identify maintenance on CTS and Critical-to-Quality assets and parts. Preventive maintenance tasks on CTS equipment are designated in this system as described in the business wide Enterprise Asset Management Program Procedure.

Certain CTS tasks have associated independent post-maintenance verification or testing. For example, in Toronto, independent verification is in place on the ventilation systems during filter changes as well as following rotoclone ductwork maintenance.

In Peterborough and Toronto respectively, 97% and 99% of CTS tasks issued were completed within 14 days of the target completion date. All CTS tasks issued in the reporting period are closed.

Preventive maintenance is considered during the assessment of changes as part of the business-wide Change Control program. Additionally, in the event of a near miss, incident or injury the preventive maintenance program for related equipment is reviewed as applicable. As a result, during the reporting period, the following improvements to preventive maintenance tasks were implemented:

- Specific instructions for cleaning the graphite coater were added to address safety concerns from dropping the top plate (Peterborough)
- A new task was generated to clean and oil the lift cylinders on the manual bundle welders (Peterborough)
- The B2 cleaning task was updated to include input and output trays of the Harper furnace and the B3 Operator's footwear (Peterborough)
- A new task was generated to inspect the bundle manipulators monthly (Peterborough)
- A pre-job review with the EHS Technician was added for Beryllium Coater Cleans (Peterborough)
- The beryllium exhaust system maintenance task was updated to require a filter change based on gauge readings, rather than visual inspection (Peterborough)
- The maintenance task for cleaning under the fuel storage racks was updated to include cleaning under the three fuel loading storage racks (Peterborough)
- A daily centrifuge level check was added to the maintenance software to ensure levels are maintained to prevent flooding in the rotoclone room (Toronto)

The preventive maintenance program is periodically assessed through self-assessments and internal audits. Key performance indicators are in place and are routinely reviewed. The program is adequate and effective and is continually improved.

## 6.5 Core Control Processes

### 6.5.1 Radiation Protection

The "Radiation Protection" Safety and Control Area covers the implementation of the radiation protection program, in accordance with the *Radiation Protection Regulations*. This program ensures that contamination and radiation doses received are monitored and controlled.

BWXT NEC has an established radiation protection program to address the hazards from UO<sub>2</sub> and keep employee doses ALARA. The major potential worker hazard is inhalation of airborne UO<sub>2</sub> particles. Measurements are performed of airborne and surface traces of uranium as an indicator of process containment efficiency. A respiratory protection program is in place. Urine samples provided by employees are used to indicate if inhalation may have occurred and to monitor clearance of uranium from the body. A lesser potential hazard exists in the form of low-level external gamma and beta doses to employees. Routine gamma surveys are conducted and Nuclear Energy Workers are issued thermoluminescent dosimeters (TLDs) to measure whole body, skin and extremity dose to ensure compliance with the regulatory radiation dose limits and the ALARA principle. The BWXT NEC program ensures that surface and airborne contamination and radiation doses to employees are monitored and controlled.

BWXT NEC has established facility specific CNSC approved Action Levels for various radiological and environmental parameters. An Action Level is defined in the *Radiation Protection Regulations* as "a specific dose of radiation or other parameter that, if reached, may indicate a loss of control of part of a licensee's radiation protection program, and triggers a requirement for specific action to be taken." Action Levels are set below regulatory limits; however, they are CNSC reportable events. Accordingly, BWXT NEC has established Internal Control Levels for various radiological and environmental parameters that are set even lower than Action Levels to act as an early warning system. An Internal Control Level exceedance results in internal investigation and corrective action.

A component of the radiation protection program is area classification. Areas of each facility are classified into four different categories for the purpose of controlling the spread of radioactive contamination, and ensuring appropriate controls are in place. These classifications are defined in the Radiation Protection Manual as follows:

- Unclassified Area - these areas do not involve nuclear substances and are considered public domain. Incidental contamination does not exceed the unclassified area Internal Control Levels.
- Active Area - these areas are designed for handling materials with loose contamination that is potentially above unclassified area Internal Control Levels. External radiation hazards are not of significant concern.
- R1 Area - these areas are designed for operations where only external radiation is of concern, and loose contamination is below R1 area Internal Control Levels.
- R2 Area - these areas are designed for operations involving exposed non-dispersible nuclear substances, where external radiation is of concern and loose contamination may be above R1 Internal Control Levels.
- R3 Areas - these areas are designed for operations involving exposed solid dispersible nuclear substances, where external radiation may be of concern and where the hazard of contaminant inhalation or ingestion is identified. Loose contamination may be above R2 Internal Control Levels and below R3 Internal Control Levels.

During the reporting period, all measurements were below Action Levels and regulatory limits.

#### **6.5.1.1 Contamination Control Data**

When radioactive material is not in a sealed container and when it is handled, there is the potential for it to be spread onto other objects. This is known as radioactive contamination. Radioactive contamination refers to small amounts of nuclear substances on surfaces or within the air, where its presence is unintended or undesirable.

Surface contamination measurements (swipes) are conducted in manufacturing areas of each facility. The potential for surface contamination is greater in the Toronto facility since UO<sub>2</sub> powder is received and handled. Contamination by itself is not necessarily an indicator of exposure potential but can be used as an indicator of housekeeping conditions; however significant amounts of loose surface uranium contamination has the potential to become airborne. If this occurs, the air monitoring results will reflect the increased airborne concentration and appropriate corrective action is then taken. Internal Control Levels are applied independently to each area classification. In the event a swipe measurement exceeds an Internal Control Level; the area is cleaned and re-swiped to verify cleanliness. Trends are monitored.

Routine surface contamination measurement results are summarized in Table 4.

	Classification and Area Description	Internal Control Level	2016		2017	
			Total Number of Samples	Total Number Samples Exceeding Internal Control Level (%)	Total Number of Samples	Total Number Samples Exceeding Internal Control Level (%)
Peterborough	R2 - Pellet Loading, Element Welding and Pellet Storage	2,200 dpm/100 cm <sup>2</sup>	548	0 (0%)	507	0 (0%)
	R1 - Bundle Assembly, Inspection, Receiving, Building 24	220 dpm/100 cm <sup>2</sup>	176	0 (0%)	176	0 (0%)
	Active - Met Lab, Waste Room	220 dpm/100 cm <sup>2</sup>	174	1 (<1%)	162	0 (0%)
	Unclassified - Items, Main Hallway	220 dpm/100 cm <sup>2</sup>	462	0 (0%)	403	0 (0%)
Toronto	R3-Powder Preparation, Pressing, Grinding, Laboratory	22,000 dpm/100 cm <sup>2</sup>	444	0 (0%)	445	2 (0.4%)
	R2-Sintering, Sorting & Stacking, Laboratory	2,200 dpm/100 cm <sup>2</sup>	504	14 (3%)	508	21 (4%)
	Active - Plant Washrooms, Laundry Room	2,200 dpm/100 cm <sup>2</sup>	144	0 (0%)	145	0 (0%)
	Unclassified	220 dpm/100 cm <sup>2</sup>	288	13 (5%)	288	15 (5%)

**Table 4: Surface Contamination Result Summary**

Peterborough surface contamination remains very low. Surface contamination results are reviewed by EHS staff and discussed if necessary at ALARA Committee Meetings. Overall, 100% of routine swipes were within Internal Control Levels, indicative of effective contamination control measures and cleaning schedules.

Toronto surface contamination remains steady in the number of samples exceeding the Internal Control Levels in 2017 over 2016. Surface contamination results are reviewed by EHS staff and discussed at Workplace Safety Committee Meetings. Overall, 97% of swipes were within Internal Control Levels, indicative of effective contamination control measures and cleaning schedules.

One personnel contamination event occurred in Toronto during the reporting period. An employee was transferring uranium powder from plastic bags inside plastic pails to a drum. This work was completed in a fume hood area with the room door closed. Appropriate personal protective equipment including respiratory protection was worn. While removing a bag from one of the pails, the employee found that

the bag had split and was pouring powder into the plastic pail below. The employee immediately stopped work, showered, changed clothing and informed his Supervisor and the EHS department. Air sampling results were reviewed as well as a urine sample submitted for analysis. Results were typical and below associated Internal Control Levels.

### 6.5.1.2 Air Monitoring Data

As part of a well-established and implemented industrial hygiene programs, both facilities sample breathing air for measurement of uranium content. Workstation air monitoring is a key performance indicator that speaks to effective administrative and engineered controls. Respiratory protection programs are in place. Non-routine work functions, such as machine maintenance, modifications, etc. are controlled by EHS Work Permits (Peterborough) or Radiation Safety Instructions (RSI) (Toronto). The EHS Work Permit/RSI specifies protective measures, including those to reduce exposure to airborne UO<sub>2</sub>. This may or may not include air monitoring and/or respirator use.

In Peterborough, each process workstation where open uranium dioxide pellets are handled are periodically monitored during routine operations for airborne uranium dioxide. All filter papers are counted in-house and verified by an independent external laboratory using delayed neutron activation analysis. In Toronto, each process workstation is monitored continuously during routine operating conditions for airborne uranium dioxide and counted in-house. Internal dose to workers in Toronto is estimated based on these air monitoring results.

Workstation air sampling results are summarized in Table 5.

	Peterborough			Toronto		
	2015	2016	2017	2015	2016	2017
Number of Workstations Sampled	4	4	4	22	21	21
Total Number of Samples Collected	44	50	46	5229	5271	5208
Total Number of Samples Exceeding Internal Control Level (facility and area specific)	0	0	0	9	2	1
Total Number of Samples Exceeding Action Level (facility and area specific)	0	0	0	0	0	0
Average Concentration (dpm/m <sup>3</sup> )	0.15	0.11	0.05	8.9	9.2	7.1
Maximum Value Recorded (dpm/m <sup>3</sup> )	1.04	0.97	0.15	294	244	306

**Table 5: Workstation Air Monitoring Summary**

In Peterborough, average and maximum workstation air monitoring results continue to remain negligible and below Internal Control Levels. No trends are discernible. In Toronto, average workstation air monitoring results are trending down as a result of ventilation system improvements.

In the reporting period, one workstation air sample exceeded the Internal Control Level. It was the result of non-routine work conducted under an RSI in an R3 mask area. Through a valve in the bottom of a cone, UO<sub>2</sub> and zinc stearate was transferred into metal pails. Workstation air monitoring results during RSI activities are not typical of normal operations, and are not subject to Internal Control Level investigation requirements. Precautions to minimize airborne exposure were considered during the planning stages of the work. Appropriate respiratory protection and protective clothing was required and worn for the duration of the work.

### 6.5.1.3 Facility Radiological Conditions

Radiation fields from storage and use of radioactive materials may result in external radiation doses to workers. In order to ensure that radiation dose rates are ALARA, routine gamma radiation surveys are conducted periodically within each facility using calibrated portable handheld radiation detectors. Measured dose rates are compared to targets for areas based on area classification and occupancy. When necessary, items are moved to alternative storage locations and/or temporarily shielded. Areas that appear routinely higher than target dose rates may be investigated for improvements, such as permanent shielding or reconfiguration.

Routine dose rate measurements are summarized in Table 6.

	Peterborough			Toronto		
	2015	2016	2017	2015	2016	2017
Total Number of Locations Surveyed	394	373	360	160	160	160
Average Dose Rate ( $\mu\text{Sv/h}$ ) on Shop Floor	2.9	3.1	3.0	2.8	2.7	2.6
Average Dose Rate ( $\mu\text{Sv/h}$ ) in Storage Areas	5.7	5.6	4.3	7.0	5.0	7.5

**Table 6: Routine Dose Rate Survey Summary**

Dose rates remain steady in both locations. The facility gamma surveys focus on radioactive material handling and storage areas and adjacent occupied locations. Variability due to the timing of the surveys is a factor in the results, as production levels and movement of materials vary over the course of a year.

### 6.5.1.4 Urinalysis Results

The presence of uranium in the urine is an indication of recent inhalation of  $\text{UO}_2$  dust or the systemic clearance of an established thorax burden. At BWXT NEC, urinalysis is used as a screening tool to initiate further review of internal dose control measures and practices but is not used to estimate internal dose. In Toronto, internal dose is estimated based on workstation air monitoring (refer to section 6.5.1.6).

All Peterborough employees working where exposed  $\text{UO}_2$  material is processed (R2 classified area) for a period greater than 30 hours per quarter, or working as a roving inspector during the quarter, submit urine samples for uranyl ion analysis. All Toronto employees working where exposed  $\text{UO}_2$  material is processed submit urine samples for uranyl ion analysis weekly or monthly, depending on the work area. Samples are analyzed by an external laboratory for uranium content using Inductively Coupled Plasma - Mass Spectrometry with a minimum detectable concentration of  $0.1 \mu\text{g U/L}$ . Results are compared to Internal Control Levels and Action Levels and entered and retained in an electronic database.

Urinalysis results are summarized in Table 7.

	Peterborough			Toronto		
	2015	2016	2017	2015	2016	2017
Number of urine samples analyzed	112	109	99	2065	1907	1621
Number of samples above Internal Control Level (5 µg U/L)	0	0	0	6	3	0
Number of samples above Action Level (10 µg U/L)	0	0	0	0	1	0
Maximum result (µg U/L)	<0.1	<0.1	<0.1	6.8	13.0	4.9

**Table 7: Urinalysis Results Summary**

Of all urinalysis samples from Peterborough processed between 2005 and 2017, only 0.3% of samples (5/1682) have measured above the minimum detectable concentration of 0.1 µg U/L, and were less than 0.5 µg U/L. These occurrences were well below the Internal Control Level of 5 µg U/L. This demonstrates that the inhalation hazards at the Peterborough facility are minimal and that current engineered and administrative controls, where applicable, are adequately controlling the risk. In Toronto, there were no sample results above the Internal Control Level of 5 µg U/L during the reporting period. There were no Action Level exceedances. This demonstrates that current engineered and administrative controls, where applicable, are adequately controlling the inhalation hazard.

**6.5.1.5 Dose Control Data**

Radiation dose refers to the energy deposited or absorbed in materials through which it passes. Equivalent dose is used to assess how much biological damage is expected from the absorbed dose. It takes the properties of different types of radiation into account. Effective dose is used to assess the potential for long-term effects that might occur in the future. It is a calculated value, measured in milliSievert (mSv), which takes into account the absorbed dose to all organs of the body, the relative harm level of the radiation, and the sensitivities of each organ to radiation. All radiation exposures received by employees in the reporting period were within Internal Control Levels, Action Levels and regulatory limits. Action Levels are site specific and are specified in the facility operating licence. Regulatory limits are specified in the *Radiation Protection Regulations*. Regulatory limits are listed in Table 8 and Table 9.

Effective Dose Limits		
Person	Period	Effective Dose (mSv)
NEW, including a pregnant NEW	(a) One-year dosimetry period	50
	(b) Five-year dosimetry period	100
Pregnant NEW	Balance of the pregnancy	4
A person who is not a NEW (i.e. a member of the public)	One calendar year	1

**Table 8: Regulatory Effective Dose Limits**

Equivalent Dose Limits			
Organ or Tissue	Person	Period	Equivalent Dose (mSv)
Lens of an eye	(a) NEW	One-year dosimetry period	150
	(b) Any other person	One calendar year	15
Skin	(a) NEW	One-year dosimetry period	500
	(b) Any other person	One calendar year	50
Hands and feet	(a) NEW	One-year dosimetry period	500
	(b) Any other person	One calendar year	50

**Table 9: Regulatory Equivalent Dose Limits**

All employees are classified as either Nuclear Energy Workers (NEWs) or Non-Nuclear Energy Workers (Non-NEWs). All contractors are classified non-NEWs. All NEWs are deemed to have a reasonable probability of receiving a dose of radiation that is greater than the prescribed limit for a member of the public (1 mSv/year) in the course of the person's work with nuclear substances or at our nuclear facilities. All fuel assembly NEWs at BWXT NEC are assigned personal passive dosimeters known as TLDs (thermoluminescent dosimeter). These passive dosimeters measure the whole body and skin doses received in each monitoring period. TLD rings are worn on certain employee's hands for a one-week period each quarter. The test results and the weekly hours of contact are used to estimate the extremity dose. TLDs are exchanged monthly (Toronto) or quarterly (Peterborough), and analyzed by a CNSC licensed external dosimetry service provider. The dosimetry service provider reports the measured doses to BWXT NEC and to the National Dose Registry. On receipt, knowledgeable staff reviews the monitoring results, and compares them to associated Internal Control Levels, Action Levels and regulatory limits.

