CONFIDENTIAL

NORDION (CANADA) Inc.
CLASS 1B FACILITY

License Number: NSPFOL-11A.01/2025

2018 ANNUAL COMPLIANCE AND OPERATIONAL PERFORMANCE REPORT to the Canadian Nuclear Safety Commission for the period JANUARY to DECEMBER 2018 (Amended August 16, 2019)

Signatures

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ABSTRACT

This Annual Compliance and Operational Performance Report (ACOPR) provides performance and operational information for Nordion's Class 1B Facility. It reports annual performance against the Nuclear Safety and Control (NSC) Act, applicable regulations, relevant safety and operational programs and the license conditions of the Nuclear Processing Facility Operating License issued by the Canadian Nuclear Safety Commission (CNSC) (License NSFPOL-11A.01/2025) and demonstrates that Nordion is operating in a safe and responsible manner.

As per Nordion's license condition on annual reporting, this report contains information on the following:

- The operation and maintenance of the facility
- A summary of facility and equipment performance and changes
- Changes to operating policies and organization
- Occurrences and personnel radiation exposures
- Releases of nuclear substances and hazardous substances from the facility
- Changes to the emergency procedures, changes that affect or may affect the facility's emergency response arrangements, training activities, drill and exercise activities and unplanned events in which the facility's emergency response organization was tested
- The results of the effluent monitoring and personnel radiation exposures of the facility
- The results of environmental monitoring
- A summary of non-radiological health and safety activities, information on minor incidents and lost-time incidents
- A summary of the Public Information Program activities
- The 2019 Environmental, Health and Safety Objectives

The key points of this report are as follows:

- The implementation of measures to ensure compliance with Nordion's Licence Conditions Handbook (LCH).
- All measurable radiation doses received by personnel and the public were within the regulatory limits of 50 mSv/yr for (Nuclear Energy Worker) NEW personnel and 1 mSv/yr for non-NEW personnel and public, and no internal dose levels or limits were exceeded.
- There were no instances in which there was potential to exceed a regulatory limit or to reach or exceed an action level.
- There were no lost time injuries and two (2) medical treatment injuries occurred.
- There were two reportable exceedances of an environmental regulatory limit or action level in 2018 involving non-radiological releases to the sanitary sewer which resulted in by-law limit exceedances. They were identified by Nordion during routine sampling and self-reported to the City of Ottawa (Refer to Section 1.1).

In 2018, Nordion's Class 1B Facility operated within the requirements of the Nuclear Safety and Control (NSC) Act, the applicable regulations and the conditions of the operating license issued by the CNSC with the exception of 12 non-compliances with the NSC Act, the regulations or with Nordion's site license NSPFOL-11A.01/2025. Eight (8) of these instances were reportable to the CNSC (refer to Appendix A).

TABLE OF CONTENTS

GLOSSARY

ACOPR	Annual Compliance and Operational Performance Report
ALARA	As Low As Reasonably Achievable
AMMS	Advanced Maintenance Monitoring System
AMP	Administrative Monetary Penalty
BH	Borehole
BOD	Biochemical Oxygen Demand
CAD	Charcoal Adsorber
CAM	Continuous Air Monitor
CAPA	Corrective Action Preventative Action
CNSC	Canadian Nuclear Safety Commission
COF	Cobalt Operations Facility
[redacted]	
CSA	Canadian Standards Association
DRD	Direct Reading Dosimeter
DRL	Derived Release Limit
EHS	Environment, Health and Safety
EMS	Environmental Management System
EPD	Electronic Personal Dosimeters
eQMS	Electronic Quality Management System
ER	Emergency Response
ERP	Emergency Response Plan
ESDC	Employment and Social Development Canada
FMEA	Failure Modes Effects Analysis
FSAR	Final Safety Analysis Reports
HEPA	High Efficiency Particulate Air
HPGe	High Purity Germanium
HSA	High Specific Activity
IAEA	International Atomic Energy Association
ICP	Incident Command Post
IMS	Incident Management System
KRMF	Kanata Radiopharmaceutical Manufacturing Facility
KOB	Kanata Operations Building
LCH	Licence Conditions Handbook
MDA	Minimum Detectable Activity
NEW	Nuclear Energy Worker
NMPF	Nuclear Medicine Production Facility
NPRMI	Non-production Radioactive Material Inventory
NSC	Nuclear Safety and Control
NVS	Nuclear Ventilation System
PIP	Public Information Program
PIT	Physical Inventory Taking
PIT-E	Physical Inventory Taking – Evaluation
PPE	Personal Protective Equipment
PTNSR	Packaging and Transport of Nuclear Substances Regulations
QA	Quality Assurance
RE	Roy Errington
RP	Radiation Protection
SAHE	Systematic Approach to Hazards Evaluation
SCA	Safety and Control Area
SCBA	Self Contained Breathing Apparatus
SOP	Standard Operating Procedures
SSTS	Sealed Source Tracking System
SSC	Structures, Systems, and Components
TDG	Transportation of Dangerous Goods

TLD	Thermo-luminescent Dosimeter
US DOT	United States Department of Transportation
US NRC	US Nuclear Regulatory Commission
WSIB	Workplace Safety Insurance Board

1. INTRODUCTION

Nordion is a business unit of Sotera Health, a recognized global leader in contract sterilization services for the medical device and pharmaceutical industries. Nordion continues to operate as a stand-alone company and is a major global supplier of radioisotopes used in nuclear medicine for diagnostic and therapeutic purposes, industrial applications, and research and development activities. The Class 1B Facility is comprised of two major production operations, one involving the processing of radioisotopes used in nuclear medicine (Medical Isotopes) and the other involving sealed sources used in cancer therapy and irradiation technologies (Gamma Technologies).

The production operations for Medical Isotopes are housed in the Nuclear Medicine Production Facility (NMPF) portion of the Kanata Operations Building (KOB) and in the Kanata Radiopharmaceutical Manufacturing Facility (KRMF). Production operations for Gamma Technologies are housed in the Cobalt Operations Facility (COF) portion of the KOB.

On July 30, 2018, Sotera Health sold the Medical Isotopes segment of Nordion's business to BWXT Technologies, Inc. (BWXT). With the sale, BWXT became the owner of Nordion's former medical isotope business, including the radiochemical manufacturing operations in Ottawa, Ontario and the isotope production facility in Vancouver, British Columbia. Nordion has retained ownership of the Gamma Technologies operations and of the Class 1B Facility. The transaction also involved the transfer of approximately 150 Nordion employees to BWXT. Nordion and BWXT also signed a long-term lease agreement that allows BWXT to continue operating from the Class 1B Facility located in Kanata, Ontario.

Notwithstanding the sale of the Medical Isotopes segment July 2018, Nordion remains the owner and operator of the Class 1B Facility in Ottawa. Until such time as BWXT obtains an operating license from the CNSC, BWXT acts as a sub-contractor to Nordion for all Medical Isotopes related Class 1B activities under Nordion's Nuclear Facility Processing License (License NSFPOL-11A.01/2025). As such, the sale of the Medical Isotopes segment has no impacts on the 2018 ACOPR for the Class 1B Facility.

A summary of the organizational structure and key environmental, health and safety (EHS) personnel is provided in Section 2.1.5.

Throughout this report, EHS significance is applied to incidents using the following definitions:

Low Risk – A finding or failure that will not result in negative impact to security, employee health and safety, the environment, registrations or licenses.

Medium Risk – A finding or failure that resulted, or could potentially result in a negative impact to security, employee health and safety, the environment, registrations or licenses.

High Risk – An event or occurrence which has a major negative impact, or potential major negative impact on security, employee health and safety, the environment, registrations or licenses.

1.1 Compliance with Other Regulations

During 2018, Nordion reported two exceedances of the City of Ottawa Sewer Use by-law (2003-514) for Biochemical Oxygen Demand (BOD). Nordion continues to work closely with the City of Ottawa to identify potential sources of this parameter.

In September 2018, the sample taken was found to have higher than by-law limits for Nonylphenols. The City of Ottawa indicated they are in the process of reviewing and changing the current by-law limits for nonylphenols. The City of Ottawa had indicated they were not concerned with these releases.

Nordion reports to the Workplace Safety Insurance Board (WSIB) whenever a reportable occupational injury or illness occurs. In 2018, there were three medical treatment injuries reported to WSIB, however one was denied. Therefore there was a total of two reportable medical treatment injuries for Nordion for 2018. There were no lost time incidents in 2018. WSIB may inspect Nordion's Occupational Health and Safety programs at any time; however, no inspections were held in 2018.

In compliance with Part II of the Canadian Labour Code, two disabling injuries were reported to Employment and Social Development Canada (ESDC). One of these reports was related to the claim denied by WSIB. Details of these injuries are provided in Section 2.8.4.

As part of the transportation program, Nordion must remain compliant with not only CNSC regulations and requirements but also those of other regulators, most prominently Transport Canada (Transportation of Dangerous Goods (TDG) regulations), US Department of Transport (US DOT) and US Nuclear Regulatory Commission (US NRC). Nordion reported one non-conformance to Transport Canada in 2018. There were no reported non-conformances with other transport regulations 2018.

There were no non-compliances related to the sealed and unsealed source reporting performed by Nordion to the Competent Authorities in France, Belgium or Switzerland.

1.2 New Licensed Activities

There have been no new licensed activities since the last compliance monitoring report.

1.3 Significant Modifications or Changes to Site or Facility

Significant modifications and repairs that were carried out in 2018 included:

- Upgraded valves and valve operators for the chilled water system

There were no structural changes to designated Active Areas.

1.3.1 Changes to Procedures Related to Operations Safety and Control

In 2018, the following changes were made to procedures related to operational safety and control:

- SE-LIC-001 “Management System for Safety”

  Revised to update the Management System for Safety and Nordion’s management of the medical isotope production facilities during the acquisition by BWXT.

- SE-EHS-009 “Regulatory Reporting of EHS Events”

  Revised to align with the new REGDOC-3.1.2 *“Reporting Requirements Volume 1: Non-Power Reactor Class 1 Nuclear Facilities and Uranium Mines and Mills”*.

- SE-LIC-007 “EHS Committee Approved Limits for Facilities”

  Updated activity limits for Glove-Box 65 and corrected documented activity limits references and reference list.

- SE-LIC-015 “Radioactive Material Inventory”

  Revised to clarify how cycle count listing is generated and to include the methods to reduce the risk of errors during cycle counting. Also updated to include a note that transferred sources are to be moved using a Subinventory transfer if they will remain in their new location for an extended period of time.

- SE-LIC-016 “Management of Safeguarded Material”

  Revised to include required elements of REGDOC-2.13.1, *“Safeguards and Nuclear Material Accountancy”,* and to address CNSC comments and recommendations on SE-LIC-016 and the transition to REGDOC-2.13.1.

- SE-OP-079 “Sealed Source Reporting”

  Document title was changed and revisions made to streamline SE-OP-079 and provide more of an outline or overview of the steps required for sealed source reporting, rather than detailed instructional steps, which are provided in individual departmental working procedures. Also, procedure updated to include new sealed source types being manufactured by Nordion.

- SE-RP-003 “Investigations”

  Updated to align with changes in responsibilities and changes to SE-LIC-001 made due to the acquisition of the medical isotopes segment by BWXT.

- SE-ENV-011 “Operational Control”

  Updated to align with the requirements of ISO 14001:2015 *“Environmental Management Systems”*

- QAP AP-45 “Change Control Procedure”

  Revised to implement a performance indicator for the “Physical Design” Safety and Control Area (SCA), to revise the definitions of “Minor”, “Moderate” and “Major” for the regulatory assessment of EHS agency submissions and to include other regulatory submissions in the definitions in addition to the CNSC.

- QAP AP-30 “Management and Control of Corporate Documents in SmartDoc”

  Revised to add a new configuration in the electronic Quality Management System (eQMS) to establish additional controls for transport package related documents referenced on CNSC-issued Transport Certificates and Special Form Certificates

- SE-HS-009 “Work Permit Authorization Program”

  Updated as continuous improvement of the work permit authorization program to add more clarity to the required processes.

- SE-RP-002 “Emergency Response Plan”

  Revised to define the reporting times for the Emergency Response Organization (ERO) to respond after it has been alerted.

1.4 Operational Challenges

In 2018 the following operational challenges were experienced by Nordion;

- Managing the sale of the Medical Isotope segment to BWXT and the transition to the landlord /tenant relationship with BWXT acting as a contractor within the Class 1B Facility managed by Nordion. In 2018 there were no issues that resulted from the sale and transition with BWXT,
- Increased production and shipments of TheraSphere,
- Ensuring, as Nordion continues to manufacture new types of sealed source products, that internal processes are maintained to ensure the correct set-up and transfer of information required for sealed source reporting, and
- Meeting the internal target for timely closure of CAPAs. Average closure rate of 76% just missing the target of 80%.

2. SAFETY AND CONTROL AREA (SCA)

2.1 Management System

2.1.1 Applicable Activities

The Management System for Safety is applicable to all CNSC licensed activities conducted under the Class 1B nuclear substance and processing facility operating license. Licensed activities include those activities undertaken to operate a nuclear substance processing facility and to service prescribed equipment.

Nordion operates the facility to process nuclear substances for medical purposes, and manufactures sealed sources for medical and industrial applications. Nordion manufactures sealed sources that are installed in prescribed equipment that are either transported to another licensee, or packaged and transported to be installed in prescribed equipment at another location or licensee. In addition, Nordion services its own self-shielded irradiator that is used to support the operations of the facility.

Nordion also services, at the Class 1B nuclear substance and processing facility, prescribed equipment from other licensees and clients for which they have provided procedures to the CNSC.

2.1.2 Management System for Safety Program Effectiveness

The annual management review of the Environmental Management System (EMS) and the Management System for Safety was conducted April 24, 2018 by the EHS Committee.

At this meeting the status of actions from the previous meeting, the Environment, Health & Safety Policy, adequacy of resources, EHS objectives and targets, and changing circumstances are reviewed and recommendations for improvement are made.

Results of the 2018 Annual Review:

1. 9 of 13 outstanding actions from the previous meetings were closed and one was cancelled. The remaining items involved adding further information regarding complaints to the EHS Performance Report, implementing a metric for the Physical Design Safety and Control Area and investigating feasibility of a program change to select root cause code when recording Hazard Identifications. These actions have since been closed. The action that was cancelled involved implementing EHS review of Instrument Deviation reports; however, upon further review, it was determined this was not necessary as there have been no instrument deviations identified in the past three years as having an EHS impact.
2. The Environment, Health and Safety Policy was reviewed and it was determined that the policy is acceptable and no changes were required.
3. The 2017 EHS Performance Report was reviewed and discussed. This report assesses the performance related to the 14 Safety and Control Areas over the past three years where this information was available. Any trends identified are addressed and tracked via a Nordion non-conformance system (ex. CAPA, Velocity EHS Action Items).
4. The 2018 Environmental Objectives and Targets were reviewed by the Committee. At the time, the environmental objectives and targets were on track. The objective and target to potentially reduce particulate matter air emissions from the glass blowing process was on hold due to reduced usage of the glass blowing facility. The EHS Committee agreed that this objective and target remain on hold.
5. Resource requirements for the EMS and Management System for Safety were discussed. The EHS Committee agreed that the programs are resourced adequately to ensure that critical issues are being addressed. Financial and specialized skills resources were felt to be adequate.

6. Three actions resulted from the meeting and there were two recommendations for improving the EHS Performance Report.

The Committee concluded that they were satisfied with the effectiveness of the EMS and the Management System for Safety.

2.1.3 Internal and External Audits

As part of the Management System for Safety and the EMS, Nordion annually conducts internal audits to identify and correct environmental, health and safety related issues. In 2018, Nordion conducted a total of 16 internal EHS audits. These audits included an audit of production areas and supporting functions as well as policy and program audits. In addition, as part of its inspection program, Nordion conducted a total of 12 health and safety inspections, and 16 environmental and fire inspections.

In 2018, there were 6 audits of Nordion by external parties, and 1 external audit conducted by Nordion of a supplier. Out of a total of 17 EHS related Corrective Actions/Preventative Actions (CAPAs) initiated in 2018, 6 CAPAs were a result of minor findings from internal audits and 1 CAPAs were a result of external audits of Nordion. Another 1 CAPA was initiated in early 2019 to address a finding from an internal audit conducted in 2018 and another 1 CAPA was initiated in early 2019 to address a finding from one external audit that was conducted late in 2018.The remaining CAPAs resulted from investigations or were issued to address observed deficiencies. A list of the internal audits and associated EHS CAPAs and other corrective actions are provided and tabulated in Appendix B.

2.1.3.1 Internal Audits

The following internal audits were conducted in 2018:

1. Process and EMS Audit of the Waste Management Program
2. EMS Program
3. Work Planning and Control
4. Safety Culture
5. Transportation Program and Quality Plan
6. Environmental Protection Program
7. Safeguards and Non-proliferation and Export/Import Controls and Sanctions Program
8. EHS Internal Audit Program
9. Audit of a Supplier
10. Supply Chain and Purchasing Requirements, Operational Control and Supplier Audit Program
11. Non-production Radioactive Material Inventory (NPRMI)
12. Documentation of Management System; Information, Documents, Records, Control of Documents and Control of Records
13. Safeguarded Material Physical Inventory Taking (PIT)
14. Non-Class 7 Dangerous Goods Program
15. Sealed Source Export Controls
16. Process Safety Audit for Removing TheraSphere Orders – Reducing Doses to Monitors

Refer to Appendix B for a summary of the findings associated with the internal audits conducted in 2018.

2.1.3.2 External Audits of Nordion

The following external audits of Nordion were conducted in 2018:

Date	Description	Result
February 27 to March 1, 2018	The CNSC conducted an inspection of Nordion's Management System	Three recommendations
May 24-26, 2018	A third party conducted a certification assessment audit against the requirements from the ISO 14001:2015 standard (Environmental Management Systems)	Eight opportunities for improvement.
June 15, 2018	The CNSC conducted an inspection of Nordion's records pertaining to the import and export of controlled nuclear substances, equipment and information	Two action notices and one recommendation
August 15-17, 2018	The US Nuclear Regulatory Commission (US NRC) conducted an inspection of Nordion's QA Approval Program.	Three observations
November 21 -23, 2018	The CNSC conducted a General Inspection	One directive, three action notices and six recommendations
November 21, 2018	Transport Canada conducted a Security Inspection	Two observations

2.1.3.3 External Audits Conducted by Nordion

Nordion conducted one EHS audit of a supplier in 2018. There was one observation and one opportunity for improvement identified during this audit.

2.1.4 Management System for Safety Program Improvements

There were no specific improvements to the Management System for Safety in 2018.

Revisions made to the Radiation Protection Program, Conventional Health and Safety Program, and the Environmental Protection Program are as discussed in Sections 2.7.8, 2.8.3 and 2.9.6, respectively.

In 2018 Nordion implemented a behavioural based safety awareness program to encourage safety discussions within the organization and to encourage employees to report near misses and hazard identifications.

2.1.5 Summary of Organizational Structure and Key EHS Personnel

Nordion is a business unit of Sotera Health, but operates as a stand-alone company. Historically, Nordion has been comprised of two business units; one involving the processing of radioisotopes used in nuclear medicine (the Medical Isotopes Business Unit) and the other involving production of sealed sources used in cancer therapy and irradiation technologies (the Gamma Technologies Business Unit).

On July 30, 2018, the Medical Isotopes segment of Nordion was sold to BWXT. Nordion continues to operate and be responsible for the Class 1B Facility and compliance with the facility license. [redacted]

Nordion - Gamma Technologies – EHS Compliance

- Vice President, BWXT Compliance (modified position resulting from the sale of Medical Isotopes to BWXT)
- Director, Regulatory & EHS (modified position resulting from the sale of Medical Isotopes to BWXT)
- Administrative Assistant
- Manager, Corporate Security
- Contract Security Supervisor
- Contract Security Officers (14)
- Manager, Radiation Safety & Nuclear Transportation (modified position resulting from the sale of Medical Isotopes to BWXT)
- Senior EHS Compliance Specialist
- Senior Licensing Coordinator
- EHS Compliance Specialist
- Facility Nuclear Compliance & Training Specialist
- Manager, EHS and Documents & Corporate Records
- Document Management & QA Support Coordinator (modified position resulting from the sale of Medical Isotopes to BWXT)
- Senior Radiation Surveyor
- Radiation Surveyor

BWXT - Medical Isotopes – EHS Compliance

- Senior Manager, Nuclear Regulatory, EHS
- EHS Assistant
- EHS Compliance Specialist
- Occupational Health Specialist
- Senior Manager, Radiation Safety
- Senior Radiation Surveyor
- Radiation Surveyor (2)
- Senior Radiation & Contamination Monitor (3)
- Radiation and Contamination Monitor (1)
- Decontamination Helper/Operator (3)

2.1.6 Changes to the Organizational Structure and Roles and Responsibilities of Key Personnel

- In July 2018, the Senior Manager, Transportation Licensing & Gamma Radiation Safety assumed the role of Director, Regulatory & EHS,
- In July 2018, the Vice-President, QA Regulatory & EHS Compliance assumed the role of Vice President, BWXT Compliance acting as liaison between Nordion and BWXT and provided regulatory and EHS compliance oversight of BWXT subcontractor activities in the Class 1B facility,
- In July 2018, the Nuclear Transportation Specialist assumed the role of Manager Radiation Safety & Nuclear Transportation,
- In July 2018, the Documentation Specialist assumed the role of Document Management & QA Support Coordinator.

2.2 Human Performance Management

2.2.1 Overall Performance of Human Performance Management

Nordion's Change Control procedure, QAP AP-45, requires that training requirements be assessed and documented for procedural changes. These requirements include assessment of the roles assigned to the document, the level of training to be completed and the training completion time. Most controlled documents require "read and understand" training regardless of the impact of changes. Change Leaders are required to consult with relevant managers and record whether this read and understand training needs to be supplemented by instructor-led classroom training and/or On-The-Job-Training (OJT). For changes assessed to have a high or medium risk safety impact, a "Training Needs Analysis" must be completed and EHS must review and approve of the final training decision.

2.2.1.1 Training Attendance Rate

Nordion designed and maintains a variety of radiation safety training courses. New employees who are not classified as NEWs receive a basic course on Health, Safety and Environment, Level I, which provides information on the facilities, emergency response procedures and alarms, and basic procedures to follow for safety in the workplace. Nuclear Energy Workers receive a NEW Indoctrination Course. To be authorized to enter the Active Area unescorted, the employee must complete and pass a written test, as evidence of understanding the principles of radiation protection and Nordion safe work practices. NEW retraining and retesting are conducted on a three year frequency. In addition, NEWs are provided with a half day Radiation Instrumentation Workshop, dealing specifically with the selection and use of radiation survey and contamination meters for the Active Area. In 2018, there were no radiation safety incidents nor were there any anomalous Thermo-Luminescent Dosimeter (TLD) readings attributed to employee radiation safety practices. This indicates that the radiation safety training was effective.

Supplementary training programs are provided to all personnel working on behalf of Nordion depending on the nature of the job and the requirements specified by their manager. These programs include, but are not limited to, such topics as "working with radioiodines", emergency response awareness, care and use of respirators, material handling training, and working safely with fume-hoods.

Employees who transport, handle, or offer dangerous goods for transport are trained in the TDG requirements. The training program includes a one day classroom training course that is required once on employment or upon job change. Retraining is conducted on a 2-year frequency and is accomplished through self-study. The self-study program is separated into three levels.

Employees are required to complete the self-study refresher training level that is appropriate for their job function. For each training course, participants must complete and pass a written test, as evidence of understanding the course contents.

A summary of the key training programs is provided in Table 1.

In 2018, the number of scheduled participants that required safety training was 560, and by the end of the year, 542 of the scheduled participants completed the training, which included refresher training. Therefore, the attendance completion rate in 2018 was 97%. The eighteen (18) courses not completed represent two employees being on extended leave and employees who completed the required training courses in January 2019.

Table 1
2018 Safety Training Programs

Program	Duration	# of Participants Requiring Training in 2018	# of Participants who Completed Training in 2018	# Participants with Overdue Refresher Training at the End of 2018
Nuclear Energy Worker (NEW) Indoctrination[3]	4 Hours	11	11	0
NEW Refresher[3]	Self Study	71	70	1[1]
Radiation Instrumentation Workshop[3]	3 Hours	64	63	1[1]
Radiation Safety Review for Operators[3]	Half Day	16	14	2[2]
Radioiodine Handling[3]	2 Hours	10	10	0
Transport of Dangerous Goods Level I[3]	Self Study	3	3	0
Transport of Dangerous Goods Level II[3]	Self Study	15	15	0
Transport of Dangerous Goods Level III[3]	Self Study	32	30	2[2]
TDG for Contractors[3]	Full Day	42	42	0
Working with BETA[3]	1 Hour	40	38	2[1]
Crane	Half Day	35	32	1[2] and 2[1]
Pallet	Half Day	12	12	0
Forklift	Half Day	17	16	1[2]
Contractor Radiation Safety Protection Training[3]	Half Day	3	3	0
Contractor Radiation Safety Protection Refresher[3]	2 Hours	29	26	3[2]
Contractor EHS Training Level I[3]	2 Hours	33	33	0
HEGS Safety Training	2 Hours	0	0	0
In-Depth Security Awareness[3]	2 Hours	8	6	2[2]
Emergency Response Part 1[3]	2 Hours	24	23	1[1]
Emergency Response Part 2[3]	2 Hours	19	19	0
Emergency Response Part 3[3]	2 Hours	2	2	0
Emergency Response: Security[3]	1 Hour	15	15	0
Emergency Response: Site Security Volunteer[3]	1 Hour	0	0	0
Emergency Response: Monitors[3]	1 Hour	0	0	0
SCBA Part 1[3] & 2[3]	1 Hour	59	59	0
TOTAL		**560**	**542**	**18**

[1] On extended leave
[2] Refresher training completed in January 2019
[3] Key EHS course

2.2.2 Evaluation of Training Effectiveness

2.2.2.1 Trainee Reaction

Trainee reaction is the degree to which participants find the training favourable, engaging and relevant to their jobs. These three components are evaluated by analyzing data collected through the completion of training evaluation forms for all internally developed key EHS training courses and delivered by EHS classroom instructors. The data is analyzed so that corrective actions can be taken, if necessary, to improve content and delivery. The degree to which trainees find the training favourable is evaluated by analyzing the overall training assessment rating for each course. Overall training is assessed as one of five options: Excellent, Very Good, Good, Poor or Very Poor. The training evaluation form allows the trainee to select which aspects related to training engagement and relevance they perceived as strengths or weaknesses. In addition, a review of the optional comments section is completed to identify any issues that would contribute to trainees discomfort and distraction that could have impacted employee engagement (such as room temperature, catering, lighting etc.).

For 2018:

- 100% of courses had an overall rating of good, very good or excellent. 0% of courses had an overall rating of poor or very poor. Therefore, overall trainee satisfaction is high.
- Training courses were perceived by trainees as engaging and relevant and trainees felt participation was encouraged.

2.2.2.2 Trainee Learning

Trainee learning is the degree to which trainees acquire the intended knowledge and skills based on their participation in the training. Learning is evaluated by the pass rate of tests written for key EHS training courses.

For 2018, 100% of trainees passed the assessment test for all key EHS training courses and there were no rescheduled tests due to failed attempts.

2.2.2.3 Training Results

Training results is the degree to which targeted outcomes occur as a result of the training. The effectiveness of training results are measured by the EHS significance (high, medium, low) and the frequency of unplanned events documented through processes such as the deviation process, the non-conformance process, investigations, and customer complaints where the root cause was determined to be related to human error or training. The targeted outcome is zero high risk unplanned events related to human error or training as well as no trend for recurrence (three or more) of the same unplanned event with the same human error or training root cause.

For 2018:

- There were no unplanned events in 2018 for which the root cause was determined to be related to human error or training

2.2.3 Confirmation of Sufficient Number of Qualified Workers

In 2018, Nordion ensured that at least the minimum number of responsible personnel was available to provide safety during overnight operations and during emergency situations. There were no changes to risk levels or available personnel.

Nordion Security is on site at all times. Radiation Surveyors are always on site when production involving radioactive materials is occurring. Nordion has key emergency response, Facilities and Production Managers on-call at all times. The Incident Manager, or the person in charge of the response, can initiate a call-in of both on-call and regular emergency response personnel. Currently there are approximately 60 Fire Wardens and Marshalls and over 80 other emergency response personnel.

Nordion routinely assesses the availability of qualified staff as part of the Emergency Response Program and through drills and exercises. Nordion tests its emergency call list annually and the results have demonstrated year over year that within one hour of the onset of an emergency, adequate emergency response personnel and at least one representative from each of the key emergency response groups would be available on-site (refer to Section 2.10).

There is a minimum of one and normally two Health Physicists on call who are qualified to establish and direct radiation safety activities to protect personnel, the public, and the environment from radiation hazards, and to develop safe work methods and procedures.

Nordion maintains a formal on-call roster that includes the Manager, Corporate Security (or designate) and the Director, Regulatory/EHS (or designate), who is also a qualified Health Physicist.

2.3 Operating Performance

2.3.1 Effectiveness in Carrying Out Licensed Activities

Licensed activities were carried out according to Nordion's programs, policies and procedures resulting in no significant unplanned events.

Nordion's programs that are in place for auditing and capturing non-conformances continue to identify issues in areas that require corrective actions. These processes functioned as expected.

The 2018 EHS program objectives are shown in Table 2. All of the EHS objectives listed in Table 2 were met in 2018 with the exception of Non-Radiological Releases, and timely closure of EHS CAPAs. The number of Medical Treatment Incidents (two) met the target of ≤6 and the number of Lost Time Incidents (none) met the target of zero. Further details of these incidents can be found in Section 2.8.4.

In 2018, a number of the hazardous occurrences involved repetitive strain injuries from performing routine work as well as slipping and falling. Nordion continues to provide increased focus on open safety discussions, ergonomic assessments, proper mechanics training, and awareness to Operations groups. Managers engage in regular safety discussions with their teams and continue to emphasize the importance of taking regular breaks to rest muscles and joints and rotating duties, as required, in an effort to avoid repetitive strain injuries.

Radioactive materials emissions (0.0038% of the Derived Release Limit (DRL) or 0.13% if using the values in the January 2019 version of Nordion's LCH) continue to be well below the target of ≤ 5% DRL, but Non-Radiological releases were above the target of 0 for a total of two in 2018. The details of these releases are found in Section 1.1.

The target of 80% of generated CAPAs closed within 1 year was not met in 2018. The average CAPA closure rate for 2018 was 76%, with the monthly closure rate ranging from 71% to 80% in 2018.

The remainder of the EHS Targets and Objectives were met for 2018. Nordion diverted 74.3% of waste from landfills, the maximum employee dose rates well under the target of ≤ 7.5 mSv/yr and Nordion completed a supplier audit by the end of 2018.

A system is in place to ensure that the manager self-assessment performance reviews are completed twice a year. The self-assessment process is audited annually. Deviations, Change Forms and complaints are reviewed yearly at the Annual Joint Environmental Management System and Management System, for Safety review.

Table 2
2018 EHS Program Objectives and Results

Objective	Measure/Target *	Result
Manage CAPAs and ensure timely closure of CAPAs	• Close out aging CAPAs within your areas • Target 80% of generated CAPAs within your areas are closed (Actions complete, excluding CAPA effectiveness/verification) within 1 year	• 76% (average for 2018)
Minimize the number and extent of occupational injuries, environmental and radiation incidents.	• The number of Medical Treatment Incidents ≤ 6 • Lost time Incidents = 0	• The number of Medical Treatment Incidents =2 • Lost time Incidents = 0
Minimize the use and release of hazardous materials to the environment.	• Radioactive materials emissions to < 4.0% of the Derived Release Limits (DRL) • Zero reportable releases of radioactive and non-radioactive hazardous materials to the environment (sanitary sewer, air, etc.)	• 0.0038% of the DRL or 0.13% if using the values in the January 2019 version of Nordion's LCH • Two reportable releases of non-radioactive hazardous materials to the environment (sanitary sewer)
Maintain radiation doses to employees as per ALARA principle.	• Maximum employee dose rate ≤ 7.5 mSv/yr	• Maximum employee dose rate was 4.23 mSv/yr.
Maintain a healthy safety culture.	• It is unacceptable to take risks in order to get the job done. Personal safety is every employee's highest responsibility. • Provide/participate in EHS Safety Talks during team meetings. • Ensure EHS information and concerns are discussed regularly at team meetings. • Ensure near-misses, hazard identifications, hazardous conditions, and workplace injuries are reported to your Manager, so that they are entered into VelocityEHS in a timely manner and appropriate corrective action(s) are taken. • Report any suspected symptoms (e.g. ergonomic or repetitive strain) to your Manager immediately or identify potential physical concerns before	• Targets established to promote safety culture only (not measured).

	they become injuries. • Wear all applicable personal protective equipment (PPE). • Submit all dosimeter(s) and rings for monitoring on time. • Follow Nordion values, EHS policies, training and procedures and coach co-workers who are observed to be working unsafely.	

*Average taken over the year.

2.3.2 Effectiveness in Implementing Operational Controls and Improving Safety Culture

EHS operational controls are documented in a specific series of documents (SE-OP and SE-HS series) and safety critical steps are added into routine production procedures. These procedures are routinely updated using Nordion's change control process when safety improvements are identified or during the document's scheduled periodic review.

In addition, in 2018 Nordion implemented a behavioural based safety awareness program to encourage safety discussions within the organization and to encourage employees to report near misses and hazard identifications.

2.3.3 Reportable Events

A list of reportable incidents, their causes and corrective actions is provided in Appendix A.

On July 23, 2018, Nordion made a voluntary disclosure to the CNSC of a non-compliance relating to a failure to provide a Pre-Shipment Notification (PSN) as required by an export license for a shipment that exported July 21, 2018. In response, the CNSC requested additional information regarding Nordion's corrective actions on November 19, 2018, which Nordion subsequently provided to the CNSC.

2.3.4 Sealed Source Tracking

Nordion has a process for reporting the transfer, receipt, export or import of sealed sources if the activity exceeds the threshold limits and within the specified timeframes as detailed in Nordion's LCH.

2.3.4.1 Sealed Source Tracking Activities

Activities which took place in 2018 included the following:

- Assignment of corrective actions and continuous improvement actions for the sealed source reporting process review. 40% of actions have been completed. The completion of 30% of the actions is contingent on the transition from the existing software platform to a more reliable platform. Nordion continues to work on the improvements to the sealed source reporting process.

2.3.4.2 Sealed Source Tracking Improvements

In 2018, Nordion made the following improvements to the Sealed Source Tracking process:

- Implemented monitoring of sealed source receipts/imports and an electronic alert message to advise when sources are received into the building, but not yet entered into the tracking system,

- Introduced verification steps for the following manual entries: updating shipment date in tracking system by Forecasting & Planning Department, manual reporting of amendments to the Export License number, and manual revisions of the bulk file,
- Revised process for review of domestic site licenses to ensure the most recent radioactive material licenses are reported,
- Simplified process for routine waste shipments by changing responsible department for revising shipment dates in the tracking system,
- Streamlined the sealed source reporting procedure and developed a Job Aid for the SSTS Bulk Upload to the CNSC web portal.

2.3.5 Non-production Sealed and Unsealed Source Inventory

The inventory of non-production sealed and unsealed sources in provided in Appendix C.

2.3.6 Annual Production

Activities relating to the procurement, possession, processing and shipping of radioactive materials are conducted under Nuclear Substance Processing Facility Operating Licence, NSPFOL-11A.01/2025.

[redacted]

[redacted]

2.4 Safety Analysis

2.4.1 Validation and Maintenance of Overall Safety Case

[redacted]

2.4.2 Modifications and Changes to Facility that May Affect Safety Analysis

In 2018 there were no modifications that affected the facility's safety analysis.

2.5 Physical Design

In 2018, Nordion did not make any modifications to the physical design of the facility. The FSAR review process identifies areas of continuous improvement to ensure that the overall design basis for the facility is both validated and maintained. In 2018, there were no significant design issues identified through these reviews. Overall, Nordion's facility design has been maintained.

2.6 Fitness for Service

2.6.1 Effectiveness of Maintenance and Testing Programs

Nordion has a system in place for the maintenance and control of equipment that supports the facility. The program provides guidelines for the documentation and maintenance of the system to ensure responsibilities are identified, filing systems are maintained, and all necessary controls are in place for facility calibration and maintenance.

Nordion uses an Advanced Maintenance Management System (AMMS) to control Nordion's calibration and maintenance activities. The AMMS is used to catalogue all equipment requiring calibration or maintenance, record equipment information, schedule maintenance, and issue work orders.

Detailed processes and rules governing the preventative maintenance program are available in Facilities Master Plan documents.

The AMMS provides the necessary oversight to ensure equipment integrity. All equipment inspections and preventative maintenance schedules are dictated by the use of the AMMS.

Unscheduled repairs are reviewed on an annual basis by Facilities to assess for trends in equipment failures. Recurring failures are reviewed by EHS Compliance for the determination of any additional corrective actions.

This continues to prove effective as during 2018, there were no major equipment failures.

2.6.2 Effectiveness of Aging Management Strategies

Every year a detailed review is carried out at the Senior Management level to discuss aging equipment at the site. This annual business plan review takes into account three criteria: safety of the facility, regulatory requirements and site improvements. When approved, the work identified during the aging equipment review is executed as a project. Projects are prioritized into three categories and funds are allocated as required. This aging equipment review process, because of the link to the Senior Management team and Finance, has been effective in keeping the Nordion facility up-to-date with current technology.

2.7 Radiation Protection

2.7.1 Dose Control Data

2.7.1.1 Occupational External Dosimetry

Tables 6 and 7 provide dosimetry data for employees grouped in various ranges of exposure. Data on the minimum, maximum and average doses for all employees are shown in Tables 8, 9 and 10. In 2018 there were 137 Active Area personnel monitored and 111 non-Active Area personnel, as shown in these tables. Of the 111 non-Active Area personnel, 18 support industrial irradiators (containing Co-60) at customer sites. These individuals are included in the Class 1B licence dosimetry as they may also receive dose from work at KOB during the dosimetry year.