BWXT NEC dosimetry results are summarized in the following sub-sections. Table 10 provides a summary of dosimetry measurements with monitored workers grouped in various ranges of exposure. Employees are divided into workgroups based on job function for dosimetry analysis and trending. Operators are employees who manufacture product and includes the Customer Site Representative. Technicians are employees who support the licensed activities, (fuel assembly or fuel handling) e.g. electrical, mechanical, quality control, laboratory, etc. Staff includes management and professional employees who support the Operators and Technicians with the licensed activities.

		Total # Individuals	Total # of Individuals in Dose Range (mSv)							
			0 - 1	1 - 5	5 - 10	10 - 20	20 - 50	50 - 100	100 - 200	200 - 500
Peterborough	Whole Body Effective	77	58	18	1	0	0	0	0	0
	Skin	77	54	7	6	9	1	0	0	0
	Extremity	24	1	4	6	7	6	0	0	0
Toronto	Whole Body Effective	61	33	23	5	0	0	0	0	0
	Skin	61	26	8	10	11	5	1	0	0
	Extremity	40	1	7	8	7	9	6	2	0

**Table 10: Radiation Dose Distribution**

### 6.5.1.6 Whole Body Effective Dose

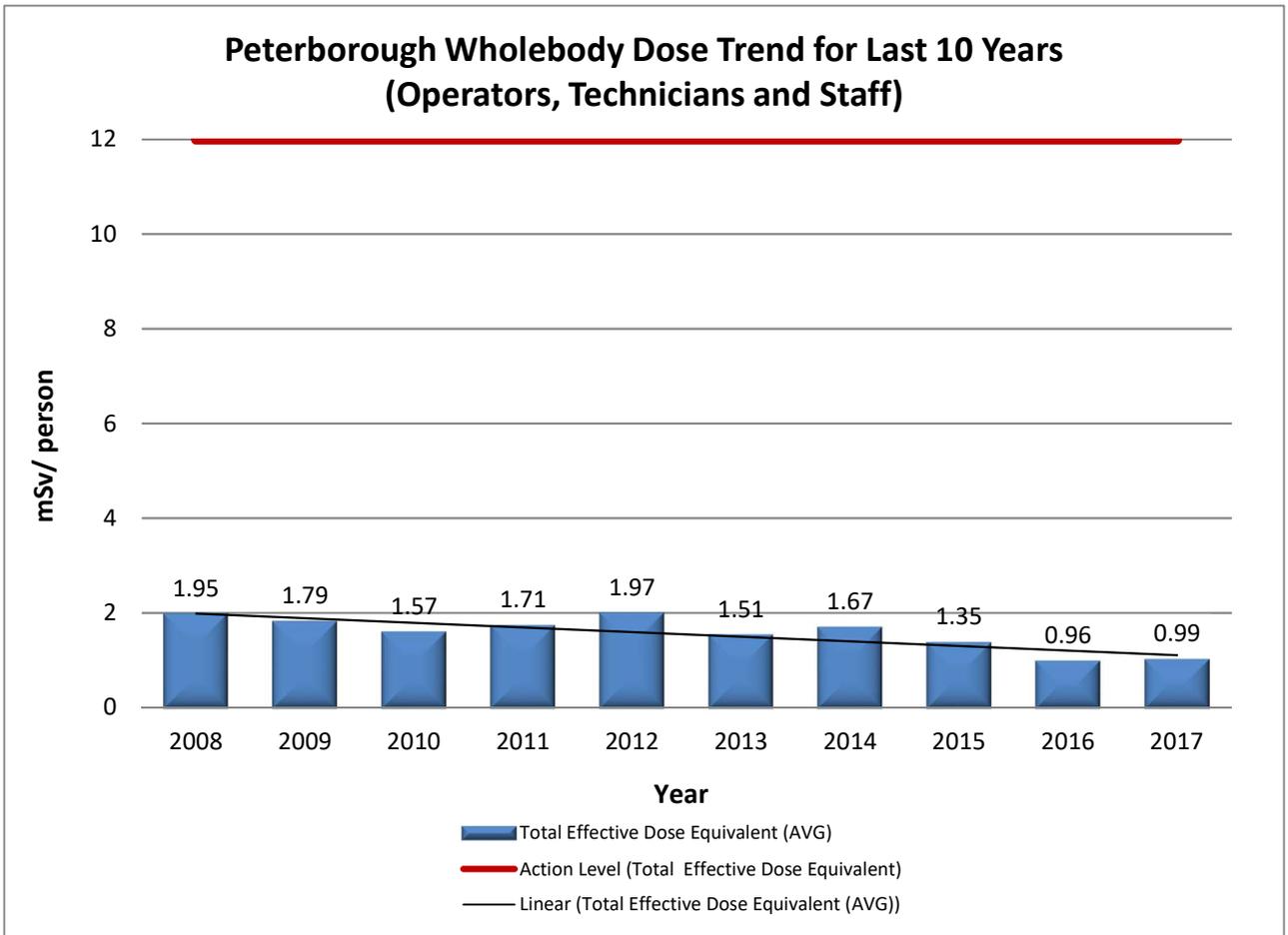
Whole body effective dose is summarized in Table 11. Data presented for Toronto is whole body effective dose, which is TLD monitored external and calculated internal dose based on workstation air monitoring. The contribution from internal dose is indicated. The average effective dose for all Toronto workers in the reporting period was 1.55 mSv. Peterborough does not have any measurable internal dose; the effective dose is the measured TLD external whole body dose. The average dose for all Peterborough workers in the reporting period was 0.99 mSv. Peterborough doses in 2016 and 2017 include the fuel assembly and the fuel handling divisions. This has slightly reduced the average Technician dose as compared to previous years.

	Year	Peterborough			Toronto	
		Operators	Technicians	Staff	Operators (Internal)	Staff
Maximum (mSv)	2017	5.05	0.61	0.79	8.54 (2.37)	0.40
	2016	5.82	1.13	0.75	11.79 (2.73)	0.23
	2015	5.77	1.29	1.69	8.38 (2.50)	3.25
Average (mSv/person)	2017	2.06	0.13	0.39	2.41 (0.71)	0.03
	2016	2.02	0.14	0.37	3.19 (1.13)	0.04
	2015	2.03	0.27	0.84	2.10 (0.90)	0.30
Minimum (mSv)	2017	0.00	0.00	0.00	0.07 (0.03)	0.00
	2016	0.00	0.00	0.00	0.27 (0.08)	0.00
	2015	0.00	0.00	0.14	0.10 (0.10)	0.00

**Table 11: Whole Body Effective Dose Summary**

**6.5.1.6.1 Peterborough Trending**

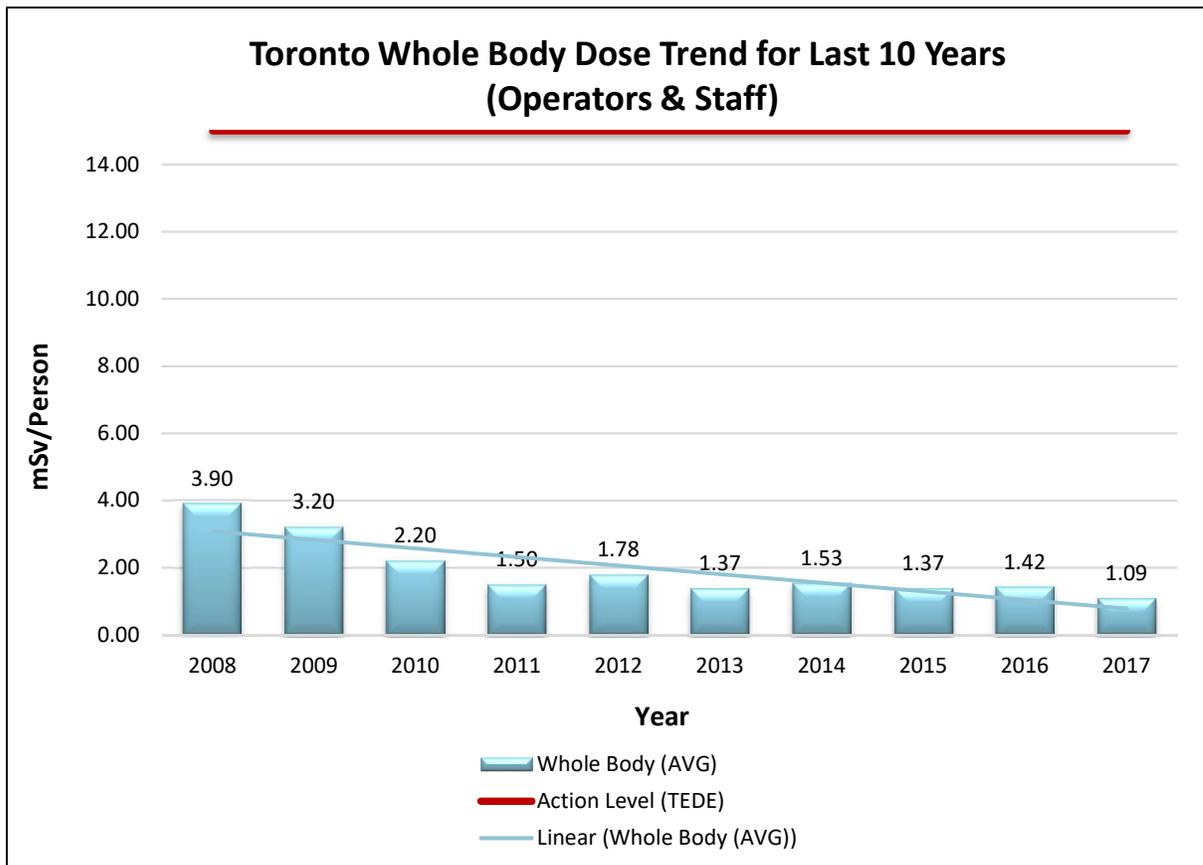
The average annual external whole body dose trend for all monitored individuals is shown in Figure 3. Whole body dose by workgroup is listed in Table 11. Overall, average external whole body dose is trending down. Maximum and average doses are also trending down in each workgroup. Dose reduction is occurring as result of ongoing efforts to improve ALARA awareness and TLD wear and storage compliance. Significant reductions to the amount of rework are also occurring. Recent ergonomic improvements (bundle manipulators, collaborative robot) and improvements to conveyor shielding in bundle welding and final inspection are also contributors to dose reductions.



**Figure 3: Peterborough 10-Year Average Annual Whole Body Dose**

**6.5.1.7 Toronto Trending**

The average annual external whole body dose trend for all monitored individuals is shown in Figure 4. Note: This is external whole body dose only, and excludes internal dose. External whole body and internal dose by workgroup is listed in Table 11. Average external whole body dose is trending down over all, with Operator dose remaining steady. Average and maximum Staff doses continue to decrease. The downward trend has resulted from a combination of shielding improvements made in the Sort and Stack, Grinding and Sintering areas and an improvement in ALARA awareness and operator experience.



**Figure 4: Toronto 10-Year Average Annual Whole Body Dose**

**6.5.1.8 Equivalent Skin Dose**

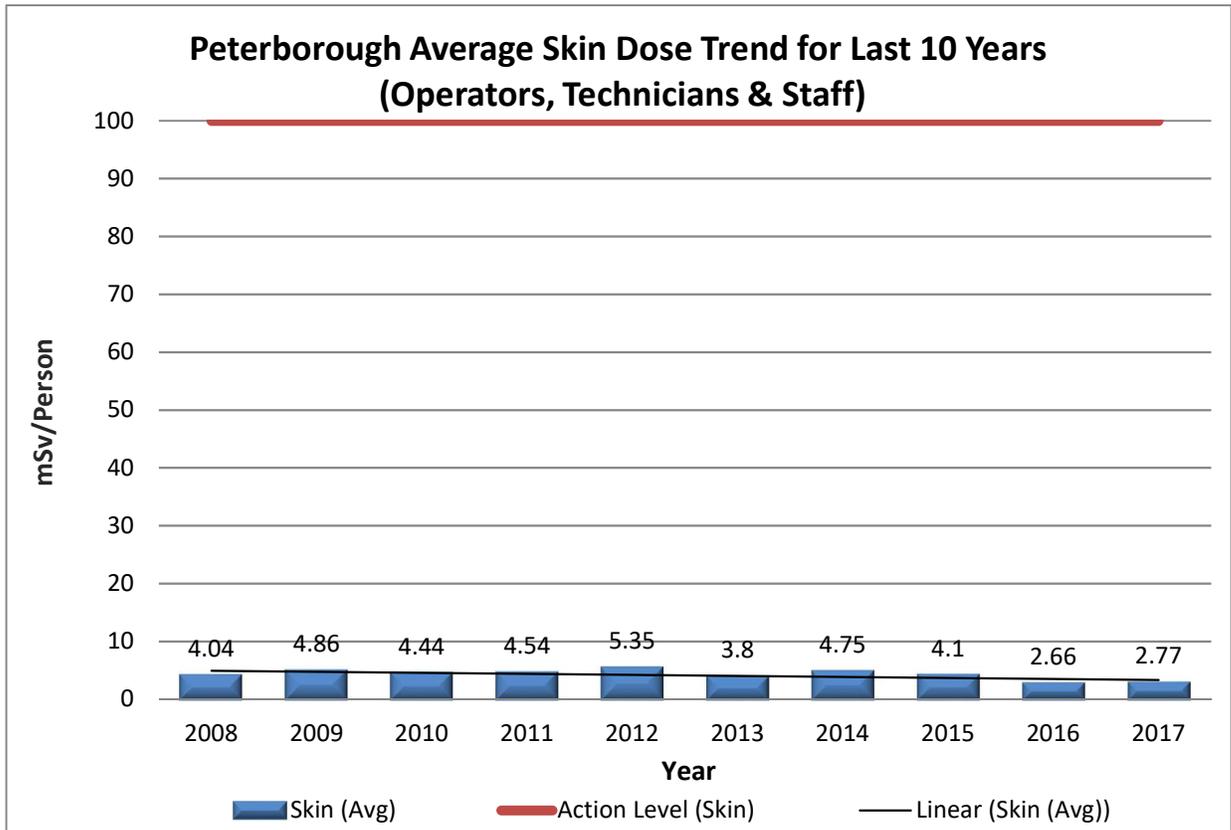
Equivalent skin dose is summarized in Table 12. Peterborough doses includes both fuel assembly and the fuel handling divisions in 2016 and 2017. This has slightly reduced the average Technician dose as compared to 2015 as that data excludes the contribution from the fuel handling division, which was reported separately at that time.

	Year	Peterborough			Toronto	
		Operators	Technicians	Staff	Operators	Staff
Maximum (mSv)	2017	25.14	0.84	1.08	54.27	4.43
	2016	21.15	1.74	0.95	74.26	4.08
	2015	22.47	2.57	3.69	54.99	3.86
Average (mSv/person)	2017	6.26	0.17	0.49	11.80	0.34
	2016	6.11	0.18	0.39	14.82	0.49
	2015	7.11	0.59	0.98	13.16	0.47
Minimum (mSv)	2017	0.00	0.00	0.00	0.15	0.00
	2016	0.00	0.00	0.00	0.00	0.00
	2015	0.00	0.00	0.14	0.00	0.00

**Table 12: Equivalent Skin Dose Summary**

**6.5.1.8.1 Peterborough Trending**

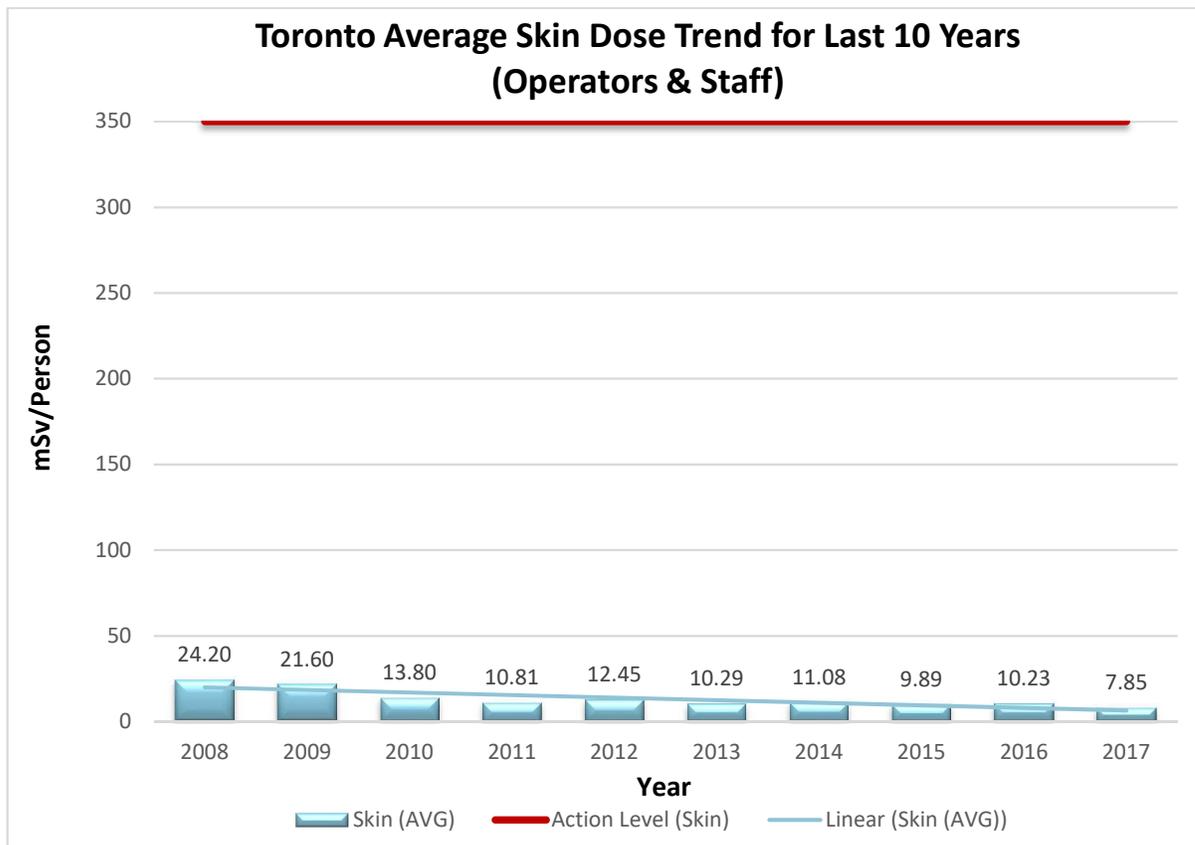
The average annual skin dose trend for all monitored individuals is shown in Figure 5. Skin dose by workgroup is listed in Table 12. Skin doses across all workgroups remain a fraction of the Action Level and regulatory limit with trends showing steady.



**Figure 5: Peterborough 10-Year Average Annual Skin Dose**

**6.5.1.8.2 Toronto Trending**

The average annual skin dose trend for all monitored individuals is shown in Figure 6. Skin dose by workgroup is listed in Table 12. Skin doses across all workgroups remain a fraction of the applicable Action Level and regulatory limit. The overall trend is showing that average skin dose is decreasing, while the trend is steady in separate workgroups over recent years. The year over year decrease in overall skin dose has resulted from a combination of shielding improvements made in the Sort and Stack, Grinding and Sintering areas and an improvement in ALARA awareness and operator experience. While the primary objective of shielding improvements is reduction in gamma exposures, there is also a reduction in overall beta fields in the work area from the shielding.



**Figure 6: Toronto 10-Year Average Annual Skin Dose**

### 6.5.1.9 Equivalent Extremity Dose

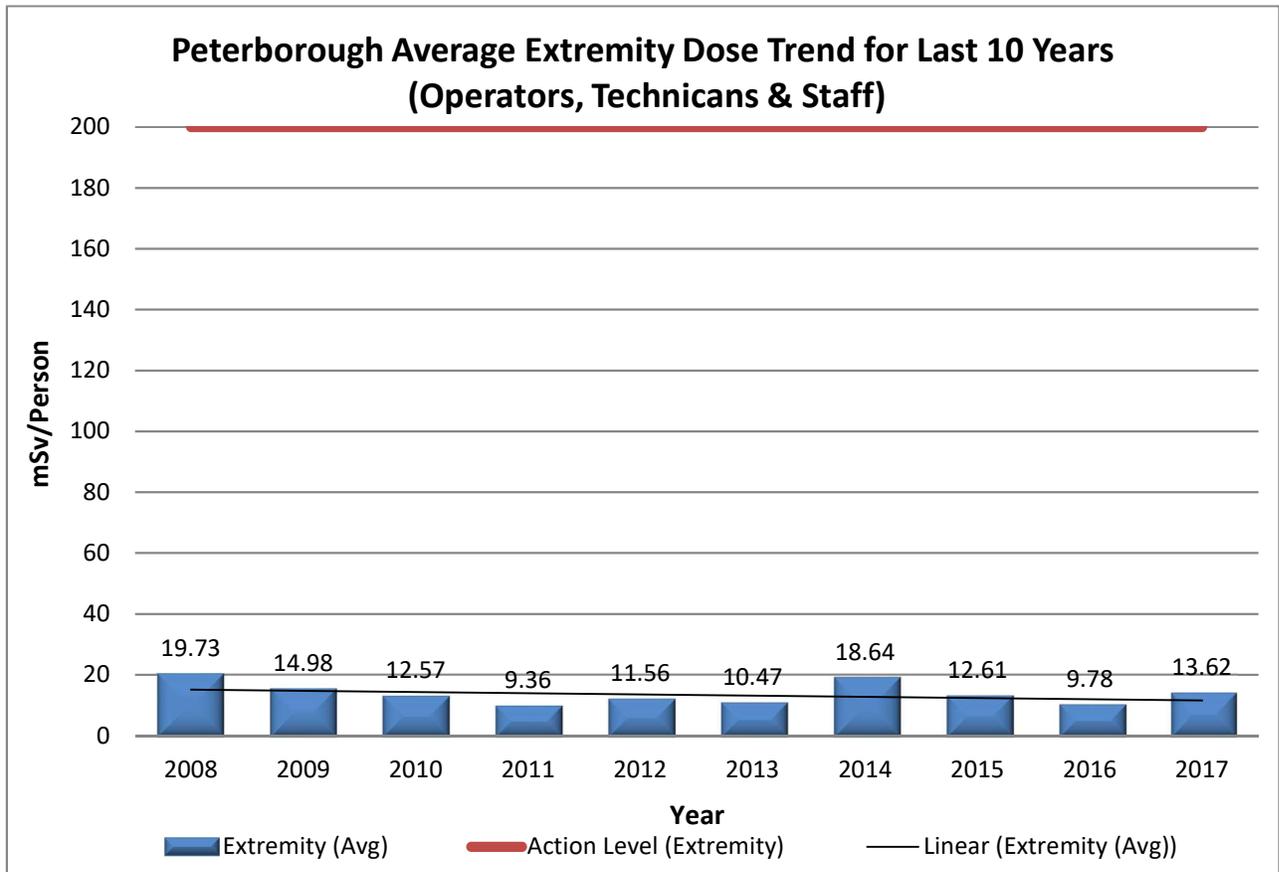
TLD rings are worn on certain individual's hands for a one-week period each quarter to measure extremity dose. A scaling factor is calculated based on hours worked in the quarter and is provided to the dosimetry service provider each monitoring period. The dosimetry service provider applies the scaling factor to the measured dose to accurately estimate the exposure. Equivalent extremity dose is summarized in Table 13. In Peterborough, fuel handling employees do not participate in the extremity monitoring program. In Toronto, Staff do not participate in the extremity monitoring program.

	Year	Peterborough			Toronto	
		Operators	Technicians	Staff	Operators	Staff
Maximum (mSv)	2017	43.18	1.20	2.17	115.07	N/A
	2016	32.84	3.6	2.25	119.47	N/A
	2015	39.34	4.98	4.82	109.62	N/A
Average (mSv/person)	2017	15.36	1.03	2.17	27.36	N/A
	2016	11.33	2.54	1.24	27.71	N/A
	2015	14.34	2.03	4.82	30.30	N/A
Minimum (mSv)	2017	1.87	0.85	2.17	0.00	N/A
	2016	0.26	0.63	0.23	0.85	N/A
	2015	0.00	0.32	4.82	0.00	N/A

**Table 13: Equivalent Extremity Dose Summary**

**6.5.1.9.1 Peterborough Trending**

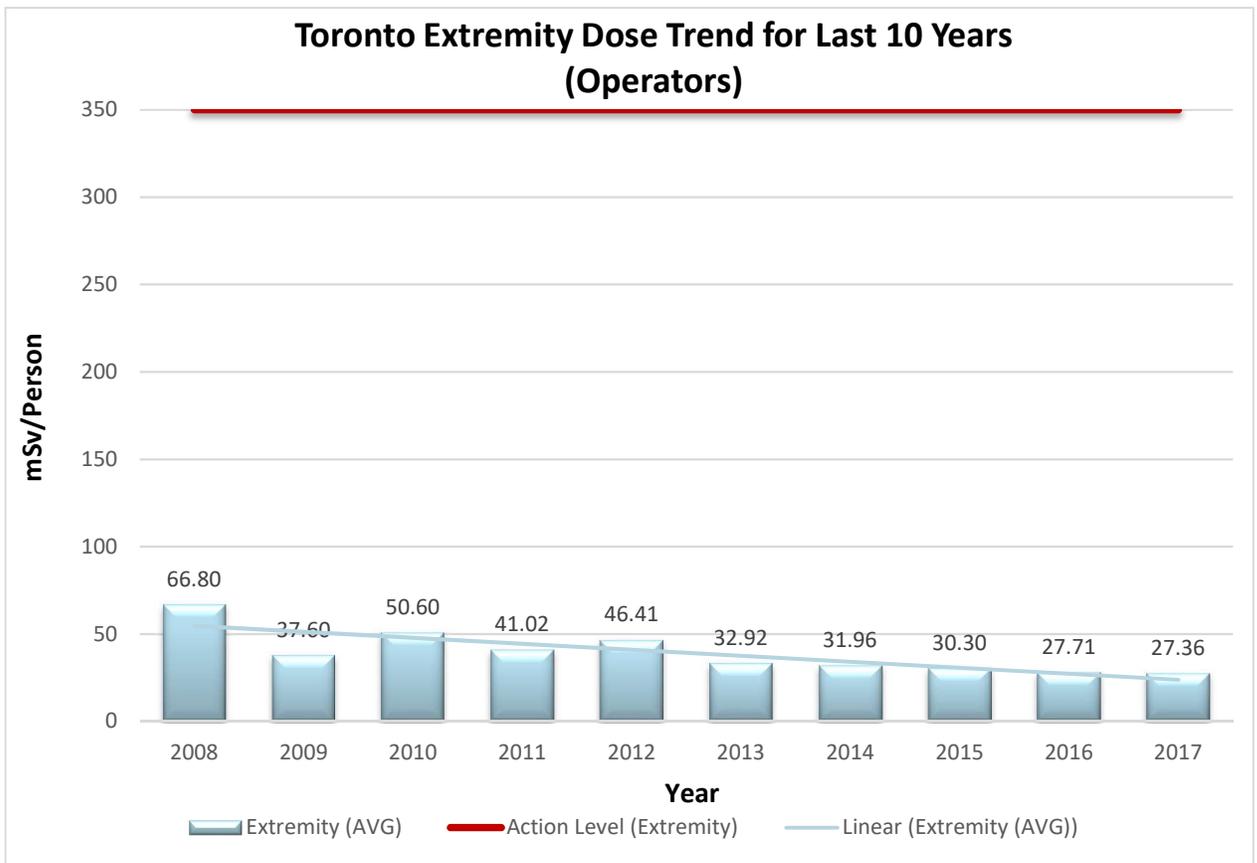
The average annual extremity dose trend for all monitored individuals is shown in Figure 7. Extremity dose by workgroup is listed in Table 13. Extremity dosimeters are worn for one week per quarter and a scaling factor is applied to account for the average number of hours worked to estimate the exposure. Extremity doses across all workgroups remain a fraction of the Action Level and regulatory limit and show a steady average dose trend.



**Figure 7: Peterborough 10-Year Average Annual Extremity Dose**

**6.5.1.9.2 Toronto Trending**

The average annual extremity dose trend for all monitored individuals is shown in Figure 8. Extremity dose by workgroup is listed in Table 13. Extremity dosimeters are worn for one week per quarter and a scaling factor is applied to account for the average number of hours worked to estimate the exposure. Average extremity doses continue to show a decreasing trend since 2008. Area shielding improvements have also reduced workstation dose rates.



**Figure 8: Toronto 10-Year Average Annual Extremity Dose**

**6.5.1.10 Exceedances of Regulatory Limits or Action Levels**

All measured radiation doses received by individuals in the reporting period were within Internal Control Levels, Action Levels and regulatory limits.

**6.5.1.11 Radiation Protection Program Effectiveness**

BWXT NEC has a well-established integrated management system for environmental, health and safety program excellence. The radiation protection program is effectively implemented. BWXT NEC has an established EHS Mission Statement that is reviewed and signed annually by the President of BWXT NEC. The Mission Statement includes a commitment to ALARA and continuous improvement. Elements of the radiation protection program such as dose monitoring, contamination monitoring, and radiation field surveys, etc. are conducted by qualified workers and reviewed internally by EHS staff and Committees on a regular basis. Details of the reviews are recorded in meeting minutes.

An internal audit and self-assessment of the radiation protection program, with a focus on elements of radiation protection program effectiveness and compliance, is conducted annually at each site. Non-conformances are addressed and tracked to completion in accordance with program requirements.

Key components of the radiation protection program include:

- Compliance with all relevant regulatory requirements;
- The setting of ALARA goals and objectives;
- Hazard recognition, risk assessment and change control processes;
- A comprehensive worker training program;
- Documented safety concerns, near misses and incidents with appropriate root-cause analysis, preventive and corrective actions.

The radiation protection program includes all worker radiation safety elements that demonstrate compliance to relevant regulations, codes and standards:

- EHS policy commitment to ALARA
- Area classifications and requirements
- Material handling
- Non-routine or high-risk work controls
- Internal and external radiation hazard assessments
- Internal and external radiation monitoring and recording

#### **6.5.1.12 Radiation Protection Program Improvements**

Continuous improvement is achieved through several review processes, including site inspections, reported safety concerns, near miss and incident investigations, self-assessments and audits. There were no major changes to the radiation protection program during the reporting period. Minor continuous improvements were instituted:

- For Toronto air flow sampling pump verifications, the deviation acceptance criteria was reviewed and updated for workstation and exhaust air flows, with a requirement to notify the EHS Leader of deviations outside the established range.
- Minor administrative edits and continuous improvements were made to 23 other work instructions across both sites.

#### **6.5.1.13 Summary of Radiation Protection Program Performance**

Radiation protection program goals are monitored through the site's ALARA Committees as summarized in section 6.5.1.14 below.

#### **6.5.1.14 Summary of ALARA Committee Performance**

The ALARA committees work to review and continuously improve elements of the radiation safety program, and implement ALARA practices where practical in order to ensure that radiation dose levels are as low as reasonably achievable. Committee members consist of both unionized and management employees. The ALARA Committees meet quarterly at a minimum. Each site committee met four times during the reporting period. Dose results, radiation protection related events, audits, and employee

concerns were reviewed and discussed. Actions are assigned and tracked as part of the meeting minutes. Committee activities are communicated to all workers.

ALARA Committee goals and results for the reporting period are provided in Table 14. Goals that are not achieved are informally reviewed by the ALARA Committee to discuss probable causes. The feasibility of achievement is discussed and implementation plans revised as needed. These are considered during future goal setting.

Both facilities achieved dose reduction goals during the reporting period, including a 37% and 24% collective dose reduction from 2016 (normalized for production) for Peterborough and Toronto respectively. The dose reduction targets are based on collective dose once it has been normalized with production quantities. This ensures the targets are based on reductions in dose and not reductions in production amounts. In Peterborough, dose reduction is occurring as result of ongoing efforts to improve ALARA awareness and TLD wear and storage compliance. Significant reductions to the amount of rework are also occurring. Recent ergonomic improvements (bundle manipulators, collaborative robot) and improvements to conveyor shielding in final inspection are also contributors to dose reductions. In Toronto, recent dose reduction is attributed to improved ALARA awareness and Operator experience.