Table 6
Personnel Dosimetry

Number of Employees														
Dose Range (mSv)	Whole Body					Skin					Eye			
	2016	2017	2018	2019	2020	2016	2017	2018	2019	2020	2017	2018	2019	2020
0	12	39	60			11	42	69			39	62		
0.01-1.00	218	192	151			208	187	142			192	149		
1.01-5.00	37	31	37			47	33	37			31	37		
5.01 - 10.00	0	1	0			1	1	0			1	0		
10.01 - 20.00	0	0	0			0	0	0			0	0		
>20.00	0	0	0			0	0	0			0	0		

Number of Employees										
Dose Range (mSv)	Right Hand					Left Hand				
	2016	2017	2018	2019	2020	2016	2017	2018	2019	2020
0	59	94	44			52	88	44		
0.01-1.00	44	16	35			47	18	34		
1.01-5.00	22	13	35			25	16	35		
5.01 - 10.00	3	1	2			3	2	3		
10.01 - 20.00	0	1	0			0	1	0		
>20.00	0	0	0			0	0	0		

Table 7
Breakdown of Whole Body Radiation Doses 5.0 to < 20 mSv

Year	Dose Range			
	5<8 mSv	8<10mSv	10<15 mSv	15<20 mSv
2014	2	0	0	0
2015	1	0	0	0
2016	0	0	0	0
2017	1	0	0	0
2018	0	0	0	0

Table 8
Average, Maximum and Minimum Worker Effective Doses (mSv)

		2014	2015	2016	2017	2018	CNSC Regulatory Limit
NEWs	**Average**	0.44	0.39	0.49	0.42	0.45	**n/a**
	Average*	0.51	0.43	0.51	0.49	0.60	
	Maximum	6.03	5.24	4.9	5.49	4.23	**50/yr; 100/5yr**
	Minimum	0	0	0	0	0	**n/a**
	Number of NEWs Monitored	269	264	267	263	248	
Contractors	**Average**	0.09	0.03	0.07	0.02	0.05	**n/a**
	Average*	0.09	0.03	0.08	0.04	0.06	
	Maximum	0.31	0.13	0.36	0.2	0.25	**1/yr**
	Minimum	0	0	0	0	0	**n/a**
	Number of Contractors Monitored	52	46	53	55	45	

***** This average is calculated excluding zero dose values.

Table 9
Average, Maximum and Minimum Worker Skin Exposure Doses (mSv)

		2014	2015	2016	2017	2018	CNSC Regulatory Limit
NEWs	**Average**	0.46	0.42	0.59	0.42	0.45	**n/a**
	Maximum	6.11	5.21	5.20	5.52	4.26	**500/yr**
	Minimum	0	0	0	0	0	**n/a**
	Number of NEWs Monitored	269	264	267	263	248	
Contractors	**Average**	0.08	0.03	0.07	0.02	0.05	**n/a**
	Maximum	0.31	0.12	0.39	0.18	0.218	**50/yr**
	Minimum	0	0	0	0	0	**n/a**
	Number of Contractors Monitored	52	46	53	55	45	

Table 10
Minimum, Maximum and Average Worker Extremity Doses (mSv)

		2014	2015	2016	2017	2018	CNSC Regulatory Limit
NEWs	**Average**	0.73	0.46	0.79	0.53	0.96	**n/a**
	Maximum	9.5	9.3	8.3	16.4	9.08	**500/yr**
	Minimum	0	0	0	0	0	**n/a**
	Number of NEWs Monitored	135	137	128	125	116	

Table 8 shows a decrease in maximum effective dose to NEWs in 2018 compared to 2017. Contractor dosimeters and doses continue to be well managed and controlled. It is worthwhile noting that the five highest doses to non-Active Area personnel involve employees who travel to customer sites with their Nordion dosimeters to work on installing Co-60 in Industrial Irradiators. These doses were 1.35 – 2.06 mSv. The next highest dose to a Nordion non-Active Area worker was 0.83 mSv. The workers that install Co-60 in off-site irradiators are included in the breakdown for effective, extremity and skin dose. One set of dosimetry data is used for those individuals working under both the Class IB processing facilities license and Nordion's Class II servicing licence.

[redacted]

Highest doses	Job position	Effective dose (mSv)
[redacted]		

Table 9 shows similar results to Table 8 for skin exposure in 2018. In Appendix D similar values for dose to the lens of the eye are observed.

[redacted]

2.7.1.2 Internal Occupational Radiation Doses

Nordion's bioassay program includes thyroid monitoring on a scheduled routine basis and whole body counting or urine analysis if air/contamination monitoring indicates it is needed.

During 2018, there were no cases of employees exceeding Nordion's administrative investigation level of 1000 Bq I-125 or I-131. [redacted] Monitoring continues for Bulk QC, Waste/Shipping, Monitoring/ Decontamination and Tech Support personnel. Due to the reduction in number of personnel monitored, thyroid attendance is no longer used as a useful leading indicator for safety culture.

Whole body counting was not performed in 2018. No urinalysis was required in 2018. In 2018 no internal doses were assigned as no radioactivity was detected during thyroid assay.

2.7.2 Significance of Results for the Dose Control Data

A further breakdown of dose trends by group, for the last five years is provided in Appendix E (Figures E.1 to E.19). The graphical trends show group average, individual maximum and group cumulative doses. This trend data is reviewed yearly at the EHS Committee and the Annual Joint Environmental Management System and Management System for Safety Review. There are a few general observations in the trend data: Maximum individual and average doses remain [redacted]

[redacted]

Maximum doses in the non-active area personnel are from the subgroup of seven Co-60 installers, whose doses are also accounted for in the Class II servicing licence. [redacted]

Table 11
Analysis of Radiation Doses and Trends

[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

2.7.3 Dose to the Public

Two sets of DRL values, which are listed in Table 16 in Section 2.9.1.1 and in the LCH, are used to calculate the dose to the public. Refer to Section 2.9.1.1 for further information. Table 12 shows the doses to the public from 2014 - 2018.

Table 12
Dose to Public

Year	(mSv)
2014	0.010
2015	0.0057
2016	0.0021
2017	0.000052
2018	0.000067

2.7.4 Contamination Control Data

The contamination control program for the Active Area includes routine sampling and monitoring on a daily basis of the floors, benches, fume-hoods, glove-boxes, support/service areas, and on a weekly basis, change-rooms and inactive floors. Regular sampling, by wipe testing, of the corridors and office areas is conducted several times daily to ensure areas are maintained contamination free and, should contamination be found, to decontaminate immediately to the levels specified in the decontamination procedure. In addition, equipment and personnel leaving the Active Area is monitored for contamination.

During 2018 operations, there were 18 instances where contamination was found and subsequently contained within the Active Area. Of the 18 contamination incidents, nine were related to contamination found on clothing, six to contamination found in limited areas of the facility (i.e. floors or other structures and equipment), two where contamination found on clothing and areas of the facility, and one to contamination found directly on personnel. No increased dose to personnel was received as a result of these incidents.

The distribution of contamination incidents from 2014 to 2018 is shown in Table 13 and Table 14 and illustrated in Figure 1.

The number of contamination events in 2018 was less than in each of 2016, 2015 and 2014, but slightly higher than the number in 2017. There is no trend in the contamination incidents by month.

[redacted] The number of contamination events for "other" isotopes in Table 14 has increased over previous years. These "other" isotopes primarily correspond to various waste isotopes found that related to the [redacted]

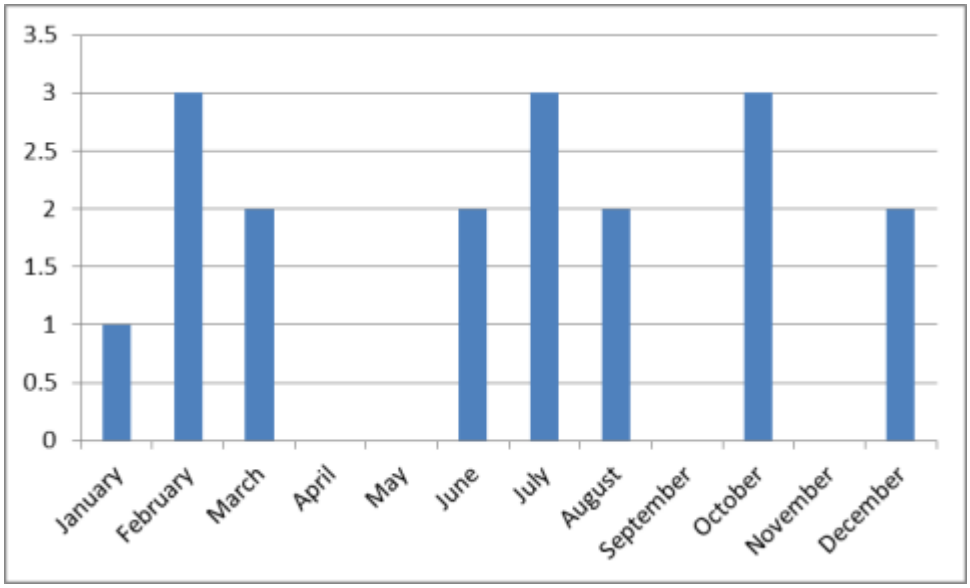
Table 13
Contamination Incidents by Contamination Level

Year	Not recorded	<500 cpm	>500 cpm, <2,000 cpm	>2,000 cpm, <10,000 cpm	> 10,000 cpm, < 50,000 cpm	>50,000 cpm	Annual Total
2014	1	2	16	12	12	4	47
2015	1	2	15	12	6	7	43
2016	0	2	10	8	4	2	26
2017	0	1	4	6	1	2	14
2018	0	5	4	6	3	0	18

Table 14
Contamination Incidents by Radionuclide

Contamination Radionuclide	2014	2015	2016	2017	2018
Not recorded/unknown	1	0	0	2	1
C-14	2	1	0	0	0
C-60	12	12	6	4	4
I-125	3	1	2	0	0
I-131	4	5	6	0	1
Mo-99	13	11	6	0	0
Y-90	7	5	0	2	8
Ir-192	0	1	1	1	0
Xe-133	2	4	0	0	0
Sr-82	1	0	0	0	0
Radon	0	2	1	0	0
Other	2	1	4	5	4
Total	47	43	26	14	18

Figure 1: Contamination Incidents by Month in 2018



2.7.5 Facility Radiological Conditions

The radiation survey program involves radiation measurements within the Active Area, and on the perimeter and exterior of the KOB. Within the Active Area, radiation surveys are generally conducted on a daily basis, throughout all the labs and rooms. Areas where radiation fields are above 2.5 mrem/hr (0.025 mSv/hr) are posted with radiation warning signs, indicating the radiation fields. In addition, surveys are conducted at employee work areas, at cells, glove-boxes, and fume-hoods, during production and test operations, to ensure radiation fields during processing are within acceptable levels. Special surveys are conducted on new processes/equipment to provide information on the safety performance of new operations. Detailed surveys are conducted on each of the Cobalt Operations cells every three years, to check for integrity of the cells and ensure radiation levels are within acceptable levels.

On a monthly basis, radiation surveys have been conducted on the perimeter of the Active Areas, and within the Inactive Office Areas. The monthly survey also includes measurement of radiation fields outside the KOB to ensure conditions have not changed in the operations that may impact the environment/exterior exposure. All the monthly surveys were conducted in 2018.

Breathing air was monitored at 12 Continuous Air Monitor (CAM) stations and at over 50 locations with 24 hour air filters. In addition to having the capability of alarming locally, CAMs are monitored and logged at the Surveyor's control panel and on the building monitoring system. The 24 hour air filters are measured at the end of the day shift on a daily basis.

For work known to have the possibility of creating radioactive contamination of the breathing air, a zone is demarcated and signage is posted requiring respirators to be worn. Respirator requirements are removed only once air monitoring measurements are below the required levels. In 2018, all breathing air sampling was performed in accordance with procedures and results indicated that processes were in control. Facility radiological conditions were very stable and routine in 2018. There were no fluctuations in 2018 radiological conditions beyond the routine movement of containers through the facility when required. Contamination incidents are discussed in Section 2.7.4.

2.7.6 Exceeding Regulatory Limits or Action Levels

In 2018, there were no exceedances of either regulatory limits or actions limits.

2.7.7 Radiation Protection Program Effectiveness

The Radiation Protection (RP) Program is reviewed by conducting process audits and process safety audits. Data and performance of the RP Program is also reviewed regularly at EHS Committee meetings. The RP Protection program continued to operate effectively in 2018.

2.7.8 Radiation Protection Program Improvements

Improvements to the RP Program in 2018 included the following:

Reduction in extremity doses ALARA to Medical Isotope Monitors as studied and documented in the Process Safety Audit for Y-90 Packaging.

2.7.9 Radiation Protection Program Performance

The objectives, goals and targets of the RP Program are shown in Table 2 of Section 2.3.1. The targets average and maximum NEW dose and environmental releases were met in 2018. These targets are tracked as key performance indicators at EHS Committee meetings and in Monthly Operational reports. The targets are reviewed yearly at the Annual Joint Environmental Management System and Management System for Safety Review. Refer to Section 3.2 Table 24 for a summary of the initiatives and targets for the upcoming year.

2.7.10 Continuous Improvements under ALARA Performance

ALARA objectives and performance is reviewed at EHS Committee meetings and all activities in the ALARA program are outlined in Nordion's internal procedure "Keeping Radiation Exposures and Doses as Low as Reasonably Achievable" (SE-RP-002). In addition to the reduction in extremity doses to Medical Isotope Monitors, which was documented in the process Safety Audit, an ALARA study was performed for four months documenting and analyzing body dose during Y-90 packaging to Quality Control and Production Technicians. This study raised awareness of dose rates from lead pots and packages, but no further improvements were identified. Performance is measured against targets and demonstrated in Table 2 of Section 2.3.1.

2.7.11 Radiation Devices and Instruments Performance

Performance of the following equipment, alarms and monitoring devices is checked at various frequencies throughout the year. Test results are indicated to be satisfactory if the tested item functioned within acceptable parameters.

2.7.11.1 Ventilation

Duplex fan tests are conducted every 6 months. This involves testing of more than 100 fans which form part of the Nuclear Ventilation System (NVS). During 2018, all High Efficiency Particulate Air (HEPA) and CAD filters were tested at the required frequency. CAD filters were tested once, which meets the minimum testing frequency of once annually.

Table 15 details the results of the NVS Filter testing and replacement. The filters summarized in Table 15 are credited with mitigating releases in Nordion's Safety Analysis reports.

Table 15
NVS Filter Efficiency Testing/Replacements

	Q1/Q2 HEPA	Q1/Q2 CAD	Q3/Q4 HEPA	Q3/Q4 CAD
Filters in fleet	**240**	**73**	**240**	**73**
Number tested	**238**	**67**	**238**	**67**
Filters which met specification	**238**	**67**	**238**	**67**
Filters out of specification	**0**	**0**	**0**	**0**
Out of specification filters replaced during test cycle	**0**	**0**	**0**	**0**
Not tested	**2**	**6**	**2**	**6**
Total replaced during this cycle	**3**	**14**	**0**	**2**
Filters (systems) removed from service	**0**	**0**	**0**	**0**
New Filters (systems) Added	**0**	**0**	**0**	**0**

Comments Q1/Q2 HEPA: Two filters were not tested as one of them is not in service and the other is inaccessible. Three new HEPA's were added to System #31 in March. This was done as an increase in the change in pressure was observed. Each filter was tested in-situ after and they all passed.

Comments Q1/Q2 CAD: Six trench filters were not tested, but are changed every three years as per procedure. Due to lack of radioiodine processing and storage in the KRMF/Radiopharmaceutical facilities, 21 CADs servicing those areas are not tested against the performance criteria, but continue to be tested regularly to research the filter performance. 14 CAD filters were changed out due to their shelf life expiring. An in-situ test was performed on 13 of the new filters and they passed. One trench filter was replaced as well and it passed lab testing prior to installation.

Comments Q3/Q4 HEPA: Two filters were not tested as one of them is not in service and the other is inaccessible.

Comments Q3/Q4 CAD: Six trench filters were not tested, but are changed every three years as per procedure. Due to lack of radioiodine processing and storage in the KRMF/Radiopharmaceutical facilities, 21 CADs servicing those areas are not tested against the performance criteria, but continue to be tested regularly to research the filter performance. Two CAD filters were changed out due to their shelf life expiring. An in-situ lab test was performed on one of the new filters and it passed. The other filter was a trench filter and it passed lab testing prior to installation.

Nuclear Medicine in-cell charcoal roughing filters are on a preventative maintenance schedule and replaced typically every six months. These filters are not credited with mitigating releases in Nordion's Safety Analysis reports.

2.7.11.2 Back-up Power Facilities

The emergency generators, which supply emergency power to the KOB, KRMF and the Heating Plant are tested monthly. Testing in 2018 was performed at the required frequency.

2.7.11.3 Radiation Evacuation Alarms

Radiation evacuation alarms are tested weekly and quarterly by the Radiation Surveyors. They are additionally tested biannually by Facilities. Testing in 2018 was performed at the required frequency and results were satisfactory.

2.7.11.4 Radiation Alarms

The radiation alarms are scheduled for testing on a weekly basis and were tested every week in 2018. The tests verify that the alarms sound at the pre-set alarm levels and that the alarms register on the Metasys monitoring system. If the alarms do not function as required, adjustments to the alarm levels and/or the Metasys are conducted immediately by Facilities. The results were satisfactory.

2.7.11.5 Sprinkler System Fire Alarms

The sprinkler system fire alarms in KOB, KRMF and the Heating Plant are tested every month. Testing in 2018 was performed at the required frequency and results were satisfactory. All dry systems were tested and verified in good operating condition in 2018 as required by the National Fire Protection Association (NFPA).

2.7.11.6 Fire Alarm Panels

The fire alarm panels for KOB, KRMF and the Heating Plant are tested and verified by the manufacturer once a year.

The fire alarm panels that monitor the KOB, KRMF and the Heating Plant are tested monthly. Testing in 2018 was performed at the required frequency and results were satisfactory.

2.7.11.7 Contamination Monitoring Equipment

Handheld contamination monitoring equipment is maintained twice a year. Area monitors are checked on a daily basis. Testing in 2018 was performed at the required frequency and results were satisfactory.

2.7.11.8 Contamination Control Equipment

The hand and foot monitors are calibrated twice a year, tested weekly and serviced on a routine basis. They are also repaired as required, which is typically two to three times a year. Testing in 2018 was performed at the required frequency and the results were satisfactory.

2.7.11.9 Environmental Monitoring Equipment

Environmental monitoring equipment is tested on a weekly basis. If required, repairs to equipment are carried out immediately after the testing by Facilities personnel or in some instances the Surveyor. In 2018, a total of 10 work orders were generated for 11 issues that were identified during weekly equipment testing.

Four work orders were due to issues with barrier monitors (Hand and Foot or Whole Body Contamination Monitors). The issues with the barrier monitors were typically due to faulty probes causing the monitor to go “Out of Service”. In the event that a barrier monitor is malfunctioning, Nordion employees will perform checks using an adjacent barrier monitor or a handheld contamination monitor.

Three work orders involved issues with air sampling pumps; however, these issues were at locations considered to be of secondary importance and alarms on the Building Management System (BMS) are not triggered for failure of these pumps. There are several spare pumps and they are replaced typically within 24 hours.

One work order was generated for an alarm signal not registering at the BMS. The issue was corrected.

Three work orders were generated due to meter or probe faults. As probes begin to fail the number of counts detected will begin to decrease over time. The weekly testing helps identify failing probes so they can be changed prior to complete failure.

There were no other issues which generated work orders.

Overall the results were very good. There were eight fewer work orders generated in 2018 than 2017.

2.7.11.10 Radiation Survey Instruments

Radiation Survey Instruments are tested on a monthly, bi-annual, or annual basis as required. In 2018, for all of the 765 calibrations performed, the “As Found” results did not constitute a safety or regulatory concern. Testing in 2018 was performed at the required frequency and the results were satisfactory. At the end of 2018, there were three out of 765 survey meters past due for the internal frequency requirements. The three meters past-due were not in use. The majority of meters are calibrated every six months. The regulatory requirement for calibration frequency is 12 months.

2.7.11.11 Trends

There were no trends identified. Some equipment did have repeated unscheduled maintenance on up to three occasions during the year, but for each of them, the maintenance occurrences were unrelated, and as such, did not require further remedial action.

2.7.12 Radiation Protection Training Program and Effectiveness

Refer to Section 2.2.1 and 2.2.2.

2.8 Conventional Health and Safety

2.8.1 Conventional Health and Safety Program Effectiveness

The Conventional Health & Safety Program is reviewed by conducting program audits, process audits, regular inspections by both employees and management, and a review of revised safety programs is performed by the Policy Health & Safety Committee. The Policy Health & Safety Committee is also responsible for reviewing the Hazard Prevention Program. In addition, the EHS Committee sets targets each fiscal year that are used to monitor the effectiveness of the safety program.

A target was established for Medical Treatment Incidents with a target of ≤ 6 and Lost Time incidents with a target of zero. Near Miss Reports and Hazard Identification Reports are tracked and are reported monthly to senior management and are provided to the EHS Committee for review.

The Conventional Health and Safety Program was last audited internally in 2016 and is on a three year schedule. No audits of the Conventional Health and Safety Program were conducted in 2018. Process safety audits are conducted annually

Refer to Section 2.1.3 and Appendix B for a description of audits and inspections for 2018.

2.8.2 Conventional Health and Safety Committee

The KOB Workplace Health and Safety Committee is represented by union and management and typically meets on a monthly basis. The KOB Health & Safety Policy Committee is represented by union and management and typically meets on a quarterly basis.

The KOB Workplace Health and Safety Committee met eleven times in 2018. The KOB Health & Safety Policy Committee met on four occasions in 2018. The accomplishments for 2018 were that the Policy Committee continued to review new or changes to existing applicable policies and programs (e.g. the newly established Safety Requirements for Machining Lead procedure and changes to the Confined Space program). In addition, the Policy Committee continued to review operational ergonomics as a standing agenda item for each meeting.

2.8.3 Conventional Health and Safety Program Improvements

Improvements to the Conventional Health and Safety Program in 2018 included the following:

- Introduction of a behavioural based safety awareness program,
- NEWSS 4 You Environmental, Wellness, Security and Safety newsletter continued to be created and made available to all employees,
- Improvements were made to the Lead Control Program and training was updated and provided to applicable employees,
- Industrial hygiene monitoring was conducted by a third party for: Asbestos,
- Confined Space Rescue training was completed along with some equipment specific training,
- Fall Protection training was reviewed and updated training provided to applicable employees. Some equipment specific training was also conducted,
- Implementation of the WHMIS 2015 requirements,
- Improvements were made to facility eyewash stations,
- Improvements were made to Nordion's Hoisting Safety Program,
- Improvements were made to the Respirator Protection Program,
- Chemical Spill Response training was completed.

2.8.4 Conventional Health and Safety Occurrences

During 2018, there were two medical treatment incidents and no lost time incidents. The details are summarized below. Figures 2 and 3 illustrate the number of Incidents by year and the Number of Days Lost by year respectively.

Medical Treatment Incidents:

Business Unit	Medical Treatment Injury	Action Taken
Medical Isotopes	Employee sustained a laceration to their right middle finger when their finger was pinched between a hot cell door and wall of the hot cell.	Door dampers were adjusted and a magnet was installed to hold the door open.
Gamma Technologies	Employee experiencing right shoulder pain that they believe is related to work in the Cobalt Operations facility.	Reminded employees of the importance of taking time to relax/stretch muscles and joints being used for tasks and to alternate tasks with coworkers as needed.

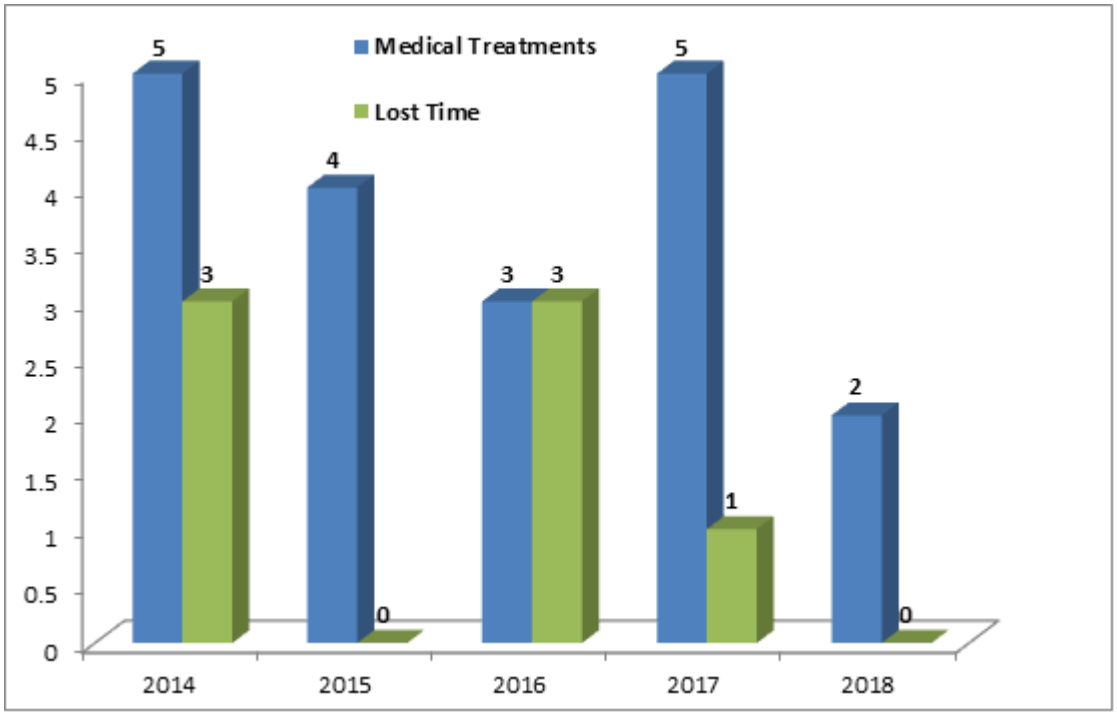


Figure 2: Number of Medical Treatments and Lost Time Incidents by Year

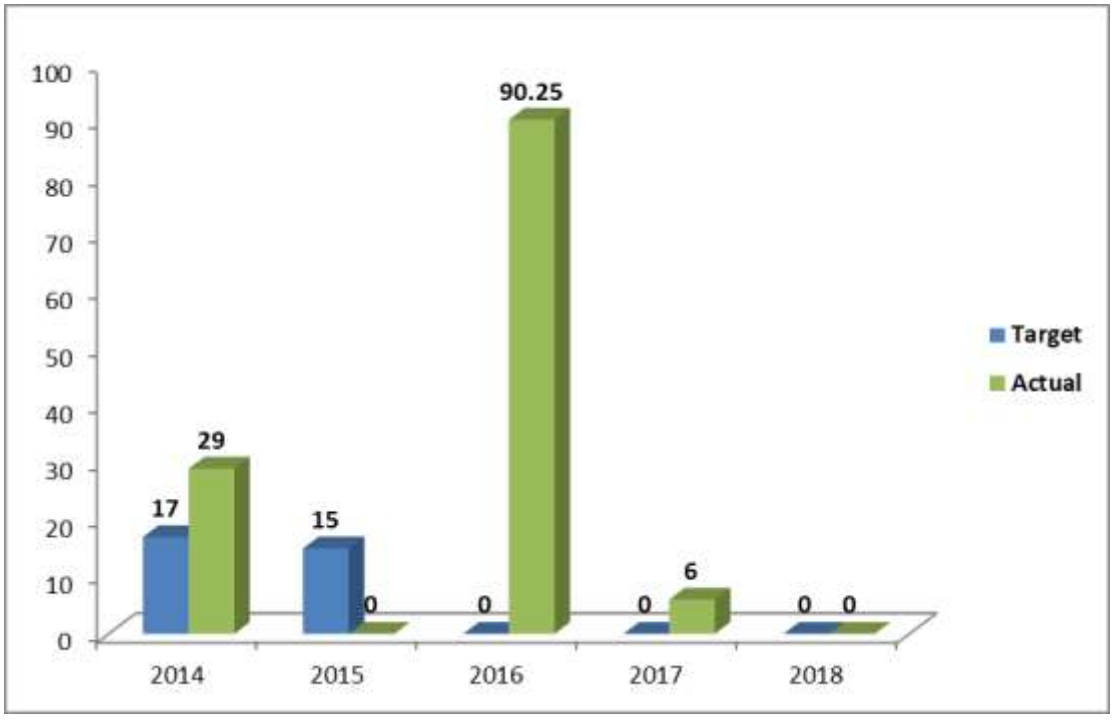


Figure 3: Number of Lost Time Days by Year

2.9 Environmental Protection

2.9.1 Air and Water Release Monitoring

The environmental monitoring program is designed to monitor and measure effluent releases to the environment and to determine radiation levels in areas exterior to the KOB. The program includes the following elements:

a) Continuous monitoring of process ventilation, exhausts ductwork, and stack emissions by use of in-situ detectors and samplers and computerized recording

b) Weekly air sampling and analyses for KOB exhaust stack emissions

c) Holding tanks for Active Area liquid effluent to allow sampling, analysis, and authorized release of liquid effluent

d) Environmental TLD program

e) Soil sampling

f) Groundwater sampling

Ventilation and stack sampling is conducted by using particulate and/or activated charcoal filters, depending on the physical and chemical nature of the radionuclide. Radioiodine sampling involves the use of activated charcoal filter cartridges, and analyses by gamma measurement. Particulates are sampled by use of cellulose filter papers and analyzed by gamma measurement.

All production operations are contained within cells, glove-boxes and/or fume-hoods. Ventilated air from these containment systems is filtered through roughing and HEPA filters and, where appropriate, activated charcoal adsorbers. These systems are designed with redundant fan/motor and filtration units that include pre-filters, primary and secondary filtration units. The Nuclear Ventilation System (NVS) has been designed and is maintained to prevent the unnecessary release of radioisotopes to the atmosphere.

2.9.1.1 Airborne Effluent

Two sets of DRL values are listed in Table 16. The values in the LCH are used to calculate dose to public. A revised LCH was issued to Nordion in January 2019 containing the values submitted by Nordion in 2016 and approved by CNSC.

In 2018, the maximum annual release of airborne effluent from any one radionuclide was from Co-60 at 0.0029% of the DRL. The total air release was 0.003% of the DRL. No Action Levels were exceeded in 2018. Dose to public using LCH DRL values was 0.03 µSv (compare with 0.02 µSv using the Impact derived DRL values).

In November of 2016 production of Mo-99, I-125, I-131 and Xe-133 ceased. Bulk QC received small amounts of I-131 during the year to maintain equipment functionality. I-125 with its longer half-life is still present in some waste and Nuclear Ventilation Systems but no releases were detected.

Note that air release activity measurements have an uncertainty of ±25% for radioiodines and particulates and ±6% for radioxenons.

Table 16
Airborne Releases

Year	Co-60 (GBq/yr)	I-125 (GBq/yr)	I-131 (GBq/yr)	Xe-133 (GBq/yr)	Xe-135 (GBq/yr)	Xe-135m (GBq/yr)
2014	0.005	0.14	0.46	15,018	13,075	18,170
2015	0.005	0.12	0.15	11,916	8,237	10,758
2016	0.006	0.21	0.35	7,277	4,299	5,421
2017	0.0034	0.0012	0.0008	0	0	0
2018	0.002	0	0.006	0	0	0
Action Levels (GBq/week)	0.001	0.1	0.2	3,000	N/A	N/A

	Co-60	I-125	I-131	Xe-133	Xe-135	Xe-135m
DRL (GBq/yr) From LCH	70.1	4,880	3,790	61,200,000	7,660,000	4,600,000
% DRL (LCH)	0.0029	0	0.00016	0	0	0

	Co-60	I-125	I-131	Xe-133	Xe-135	Xe-135m
DRL (GBq/yr) From 2019 DRL	250	952	686	677,000,000	102,000,000	69,000,000
% DRL (From 2019 DRLs)	0.0008	0	0.0009	0	0	0

[redacted]

2.9.1.2 Liquid Effluent

Two sets of DRL values are listed in Table 17. The values in the first version of the LCH are used to calculate dose to public. Also included for comparison are the DRL values from the January 2019 revision 1 of the LCH.

Allowable liquid effluent releases to the environment are also limited to values in SE-OP-013, “Water Effluent Monitoring”. The five year variation in activities released is listed in Table 17. Each release of liquid effluent in 2018 was well below the values in SE-OP-013 (exceedance of which would be Action Level reporting). All liquid effluent releases have been below the Nordion action levels and well within CNSC licensed limits. A summary of liquid releases, expressed as a % DRL, is provided in Table 17.

The City of Ottawa is informed whenever a release to the sanitary sewer takes place. In addition, a monthly summary report of the activity levels released is provided to the City of Ottawa.

Midway through 2014, the Minimum Detectable Activity (MDA) for I-125 was raised, due to the replacement of an aging NaI(Tl) (sodium iodide activated with thallium) detector with a new low energy window High Purity Germanium (HPGe) detector. The low energy window HPGe detector has lower efficiency than the obsolete NaI(Tl) detector.

Note that liquid release activity measurements have an uncertainty of ±10%.

Table 17
Liquid Releases (GBq/yr)

Year	Litres	β<1MeV	β>1MeV	I-125	I-131	Mo-99	Co-60	Nb-95	Zr-95	Cs-137
2014	600162	0.209	0.05	0.051	0.006	0.055	0.018	0.0007	0.0005	0.0004
2015	590570	0.191	0.044	0.111	0.006	0.06	0.019	0.001	0.001	0.0004
2016	680559	0.222	0.051	0.144	0.006	0.052	0.026	0.001	0.0015	0.0007
2017	661376	0.212	0.048	0.145	0.006	0.049	0.022	0.001	0.002	0.0007
2018	713224	0.243	0.055	0.146	0.007	0.055	0.027	0.001	0.0017	0.0007

	β<1MeV*	β>1MeV*	I-125	I-131	Mo-99	Co-60	Nb-95	Zr-95	Cs-137
DRL (GBq/yr) From LCH	66,000	210,000	73,600	23,300	1,120,000	155,000	558,000	749,000	137,000
% DRL (LCH)	3.68E-04	2.60E-05	1.98E-04	2.92E-05	4.87E-06	1.72E-05	1.91E-07	2.33E-07	4.96E-07
*β<1MeV Ni-63 DRL value used, β>1MeV Y-90 DRL used									

	β<1MeV*	β>1MeV*	I-125	I-131	Mo-99	Co-60	Nb-95	Zr-95	Cs-137
DRL (GBq/yr) From 2019 DRL	763	35,000	1,190	389	10,200	35.4	3,250	2,060	24.8
% DRL (2019 DRLs)	3.18E-02	1.56E-04	1.22E-02	1.75E-03	5.35E-04	7.55E-02	3.28E-05	8.47E-05	2.74E-03

Releases in Table 17 are compared against the values in the LCH. If the critical receptor was the same group for all radionuclides the dose to public would be 0.037 µSv (compare with 1.3 µSv using the 2019 LCH values). This value is a conservative over estimate because the critical receptor has been used as the same receptor and the DRLs are conservatively calculated.

The majority of the recorded releases are the minimum detectable activities being conservatively reported as real values instead of using zero. [redacted]

The increase is actually due to a change in measurement technique, as mentioned previously. The low energy window HPGe detector has lower efficiency than the obsolete NaI(Tl) detector. This change accounts for the increase in the I-125 liquid release from 2013 to 2014 and in subsequent years.

In early 2016, Nordion made a change to the calculations used to determine the MDA for Zr-95. As the level of Z5-95 in the liquid effluent is low, often below the MDA, this has resulted in the appearance of an increase in the Zr-95 liquid releases compared to previous years.

Nordion continues to report liquid releases as equal to the MDA even when it is suspected that nothing was released. Nominal increases in the reported values for Nb/Zr-95 and Cs-137 are also noted, however even assuming these releases are real they only represent nSvs of dose to the public which is several orders of magnitude lower than published de minimis values.

2.9.1.3 Environmental TLDs

The locations of environmental TLDs are shown in Appendix G and listed in Table 18. The existing environmental TLD placement corresponds roughly to the historical locations of these dosimeters. The dosimeters are deployed to generally cover the points of a compass and preferentially to the east of the facility, which is the direction of the prevailing winds. The TLDs are also placed in residences of Nordion employees.

All environmental TLD readings for 2018 were well below the public limit of 1 mSv. The similarity in the recorded dose in these locations year over year, taken with the absence of any contamination found in soil illustrates that the variation between locations is due to variations in natural background radiation at these different times and locations.

Table 18 – Environmental TLDs

Location		2014 (mSv)	2015 (mSv)	2016 (mSv)	2017 (mSv)	2018 (mSv)
16	[redacted]	0.088	0.094	0.133	0.032	0.086
17	[redacted]	0.192	0.177	0.241	0.169	0.132
18	[redacted]	-0.046	-0.024	0.035	-0.052	-0.071
19	[redacted]	0.014	0.065	0.128	0.037	0.08
20	[redacted]	0.078	*	0.078	0.061	0.079
32	[redacted]	0.04	0.02	0.037	-0.041	0.031
33	[redacted]	-0.049	-0.02	0.003	-0.057	0.036
38	[redacted]	0.058	*	0.161	0.036	0.082
57	[redacted]	0.075	-0.008	0.004	-0.047	0.003
58	[redacted]	0.09	0.065	0.149	0.046	0.144

* missing TLD

2.9.2 Significance of Air and Water Release Monitoring Results

[redacted] It has been the practice of Nordion to only quantify air releases which have been identified first by reports generated by multi-channel analyzers, then on annual review all spectra are reviewed visually for evidence of peaks which were not correctly identified or quantified. This was found to be an issue with I-125 quantification, as software looked for the 35.5 keV low yield gamma peak and not the more abundant low energy x-rays at ~27 keV. Therefore, an annual correction was performed. However, in 2018 there was no evidence of an I-125 release from any of the stacks. If Nordion were to apply MDA values to Co-60, I-131 and I-125, releases in 2018 would be 0.0022 GBq of Co-60, 0.013 GBq of I-131 and 0.0063 GBq of I-125. [redacted]

As in previous years, liquid releases closely followed liquid release volumes due to Nordion's practice of assuming the MDA is the level of the release. No other specific trends were noted.

Trends in changes in volumes of water released from the facility continue to be generally proportional to activities released. Nordion employs a conservative practice of assuming the MDA is always released in liquid effluent. This explains why the year over year trend very closely follows the number of litres released. In August 2014, Nordion switched from a NaI(Tl) detector to a low energy window HPGe detector with slightly less efficiency in the I-125 range, which on paper will contributed to higher releases being reported in 2014 and subsequent years although no I-125 was actually detected. The next largest factor is variation in the MDA between the Cobalt Operations Facility and the Nuclear Medicine Production Facility. Every year only a small percentage of the release reported is activity detected over the MDA.

In fact, only approximately 5 % of the total measurements done on liquid effluent in 2018 were above the MDA. Therefore, the liquid effluent monitoring results indicate a dose to the public that is based on activity values which were over-estimated by a factor of twenty (20). Due to the conservative approach used by Nordion, the estimated dose to the public from liquid effluent is greatly over estimated.

2.9.3 Exceeding Regulatory Limits or Action Levels

There were no instances of exceeding CNSC environmental regulatory limits or action levels in 2018.

2.9.4 Environmental Protection Program Effectiveness

A review of the performance related to the Environmental Protection Program and the Environmental Management System is conducted on an annual basis. In 2018, this review was held during the Annual EHS Program Review on April 24, 2018. The results of the review are summarized in Section 2.1.2.

Refer to Section 2.1.3 for a summary of internal and external inspections, audits and reviews. A list of the internal audits and associated findings and opportunities for improvement are provided in Appendix B.

2.9.5 Environmental Protection Program Activities

Activities which took place in 2018 included the following:

- Conducting a total of 16 fire and environmental inspections to identify areas for improvement and/or concerns,
- Conducting a supplier audit of a supplier whose goods/services could have a significant impact on the environment,
- Nordion was subject to an ISO 14001:2015 certification audit. No non-conformances were identified and eight opportunities for improvement were identified during the course of this audit.

2.9.6 Environmental Protection Program Improvements

In 2018, Nordion made the following improvements to the Environmental Protection Program:

- Implemented changes to the Environmental Management System to meet the requirements of ISO 14001:2015.

2.9.7 Environmental Protection Program Performance

A description of the Environmental Protection Program Initiatives is provided in Table 19, along with the results/outcomes.