	Goal	Actual	Result
Peterborough	3% reduction in collective whole body dose (normalized for production)	37% reduction	Achieved
	>97% compliance in TLD audits	100% compliance	Achieved
	Conduct four shop floor demonstrations of the ALARA principles	4/4	Achieved
	Complete one shielding project	Complete	Achieved
Toronto	Downward collective employee dose trend (normalized for production)	24% reduction	Achieved
	Ventilation improvements: average annual concentration of workstation air monitoring results <10 dpm/m <sup>3</sup>	7.1 dpm/m <sup>3</sup>	Achieved
	5% reduction in surface contamination monitoring results that exceed the Internal Control Level compared to 2016	37% increase	Not Achieved
	Shop floor meetings/demos/posters (4)	4/4	Achieved
	Complete one shielding project	0/1	Not Achieved

**Table 14: ALARA Committee Goals and Results**

2018 goals for Peterborough are established as follows:

1. 3% reduction in collective whole body dose (normalized for production)
2. >99% wear and storage compliance in TLD audits
3. Complete a shielding project by year end

4. Develop and implement a uranium specific spill response plan by year end

2018 goals for Toronto are established as follows:

1. Establish four proactive trending data charts and incorporate into committee meetings
2. Conduct four audits on TLD wearing practices to enforce proper radiation monitoring
3. Produce four ALARA Awareness posters or demonstrations to promote radiation protection

**6.5.1.15 Summary of Radiation Protection Training Program and Effectiveness**

Radiation protection training programs are compliant with the SAT methodology. An internal or external specialist in radiation protection periodically provides classroom training to new and continuing NEWs or those working in areas with radioactive materials. Online training is also available to employees with computer access. Testing is performed on completion of the training to demonstrate employee understanding. Training completion is monitored using a learning management software system, which tracks and triggers retraining as required.

In Peterborough, an online Manufacturing Area Hazards Awareness course was rolled out to all employees with security badge access to the manufacturing areas. Course content includes general shop floor rules, radiation fundamentals, sources of ionizing radiation, health effects, emergency response and other safety-related content.

	Course Name	Number of Employees Who Required Course	% Required Completed
Peterborough	Manufacturing Area Hazards Awareness (Includes Radiation Safety) (Initial and Refresher)	285	100%
Toronto	Radiation Safety (Initial and Refresher)	56	100%

**Table 15: Radiation Protection Training Summary**

**6.5.1.16 Summary of Radiation Device and Instrumentation Performance**

Radiation detection instrument error can occur due to a variety of factors: drift, environment, electrical supply, addition of components to the output loop, process changes, etc. Each site maintains a system for managing radiation detection instrument calibrations. Calibration is conducted to ensure accurate indication during field use. Calibrations are performed under environmentally controlled conditions suitable for the inspections, measurements, and tests being performed, as determined by the equipment manufacturer. Calibration intervals are established, so that calibration occurs before any anticipated significant changes occur in measurement capability. Radiation detection equipment calibrations are conducted within 12 months of the previous calibration as required by regulation.

All active radiation devices and instruments were maintained in a state of safe operation. Where calibration is expired or where detectors fail calibration, they are removed from service until they are repaired and meet radiation calibration expectations.

The calibration program was updated to include processes for reviewing and accepting calibration reports/certificates, and actions to be taken in the event of unsatisfactory or questionable results.

#### **6.5.1.17 Summary of Inventory Control Measures**

Non-production sealed and unsealed radioactive sources are used for instrument checks and training exercises. Access to sources is controlled and inventory is verified periodically. A current inventory of non-production radioactive sources is maintained by each facility. The inventory for each facility is provided in Appendix A and B, submitted to CNSC separately.

### **6.6 Conventional Health and Safety**

The "Conventional Health and Safety" Safety and Control Area covers the implementation of a program to manage non-radiological workplace safety hazards and to protect personnel and equipment.

BWXT NEC has a well-established integrated management system for environmental, health and safety program excellence. This is ensured through the effective implementation of program elements. BWXT NEC has an established EHS Mission Statement that is reviewed and signed annually by the President of BWXT NEC. BWXT NEC's objective is to eliminate or minimize as low as reasonably achievable both known and potential environmental, safety and health hazards which could impact our employees and the communities in which they live. EHS is a shared responsibility, top business priority and is continually improved.

#### **6.6.1 Health and Safety Program Effectiveness**

Key components of the Health and Safety program include:

- Compliance with all safety and health-related regulatory requirements;
- The setting of EHS goals and objectives;
- Hazard recognition, risk assessment and change control processes;
- A comprehensive worker training program;
- Documented safety concerns near misses and incidents with appropriate root-cause analysis, preventive and corrective actions.

The EHS program includes all worker safety elements that demonstrate compliance to relevant regulations, codes and standards:

- EHS Policy
- Hazard Analysis and Regulatory Compliance
- Employee Involvement
- EHS Specialist
- Accident/Incident Investigation
- EHS Training
- Housekeeping
- Personal Protective Equipment
- Contractor Safety
- Emergency Preparedness/Response

- Risk Assessments
- High Risk Operations
- Change Control and Preventative Maintenance
- Industrial Hygiene
- Chemical Management
- Ergonomics
- Lock-Out Tag-Out

Continuous improvement is achieved through several review processes, including site inspections, reported safety concerns, near miss and incident investigations. The effectiveness of the overall program is reviewed throughout the year and evaluated in the annual management review.

A total of 71 (Peterborough) and 40 (Toronto) investigations and inspections were conducted in the reporting period. This includes WSC inspections, manager inspections, and near miss, incident and injury investigations. These investigations and inspections led to a total of 255 (Peterborough) and 135 (Toronto) actions logged and tracked to closure. In Peterborough, the top finding categories were housekeeping, chemical management, emergency equipment, electrical – equipment, facility, infrastructure and walking/working surfaces. In Toronto, the top finding categories from WSC inspections were housekeeping, radiation safety, unsafe condition, chemicals, personal protective equipment and electrical. And, the top finding categories from incident/injury investigations were ventilation, fire protection, policies/procedures/written programs, industrial hygiene program management, fire protection and general environmental controls.

The Toronto site was injury-free in 2017 and achieved a BWXT President and Chief Executive Officer Safety Award as recognition for their excellent safety performance.

### **6.6.2 Workplace Safety Committee Performance**

The Workplace Safety Committee (WSC) contributes to making the plant as safe as possible by promoting health and safety awareness, making recommendations to workers and management regarding safe work practices, and monitoring health and safety issues until resolved. The WSCs meet all relevant regulatory requirements. All elements of the Health and Safety program are reviewed and improved by the WSC. Committee members consist of both unionized and management employees. Each facility committee meets monthly, with a minimum of nine meetings required annually. In Peterborough, eleven meetings were held with quorum. In Toronto, ten meetings were held with quorum.

Established goals for each facility's reporting period are summarized in Table 16.

	Goal	Actual	Result
Peterborough	Meet at least 9 times/year	11	Achieved
	Every area inspected at least quarterly	4/4	Achieved
	Review and validate WSC Charter	1/1	Achieved
	Joint meeting/discussion with other EHS teams (ALARA, Ergonomics, ERT, Beryllium)	4/4	Achieved
	Review a section of the Canada Labour Code part II at meetings	11/11	Achieved
	Canada Labour Code training for committee members	Complete	Achieved
Toronto	Committee member training on electrical safety regulations	Complete	Achieved
	Program Review (Risk Assessments or EHS procedures) x 3	3/3	Achieved
	Shop floor involvement/communication – increase by 10% over 2016	33% increase	Achieved
	Joint meeting with other EHS teams	0	Not Achieved

**Table 16: Workplace Safety Committee Goals and Results**

2018 goals for Peterborough are established as follows:

- Meet at least 9 times/year
- Develop two methods to promote Health and Safety Awareness by year end
- Conduct joint meetings/discussions with other EHS teams (ALARA, Ergo, ERT, Beryllium) by year end
- Review the Workplace Inspection Checklist (EHS-F-H&S-001P) content for accuracy and update as necessary by year end
- Review and define training requirements for WSC members by year end

2018 goals for Toronto are established as follows:

- Review one EHS program per quarter to promote program compliance
- Conduct formal workplace safety committee training by November 2018
- Complete one WSC activities presentation at an all employee meeting by year end
- Conduct one joint meeting with the other EHS teams (ALARA, Ergo) by year end

**6.6.3 Health and Safety Program Improvements**

Continuous improvement is achieved through several review processes, including site inspections, reported safety concerns, near miss and incident investigations. Chemical management is a well-established health and safety program element. In 2015, Workplace Hazardous Material Information

System (WHMIS) legislation (Hazardous Products Regulations) was updated to require compliance to the Globally Harmonized System of Classification and labelling of Chemicals (GHS) for specified controlled or hazardous products. WHMIS is designed to address employers' and workers' right to know about the hazards and safe work practices related to certain chemicals. GHS defines and classifies the hazards of chemical products, and consistently communicates health and safety information on labels and safety data sheets. A multi-year transition plan was announced giving suppliers until May 31, 2017 to use WHMIS 1988 or WHMIS 2015 to classify and communicate the hazards of their products. Beginning June 1, 2017 to May 31, 2018, distributors can continue to use WHMIS 1988 or WHMIS 2015. Employers can continue to use WHMIS 1988 or WHMIS 2015 until December 1, 2018. This means that workplaces will continue to see both WHMIS 1988 and WHMIS 2015 labelling and safety data sheets through 2018.

Under WHMIS 2015, employers must continue to:

- ✓ Educate and train workers on the hazards and safe use of products
- ✓ Ensure that hazardous products are properly labelled
- ✓ Prepare workplace labels and SDSs as necessary
- ✓ Provide access for workers to up-to-date SDSs
- ✓ Review the education and training provided to employees annually or whenever work conditions or hazard information changes.

During this transition period, BWXT NEC has included both 1988 and 2015 systems in their employee-training programs, and continues to update secondary labeling and provide SDSs compliant with WHMIS 2015 as products come in. Into 2018, BWXT NEC will update the Chemical Management Programs and associated labeling systems, perform site-wide chemical sweeps and revise education and training programs in consultation with the workplace safety committees to meet WHMIS 2015.

As a result of a root cause investigation into the use of incorrect filter cartridges for infrequent maintenance tasks a number of corrective actions were identified. Several improvements were implemented including to the management system (i.e. purchasing and receiving controls) and worker training.

Several other continuous improvements to the Health and Safety program were instituted during the reporting period with the focus on training. Training modules were updated or created with compliance to the SAT methodology:

- Respiratory Protection Awareness
- Canada Labour Code Part II
- B3 Area Donning & Doffing (Peterborough)
- External and Internal Radiation Hazard Monitoring (Toronto)

In addition, a charter was developed for the Emergency Response Team in Peterborough.

#### **6.6.4 Hazardous Occurrences**

Under the *Canada Occupational Health and Safety Regulations* there are several different types of hazardous occurrences including:

- **Minor Injury:** any employment injury or an occupational disease for which medical treatment is provided and excludes a disabling injury.

- **Disabling Injury:** any employment injury or an occupational disease that results in either time loss, or modified duties. Disabling injuries can be either temporary (sprained wrist), or permanent (severed limb), depending on whether or not the employee is expected to make a full recovery.
- **Loss of Consciousness:** from an electric shock or a toxic or oxygen deficient atmosphere.
- **Rescue / Revival or other Emergency Procedures:** any incident that requires emergency procedures to be implemented, such as a hazardous substance spill, bomb threat or violence prevention procedure.

Annual reports are provided to the Minister Employment and Social Development Canada as required by regulation.

In Peterborough, there was a total of ten first aids and one recordable injury. The recordable injury occurred in fuel assembly and required medical aid. There was no lost time; the worker returned to regular duties the following shift. Of the ten first aids, seven occurred in fuel assembly, two in fuel handling and one in the office. Three of the injuries were classed as *contact by*; two of the injuries were classed as *rubbed or abraded*; and the remaining were classed as struck by, body position/posture, falls, lifting/lowering/carrying/pushing/pulling and repetition. There were 23 near miss events logged in Gensuite following defined event classification criteria. The top noted categories were industrial hygiene, safety, waste and water.

In Toronto, there were no recordable injuries. There was a total of 11 first aids. Nine out of the 11 first aids involved an injury to the hand or fingers. Four of the injuries were classed as *struck against* and four were classed as *contact with a sharp object*. There were 14 near miss events logged in Gensuite following defined event classification criteria and the top three categories were safety, radiation protection, and environmental.



## **PART II: PUBLIC AND ENVIRONMENTAL PROTECTION**

## 6.7 Environmental Protection

The "Environmental Protection" Safety and Control Area covers programs that monitor and control all releases of nuclear and hazardous substances into the environment, as well as their effects on the environment as a result of licensed activities.

BWXT NEC facilities are ISO 14001:2004 or 2015 registered to ensure effective environmental management systems are in place to achieve environmental goals and objectives. The environmental management system considers all relevant legal requirements. These programs demonstrate compliance to relevant federal and provincial legislation. Environmental protection programs are also compliant with CSA N288.4-10, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills*, CSA N288.5-11, *Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills*, and CSA N288.6-12, *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills*.

BWXT NEC has established facility specific CNSC approved Action Levels for various environmental parameters. An Action Level is defined in the *Radiation Protection Regulations* as "specific dose of radiation or other parameter that, if reached, may indicate a loss of control of part of a licensee's radiation protection program, and triggers a requirement for specific action to be taken." Action Levels are also applied to environmental protection. Action Levels are set below regulatory limits; however, they are CNSC reportable events. Accordingly, BWXT NEC has established Internal Control Levels for various environmental parameters that are set even lower than Action Levels to act as an early warning system. Internal Control Level exceedances trigger an internal investigation and corrective actions; however, they are not CNSC reportable events.

The Peterborough facility uses beryllium as part of the fuel bundle manufacturing process. Beryllium use in a federally regulated facility is governed by the *Canada Labour Code Part II* and the *Canada Occupational Health and Safety Regulations*. The Environmental Protection Act of Ontario (R.S.O. 1990, c. E. 19) and Ontario Regulation 419/05 *Air Pollution – Local Air Quality Regulation* determine the permitted concentration of contaminant release. The release limit at the Point of Impingement (POI) for Beryllium is currently set at 0.01 µg per cubic meter of air. The POI is the plant/public boundary. BWXT NEC has established an Action Level of 0.03 µg/m<sup>3</sup> and an Internal Control Level of 0.01 µg/m<sup>3</sup> at the stack exit, which are both very conservative. At the request of the CNSC, beryllium emission monitoring results are summarized where applicable in the following sub-sections.

### 6.7.1 Air Effluent Monitoring

#### 6.7.1.1 Peterborough

A single process uranium air emission point exists in the Peterborough facility. The R2 Area Decan Station exhausts through a High Efficiency Particulate Air and absolute filter. The facility performs continuous in-stack monitoring drawing a sample of air across a filter capable of trapping uranium dust. The filter papers are analyzed in-house and verified externally by an independent laboratory for testing by delayed neutron activation analysis. The minimum detection limit is 0.01 µg uranium. Results are compared to the previous results and to relevant Internal Control Levels and Action Levels.

Three beryllium air emission points exist in the Peterborough facility. The facility performs continuous in-stack monitoring drawing a sample of air across a filter capable of trapping beryllium. The filter is analyzed for beryllium using the Atomic Absorption method or the Inductively Coupled Plasma - Atomic Emission Spectrometer method at an external independent laboratory. The result is related to the air volume passed through the filter. The minimum detection limit is 0.002 µg beryllium. A calculation of the concentration is then made.

A summary of air effluent sampling results is in Table 17.

### 6.7.1.2 Toronto

The Toronto facility performs continuous in-stack sampling and boundary air monitoring for uranium. The facility performs continuous in-stack monitoring drawing a sample of air across a filter capable of trapping uranium dust. The samples are analyzed daily and verified externally by an independent laboratory periodically. Boundary samples are high volume air samples drawn at five positions strategically located around the facility perimeter. Boundary samples are analyzed externally by an independent laboratory. The external independent laboratory tests the filter papers by delayed neutron activation analysis. The minimum detection limit is 0.01 µg uranium. Results are compared to the previous results, and to relevant Internal Control Levels and Action Levels.