A summary of initiatives and targets for the upcoming year is provided in Table 20.

Table 19

2018 Environmental Objectives

Objective	Result / Outcome
Assess opportunities to reduce releases to water	• All waste from the Decontamination Room is now run through ion exchange columns • Containers are wiped at the vent line to capture contamination before cleaning • Ultrasonic effluent test rinse process has been modified to reduce the amount of waste being processed in the Decontamination Room • Container monitoring during unloads to determine the level of contamination during showering
Conduct an audit of a supplier whose goods and/or services could have a significant impact on the environment.	An audit of supplier whose services could have a significant impact on the environment was completed in 2018.
Investigate energy reduction opportunities	A total of 35,000 kWh annually was saved through the implementation of the following initiatives: • Lighting schedules for RE building were adjusted, saving approximately 1% of the energy used for lights in the RE building • Install Variable Frequency Drive motor on AHU#4 resulting in savings of approximately 10,000 kWh per year • Various outdoor and indoor lighting was replaced.. An estimated 25,000 kWh per year was saved. Due to changes unknown at the time of initiating this objective (the sale of Medical Isotopes to BWXT) the target of 70,000 kWh per year total energy savings could not be met. Nordion did however reduce energy consumption by an estimated 35,000 kWh per year as a result of this objective.
Reduce particulate matter air emissions (continued from 2016)	This objective is on hold until 2019 due to lack of production in the glass blowing lab.

Table 20
2019 Environmental Objectives and Targets

Objective	Target
Conduct an audit of a supplier whose goods and/or services could have a significant impact on the environment.	Complete one supplier audit in accordance with SE-ENV-019 “External Supplier Environmental Audits by the end of December 2019.
Investigate energy reduction opportunities	Estimated savings of 35,000 kWh per year
Reduce particulate matter air emissions (continued from 2016)	Investigate and implement (as feasible0 filtration to air leaving the Glass Blowing Lab for particulate matter emissions.

2.9.8 Groundwater and Soil Sampling and Monitoring

2.9.8.1 Soil Sampling

Soil sampling was conducted annually to determine the presence or absence of radioactive materials in the soil. It was last performed in 2018. No radionuclides attributable to licensed activities were detected in the soil samples.

2.9.8.2 Groundwater Sampling

Figure G.3 (Appendix G) shows current groundwater well locations.

Nordion has completed a gap analysis against the requirements of CSA N288.7-15, *“Groundwater protection programs at Class I nuclear facilities and uranium mines and mills”* and is currently updating internal procedures and programs to meet these requirements and fill gaps identified.

2.9.8.2.1 Non-Radiological Sampling

Since 2005, Nordion has been monitoring the groundwater at least once a year for non-radioactive contaminants. Holes are bored into the ground at varying depths, in various locations, until the ground water has been reached. The locations of these boreholes are illustrated in Figure G.3 (Appendix G).

After samples have been taken from each borehole, they are sent to an accredited laboratory for analysis and parameters for analysis are chosen with consideration to past sampling.

The results are monitored to ensure there are no significant shifts or trends in the sample results that could indicate a change to the groundwater. Results are also compared to the background well which represents the water quality as it enters the property. As a conservative reference, results are compared against limits from the following requirements:

- Soil, Ground Water and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act,
- Ontario Drinking Water Standards, Objectives and Guidelines.

Non-radiological groundwater samples were taken on June 8, 2018. Results, including those from the recent analysis, from five years previous and from the original sampling in 2005 are provided in Appendix F by borehole, with borehole two (2005-BH2) representing background conditions.

The results of this analysis demonstrated that there were no significant changes in the groundwater in 2018 compared to past years. This indicates that Nordion's operations have not had a significant impact on the groundwater.

2.9.8.2.2 Radiological Sampling

Since 2014, Nordion has been monitoring groundwater at least once a year for radiological contaminants.

Samples are taken in from the following boreholes to assess potential radiological contaminants:

- 1991-BH1
- 1991-BH2
- 1991-BH3
- 1991-BH4
- 2012-BH1

It was determined that only naturally occurring radionuclides which are not processed at this site were detected.

2.10 Emergency Management and Fire Protection

2.10.1 Emergency Preparedness Program Effectiveness

Management has assessed the existing program and deemed it effective through historical success in meeting the response objectives during exercises.

Nordion completed all of its scheduled activities for 2018.

2.10.2 Emergency Preparedness Program Activities

Nordion has an extensive emergency preparedness program to respond to various types of emergency situations, including on-site and off-site emergencies. During 2018, a number of Emergency Response (ER) exercises were conducted to test these emergency response plans and response personnel.

Activities which took place in 2018 included:

- Testing of the Fire Safety Plan in each of the three buildings (KOB, RE Building, and Heating Plant), including alarm activation and full evacuation,
- Testing of the ER Contact List to ensure accuracy of telephone numbers listed, to determine availability of personnel, and to estimate response times.

2.10.3 Emergency Preparedness Program Performance

The emergency preparedness program performance was tested during exercises and drills noted in the previous section. During these, Nordion executed an effective response and demonstrated good interoperability with city first responders.

Overall compliance with the Emergency Management Program was proven satisfactory. There were no events (planned or actual) demonstrating non-compliance with the Emergency Management Program.

There were no deficiencies with the Emergency Management Program systems or equipment in 2018.

2.10.4 Emergency Preparedness Program Improvements

In 2018, Nordion completed program enhancements to address minor areas for improvement identified in exercises and drills and other continuous improvements. As noted above, these included:

- Designing and implementing minor revisions to the program to address items identified during the 2016 major exercise,
- Designing and implementing minor plan adjustments related to the sale of the Medical Isotopes business. These were limited to command and control

relationships and liaison. The response plans were otherwise unchanged due to the sale,
- Creating additional refresher training courses using online delivery tool,
- Holding a tabletop exercise involving the Incident Command Post personnel pool as participants or observers.

2.10.5 Fire Protection Program Effectiveness

Fire drills/evacuations were conducted in the Heating Plant, the RE Building and the KOB in 2018. There were no significant findings identified as a result of these drills.

The objective of the fire protection program is to promote life safety, the conservation of property and essential equipment, the protection of the environment and the continuity of operations through provisions of fire prevention and fire protection measures. Nordion met all scheduled activities related to the fire protection program in 2018. An annual facility condition inspection was conducted by a third party in 2018 with one recommendation identified.

2.10.6 Fire Protection Program Activities

Activities that took place in 2018 included:

- Testing of the fire safety plans. This test involved evacuation of the three buildings (KOB, RE Building and Heating Plant) by activation of the building fire alarm system,
- Conducting 16 fire and environmental inspections,
- Conducting an annual facility condition inspection with one recommendation noted.

A fire protection program audit was conducted in 2016 and is conducted every three years as required by CSA standard N393, “Fire protection for facilities that process, handle, or store nuclear substances”.

2.10.7 Fire Protection Program Performance

Overall, compliance with the Fire Protection Program was satisfactory.

2.10.8 Fire Protection Program Improvements

Improvements to the Fire Protection Program in 2018 included:

- Updating the Fire Safety Plan and Fire Warden and Fire Marshall Responsibilities procedures.

There were no changes to training, methods, instrumentation, or equipment in 2018.

2.11 Waste Management

2.11.1 Effectiveness of Waste Segregation and Minimization

Nordion production facilities have been designed and operated in a manner to prevent radioactive waste being released to municipal garbage or sewer systems and to ensure that releases to the environment via air or water emissions are within limits approved by the CNSC. All radioactive waste that is generated through the production operations is collected and sent to a CNSC approved radioactive waste management facility.

Nordion has designated space and processes to store and segregate radioactive waste that is generated in Operations [redacted] Additional space for storage of divertible waste, (i.e. waste generated within the Active Area at Nordion that has been deemed safe to divert and dispose of by conventional waste disposal methods, such as landfill), exists in [redacted], if needed. These areas are segregated rooms or bays that are designated for this purpose. Space is also designated for storage of containers and management of waste being prepared for shipment to the external waste management facilities.

Nordion's non-radiological waste diversion program has seen significant improvement over the last three years, increasing diversion rates from 64% in 2015 to 74.3% in 2018. These increases were the result of improved signage, expansion of the organics program to include coffee cups and improved awareness of waste diversion programs.

2.11.2 Identification and Characterization of Waste Streams

[redacted]

2.11.3 Waste Shipments

[redacted] In 2018, there were no shipments to [redacted] of radioactive liquid waste by Nordion.

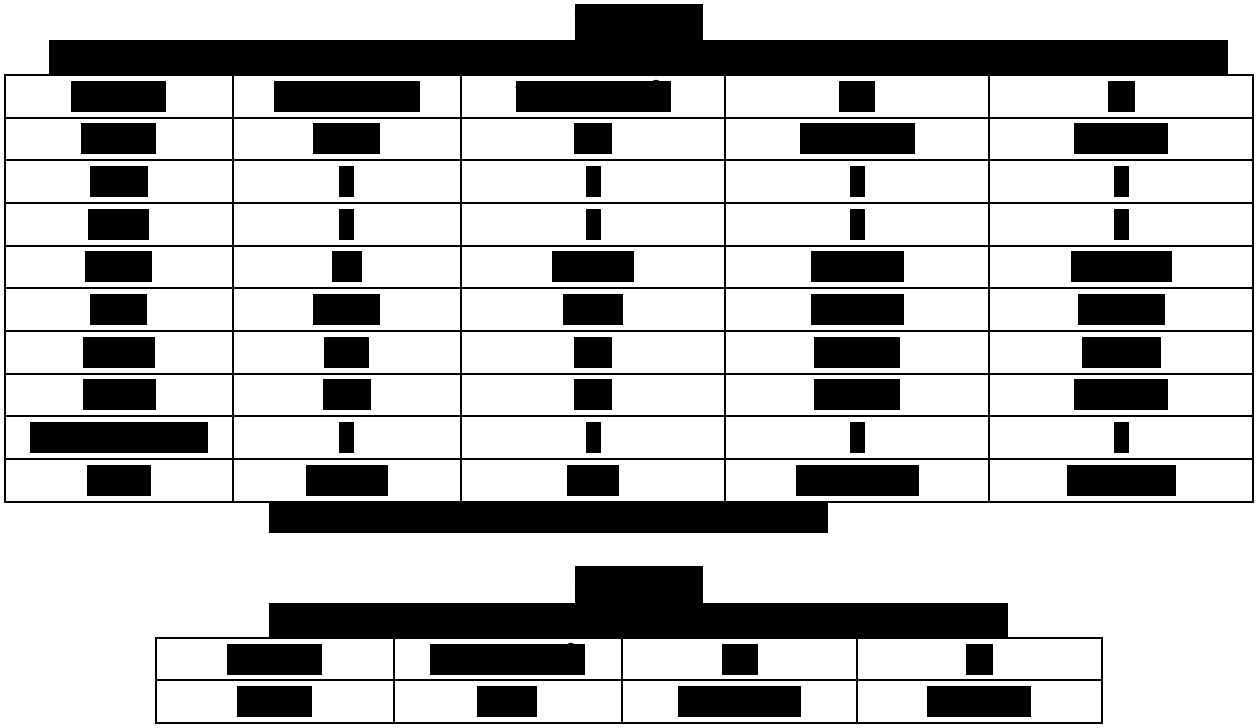
[redacted]

In 2018, approximately [redacted] of solid and liquid hazardous (chemical) waste was disposed of by Nordion via a licensed waste disposal company.

In 2018 [redacted] that met CNSC unconditional clearance levels was disposed of to landfill as part of the waste diversion program.

[redacted]

[redacted]			
[redacted]			
[redacted]			
[redacted]			
[redacted]			
[redacted]			
[redacted]			
[redacted]			



2.11.4 Waste Management Program Performance

- The amount of non-hazardous waste diverted from landfill – Nordion diverted an estimated 74.3% or [redacted] of waste from landfill in 2018,
- The amount of waste diverted from licensed radioactive waste facilities – [redacted] that met CNSC unconditional clearance levels was disposed of to landfill as part of the waste diversion program.

The waste management program was audited in 2018 and is on a three year frequency for auditing. Annually Nordion has a waste audit conducted by a third party (non-hazardous waste only). The results of this audit are summarized below:

- 74.3% diversion rate,
- 95%+ diversion rate for:
  - Aluminum food/beverage cans & foil,
  - Scrap Metal,
  - Cardboard,
  - Fine Paper,
  - Glossy magazines, flyers/posters,
  - Newsprint/Packing Paper,
  - Wood/Skids,
  - Spent lighting tubes/bulbs/ballasts,
  - Shredded Paper.

2.11.5 Waste Management Program Improvements

Improvements to the Waste Management Program in 2018 included the following:

- Continued work related to Nordion initiatives to reduce Ir-192 process wastes and implement the practice of storing Ir-192 process waste for decay and then sending to [redacted] as low-level waste (versus sending to [redacted]),
- [redacted] of returned Cobalt was recycled into new source manufacturing,
- [redacted] of returned Cobalt was added to inventory in 2018 to support the recycling program.

2.12 Nuclear Security

Details of Nordion security and any security improvements of 2017 were provided in the Nordion Physical Security Report and Security Plan for 2018, submitted in February 2018. These safeguards and improvements are prescribed information and were reviewed and accepted by CNSC Security as part of the 2017 Type ll Security Inspection.

2.13 Safeguards and Non-proliferation

2.13.1 Safeguards Program Effectiveness

Nordion has a safeguards that meets the safeguards requirements of the CNSC regulatory document REGDOC 2.13.1-Safeguards and Nuclear Material Accountancy, CNSC *Nuclear Non-Proliferation Import and Export Control Regulations*, the *Nuclear Safety and Control Act* and *General Nuclear Safety and Control Regulations*.

2.13.2 Safeguards Program Performance

In 2018, Nordion performed accounting and reporting of nuclear material as required by REGDOC 2.13.1-Safeguards and Nuclear Material Accountancy. Nordion completed a PIT of safeguarded material from which there were two observations and three opportunities for improvement (refer to Appendix B).

In 2018, Nordion was not selected for the IAEA Physical Inventory Verification (PIV) and the CNSC did not conduct a Physical Inventory Taking - Evaluation (PIT-E).

2.13.3 Safeguards Program Improvements

The safeguards program document was revised and reorganized to align with and demonstrate compliance with REGDOC-2.13.1.

2.14 Packaging and Transport of Nuclear Substances

Nordion routinely ships both sealed and unsealed sources of nuclear substances in Type B, Type A and Excepted packages. Nordion also routinely ships waste materials in these same package types. Shipments of Nordion's products are made via road, air and sea. Shipments of waste are routinely made via road transport.

In 2018, Nordion shipped approximately [redacted] packages containing various radioactive materials.

The Packaging and Transportation Program at Nordion provides a high level overview of Nordion's transportation of radioactive materials program. The program applies to employees involved in design, production, use, inspection, maintenance and repair of packages, and the preparation, consigning, handling, loading, carriage, storage during transport, receipt at final destination, and unloading of packages. It applies to various types of packages including Type A, Type B, and Excepted packages. The content of the program was modeled on regulatory requirements listed in the CNSC *Packaging and Transportation of Nuclear Substances Regulations 2015*, Transport Canada *Transportation of Dangerous Goods Regulations*, IAEA *SSR-6* Regulations for the Safe Transport of Radioactive Material (2018 Edition), US DOT 49 CFR, and US NRC 10 CFR part 71.

In 2018, Nordion reported eight non-conformances related to packaging and transport of nuclear substances. All of these reportable non-conformances were reported as "dangerous occurrences" pursuant to subsection *37(1) of the Packaging and Transportation of Nuclear Substances Regulations*. All eight of the non-conformances were the result of other parties

(carriers or customers) handling Nordion packages. Refer to Appendix A for further information regarding these incidents.

One of the events reported to the CNSC (Type A Package missing in transit) was also reportable event pursuant to the TDG regulations.

2.15 Public Information Program (PIP)

2.15.1 Public Information Program Activities

Nordion is committed to fully disclosing its activities to the public in an effort to maintain transparency to the surrounding community and to the City of Ottawa. Nordion's website is the primary communications vehicle. In 2018, 25,940 unique users visited Nordion.com 34,772 times looking at a total of 62,752 pages.

In absence of offering on-site facility tours to the general public, Nordion offers the general public a glimpse into our campus through an online Nordion Virtual Tour.

Every two years, Nordion hosts a community event with the general public. In 2016, the community event was a Community Café. In November 2018, Nordion's Director, Regulatory Affairs & EHS spoke at Carleton University about the value of a Science, Technology, Engineering, Math (STEM) degree in the global healthcare industry and discussed the environmental release and doses to the public attributed to Nordion's Class 1B Facility operations. (http://sssc.carleton.ca/nordion).

In 2018, Nordion published the following information in their "Public Disclosure" web page:

- February: Q4 2017 Event Report,
- April 17: Nordion announced the intent to sell the Medical Isotopes busness to BWXT,
- May: Nordion announced that the CNSC would be onsite May 29-30 to conduct routine environmental sampling,
- May 28: Nordion announced that volunteers were planting shrubs along the Nordion side of the creek that crosses Nordion's property to help reduce erosion of the creek shore banks,
- June 13: Nordion announced the sale of unneeded office building and surplus land,
- July: Annual Compliance and Operational Performance Report 2017,
- May: Q1 2018 Event Report,
- August: Q2 2018 Event Report,
- September: Nordion announced that there was no impact to their facility as a result of the significant storm that passed through Ottawa on September 21,
- November: Q3: 2018 Event Report.

Nordion's website includes a feedback survey form in the Social Responsibility section as a mechanism to invite the public to provide feedback on Nordion's Public Information Program and to learn how the public would like the program to evolve. A copy of the feedback survey form is provided in Appendix I. In 2018, one (1) survey was completed in which the person asked a generic operations-related question.

Nordion also conducted a public survey in 2018. Impressions of Nordion remained steady since the public survey conducted in 2016 with a majority of Kanata residents still having a favourable or somewhat favourable impression of Nordion. Perceptions of safety remain consistent with a mean score of 8 out of 10.

Nordion regularly issues news releases to inform the public of company initiatives, achievements, and issues that the business may be facing. In 2018, there were no media articles related to Nordion environment, health and safety issues or topics. As the context of media coverage referring to Nordion was business-oriented, there was no media analysis of public opinion.

Nordion uses social media such as Facebook, Twitter, and LinkedIn to inform the public of the company's initiatives. In 2018, there were no negative comments pertaining to events or questions related to environment, health and safety.

On December 13, 2018, Nordion published an ad in the *Community Voice*, a bi-weekly newspaper distributed to 46,230 homes and businesses in the Kanata/Stitsville area. A copy of the ad is provided in Appendix I. The ad underlined Nordion's ongoing commitment to protect the safety of employees, the community and the environment, referred to the Kanata facility as a Class 1B nuclear facility, noted that Nordion is certified to ISO 14001, an international standard for environmental management systems; and encouraged the public to contact Nordion with any questions, comments, or concerns.

2.15.2 Public Information Program Summary of Questions/Concerns Raised by the Public

One (1) request for information was received by email from a member of the general public. This request related to information regarding the Cobalt 60 process and whether Nordion has a nuclear reactor onsite.

2.15.3 Public Information Program Improvements

Through the year, Nordion updates its website content and online Nordion Virtual Tour content to keep it current. In 2018, the Nordion website was modified to make EHS-related information more prominent.

2.16 Financial Guarantee

The Financial Guarantee, as approved by the Commission and based on the Facility's Decommissioning Plan, remains valid and in effect.

2.17 Site Specific Information

Nordion's site-specific reporting requirements are as follows:

- Nordion shall submit a written notification of changes to the facility or its operation, including deviation from design, operating conditions, policies, programs, and methods, referred to in the licensing basis,
- Nordion shall, when aware that an action level has been reached, notify the Commission within seven days,
- Nordion shall prepare and submit to the Commission an Annual Compliance Report by March 31st of each year,
- Nordion shall report the transfer, receipt, export or import of sealed sources if the activity exceeds the threshold limits and within the specified timeframes as detailed in the LCH,
- Nordion shall report annually to the CNSC on the status of the financial guarantee, to inform that it remains valid, in effect and adequate to fund decommissioning of the facility.

In 2018, Nordion submitted written notification of changes to programs and documents to the CNSC.

In 2018, there was one event with regard to sealed source reporting:

- The incorrect version of a recipient's license number was reported to the CNSC Sealed Source Tracking System (SSTS) for the transfer of sealed sources to the recipient's license. Nordion revised the process for the regulatory assessment of customer's authorization to

possess nuclear substances to include transfers to domestic customer licenses and developed a process to pro-actively update site licenses in Nordion's tracking system.

This event was not reportable to the CNSC. There were no trends identified in 2018 with regard to SSTS-related events. Over the three-year period from 2016-2018 it was identified that reporting issues most often occur for non-routine and/or return shipments. These have been areas of focus for the sealed source reporting process reviews.

In 2014, Nordion conducted a process review of sealed source reporting and implemented some improvements. In 2016, Nordion repeated the process review incorporating a different analysis method to ensure all avenues for error were identified. The process review was completed and corrective and continuous improvement actions were summarized and assigned. 40% of actions have been completed. The completion of 30% of the actions is contingent on the transition from the existing software platform to a more reliable platform. Nordion continues to work on the improvements to the sealed source reporting process.

Nordion complied with all other site-specific reporting requirements. In 2018, there were no exceedances of action levels. Nordion reported on August 30, 2018 to the CNSC on the status of the financial guarantee.

3. FUTURE PLANS AND CONCLUDING REMARKS

3.1 Improvement Plans and Future Outlook

Nordion is planning the installation of an additional cell (Cell 1) in Nordion's Cobalt Operations Facility.

[redacted]

The forecasted plans for next year that would require CNSC regulatory oversight are as follows:

[redacted]

3.2 Safety Performance Objectives for 2019

Nordion's 2019 EHS Program Objectives and Targets and Health and Safety Objectives are shown in Table 24.

3.3 Concluding Remarks

Based on the information provided in this report, Nordion continues to demonstrate its capacity to operate in a manner that protects the safety of employees and causes no adverse effects to the public or the environment.

Table 24
2019 EHS Program Objectives and Targets

Objective	Measure/Target *
Manage CAPAs and ensure timely closure of CAPAs	• Close out aging CAPAs within your areas, • Target 80% of generated CAPAs within your areas are closed (Actions complete, excluding CAPA effectiveness/verification) within 1 year.
Close out Quality/EHS Management Systems in a timely manner (where applicable to your areas)	• Initiate and complete document anniversary review (periodic review) in 2019, • Complete Complaint Investigations within the target of 14 days from initiation and closure within 60 days, • Ensure target dates are set for all Change Control forms (target closure is 6 months), • Deviations/non-conforming material reports should not exceed 30 days, • Overall percentage of overdue training ≤2%.
Minimize the number and extent of occupational injuries, environmental and radiation incidents.	• The number of Medical Treatment Incidents ≤ 5, • Lost time Incidents = 0.
Minimize the use and release of hazardous materials to the environment.	• Radioactive materials emissions to < 4.0% of the Derived Release Limits (DRL), • Zero reportable releases of radioactive and non-radioactive hazardous materials to the environment (sanitary sewer, air, etc.),
Maintain radiation doses to employees as per ALARA principle.	• Maximum employee dose rate ≤ 7.5 mSv/yr.
Maintain a healthy safety culture. *	• It is unacceptable to take risks in order to get the job done. Safety is every employee's **highest** responsibility. Actively participate in regular safety discussions, • Immediately report near-misses, hazard identifications, suspected ergonomic symptoms and workplace injuries to your Manager.

***Note: Some Health and Safety Targets have been established to promote safety culture only and are therefore not measureable.**

APPENDIX A
Reportable Events

Date of Occurrence	Incident No.	Description	Regulation/Requirement to which the Event is Non-compliant and/or Reporting Requirement	Causes	Corrective Actions
18-Feb-04	**18-04**	A Type B package was damaged during handling by the carrier. The radioactive contents remained intact.	Reportable under Section 37(1) of the PTNSR as event is a dangerous occurrence as per Section 35(b) of the PTNSR.	The package was damaged while being handled by the carrier. Root cause determination is the responsibility of the carrier.	No corrective actions by Nordion as the carrier is responsible for implementing corrective actions. The Package was removed from inventory and will not be repaired.
18-Apr-15	**18-05**	Type B package was damaged in transit.	Reportable under Section 37(1) of the PTNSR as event is a dangerous occurrence as per Section 35(b) of the PTNSR.	The package was damaged in transit. Root cause determination is the responsibility of the carrier.	The package was repaired.
18-Apr-20	**18-06**	A Type A package could not be located in transit while in the care of the carrier.	Reportable under Section 37(1) of the PTNSR as event is a dangerous occurrence as per Section 35(c) of the PTNSR and Section 8.16 of the Transportation of Dangerous Goods Regulations.	The package was lost in transit. Root cause determination is the responsibility of the carrier.	The package was located by the carrier. No action required by Nordion.
18-Aug-01	**18-15**	A transport package was returned with damage on the inside of the package plug.	Reportable under Section 37(1) of the PTNSR as event is a dangerous occurrence as per Section 35(b) of the PTNSR.	The damage occurred during handling by a third party source installer. Nordion had previously provided instructions on the proper handling and preparation for shipment to the distributor in the region.	Nordion followed up with the distributor in the region to clarify the concerns and requirements for package handling. The package has been placed in quarantine and will not be used until repaired.

Date of Occurrence	Incident No.	Description	Regulation/Requirement to which the Event is Non-compliant and/or Reporting Requirement	Causes	Corrective Actions
18-Oct-22	**18-18**	A contract carrier transport vehicle carrying a Nordion shipment of empty containers was involved in a minor accident.	Reportable under Section 37(1) of the PTNSR as event is a dangerous occurrence as per Section 35(a) of the PTNSR.	This was the result of an accident.	No injuries were sustained by the driver and there was no effect on the safety of the containers. The conveyance continued on its route.
18-Oct-26	**18-19**	A contract carrier transport vehicle containing packages grazed a loaded carrier trailer while parking in Nordion's compound.	Reportable under Section 37(1) of the PTNSR as the event is a dangerous occurrence as per Section 35(a) of the PTNSR.	The contract carrier misjudged his spacing when backing up the trailer.	Minor damage to the tarp around the parked trailer was repaired. The packages were transferred to a different trailer for shipment.
18-Nov-14	**18-22**	Upon disassembly, a returned empty transport container contained areas with fixed contamination.	Reportable under Section 37(1) of the PTNSR as the event is a dangerous occurrence as per Section 35(f) of the PTNSR.	The contamination occurred at the customer's site.	Nordion ensured the transport truck and trailer did not contain contamination. The non-fixed contamination was removed and the container was returned to the fleet. Nordion notified the customer.
18-Nov-25	**18-23**	The shielding vessel plug of a Type B transport package received from a supplier was improperly secured.	Reportable under Section 37(1) of the PTNSR as event is a dangerous occurrence as per Section 35(g) of the PTNSR.	The packaging error occurred at the supplier's site. Root cause determination is the responsibility of the supplier.	Nordion notified the supplier. No further action required by Nordion.

Appendix B
Summary of Corrective Actions Associated with the Internal Audits Conducted in 2018

CAPA = Corrective Action Preventive Action
D&PE WR = Development and Process Engineering Work Request
CR = Change Request in EQMS
VEHS = Velocity EHS (compliance management tool)
CF = Change Form
OFI – Opportunity for Improvement

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
1	Process & EMS Audit - Waste Management Program	1 Minor Finding	CAPA 190302 CAPA 190303	Active Area staff did not demonstrate a good understanding of the purpose of the different colored waste bags.	Review the practice of using yellow and clear bags for Contaminated/Active Waste. Cease use or clarify the practice in the procedures. Two CAPAs initiated – one Nordion and one BWXT	Open Open
		10 Observations	AC-CMP-20190320-002	Current work practices for monitoring biohazardous waste pails for radionuclides are not done as per the procedure.	Revise the procedure to reflect the current work practices.	Open
			AC-CMP-20190320-003	The routine waste block documents in Cobalt Operations do not indicate the current Nordion contact.	Work with waste disposal facility to revise the waste block documents for Cobalt Operations.	Open
			AC-CMP-20190320-004	Procedure 070599.SOP does not reflect the current process for analysis of liquid wastes.	Revise the procedure to reflect the current practice of having liquid wastes analyzed by both Nordion QC and an external third party.	Open

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
			AC-CMP-20190320-005	One waste container location had a yellow bag bearing the words “Radioactive Waste”, but the can itself was labelled as “non-Radioactive”.	Review the type of waste can that is required at this location and enforce its use. Add an additional waste container if a collection point for both Radioactive and Non-Radioactive wastes is required.	Open
			AC-CMP-20190320-006	Flammables were located in the miscellaneous and oxidizers chemical storage cabinets in the Medical Isotopes Shipping Area.	Review chemical storage requirements with staff.	Open
			AC-CMP-20190320-007	There are discrepancies in the forklift training requirements for Surveyors.	Review and revise, as required the fork lift training requirements for the Surveyors.	Open
			AC-CMP-20190320-008	Procedure P-002 does not reflect that the Nordion Global Business Practice Standards have been replaced with the Sotera Global Code of Conduct.	Revise the procedure.	Open
			AC-CMP-20190320-009	Training was overdue for a Gamma Technologies employee at the time of the audit.	Ensure completion of the required training.	Open
			AC-CMP-20190320-010	The Medical Isotopes Shipping Area lead collection bins were not labelled or identified.	Label the lead collection point.	Open
			AC-CMP-20190320-017	Some roles do not have CO-MD/OP-0023, CO-MD/OP-0022 and 100054.SOP as training requirements.	Update the training requirements for the identified personnel.	Open

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
		8 OFI's	CHR-3284-NUM	SE-HS-008 does not reflect the use of an inventory sheet in the chemical storage sheds.	Update the procedure.	Open
			CHR-3285-NUM	Procedure 100809.SOP does not reflect the current practice for the incubation period.	Update the procedure to reflect current practice.	Open
			AC-CMP-20190320-011	Old computer parts were present in the collection bin for fluorescent light bulbs.	Install signage at the collection point and remind staff that the collection bin is for light bulbs only.	Open
			AC-CMP-20190320-012	Two large green recycling bins containing glass and plastic were not labeled.	Label the bins.	Open
			AC-CMP-20190320-013	There is no paper collection bin in the Equipment Shed.	Place a paper collection bin in the Equipment Shed.	Open
			AC-CMP-20190320-014	The Heating Plant washroom waste bin had no "organics only" label.	Label the washroom waste bin.	
			AC-CMP-20190320-015	Recommend revising 070019.SOP, Non-Routine Waste Disposal F1 to allow for multiple recommendations for different items to be sent for disposal or to require only one recommendation per completed form.	Review and revise the form and procedure, as necessary.	Open
			AC-CMP-20190320-016	The yellow shipping containers used to transport chemicals from the Shipping area to the chemical storage sheds do not include materials to secure chemicals for transport.	Investigate methods to secure chemicals during transport to the storage sheds and implement as feasible.	Open

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
2	EMS Audit	4 Observations	n/a	The VP, QA, Regulatory & EHS Compliance does not have three environmental procedures as training requirements.	Revise training requirements for the VP, QA, Regulatory & EHS Compliance.	Closed
			n/a	Nordion procedure SE-EHS-015, Management Review did not fully conform to Section 9.3 of the ISO 14001:2015 Standard.	Revise SE-EHS-013 to include the missing requirements of Section 9.3 of the ISO 14001:2015 Standard.	Closed
			AC-20180501-001	Emergency Alarms and Response training was overdue for one employee.	Ensure completion of the required training.	Closed
			n/a	Two Actions specified in the “Fire Drill/Event Summary Report” were not added to the ERP Action Registry.	Add the actions to the ERP Action Registry.	Closed
		2 OFIs	CHR-2842-NUM	Recommend revising Appendix A of SE-ENV-001 to include the new Life Cycle Analysis document, SE-ENV-029, under “Operational Planning and Control”.	Revise the procedure.	Open
			CHR-2772-NUM	Recommend updating procedure SE-ENV-013, Emergency Preparedness and Response to reflect that representatives of Facilities and Production are included in the “Emergency Management Working Group”, depending on the topics and nature of situations/issues that need to be discussed.	Revise the procedure.	Closed

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
3	Safeguarded Physical inventory	2 Observations	AC-CMP-20181107-003	Two safeguarded items were transferred from R&D facility to the waste storage room without the Safeguarded Inventory Control Form.	Review requirements of SE-LIC-016 with R&D staff.	Open
			n/a	Two Depleted Uranium transport containers were not on the in-field DU inventory lists.	Add the two DU transport containers to the electronic inventory system.	Closed
		3 OFI's	n/a	Recommend adding the unique identification number for a split off portion of a liquid Quality Control check source to the List of Inventory Items for Exempted Material.	Add the unique identification number to the inventory listing.	Closed
			n/a	A safeguarded item was not initially physically verified as its unique identifier number was not indicated on the inventory listing. Recommend updating the List of Inventory Items for Safeguarded Material to include the unique identifier 1297 for future reconciliations.	Update the inventory listing.	Closed
			AC-CMP-20181024-001	Recommend EHS review all inventory lists for completeness prior to providing them to the auditor for future physical inventory taking and non-production radioactive material inventory audits.	Ensure review of inventory lists for completeness.	Open

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
4	Non-Production Radioactive Material Inventory (NPRMI)	1 Minor Finding	CAPA 190107	An additional source was located in the storage cabinet in the Cobalt Decontamination area.	Review and revise, as necessary, the process for receiving Non-Production Radioactive Material in the Cobalt Decontamination area.	Open
		9 OFI's	AC-CMP-20190201-001	Two non-production sources were found in the incorrect location as these sources are located in high radiation alarm meters.	A comprehensive list of high radiation alarms containing sources was created. All accessible alarms were labeled to indicate that source tracking is required and work orders were updated with instruction to update the locator in the Common Business System (CBS). Label the remaining high radiation alarms currently located in the Cobalt Operations Facility ceiling area.	Open
			AC-CMP-20190201-002	One source in Radiochemical Quality Control was not listed in the inventory report as it was added to CBS just before the report was generated.	Confirm the source is listed on the next cycle count report.	Open
			AC-CMP-20190201-006	The label of a source was falling off.	Apply a new label to the source.	Open
			AC-CMP-20190201-007	The serial number for one source in the inventory report did not exactly match its label.	Update the serial number for the source in CBS.	Closed

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
			AC-CMP-20190201-003	Recommend checking sources contained in a clear plastic bag for leakage and dispose.	It was confirmed that the sources were not leaking. Review non-production radioactive material inventory in this area and dispose of any un-needed sources.	Open
			AC-CMP-20190201-005	The inventory report does not indicate that some items in R&D contain more than one part. Recommend providing an indication that items contain more than one part.	Update the cycle count inventory sheets to include quantities that are to be present for sources that have more than one part.	Open
			AC-CMP-20190204-004	A source was found on a list posted to a waste storage pail in Room 1108, but not listed on the inventory report or the EHS spreadsheet.	Verify the presence of all sources on the list posted to the waste storage pail in Room 1108 when the pail is prepared for transfer to a waste disposal facility.	Open
			AC-CMP-20190204-005	Recommend labeling additional source located in the storage cabinet in the [redacted] area with its unique identifier 1306. Recommend re-numbering and relabeling source serial number 62-103 to its unique identifier 1289.	Source 62-103 was renumbered. Ensure relabeling of sources.	Open
			AC-CMP-20190204-006	Source 698 was found on the inventory report, but not listed on the EHS spreadsheet.	Add source 698 to the EHS inventory spreadsheet.	Closed
5	EHS Internal Audit Program	None	n/a	n/a	n/a	n/a

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
6	Work Planning and Control	1 Minor Finding	CAPA 180604	One Elevator Safety and two Argon Fire Suppression inspections were not completed within the required timeframe.	Review expectations with suppliers for completion of inspections. Ensure corrective actions are put in place with the suppliers to prevent future delays. Assess long term strategies to ensure resource and equipment availability.	Open
		2 Observations	AC-CMP-20180627-001	Nitrile gloves were not used by the Radiochemistry Quality Control group as specified in SE-HS-042.	Ensure that the requirement for the use of nitrile gloves is communicated to employees who handle mercury.	Open
			AC-CMP-20180627-001	A Senior Technician was not aware of the spill kit and the spill kit location.	Ensure that the spill kit location and instructions for use are communicated to employees who handle mercury.	Open
		4 OFIs	AC-CMP-20180627-002 CHR-3209-NUM	Two out of three Workplace Health and Safety Committee meeting minutes reviewed did not contain the review of hazard identifications and hazard rankings. Recommend indicating the required frequency for the review of hazard identifications and hazard rankings in SE-HS-025.	Add the required frequency of the review to SE HS-025.	Open
			AC-CMP-20180627-004	There is no place to record the Director review on the Job Hazard Analysis/Risk Assessment form.	Modify the Job Hazard Analysis/Risk Assessment form to include a field to record Director review.	Closed

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
			AC-CMP-20180627-004	Two out of four Job Hazard Analysis/Risk Assessment forms reviewed did not have the date of the review or date of when updates were last done.	Modify the Job Hazard Analysis/Risk Assessment form to include fields to record the date when reviews or updates were last completed.	Closed
			AC-CMP-20180627-005	Procedure SE-HS-043 does not specify process for follow-up of actions or record retention requirements.	Revise SE-HS-043 to include process for follow-up of actions and record retention requirements.	Closed
7	Safety Culture	2 OFIs	AC-CMP-20190213-006	Safety Culture program requirements are outlined in portions of numerous documents listed in the Safety Culture section of SE-LIC-001. Recommend outlining Safety Culture Program requirements in a single program document.	Create a Safety Culture Program document.	Open
			AC-CMP-20190213-008	Corrective Actions resulting from workplace inspections are tracked through various systems at Nordion (ex. VelocityEHS, Site Support System); however, there is no formal process for follow-up to check that these actions are closed in a timely manner.	Assess implementation of a formal process to check that Corrective Actions resulting from workplace inspections are closed in a timely manner.	Open
8	Transportation Program and Quality Plan	2 Minor Findings	CAPA 181101	A number of required maintenance steps were not performed on a Nordion Type B transport package.	Currently long-term corrective actions are being assessed and planned.	Open

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
			CAPA 181102	An obsolete version of the operating procedure for a Nordion Type B package was available in EQMS. The current version had been received but not entered in EQMS.	Currently long-term corrective actions are being assessed and planned.	Open
		7 Observations	AC--20181113-002	The Common Business System (CBS) collection plan does not include the requirement for heat shield inspection. While the heat shield has not been used to date in the current configuration, the collection plan should include a field to record that inspection of the heat shield was completed or is not required for the current configuration.	Modify the procedure or the CBS collection plan.	Open
			AC-20181119-001	Regulatory approval for a design change to the F-522 package was not obtained prior to making the Design, Manufacture and Operation Specification (DMOS) effective.	Implement a third level of approval in EQMS for regulatory approval for specific documents referenced on CNSC transport and special form certificates.	Closed
			CHR-2486-NUM	Two forms required by procedure 000069.SOP were not completed as part of the F-522 project.	Modify procedure 000069.SOP to allow for the use of either Form F2 or a memo to file to capture the required Design Review Minutes.	Closed