A summary of air effluent sampling results is in Table 17 and Table 18.

	Stack Description	Emission Contaminant	Total Number of Samples	Action Level (µg/m <sup>3</sup> ) (# Samples Exceeding Level)	Highest Value Recorded (µg/m <sup>3</sup> )	Average Value Recorded (µg/m <sup>3</sup> )	Total Discharge (g)
Peterborough	R2 Decan	Uranium	46	1.0 (0)	0.003	0.000	0.002
	North	Beryllium	46	0.03 (0)	0.001	0.000	N/A
	South	Beryllium	46	0.03 (0)	0.001	0.000	N/A
	Acid	Beryllium	46	0.03 (0)	0.001	0.000	N/A
Toronto	Rotoclone	Uranium	248	1.0 (0)	0.180	0.004	1.35
	6H-68	Uranium	248	1.0 (0)	0.160	0.009	3.06
	4H-48	Uranium	248	1.0 (0)	0.130	0.002	0.41
	Furnace #1	Uranium	248	1.0 (0)	0.440	0.017	0.90
	Furnace #2/4	Uranium	248	1.0 (0)	0.150	0.002	0.29
	Furnace #5/6	Uranium	248	1.0 (0)	0.230	0.009	1.43

**Table 17: Summary of Releases to Air at Exhaust Stacks**

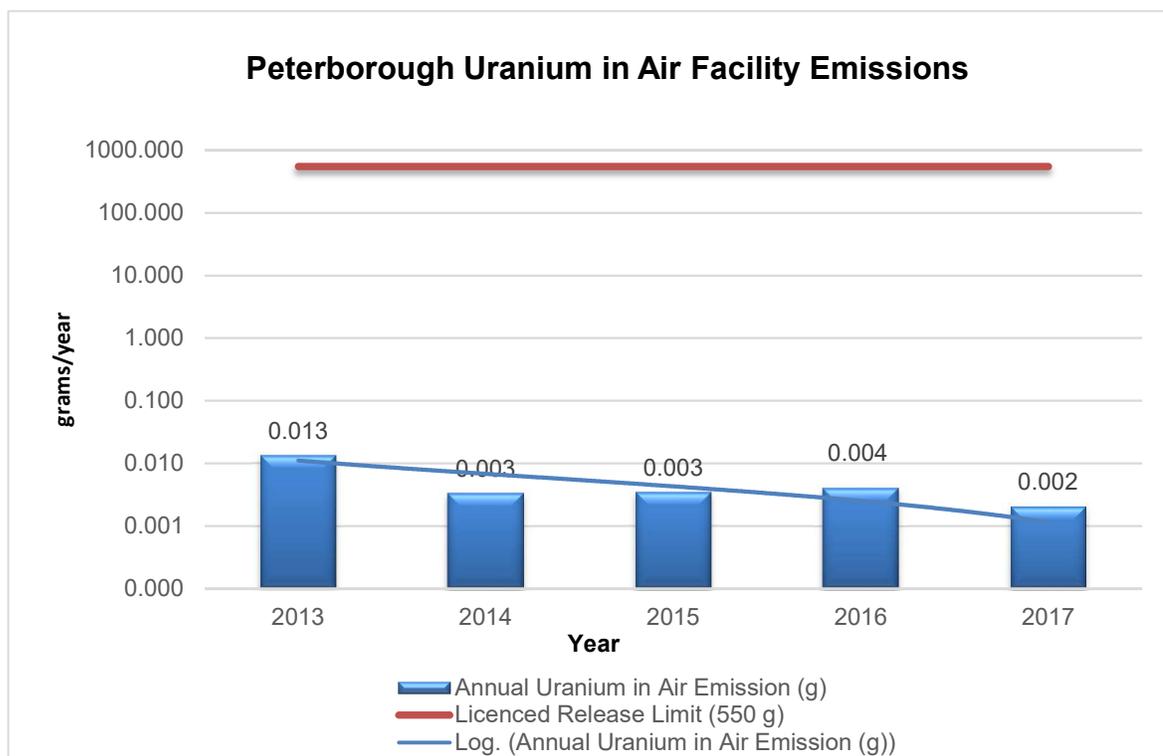
	Peterborough	Toronto		
		2015	2016	2017
Number of Boundary Samples Taken	N/A	265	260	260
Number of Samples > Action Level (0.08 µg/m <sup>3</sup> )	N/A	0	0	0
Average Concentration (µg U/m <sup>3</sup> )	N/A	0.001	0.001	0.000
Highest Value Recorded (µg U/m <sup>3</sup> )	N/A	0.002	0.039	0.008

**Table 18: Summary of Boundary Air Quality Monitoring**

Air monitoring results are trended over five years as shown in the Figure 9 and Figure 10. Toronto's average boundary monitor results are trended over five years as shown in Figure 11.

**6.7.1.2.1 Peterborough Trending**

Air release results continue to remain low and well below the Action Level of 1 µg/m<sup>3</sup>. The five-year trend graph of annual air releases, presented in Figure 9, shows a stable five-year performance consisting of very low air releases. The total release of 0.002 g in the reporting period is well below the regulatory established discharge limit of 550 g.

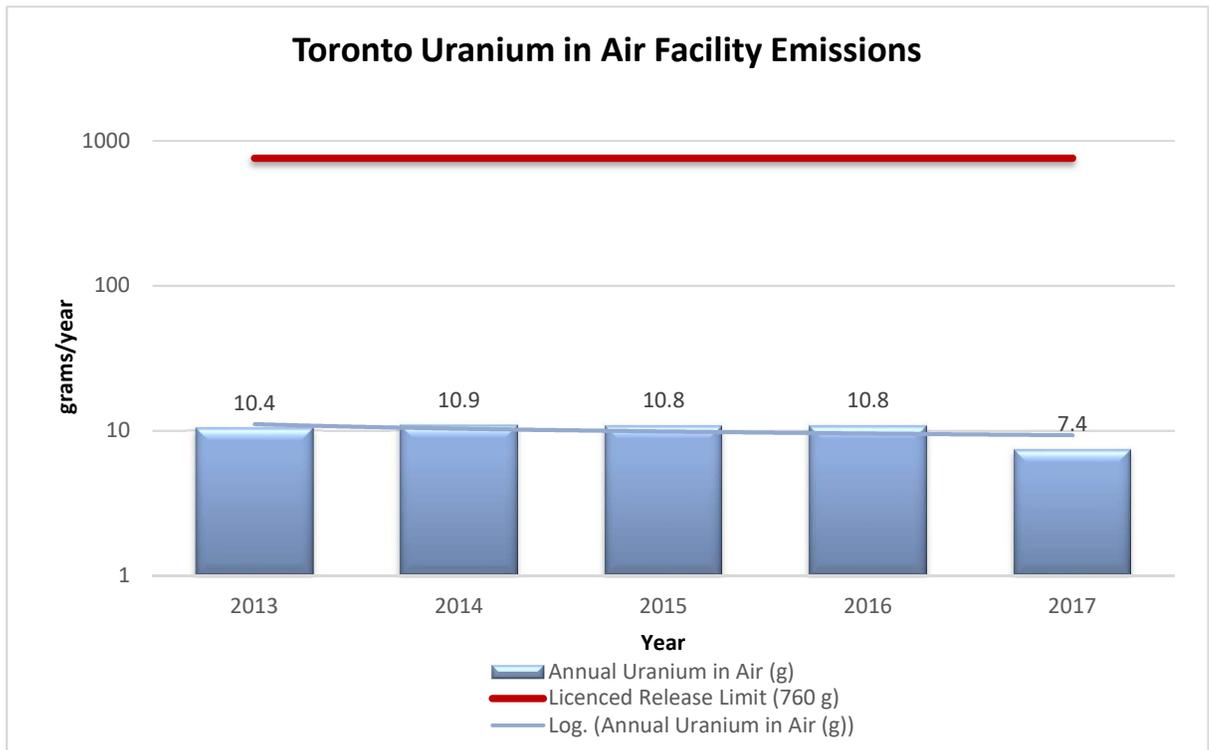


**Figure 9: Peterborough Stack Air Emission Trending**

Note: the above graph has a logarithmic scale

**6.7.1.2.2 Toronto Trending**

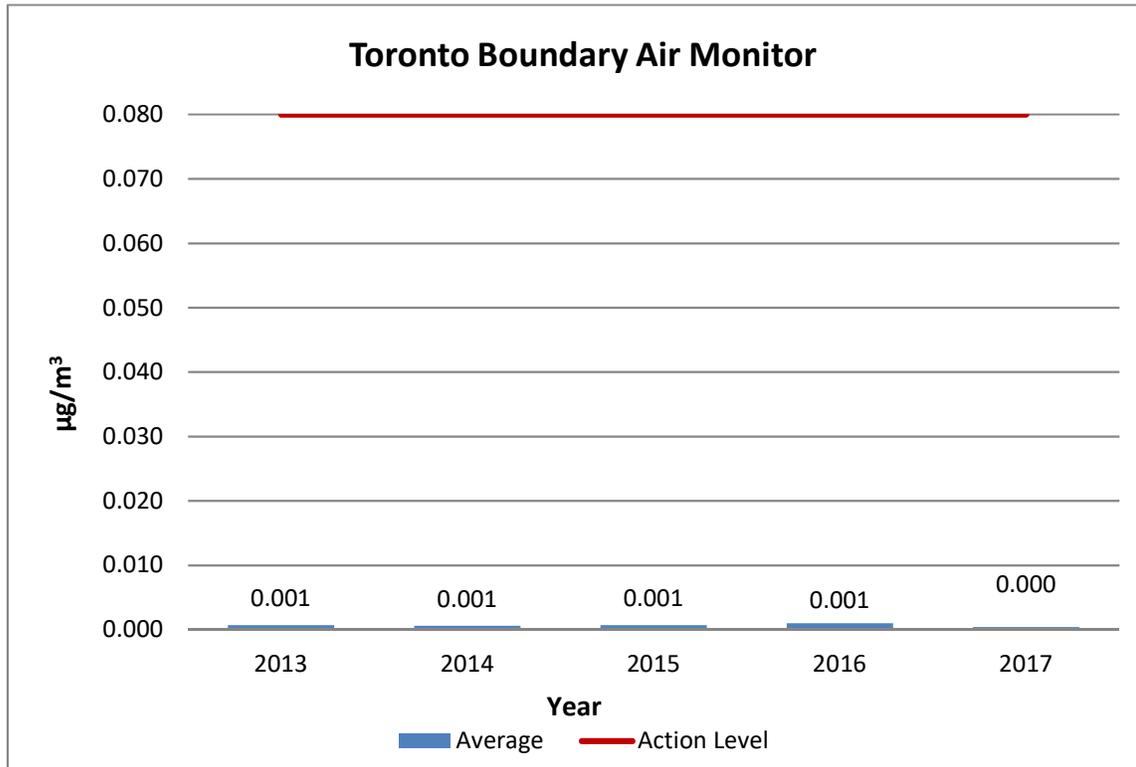
The Toronto stack air emission trend is steady. The total release of 7.4 g during the reporting period is well below the discharge limit of 760 g. The total release includes all monitored locations (Rotoclone, 6H-68, 4H-48, Furnace #1, Furnace #2/4 and Furnace #5/6). The downward trend is primarily the result of measured furnace stack emissions in 2017, rather than the conservative estimates applied from 2013 through 2016. In addition the furnace filter housings were replaced in late 2016 to improve performance and improve ease of maintenance tasks including filter changes.



**Figure 10: Toronto Stack Air Emission Trending**

Note: the above graph has a logarithmic scale

Toronto's average boundary monitor results are trended over five years in Figure 11 and consist of very low uranium in air concentrations. The boundary air monitor maximum concentration measurements also continue to remain low and well below the Action Level of 0.08  $\mu\text{g}/\text{m}^3$ .



**Figure 11: Toronto Boundary Monitor Air Concentration Trending**

### 6.7.2 Water Effluent Monitoring

In Peterborough, all potentially uranium-contaminated wastewater is held for determination of the quantity and concentration of uranium prior to disposal. Liquid waste generated from routine activities, such as washing floors, walls and equipment in the uranium pellet loading and end closure weld area, is held in a 205 Litre (45-gallon) drum stored in the maintenance area. Most of the potentially contaminated waste water originates from floor washing. The water is filtered prior to sampling, and then sent for independent analysis at an external laboratory. The minimum detectable concentration is 0.000002 mg U/L (parts per million (ppm)).

After the water sample result is verified to be below the Internal Control Level of 3 ppm and the Action Level of 6 ppm (per batch), the wash water is filtered again during discharge to the sanitary sewer Total grams are measured prior to additional filtering and dilution during discharge.

A second liquid effluent from the Peterborough facility is beryllium in water that is generated from equipment use and washing. BWXT NEC has established an Internal Control Level of 4  $\mu\text{g}/\text{L}$ , which is conservative and consistent with international drinking water guidelines for beryllium. All potentially beryllium contaminated water passes through a weir settling system prior to release to the sanitary sewer. Regular sampling of the beryllium wastewater is conducted. The water sample consists of a 24-hour composite sample taken from the outflow lines. It is sent for analysis at an external independent

laboratory. The minimum detectable concentration is 0.007 µg Be/L (0.000007 mg Be/L or parts per million (ppm)).

In Toronto, bulk quantities of UO<sub>2</sub> powder are handled. This requires frequent cleaning and washing, creating higher concentrations of uranium in wastewater to be treated. The water is used to clean protective clothing, walls, floors, equipment and in various other janitorial functions. The water is treated to remove uranium dioxide and the concentration of UO<sub>2</sub> in waste water leaving the treatment system is measured in-house. The concentration of UO<sub>2</sub> in the total waste water leaving the plant premises is calculated and compared to the Internal Control Level of 3 ppm and the Action Level of 6 ppm (per batch). A weekly composite sample is prepared and sent for independent analysis at an external laboratory. The minimum detectable concentration is 0.000001 mg U/L or parts per million (ppm).

The water effluent treatment system at the Toronto facility operates as follows:

1. Waste water is held in batches
2. Each batch is treated, then sampled
3. Each batch is only released when in-house sample results confirm the concentration is less than 3 ppm (note: The Action Level for a batch is 6 ppm)
4. The released water mixes with sanitary water

Results from water effluent monitoring are summarized in Table 19. Sample measurements are taken prior to mixing with non-process water. Annual discharges for uranium are trended in Figure 12 and Figure 13. Beryllium average and maximum concentrations and Internal Control Level exceedances are trending down following the replacement of the weir settling system in December 2015. Where Internal Control Levels are exceeded, internal investigation is conducted and corrective/preventive actions are tracked to closure.

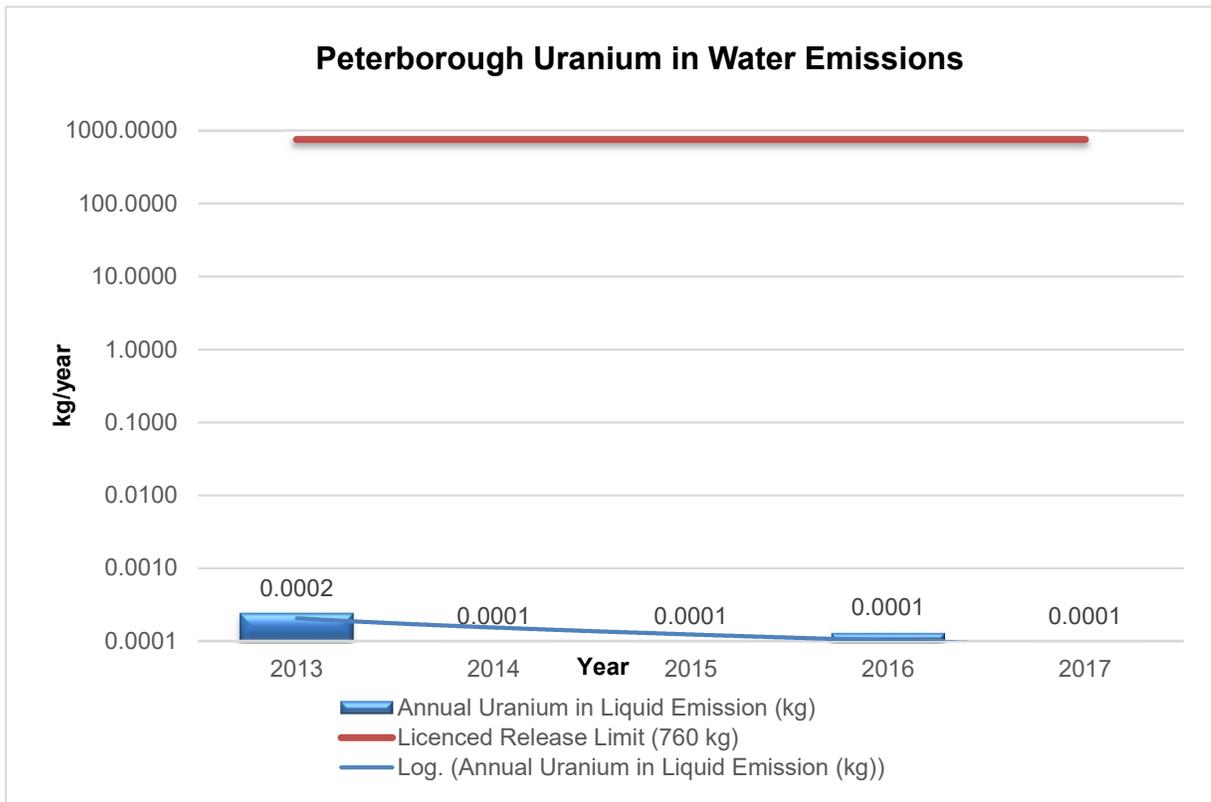
	Peterborough			Toronto		
	2015	2016	2017	2015	2016	2017
Total Amount of Liquid Discharged (L) from Uranium Processing Areas	820	820	820	1,487,250	1,239,375	1,140,225
Maximum Uranium Concentration in Undiluted Water (ppm)	0.09	0.48	0.09	2.44	2.80*	2.56
Average Uranium Concentration in Undiluted Water (ppm)	0.07	0.15	0.04	0.47	0.81*	1.13
Number of Samples Exceeding Action Level (6 ppm per batch)	0	0	0	0	0	0
Total Uranium Discharge to Sewer (g)	0.06	0.13	0.11	390	650	941
Minimum pH	N/A	N/A	N/A	6.6	6.7	6.1
Average pH	N/A	N/A	N/A	7.1	7.1	7.2
Maximum pH	N/A	N/A	N/A	7.7	7.7	7.8
Total Number of Samples Analyzed for Beryllium Concentration in Water	20	18	17	N/A	N/A	N/A
Maximum Beryllium Concentration in Water µg/L	65.5	2.5	5.4	N/A	N/A	N/A
Average Beryllium Concentration in Water µg/L	4.5	0.4	1.0	N/A	N/A	N/A
Number of Samples Exceeding Internal Control Level (4 µg/L)	3	0	2	N/A	N/A	N/A

**Table 19: Liquid Effluent Monitoring Results**

\*Values are revised from 2016’s annual compliance report to reflect undiluted concentrations; diluted concentrations were previously reported in error.

### 6.7.2.1 Peterborough Trending

In Peterborough, the five-year trend graph of uranium water releases shows a stable five-year performance consisting of very low water releases. The sample batch number size is limited and trending is difficult due to small random fluctuations in low concentrations. Water release results continue to remain low and below the Action Levels of 6 ppm (per batch) and 3 ppm (annual average). The total release of 0.11 g is a very small fraction of the derived release limit and of the regulatory discharge limit of 760 kg/year.

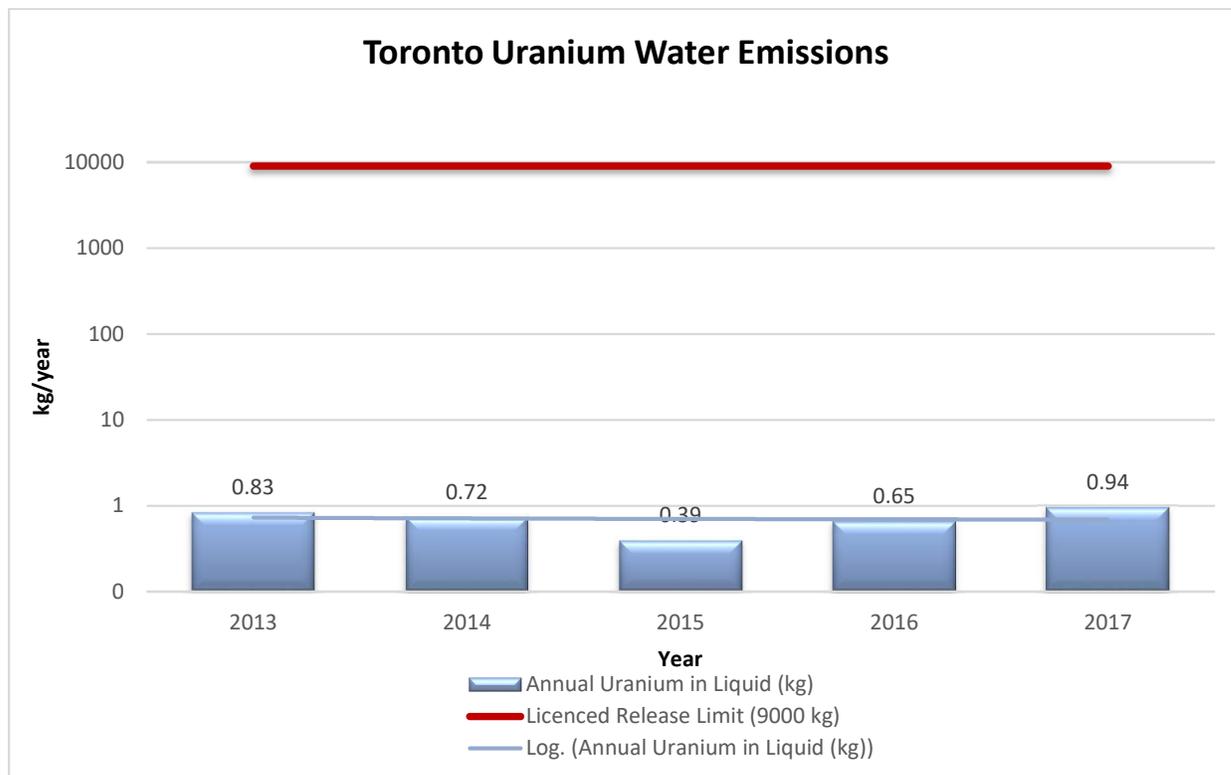


**Figure 12: Peterborough Water Emission Trending**

Note: the above graph has a logarithmic scale

### 6.7.2.2 Toronto Trending

Toronto liquid effluent releases are showing a stable trend over five years. Water release results continue to remain low and below the Action Levels of 6 ppm (per batch) and 3 ppm (annual average). The total release of 0.94 kg during the reporting period is well below the derived release limit of 9000 kg/year.



**Figure 13: Toronto Water Emission Trending**

Note: the above graph has a logarithmic scale

### 6.7.3 Well and Soil Sampling Measurements/Monitoring

Well monitoring is not required at either facility.

Uranium may be detected at low levels in various rocks, ores, soil, water, air and plants. In Ontario, background levels of uranium in soil are generally below 2.5 µg/g. The Canadian Council of Ministers of the Environment (CCME) have established soil quality guidelines to protect human health and the natural environment. The guidelines represent levels of uranium in soil below which no risk to human health is expected. For residential and parkland land use, the guideline is 23 µg/g; for commercial use, the guideline is 33 µg/g; for industrial land use the guideline is 300 µg/g. These guidelines have been adopted by the Ontario MOECC and are listed in Ontario Regulation 153/04. Uranium content in soil at concentrations higher than the MOECC standards suggest a need for further assessment, and mitigation of the source of the uranium to eliminate potential exposure and environmental impairment.

The facilities UO<sub>2</sub> air emissions are the primary pathway for potential release into the natural environment by impingement on the ground surface in the immediate vicinity of the facility depending on the wind direction. UO<sub>2</sub> is insoluble in water but may be washed into the soil by rainfall, snow, etc. Surface

uranium levels will indicate deposited emissions. It is noted that the amount of uranium released through air emissions from both facilities in any year, based on actual measurements, is extremely low.

Depositions of uranium are measured by taking small samples of surface soil and analyzing for natural uranium. Soil sampling is not conducted at the Peterborough facility due to the negligible air release amounts. Soil sampling is conducted annually at the Toronto facility. If soil analysis indicates rising natural uranium levels, emissions may have increased and investigation is made into the cause(s).

At the Toronto facility, samples of surface soil are retrieved from 49 locations in accordance with a documented plan by a third-party consultant. The samples are analyzed by an independent laboratory by Inductively Coupled Plasma Mass Spectrometry for natural uranium in parts per million. The minimum detectable concentration is 1.0 part per million (1.0 µg U/g). Results are compared to previous years and the CCME guidelines. A summary of results taken in the reporting period is listed in Table 20. Each individual soil sampling result is listed in Table 21. Locations are colour coded per their area classification: BWXT NEC property is **blue**, industrial/commercial lands are **purple**, and all other locations are **green**. Note: location ID 39 and 40 were removed from the plan in 2013 because of inaccessibility due to construction.

	Location Description		
	On BWXT NEC property	On industrial/commercial lands, i.e. south rail lands	All other locations, i.e. residential
Relevant CCME Guideline (µg U/g)	300 µg U/g	33 µg U/g	23 µg U/g
Number of Samples Taken	1	34	14
Average concentration (µg U/g)	1.7	3.0	1.0
Maximum concentration (µg U/g)	1.7	20.6	1.6

**Table 20: Toronto Soil Sampling Result Summary**

Sample Location ID	Uranium Content (µg U/g)	% of guideline
1	<1.0	<4.3
2	<1.0	<4.3
3	1.7	0.6
4	<1.0	<3.0
5	1.1	3.3
6	6.2	18.8
7	2.2	6.7
8	20.6	62.4
9	2.4	7.3

Sample Location ID	Uranium Content ( $\mu\text{g U/g}$ )	% of guideline
10	2.9	8.8
11	2.0	6.1
12	1.9	5.8
13	2.1	6.4
14	4.7	14.2
15	3.4	10.3
16	9.3	28.2
17	12.6	38.2
18	1.4	4.2
19	1.3	3.9
20	1.3	3.9
21	1.2	3.6
22	1.2	3.6
23	1.5	4.5
24	1.1	3.3
25	3.7	11.2
26	1.5	4.5
27	1.4	4.2
28	1.5	4.5
29	<1.0	<3.0
30	2.3	7.0
31	2.0	6.1
32	1.0	3.0
33	<1.0	<3.0
34	<1.0	<3.0
35	<1.0	<3.0
36	<1.0	<4.3
37	<1.0	<3.0
38	<1.0	<4.3
41	<1.0	<3.0
42	<1.0	<4.3
43	1.6	7.0

Sample Location ID	Uranium Content ( $\mu\text{g U/g}$ )	% of guideline
44	<1.0	<4.3
45	<1.0	<4.3
46	<1.0	<4.3
47	<1.0	<4.3
48	<1.0	<4.3
49	<1.0	<4.3
50	<1.0	<4.3
51	<1.0	<4.3

**Table 21: Toronto Individual Soil Sampling Results**

The analytical results for uranium concentrations for all soil samples analyzed are, without exception well below the acceptable standard published by the MOECC under Ontario Regulation 153/04 and CCME soil quality guideline. Uranium content increased marginally compared to the 2016 results at 14 locations. Eleven sample locations throughout the community are lower than both the 2016 and 2015 results showing an overall downward trend year over year in uranium content at these sample locations. Overall, the results are similar to historical results.

**6.7.4 Exceedances of Regulatory Limits or Action Levels**

No Action Levels or regulatory limits were exceeded during the reporting period.

**6.7.5 Total Estimated Doses to Members of the Public**

Radiation doses to members of the public are specified in the *Radiation Protection Regulations* and listed in Table 8. Effective dose is used to assess the potential for long-term effects that might occur in the future. It is a calculated value, measured in mSv, which takes into account the absorbed dose to all organs of the body, the relative harm level of the radiation, and the sensitivities of each organ to radiation. To ensure compliance with this regulation, BWXT NEC has established “Derived Release Limits” for uranium emissions to the environment. The facility Derived Release Limits account for the realistic exposure pathways as described in the facilities Radiation Protection Manual to restrict dose to a member of the public to 1 mSv (1,000  $\mu\text{Sv}$ ) per year, which is the regulatory dose limit. The Derived Release Limits assume that a member of the public occupies the BWXT NEC boundary continuously (24 hours per day, 365 days per year). The realistic pathways considered are summarized in Table 22. Note: Liquid effluent is not included in the calculation of public dose as the effluent from both facilities is discharged directly to city sewer systems and is not used for drinking.

Pathway	Description
Air immersion	Airborne UO <sub>2</sub> particles can expose members of the public via direct radiation This is accounted for in the Peterborough and Toronto Derived Release Limits
Air inhalation	Airborne UO <sub>2</sub> can expose members of the public via inhalation This is accounted for in the Peterborough and Toronto Derived Release Limits
Soil deposition gamma radiation ground shine	Gamma ground shine dose from direct radiation This is accounted for in the Toronto Derived Release Limit
Soil deposition beta radiation ground shine	Beta ground shine dose from direct radiation This is accounted for in the Toronto facility Derived Release Limit
Soil re-suspension and inhalation	Soil re-suspension and inhalation dose This is accounted for in the Toronto facility Derived Release Limit
Gamma radiation	Gamma radiation measured using environmental TLDs strategically located along the plant boundaries

**Table 22: Radiological Exposure Pathways**

In Peterborough, through direct correlation with the facility Derived Release Limits, the estimated effective dose as a result of air releases during the reporting period is 0.00 µSv. Environmental TLDs at the Peterborough plant boundary are in place and used to estimate a public gamma dose. The estimated effective dose as a result of direct gamma radiation during the reporting period is 0.00 µSv. As a result of Peterborough operations, the total estimated radiation dose to a member of the public is 0.00 µSv.

In Toronto, through direct correlation with the facility Derived Release Limits, the estimated effective dose as a result of air releases during the reporting period is 0.49 µSv. Environmental TLDs at the Toronto plant boundary are in place and used to estimate a public gamma dose. The estimated effective dose as a result of direct gamma radiation during the reporting period is 17 µSv. As a result of Toronto operations, the total estimated radiation dose to a member of the public is 17.49 µSv. The change in the Toronto gamma contribution compared to previous years was the result of a change in the placement of the background TLD.

In comparison to the 1 mSv (1,000 µSv) per year effective dose limit to a member of the public, doses from the operations at the Peterborough and Toronto facilities are a fraction of the regulatory public dose limit. This is summarized for the current and previous reporting periods in Table 23.

Period	Peterborough		Toronto	
	Estimated Annual Public Dose (µSv)	% of Public Dose Limit (1,000 µSv = 1 mSv)	Estimated Annual Public Dose (µSv)	% of Public Dose Limit (1,000 µSv = 1 mSv)
2017	0.0	0%	17.5	1.8%
2016	0.0	0%	0.7	0.0%
2015	0.0	0%	10.1	1.0%

**Table 23: Estimated Annual Public Dose**

### 6.7.6 Environmental Protection Program Effectiveness

BWXT NEC has a well-established integrated management system for environmental, health and safety program excellence. This is ensured through the effective implementation of program elements. BWXT NEC has an established EHS Mission Statement that is reviewed and signed annually by the President of BWXT NEC. BWXT NEC’s objective is to eliminate or minimize as low as reasonably achievable both known and potential environmental hazards which could impact our employees and the communities in which they live. EHS is a shared responsibility, top business priority and is continually improved.

The Peterborough facility achieved registration to the updated ISO: 14001:2015 Environmental Management System (EMS) standard. The Toronto facility maintained registration to the 2004 version of the standard. As part of maintaining ISO 14001 registrations a documented EMS is in place that is audited by a third party registrar annually and determined to meet the requirements of the standard. An EMS is in place to identify and control environmental aspects and drive continuous improvement to enhance performance and minimize risk to the employees and the public.

Key components of the environmental protection program include:

- Compliance with all environmental-related regulatory requirements;
- The setting of environmental goals and objectives;
- Hazard recognition, risk assessment and change control processes;
- A comprehensive worker training program;
- Documented environmental concerns, near misses and incidents with appropriate root-cause analysis, preventive and corrective actions.