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
			CHR-3119-NUM CHR-3210-NUM	The practice of receipt and shipment of packages differs slightly between Medical Isotopes (BWXT) and Gamma Technologies (Nordion). There are inconsistencies in the procedural requirements.	Update procedures.	Open
			AC-20181113-003	Procedure 060201.SOP does not reflect the current practice for completion of Waybills.	Update procedure 060201.SOP to reflect the current practice with respect to completion of Waybills.	Open
			AC-20181113-001	Two Global Logistics procedures require updates to reflect current practices.	Update the two procedures to reflect current practices.	Closed
			n/a	The handling and loading of a package inner flask was not done as per the procedures.	Revise documentation to reflect current practices.	Closed
		1 OFI	n/a	A contract carrier driver removed the placards from his vehicle prior to loading at Nordion.	The issue was discussed with the driver at the time. Discuss the issue with the contract carrier's management.	Closed
9	Environmental Protection Program	5 OFIs	AC-20181220-001	Derived Release Limits (DRLs) in REP-EHS-009 took effect January 2018; however, the Licence Condition Handbook (LCH) and procedure SE-RP-001 have not been updated with the (new) DRLs.	Request an amendment to the LCH to incorporate the new DRLs and update the program documentation (SE-RP-001) accordingly.	Open
			AC-20181220-002	Since 2012, Nordion's Annual Compliance Reports (ACRs) have not included the dosimetry data for one of the environmental TLDs.	Ensure the results for all environmental TLDs are included in the 2018 ACR.	Closed

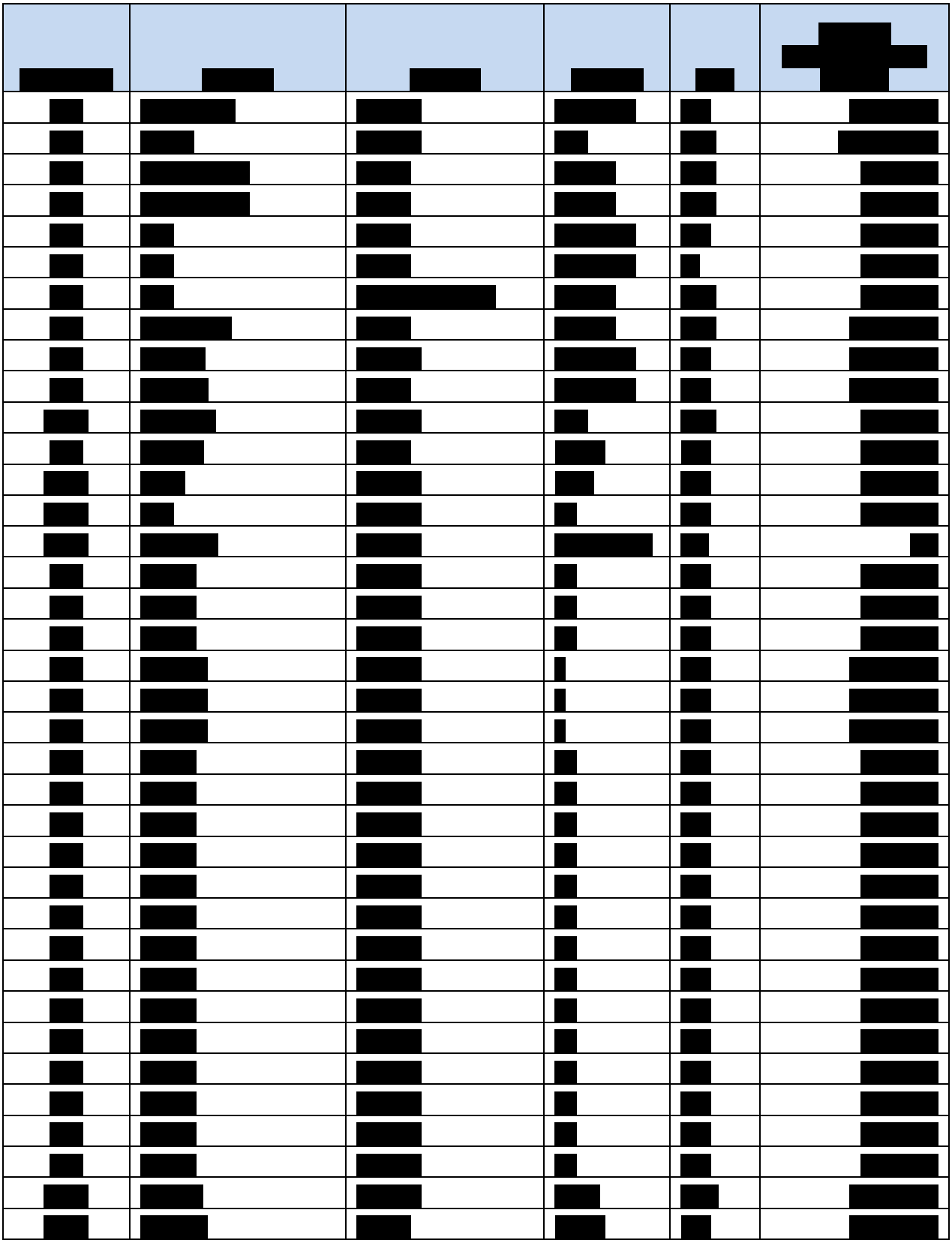
	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
			AC-20181220-003	Recommend referencing "Nordion Environmental Monitoring Program Design Document" report in SE-ENV-015.	Update SE-ENV-015 to reference the Report.	Open
			AC-20181220-004	For the release of contaminants in effluents there is an Action Level only for Co-60 in air (and no other radionuclides).	Revise procedures to include justification for the exclusion of certain radionuclides (such as Mo-99, Ir-192 or Y-90) from requiring an Action Level.	Open
			AC-20181220-005	N288.5 recommends that factors that could contribute to the uncertainty in a measured or calculated value should be identified and ranked according to their contribution. Uncertainties in releases to the environment are currently calculated and reported in the ACR. The calculation is documented in a spreadsheet.	Create a uncertainty estimation protocol considering all contributors to uncertainty.	Open
10	Safeguards, Non-proliferation and Export/Import Controls and Sanctions Program	2 Observations	n/a	Two employees did not have SE-LIC-016 as a training requirement.	Add procedure SE-LIC-016 to the training requirements for the two employees.	Closed
			CHR-3091-NUM	The positions listed in Section 9 of CPM-7-06 are incorrect.	Revise CPM-7-06.	Open
11	Sealed Source Export Controls	None	n/a	n/a	n/a	n/a
12	Document Control and Records	1 Minor Finding	CAPA 190106	Emails are not being sent to External Document Owners to update the inventory of external documents.	Corrective actions are currently being developed.	Open

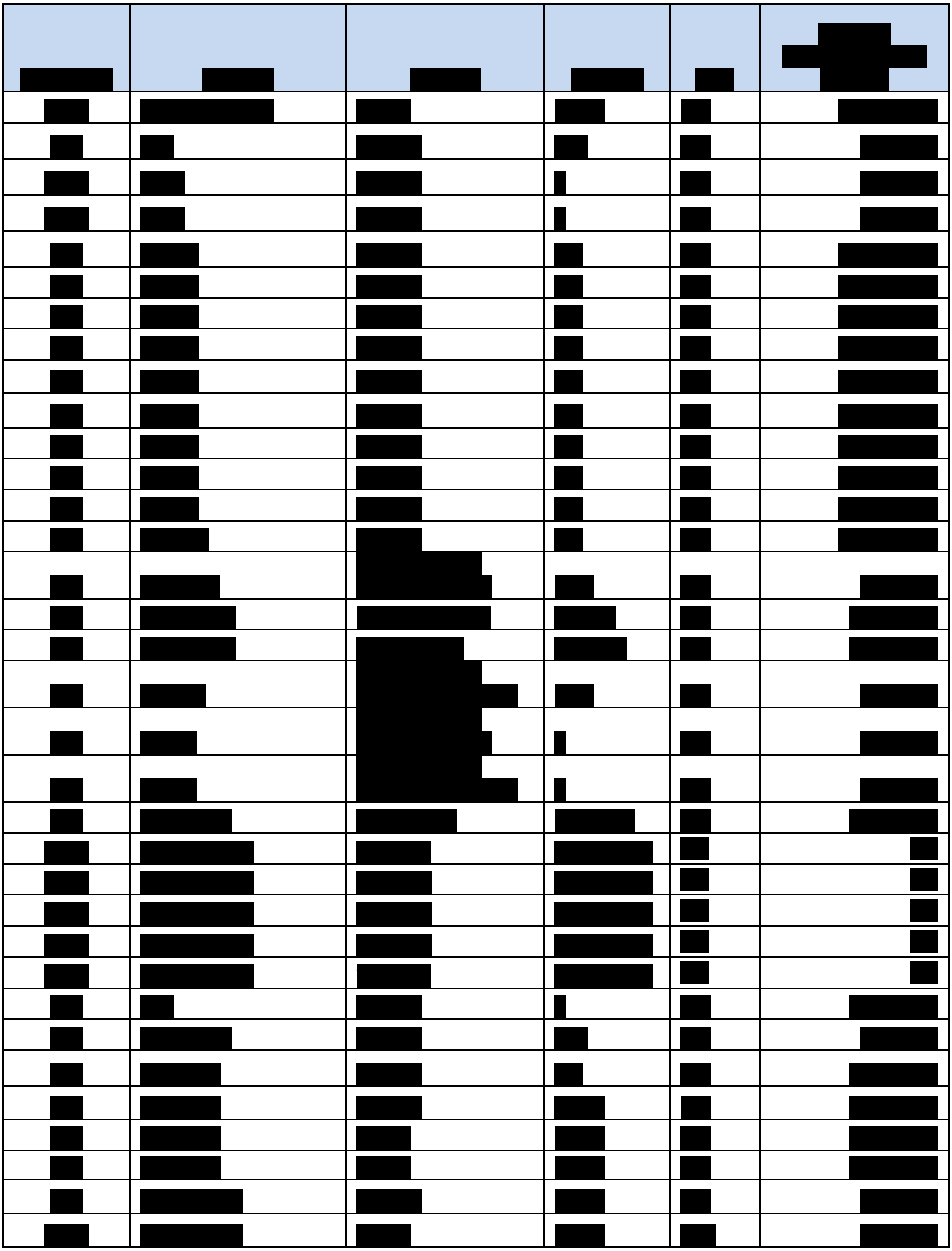
	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
		1 Observation	AC-20190207-003	A closed Change Form did not contain the QAP AP-45 F6 “New Document Metadata Requirements”.	The form was completed and filed with the Change Form.	Closed
		1 OFI	CHR-3233-NUM	Recommend removing “Health Physics Records from CPM-7-09 as there are no records associated with Health Physics to retain.	Revise CPM-7-09 to remove “Health Physics Records”.	Open
13	Supply Chain	1 OFI	AC-CMP-20181109-002	SE-ENV-019 specifies that a Supplier Self-Assessment form will be sent to the supplier as preparation for the supplier audit. Recommend sending a copy of the Self-Assessment forms obtained prior to Supplier Audits to Supply Chain Management for filing and saving the form in a designated location for future reference.	Ensure copies of forms are sent to Supply Chain Management for their supplier file and electronic versions are saved to supplier file folder in EHS.	Open
14	Transportation of Dangerous Goods – Non-Class 7	4 Minor Findings	AC-20181004-001	The shipping documents for two chemicals did not note the subsidiary class, as required by the TDG Regulations Section 3.5.	Ensure review of the shipping documents for shipments of these chemicals to ensure the proper class has been identified.	Open
			AC-20181004-002 AC-20181004-003	There is no formal documentation to justify the classification of UN3373 (Biological Substance) and UN3264 (Corrosive Liquid) as required by the TDG Regulations Section 2.2.1.	Document the justification of the UN3373 classification. Document the justification for the UN3264 classification.	Closed Open

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
			n/a	Microbiology Technicians who perform packaging activities did not have TDG training as a training requirement.	Add TDG training as a requirement for personnel as identified by the Quality Control Manager.	Closed
			CAPA 181001	There are no formal procedures for the shipment of non-radioactive dangerous goods.	Create a new procedure detailing the requirements and instructions for the shipment, packaging and documentation of non-radioactive dangerous goods.	Open
		1 OFI	n/a	Several shipments met the limit threshold for Excepted Quantities exemptions; however there were no Excepted Quantities labels observed in the work areas.	Labels are available in Global Logistics and any required labelling will be provided prior to shipment.	Closed.
15	Process Safety Audit for Removing TheraSphere Orders – Reducing Doses to Monitors	None	n/a	n/a	n/a	n/a

NOTE: The actions from the Supplier audit (listed in Section 2.1.3.1) have not been included in the above table; however findings are being managed in accordance with internal procedures.

Appendix C
Non-Production Sealed and Unsealed Source Inventory





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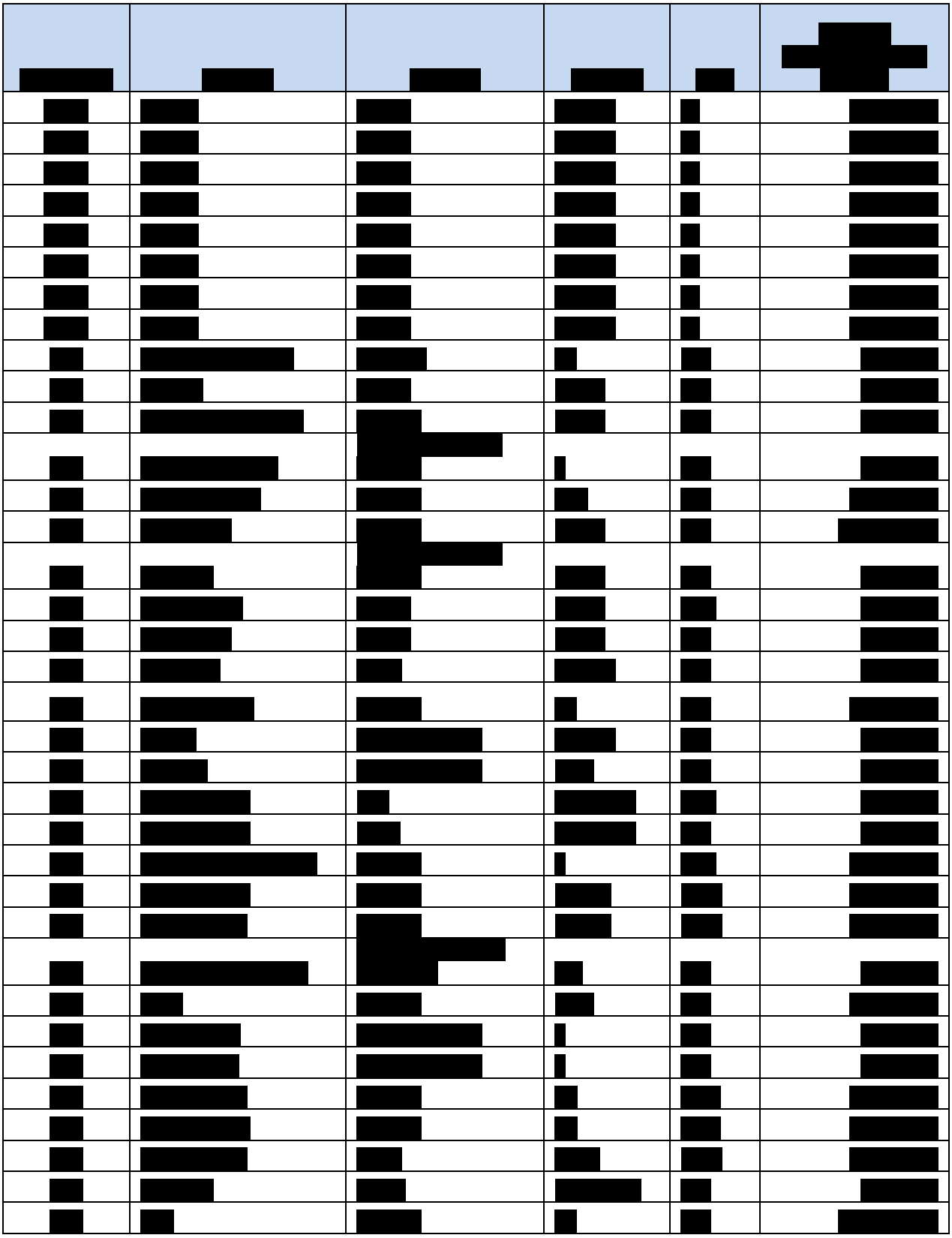

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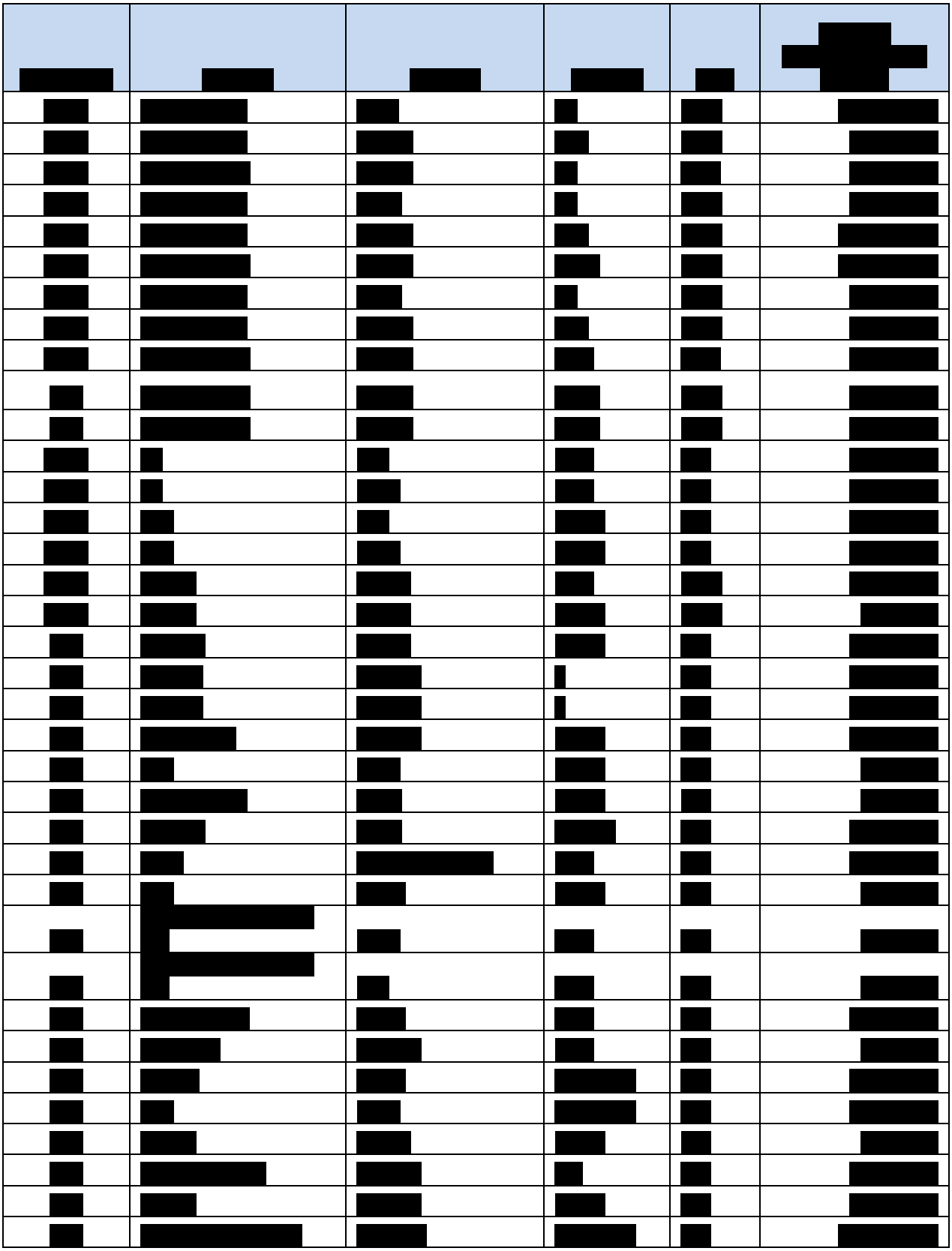