The EHS program includes all environmental protection elements that demonstrate compliance to relevant regulations, codes and standards:

- Air
- Water
- Waste
- Dangerous goods shipping
- Boundary radiation monitoring
- Soil sampling (Toronto)

Internal inspections are completed on a routine basis and focus on all areas of the plant. The purpose of these inspections is to identify environmental as well as health and safety issues. WSC members carry out routine plant inspections. After an inspection, the findings are documented, corrective actions identified, and submitted to responsible personnel to address. Depending on the complexity of the finding immediate action may be required (i.e. equipment shutdown), or the action may be incorporated into meeting minutes, or tracked in the ATS.

The following audits of the environmental protection program are conducted at each facility:

- The EMS is audited internally every year as per ISO 14001:2004 or 2015
- The EMS is audited externally (by SAI Global) every year as per ISO 14001:2004 or 2015
- An annual self-assessment is conducted

Following proactive reviews, such as audits or self-assessments, the findings are documented, corrective actions identified and tracked to completion in ATS.

In the reporting period, there were 26 environmental related findings for Peterborough and 46 for Toronto. These findings were identified from internal and external inspections and audits, self-assessments, employee concerns, incident investigations and other program reviews. The top category groups for Peterborough were environmental – multi-media, management systems, waste and water. The category groups for Toronto were ventilation, management systems and waste. There were no major non-conformances at either site.

#### **6.7.7 Environmental Protection Program Improvements**

Continuous improvement is achieved through several review processes, including site inspections, reported concerns, near miss and incident investigations, self-assessments and audits.

In the reporting period, the Peterborough EMS was improved for compliance to the 2015 version of the ISO 14001 standard and achieved registration in 2017. The program improvement included assessment and understanding of the context of the organization within the environment, and a determination of the internal and external issues that result in risks and opportunities. These risks and opportunities were assessed and action planned to address them as related to identified environmental aspects, compliance obligations, or needs and expectations of interested external or internal parties.

In Toronto, automation of the water effluent treatment process was implemented primarily to improve consistency in the treatment process. The automation also introduced alternate chemicals and allowed for the elimination of one of the treatment chemicals.

In addition, for Toronto boundary air sampling, station location selection was documented. An orifice calibrator calibration procedure was also implemented. For Toronto soil sampling, an explanation for sampling location determination was documented.

#### **6.7.8 Environmental Protection Program Performance**

Environmental protection goals and results are summarized in Table 24.

	Goal	Actual	Result
Peterborough	Investigate the feasibility of recycling zirconium skeletons to reduce beryllium hazardous waste	Complete	Achieved
	Implement preventive maintenance for significant environmental aspects in Nuclear Services	Complete	Achieved
	Roll-out manufacturing area hazards awareness training to the site	100% Completion	Achieved
Toronto	Water Effluent – Average tank releases <0.8 ppm	0.8 ppm	Not Achieved
	Water Effluent – Investigate the removal of a secondary chemical	Complete	Achieved
	Air Emissions - >5% reduction over 5-year average	38% Reduction	Achieved
	Energy/Greenhouse Gases – Reduce identified air leaks by 25%	85% Reduction	Achieved
	Chemical – Reduce on-site inventory by 5% from 2016	13% Reduction	Achieved
	Waste Management – Set-up processing area in B7	Cancelled	Not Achieved

**Table 24: EMS Program Goals**

2018 goals for Peterborough are established as follows:

1. Update chemical spill response plan by year end
2. Improve spill containment at the berg chiller by year end
3. Beryllium hazardous waste reduction by >10% from previous year
4. Complete one asbestos abatement project by year end

2018 goals for Toronto are established as follows:

1. Energy/Greenhouse Gases – Reduce identified air leaks by 25%
2. Chemical – Reduce on-site inventory by 5% from 2017
3. Chemical – Replacement of three janitorial chemicals to environmentally friendly substitutes
4. Waste Management – Trial new cleaning machine for decontamination of materials

## 6.8 Emergency Management and Response

Each facility has established emergency response plans that describe the actions to be taken to minimize the health and environmental hazards, which may result from fires, explosions, or the release of hazardous materials. The plans include effects to the local area and members of the public. The plans are intended to reduce the risk of fires within the facility and assist emergency staff and plant personnel in understanding key emergency response issues, and assist the facility in protecting employees, the local community and the environment through sound emergency management practices. The emergency response plans were developed in accordance with federal laws and standards as follows and fulfils the CNSC operating licence requirements

- CAD/CSA-Z731-03, *Emergency Planning for Industry Standard*

- CNSC Regulatory Guide G-225, *Emergency Planning at Class I Nuclear Facilities and Uranium Mines and Mills*
- The Province of Ontario Nuclear Emergency Plan Part VIII
- Canada Labour Code
- CNSC Regulatory Document REGDOC 2.10.1, *Nuclear Emergency Preparedness and Response*
- NFPA 801, *Fire Protection for Facilities Handling Radioactive Materials*
- CSA N393-13, *Fire Protection for Facilities that Process, Handle, or Store Nuclear Substances*

### **6.8.1 Review of Emergency Preparedness Program Activities**

In Toronto, BWXT NEC initiated a formal project team to address the deficiencies identified in the CNSC Emergency Response Compliance Inspection report issued March 27, 2017. BWXT NEC began a major revision of the Emergency Response Program including redistribution of roles and responsibilities. A designated Emergency Operations Centre (EOC) location was established in Toronto and equipped with the tools and technology required to respond to an emergency event. The improvement project continues into 2018.

Tests of the emergency response plans were performed in the following areas:

At the Peterborough site:

1. Fire safety/Evacuation (two)
2. Medical emergency (two)
3. Beryllium ventilation system failure (one)

The drills, events and exercises at the Peterborough facility resulted in 12 actions being identified and tracked to completion in the ATS. Actions were related to egress, emergency equipment and signs/signals/barricades.

At the Toronto site:

1. Fire/evacuation drill (four)
2. Crisis management drill (one)
3. Emergency response equipment exercise (one)
4. Lone worker drill (one)

The drills and exercise at the Toronto facility resulted in five actions being identified and tracked to completion in the ATS. Actions were related to air monitoring, egress, procedures, signs/signals/barricades and training/communication.

### **6.8.2 Emergency Preparedness Training Program and Effectiveness**

Emergency preparedness training is achieved through response drills where actual responses are regularly critiqued to continually improve the effectiveness of the process. These are conducted at least annually, as described in section 6.8.1.

All employees are trained on established fire prevention measures, emergency situation responses, emergency evacuation routes and their responsibilities. Awareness training is conducted during new employee orientation and refreshed through response drills.

Emergency responders are provided with the level of training necessary to allow them to effectively perform their designated services as defined in each facilities training matrix.

Training course completion is summarized in Table 25.

	Course Name	Number of Employees Who Required Course	% Required Completed
Peterborough	Emergency & Disaster Preparedness	196	100%
	Portable Fire Extinguisher Training (Practical)	12	83%
	Portable Fire Extinguishers	293	100%
	First Aid/CPR/AED	24	100%
Toronto	Emergency & Disaster Preparedness	56	100%
	Portable Fire Extinguisher Training (Practical)	0	100%
	Portable Fire Extinguishers	57	100%
	First Aid/CPR/AED	13	100%

**Table 25: Emergency Preparedness and Fire Prevention Training Summary**

**6.8.3 Fire Protection Program Activities and Effectiveness**

The fire protection programs are well-established and effective. The documented fire hazards analysis (FHA) identifies the facility fire hazards and their potential impact on the worker and public safety and asset protection. The current FHAs, previously accepted by the CNSC, meets the required standards and remained in effect during the reporting period. The facilities maintain documented fire safety plans that are compliant with the National Fire Code of Canada, the National Building Code of Canada and NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials*. The fire safety plans are based on the documented FHA and ensures that measures are appropriate to the facility. It provides information on resources in the buildings, emergency procedures and actions to be taken in the event of a fire. It includes the training schedule and duties of designated personnel, details maintenance procedures and fire protection measures. The information assists the occupants in utilizing life safety features in the buildings, ensure an orderly evacuation at the time of an emergency and provide a maximum degree of flexibility to achieve the necessary fire safety for the buildings.

Fire protection systems are inspected and tested in accordance with the National Fire Code of Canada following an established schedule. A third-party review and internal self-assessment is conducted annually at each site. Identified continuous improvements are tracked to completion using the ATS. As the primary responders for the facilities, site familiarization tours are conducted annually with Peterborough and Toronto Fire Services.

Continuous improvement is achieved through several review processes, including site inspections, reported safety concerns, near miss and incident investigations, drills and self-assessments. In the reporting period, there were 42 ATS findings for Peterborough and 32 for Toronto, related to emergency preparation, egress and fire protection. Findings entered into these categories originated from routine

site safety inspections, self-assessments, drills and third-party audits. There were no major non-conformances.

#### **6.8.4 Fire Protection Program Improvements**

There were no significant changes to the facilities fire protection programs during the reporting period. The annual third party fire safety inspection scope was updated to include CSA standard N393-13 *Fire Protection for Facilities that Process, Handle, or Store Nuclear Substances*.

Physical plant changes are periodically made to improve fire protection programs. In Peterborough, a fire separation between building 21 first floor janitorial stores and building 21 manufacturing area was installed. In Toronto, as a result of an investigation into a small hydrogen flame originating from a leaky union, old mechanical unions on the copper pipes under the furnaces were replaced with copper couplings.

#### **6.9 Waste and By-Product Management**

The "Waste and By-product Management" 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 Safety and Control Area also covers the ongoing decontamination and planning for decommissioning activities.

Radioactive wastes are any materials that contain a radioactive nuclear substance, and which have been declared to be waste. BWXT NEC has an effective and well-established radioactive waste disposal program that ensures all radioactive waste disposals are compliant with the Nuclear Safety and Control Act and Regulations and the facility operating licence conditions. All radioactive waste disposals are conducted in accordance with regulations and the conditions in the facility operating licence.

Radioactive solid waste generated from fuel manufacturing, which consist of, or are contaminated by uranium are accumulated in controlled and classified areas. A low volume of radioactive wastes from Peterborough are transported to and consolidated with the Toronto facility wastes. These are combined, compacted for volume reduction where possible, and shipped routinely to a licensed radioactive waste disposal facility. In Toronto, only about 0.01% of the uranium that is processed ends up in waste streams. Nearly all nuclear material is used in the product or recycled back to the supplier.

The Peterborough site conducts an annual Waste Audit and Waste Reduction Work Plan in accordance with Ontario Regulation 102/94 under the Environmental Protection Act. The audit serves to assess and advance the non-nuclear waste diversion initiatives and consists of the physical collection and sorting of generated waste and includes a waste composition study. It provides a prepared Waste Reduction Work Plan where areas of success are highlighted and opportunities for improvement are identified through waste reduction, reuse and recycling. The results of the audit are communicated to employees and waste reduction and diversion initiatives are undertaken.

Waste management and generation details are further described in Appendix C, submitted to the CNSC separately.

#### **6.10 Nuclear Security**

The "Nuclear Security" Safety and Control Area covers the programs required to implement and support the security requirements stipulated in the regulations, in the operating licence, and in industry expectations for the facilities.

Each site maintains a documented security program, which identifies the individual responsibilities for implementation and maintenance of the program. The manuals include instructions for administering the security program, provides the basis for security protocols and identifies the controls in place to meet

regulatory requirements in the Nuclear Security Regulations and facility operating licence conditions. Facilities are compliant with requirements. As a continuous improvement initiative, the documented programs were updated and submitted to the CNSC for review. Program details are prescribed information and confidential.

Security awareness training was developed and provided to all employees. The training covers general security awareness including regulatory bodies and regulations, obligations of workers, identifying and reporting suspicious activity/security concerns, physical security, controlled access requirements and the badging protocol.

### **6.11 Safeguards and Non-Proliferation**

The "Safeguards and Non-proliferation" 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. BWXT NEC has implemented and maintains a safeguards program and undertakes all required measures to ensure safeguards implementation in accordance with IAEA commitments and CNSC regulatory document RD-336 *Accounting and Reporting of Nuclear Material*. Movement of safeguarded nuclear material (inventory changes) are documented and reported to the CNSC as required.

In Peterborough, a Physical Inventory Taking was conducted on July 10<sup>th</sup> 2017. A Physical Inventory Verification and Design Information Verification involving the CNSC and the IAEA followed on July 11<sup>th</sup> and 12<sup>th</sup>, 2017. In Toronto, the Physical Inventory Taking was conducted on July 12<sup>th</sup>. A Physical Inventory Verification and Design Information Verification involving the CNSC and IAEA followed on July 13<sup>th</sup> and 14<sup>th</sup> 2017. The scope of the Physical Inventory Verification concerned book examination, physical verification of nuclear material and evaluation of the quality and performance of BWXT NEC Inc.'s measurement system. The scope of the Design Information Verification concerned verification of the facility, general building design, essential equipment, accounting procedures, operator's measurement system, nuclear material characteristics, nuclear material location & flow and operational status of the facility.

Short Notice Random Inspections were conducted by the CNSC and IAEA on May 4<sup>th</sup> 2017 and December 13<sup>th</sup> 2017 in Peterborough. The scope concerned verification of records for current shipments of finished product. No major non-conformances were noted.

### **6.12 Packaging and Transport of Nuclear Substances**

The "Packaging and Transport of Nuclear Substances" Safety and Control Area covers the packaging and transport of nuclear substances and other nuclear materials to and from the licensed facilities.

Routine shipments of both dangerous goods and non dangerous goods are made between suppliers, the Toronto plant, and the Peterborough plant and customer nuclear generating stations. In the reporting period, all packaging and shipments to and from both facilities were conducted safely according to relevant regulations.

BWXT NEC has an established Emergency Response Assistance Plan (ERAP) compliant to Part 7 of the TDG. It is in place to ensure that timely and effective response protocols are in place with the intent to protect public safety, property and the environment in the event of an accident involving the transportation of natural or depleted uranium dioxide. Transportation of uranium materials to and from BWXT NEC are included in the plan. In the reporting period, the plan was updated and approved by Transport Canada. A classroom training session pertaining to radiation safety, safe handling of shipments and the ERAP was held internally and for a contracted third-party emergency responder.

## **6.13 Other Matters of Regulatory Interest**

### **6.13.1 Public Information Program**

#### **6.13.1.1 Employee/Internal Communications**

BWXT NEC has approximately 400 employees at three locations in Ontario – Arnprior, Peterborough and Toronto.

The primary focus for 2017 employee communications was the integration of employees to BWXT. The integration process required extensive communication in order to effectively support the transitions and changes required, while helping to ensure that employees were able to continue to perform their jobs safely and without disruption.

All-employee meetings, electronic updates, internal leadership blogs and an internal electronic platform for housing information provided employees with a wealth of information in order to help them successfully transition to BWXT. There was no interruption to work or impact on overall performance.

#### **All-Employee Meetings**

2017 began with in-person all-employee meetings at all three locations featuring the president of BWXT Canada and BWXT NEC. The annual employee barbeque was also leveraged as an opportunity to provide an update to employees. Year-end all-employee meetings were also held at all three locations. The meetings provided employees with general business updates and health, safety and quality performance.

#### **Executive Blogs**

Executive blogs are a tool used to provide insightful, high-level information to employees. The blogs are housed on BWXT's internal employee portal, myBWXT, and distributed to all employees via email.

The blogs covered a range of topics such as integration updates, safety and quality, community relations activities and other general business updates/information.

#### **Monitors and Information Boards**

Television monitors are installed on the manufacturing floors and lunch rooms at the Peterborough and Toronto facilities. The monitors are used regularly to communicate messages to employees who do not work on a computer due to the nature of their jobs. Information that is regularly communicated include:

- Integration Messages/Information
- Safety Awareness Tips
- EHS Updates
- Site Visitors
- Schedule Updates
- Training Opportunities
- Local company-sponsored events/activities

The use of the television monitors help BWXT NEC communicate more effectively and timely with production and manufacturing-based employees. Information is updated and changed as needed and approximately 100 messages were posted to the monitors at each location last year.

Employee information boards located in the manufacturing areas are a place where employees without regular use of computers can pick up printed communications. These included blog posts, stories from the employee portal, safety information and other company information.

### **Internal Portal**

The internal portal, myBWXT, houses a range of content including EHS, executive blogs, policies, press releases and other resources to assist employees with retrieving information.

myBWXT is also a source of general company news and information such as the annual CNSC license review meeting, project updates, contract wins and BWXT community activities.

#### **6.13.1.2 Government Stakeholders**

BWXT NEC places great importance on its relationships with all levels of local elected officials in the communities in which it operates and works to ensure there is open communication and awareness of BWXT NEC's operating activities.

In 2017, facility tours and/or meetings were conducted with:

- MP for Peterborough-Kawartha
- Mayor of Peterborough
- MPP for Peterborough
- MP for Davenport
- Ontario Minister of Energy

BWXT NEC also reached out to the MPP for Davenport and Councillor, Ward 17, Davenport, but scheduling challenges prevented meeting in 2017.

BWXT NEC also participated in Canadian Nuclear Association activities including Hill Day (May) and Fall Legislature Day (September).

#### **6.13.1.3 Community Volunteerism**

The transition to BWXT resulted in the need to rebuild the volunteer program to ensure the program aligned with BWXT corporate objectives and complied with company policies. The rebuilding process also required the development of main infrastructure components such as a portal and program charter.



BWXT NEC rebuilt all components of its volunteer program over the course of 2017 and officially launched the new program, called BWXT Volunteer Strong, to employees in November. The program has the full support of leadership

and has been received positively by employees.

Through BWXT Volunteer Strong, all employees have the opportunity to help build stronger communities for those that live and work in them and can volunteer time and expertise to local causes that are important to the communities in areas such as education, health & wellbeing, arts & culture, environment and aboriginal.

In 2017, BWXT NEC Peterborough employees supported the Angel Tree program through the Kinark Child and Family Services, Big Brothers & Big Sisters Peterborough and launched a kid's winter clothing drive for Prince Of Wales Public School. Over the month of May, employees at BWXT NEC Peterborough traded in their cars for more environmentally-friendly modes of transportation as part of the Peterborough Moves, Community Shifting Gears competition which encourages participants to

change their daily transportation habits by forgoing their car and choosing instead to ride a bike, walk, take public transportation or carpool. BWXT NEC earned two awards – one for rookie workplace of the year, and one for runner-up, large workplace category.

#### 6.13.1.4 Community Investment

In Peterborough, BWXT NEC made a financial donation to Prince of Wales Public School to assist the school with purchasing tools/equipment that support Science, Technology, Engineering and Math learning. Gate collections were conducted through the Volunteer Strong program in support of the Canadian Cancer Society's Daffodil Days and Pink Ribbon Campaign. BWXT NEC also launched a United Way payroll deduction campaign in support of the Peterborough & District United Way.

In 2017, BWXT NEC joined the Peterborough & District Chamber of Commerce.

In Toronto, BWXT NEC reached out to Pauline Junior Public School to identify opportunities to provide financial support to the school to enhance student's learning experience in Science, Technology, Engineering and Math.



#### 6.13.1.5 Sponsorship and Special Events

BWXT NEC sponsored the 2017 Peterborough Dragon Boat Festival as a Silver Sponsor. This festival is one of the largest local events in the Peterborough community. BWXT NEC employees also enter a 20-person Dragon Boat team who all wear BWXT NEC branded gear.

BWXT NEC also lends its support to the host communities of nuclear power plants as they play an important role in Ontario's nuclear industry and some BWXT NEC employees also live and work in these communities:

- Saugeen Ojibway Nation's Youth Leaders in Training
- Spinal Cord Injury Ontario
- Huron Shores Hospice
- United Way of Bruce Grey
- Liv-a-Little
- Unity for Autism
- Wounded Warriors Canada
- Kincardine & Community Health Care Foundation
- Saugeen Memorial Hospital

#### 6.13.1.6 Tours

Tours are an excellent way for community members, elected officials and other stakeholders to become more familiar with BWXT NEC's operations. In addition to the tours provided to elected officials and industry groups, BWXT NEC also conducted tours with the Trent University Physics Group, the Peterborough Regional Health Centre Foundation, Peterborough Public Health and worked with a number of other groups to plan and schedule tours that will occur in 2018.

BWXT NEC also met with the Parent/Teacher Council at Prince of Wales Public School in November to provide an overview of its Peterborough operation including health, safety and environmental performance. BWXT NEC is in the process of scheduling a tour for the Parent/Teacher council in 2018.

### 6.13.1.7 Community Barbeques

BWXT NEC has hosted community barbecues in Toronto since 2015 and Peterborough since 2016. These events create a platform for the exchange of information between BWXT NEC and community members and helps to build positive relationships within the communities.

Community barbecues were held in Peterborough on June 15, 2017 and in Toronto on June 22<sup>nd</sup>. The barbecues are held as another means to engage neighbours, community members and other stakeholders, and educate them on the respective facility's operations.

The Peterborough barbeque was the second for the Peterborough operation and an estimated 150+ community members came out. BWXT NEC conducted the barbeque from 2 to 5 p.m. on a Thursday in an effort to engage more of the parents of students at Prince of Wales Public School which was an effective strategy.

The 2017 Toronto community barbeque attracted an estimated 130 community members.

Senior leaders and managers staffed the barbecues and provided information about its operations and educated guests on the role of nuclear in Ontario.

Guests were treated to free barbeque fare such as hamburgers and hotdogs, and could speak with leaders from BWXT. Large posters provided visuals and information about BWXT NEC's history, highly-skilled workforce, engineering and manufacturing capabilities, track record of safety and regulatory compliance, public information program and facts about natural uranium.



#### **6.13.1.8 Community Newsletters**

Community newsletters are used by BWXT NEC as a tool to share information with the local communities about the company's operational performance, health and safety, activities in the community and general information.

Three newsletters were issued to the Toronto community in 2017. The distribution of Toronto newsletters were 1,700 in January and June, and then increased to 2,200 for the October issue. The Toronto newsletter is translated to Portuguese and included in the mailing.

In Peterborough, three newsletters were distributed to the community over the course of the year. Approximately 1,500 addresses were sent the newsletter in January, and this was increased to 1,700 for the June and October issues.

#### **6.13.1.9 Community Liaison Committee - Toronto**

The Toronto Community Liaison Committee (CLC) was established in 2013 and meets four times per year at the Toronto facility in the evenings. The CLC is a forum for the exchange of information between the community and BWXT NEC. The CLC is not a decision-making body but provides a forum for members to bring forward questions, discuss concerns and identify opportunities to improve community relations. BWXT NEC seeks to learn more about community priorities, interests and activities, and improve how it shares information about work at the Lansdowne Avenue facility, health & safety initiatives and community activities.

To help support the continued improvement and health of the CLC, BWXT NEC conducted a recruitment campaign in the fall of 2016. A call for applicants, along with the application, were posted on the website and a call for applicants was included in the November 2016 Toronto Community Newsletter. Letters and applications were mailed or emailed to local community organizations and banners advertising the CLC recruitment were placed on the fence line at the Toronto facility. Current CLC members supported efforts by encouraging their networks in the community to apply for membership. The efforts resulted in one new application to the committee which was accepted upon review. Recruitment efforts will occur annually.

The new member was provided with an orientation session that included an overview of BWXT NEC's operations and a tour of the facility.

In 2017, including the new member, there were a total of five members who are residents in the community.

Members meet with staff to discuss the facility's operations and receive updates on topics such as emergency planning and training, community initiatives and environmental monitoring. CLC members provide input on BWXT NEC activities such as newsletter content, annual barbeque planning, community initiatives, etc. Their input is valuable in guiding communications efforts with area residents.

Key topics discussed at CLC meetings in 2017 included updates on the transition to BWXT NEC, Annual Compliance Report overview, community barbecue planning, BWXT NEC website review, and health and safety updates. BWXT NEC also invited the Nuclear Waste Management Organization to come to the September meeting and share information with CLC members about the organization and the plans for safely managing Canada's used nuclear fuel. This presentation was very well received by the CLC members who provided positive feedback.

2017 CLC meeting dates:

- Mar. 21, 2017 (orientation for new member)
- Mar. 28, 2017

- June 13, 2017
- Sept. 27, 2017
- Nov. 14, 2017

Meeting records are posted to the Company's website.

Recruitment for 2018 began in the fall of 2017 and new members will be provided with an orientation session including a facility tour.

#### **6.13.1.10 Website**

The website was rebranded to BWXT Nuclear Energy Canada and is located at [www.nec.bwxt.com](http://www.nec.bwxt.com).

The rebranded website launched on December 19, 2016 and a redirection was implemented to point the old website to [www.nec.bwxt.com](http://www.nec.bwxt.com).

The website provides information about the Company's operations and activities that can be accessed by members of the public and other key stakeholders 24/7.

In 2017, there were 12,017 total sessions from 8,132 users. Top pages visited were: Home page (54 per cent of all unique page views), Contact Us (9.5 per cent) and What We Do (8 per cent).

Over the course of 2017, new information was updated on the website. The following represents some of the updates that were made to the website:

- The 2017 annual compliance report was posted;
- A call for applications to the Toronto CLC was posted;
- Copies of the Toronto (three) and Peterborough (two) newsletters were posted;
- Community barbeque information was posted; and
- The Independent Environmental Monitoring Program results for Toronto 2016 was posted.

In 2017, BWXT NEC began work on redesigning and conducting further updates to the website, an effort that will launch in 2018.

#### **Public Inquiries**

Members of the public can contact the company through a toll-free 1.800# and a general email. The toll-free number is 1-855-696-9588 and the email is [questions@bwxt.com](mailto:questions@bwxt.com). Both are posted on BWXT NEC's website and provided in Community newsletters.

In 2017, 132 emails were received and 70 phone calls. Key topics were:

- Employment verification requests
- Employment or co-op student inquiries/resume submissions
- Security clearance requests

A small percentage of emails related specifically to the Toronto operations with local residents asking questions about the facility's uranium processing activities and potential health impacts. These questions were all answered and recipients appeared satisfied with the responses.

### 6.13.1.11 Media

#### Earned Media

The media are a valuable component of BWXT NEC's communications program and are recognized as a key conduit for BWXT NEC to deliver information about its operations and activities to the broader communities.

In 2017, BWXT NEC issued two press releases. The first release, issued in February, was regarding the delivery of the Bruce Reactor Inspection System to Bruce Power. The second release, issued in August, announced that BWXT NEC had been awarded a contract for primary heat transport motors by Bruce Power.

BWXT NEC was mentioned in the local Peterborough news on numerous occasions noting that BWXT NEC will continue to operate at its current location as is not impacted by the announcement made by GE regarding its plans at the Peterborough site.

Overall, media coverage in 2017 was positive.

#### Advertising

2017 advertising included the placement of ads in:

- Business Advantage, Celebrating 150 Years of Business in Peterborough and the Kawarthas
- Peterborough This Week (in support of Crime Stoppers)

### 6.13.1.12 Social Media



... BWXT NEC leverages BWXT's social media channels which include Twitter, Linked-In and Facebook to share information about BWXT NEC activities. 2017 was the first year that BWXT NEC engaged via Facebook, enhancing its overall social media presence. In total, 28 tweets were sent out in 2017 and 28 Facebook posts were made. Tweets were used to create awareness of the community barbeques and volunteer activities in the Peterborough and Toronto communities.

A variety of information was shared via social media such as:

- Job Opportunities;
- Engineering Month Employee Profiles;
- News;
- Community Activities (BBQs, CLC, etc.); and
- Information about BWXT NEC's capabilities, products and services (i.e. BRIMS, CANDU fuel, etc.).

### 6.13.1.13 Public Disclosures Protocol

BWXT NEC has a Public Disclosure Protocol in place that sets out guidelines to providing timely information to interested members of the public and other stakeholders. Disclosures are posted to the Company website and emailed to a distribution list of interested individuals and groups.

Information about the Public Disclosure Protocol is made available on the website along with any disclosures made. In 2017, four Public Disclosures were made, three at the Toronto location and one at the Peterborough site.

The Disclosures made related to Toronto were:

- Sept. 27 – False alarm resulting from a routine maintenance test.
- May 29 – False alarm resulting from a sprinkler head activating.
- Apr. 15 – False alarm accidentally triggered by an employee.

The Disclosure made related to Peterborough was:

- Nov. 2017 – Incorrect Personal Protective Equipment used.

### 6.13.1.14 Indigenous Relations

BWXT Canada and BWXT NEC together joined the Canadian Council of Aboriginal Business (CCAB) in September, 2017, and are actively working towards becoming Progressive Aboriginal Relations (PAR) certified. Currently the company is PAR Committed – which signifies commitment to continual improvement in Indigenous relations and intention to undergo external verification of performance in the future.

A PAR Committee was established and a Canada-wide company policy for Indigenous Relations was developed in 2017 which is publicly available on BWXT NEC's website.

This program supports BWXT NEC's commitment to engaging Indigenous stakeholders and building and sustaining meaningful long-term relationships. Additionally, the company joined the Indigenous Relations Suppliers Network established by Bruce Power in 2017.

### 6.13.2 Site-Specific

BWXT NEC met all site-specific reporting requirements.

#### 6.13.2.1 Nuclear Criticality

This section is not applicable. BWXT NEC does not have an active Nuclear Criticality Program since neither facility processes enriched uranium.

#### 6.13.2.2 Nuclear Liability

BWXT NEC retains financial security in the form of insurance as required by the Nuclear Liability and Compensation Act.

Decommissioning plans are required in accordance with CNSC guidance document G-129, *Decommissioning Planning for Licensed Activities*. Plans are in place to ensure forethought for materials and waste management, radiological surveys, conventional health, safety and security, emergency response, quality assurance, financial guarantees, environmental assessment and final end-state reporting in the event of future site decommissioning activities. As a result of the amalgamation and the formation of BWXT NEC in December 2016, BWXT NEC provided a replacement financial guarantee reflecting the corporate name change in early January 2017 in accordance with CNSC

guidance document G-206, *Financial Guarantees for the Decommissioning of Licensed Activities*. The amount of the replacement financial guarantee was unchanged and is based on preliminary decommissioning plans previously accepted by the CNSC. Plan updates are required every 5 years.

### 6.13.3 Improvement Plans and Future Outlook

BWXT NEC has well-established and implemented continuous improvement processes in an ongoing effort to improve products, services and the safety of our licensed activities.

The following additional improvements are planned during the next year:

- Implementation of a significantly revised Emergency Plan at the Toronto facility.
- Updates to the Chemical Management Programs and associated labeling systems, including site-wide chemical sweeps, and revision of education and training programs to implement WHMIS 2015.

### 6.13.4 Safety Performance Objectives for the Following Year

BWXT NEC remains committed to continuously improve our EHS programs to improve efficiency and minimize risk to employees, the public and the environment.

Facility operations are projected to remain constant in 2018. Fuel production levels are projected to be similar to the amount processed in 2017. The facility operating licence remains valid until 2020.

## 7 CONCLUDING REMARKS

BWXT NEC is committed to the establishment and continuous improvement of a healthy Safety Culture. Safety Culture refers to the core values and behaviours resulting from a collective commitment by our company's leaders and individuals to emphasize safety, quality, ethics, and security over competing goals to ensure protection of employees, the public and the environment. It is a top business priority to continuously improve our EHS systems to protect fellow employees, the environment, and our communities against environmental, health and safety hazards. BWXT NEC management recognizes, reviews, prioritizes and controls workplace hazards and ensures compliance with applicable regulatory requirements, applicable codes and company policies.

Governed by an integrated management system, conventional health and safety, radiation protection programs and environmental protection programs are well implemented. All radiation dose measurement results were below Internal Control Levels, Action Levels and regulatory limits. Environmental protection programs were well implemented. There were no significant environmental issues or incidents encountered during the reporting period. Both facilities maintained ISO 14001 Environmental Management System registrations. Facility emission results were very low and below Action Levels and regulatory limits. Annual releases to the air and water were both a very small fraction of regulatory limits, resulting in minimal dose to the public.

All production and possession limits were respected. Transportation of dangerous goods was conducted safely between suppliers, customers and waste vendors without risk to workers, the public or the environment.

This annual compliance monitoring and operational performance report demonstrates that BWXT NEC has successfully met the requirements of the Nuclear Safety and Control Act, Regulations and CNSC Class IB nuclear facility operating licence requirements.