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Appendix D
Additional Radiation Dose Data – Effective and Equivalent Dose and Lens of the Eye

Table D.1
Minimum, Maximum and Average Worker Effective Doses (Active Area and Non-Active Area Personnel) (mSv)

		2014	2015	2016	2017	2018	CNSC Regulatory Limit
Active Area Personnel (NEWs)	**Average**	0.65	0.56	0.75	0.67	0.71	n/a
	Maximum	6.03	5.24	4.9	5.49	4.23	50/yr; 100/5yr
	Minimum	0	0	0	0	0	n/a
	Number Monitored				141	137	
Non-Active Area Personnel (NEWs)	**Average**	0.14	0.16	0.2	0.13	0.14	n/a
	Maximum	1.73	1.88	2.06	1.5	2.07	50/yr; 100/5yr
	Minimum	0	0	0	0	0	n/a
	Number Monitored				122	111	

Table D.2
Minimum, Maximum and Average Equivalent Skin Exposure Doses (mSv)

		2014	2015	2016	2017	2018	CNSC Regulatory Limit
NEWs	**Average**	0.46	0.42	0.59	0.42	0.45	n/a
	Maximum	6.11	5.21	5.2	5.5	4.26	500/yr
	Minimum	0	0	0	0	0	n/a
	Number Monitored	269	264	267	263	248	
Contractors	**Average**	0.07	0.03	0.07	0.02	.05	n/a
	Maximum	0.31	0.12	0.39	0.18	0.28	50/yr
	Minimum	0	0	0	0	0	n/a
	Number Monitored	52	46	51	55	45	
Active Area Personnel (NEWs)	**Average**	0.69	0.58	0.92	0.67	0.70	n/a
	Maximum	6.11	5.21	5.2	5.52	4.26	500/yr
	Minimum	0	0	0	0	0	n/a
	Number Monitored				141	137	
Non-Active Area Personnel (NEWs)	**Average**	0.15	0.16	0.22	0.13	0.14	n/a
	Maximum	1.78	1.9	2.09	1.59	2.06	500/yr
	Minimum	**0**	0	0	0	0	n/a
	Number Monitored				122	111	

Table D.3
Minimum, Maximum and Average Equivalent Extremity Doses (mSv)

		2014	2015	2016	2017	2018	CNSC Regulatory Limit
NEWs	**Average**	0.73	0.46	0.79	0.53	0.96	n/a
	Maximum	9.5	9.3	8.3	16.4	9.08	500/yr
	Minimum	0	0	0	0	0	n/a
	Number Monitored	135	137	128	125	116	
Active Area Personnel (NEWs)	**Average**	0.73	0.48	0.86	0.58	1.03	n/a
	Maximum	9.5	9.3	8.3	16.4	9.08	500/yr
	Minimum	0	0	0	0	0	n/a
	Number Monitored				109	106	
Non-Active Area Personnel (NEWs)	**Average**	0	0	0	0.20	0.23	n/a
	Maximum	0	0	0	1.8	1.66	500/yr
	Minimum	0	0	0	0	0	n/a
	Number Monitored				16	10	

Note: Contractors are not monitored for extremity dose.

Table D.4

Minimum, Maximum and Average Equivalent Dose for Lens of the Eye (mSv)

		2017	2018	CNSC Regulatory Limit
NEWs	**Average**	0.42	0.45	**n/a**
	Maximum	5.52	4.27	**50/yr; 100/5yr**
	Minimum	0	0	**n/a**
	Number Monitored	263	248	
Contractors	**Average**	0.022	0.05	**n/a**
	Maximum	0.2	0.26	
	Minimum	0	0	**n/a**
	Number Monitored	55	45	
Active Area Personnel (NEWs)	**Average**	0.67	0.71	**n/a**
	Maximum	5.52	4.27	**50/yr; 100/5yr**
	Minimum	0	0	**n/a**
	Number Monitored	141	137	
Non-Active Area Personnel (NEWs)	**Average**	0.13	0.14	**n/a**
	Maximum	1.61	2.06	**50/yr; 100/5yr**
	Minimum	0	0	**n/a**
	Number Monitored	122	111	

APPENDIX E
5-Year Trending of Whole Body Doses for NEW Groups at Nordion

Figure 1: Cobalt Production Technicians

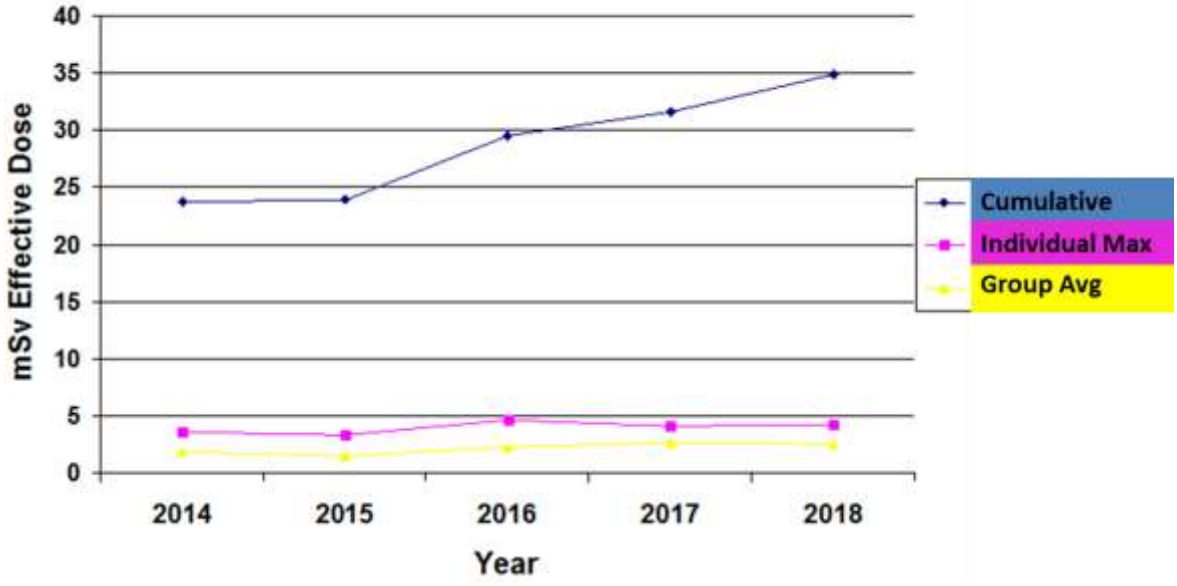


Figure 2: Cobalt Monitoring, Decontam and Shipping

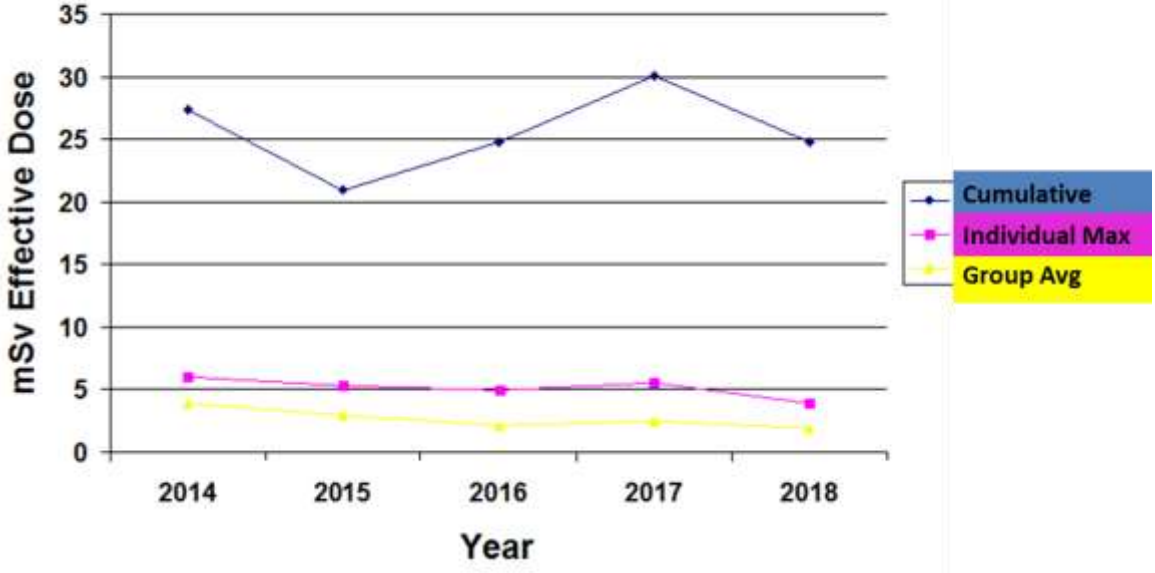


Figure 3: Cobalt Development

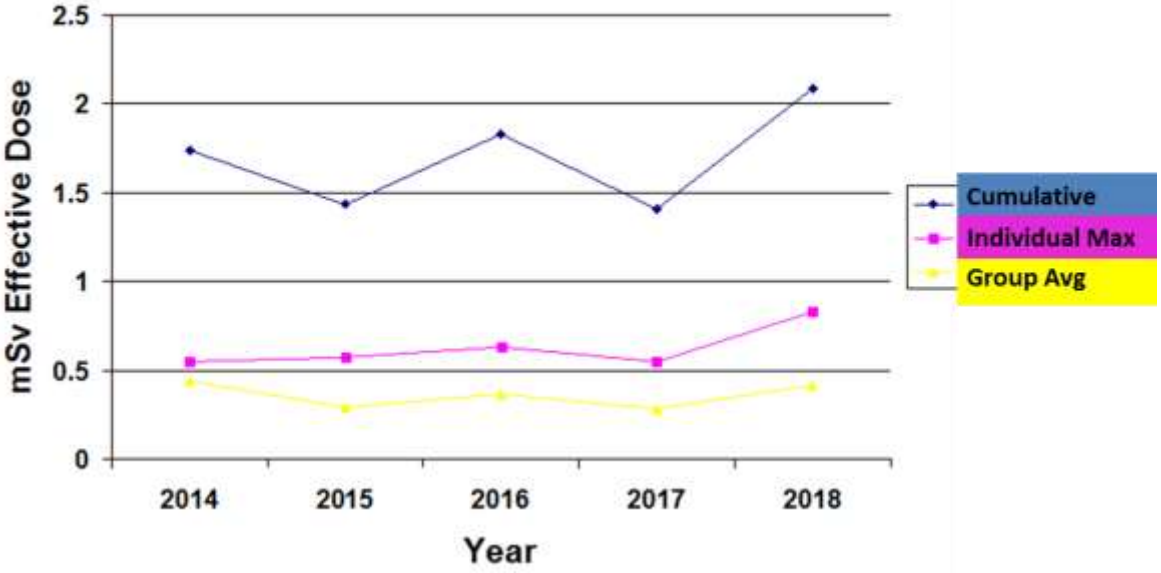


Figure 4: QC Cobalt

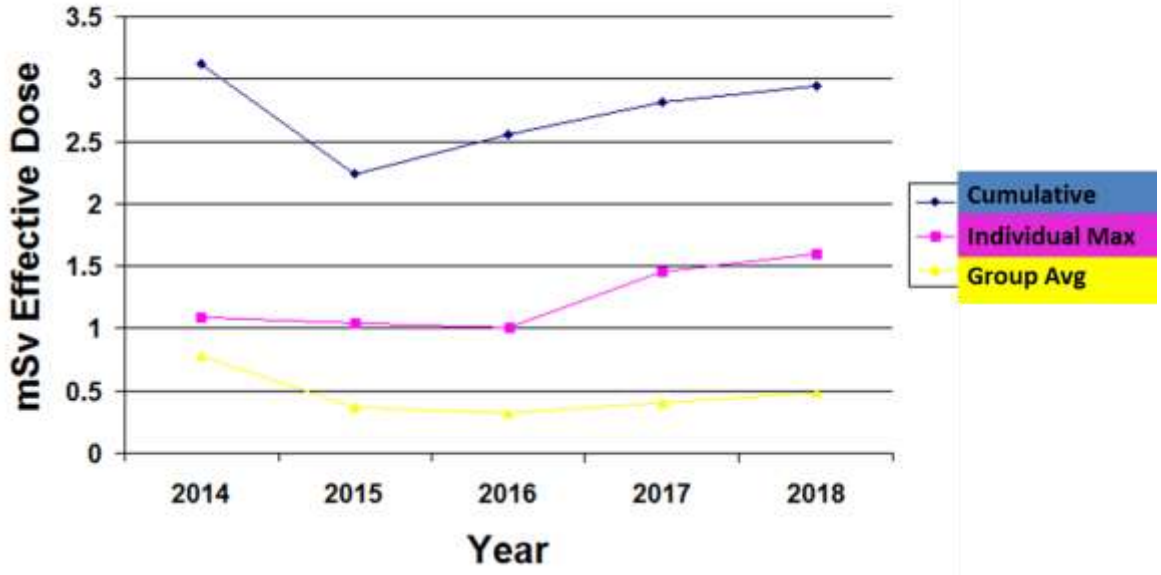


Figure 5: Radiopharm Development

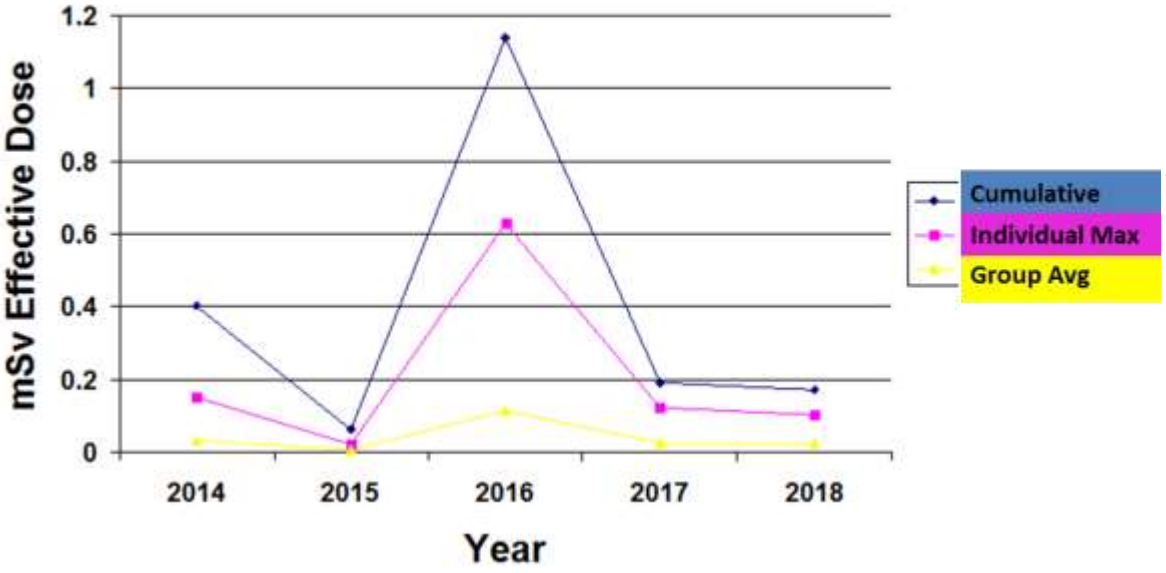


Figure 6: Technical Support

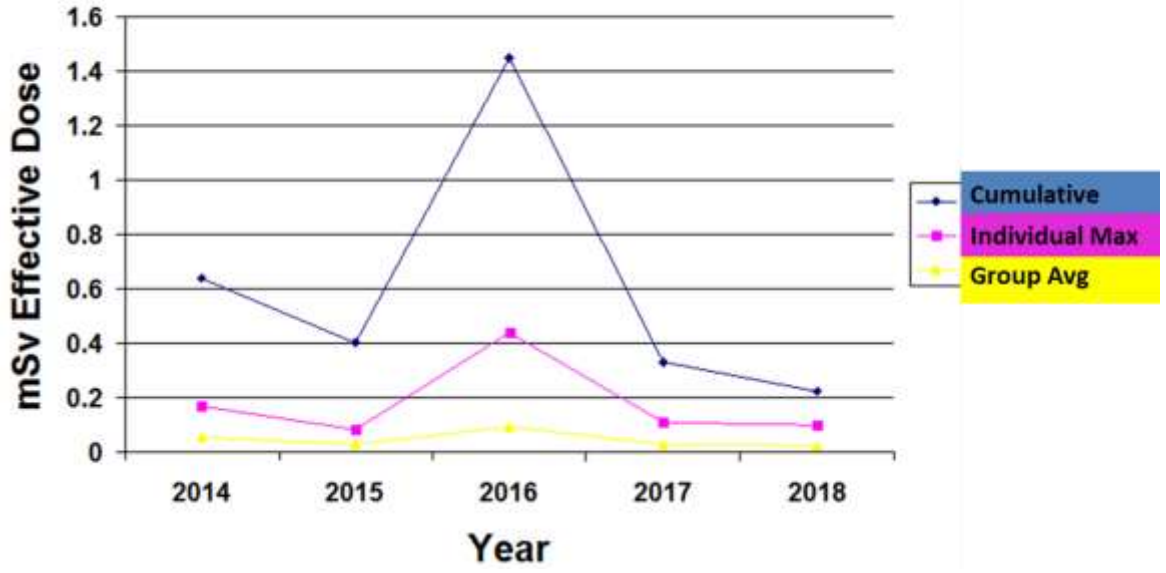


Figure 7: Nuclear Medicine Shippers, Waste, Containers

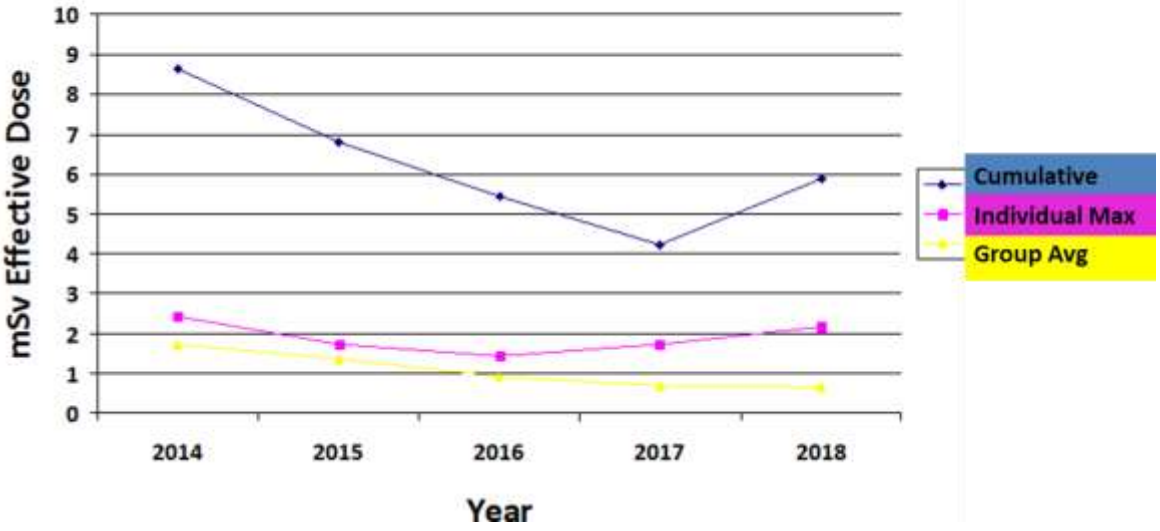


Figure 8: I-125, I-131 & Ir-192 Production Technicians

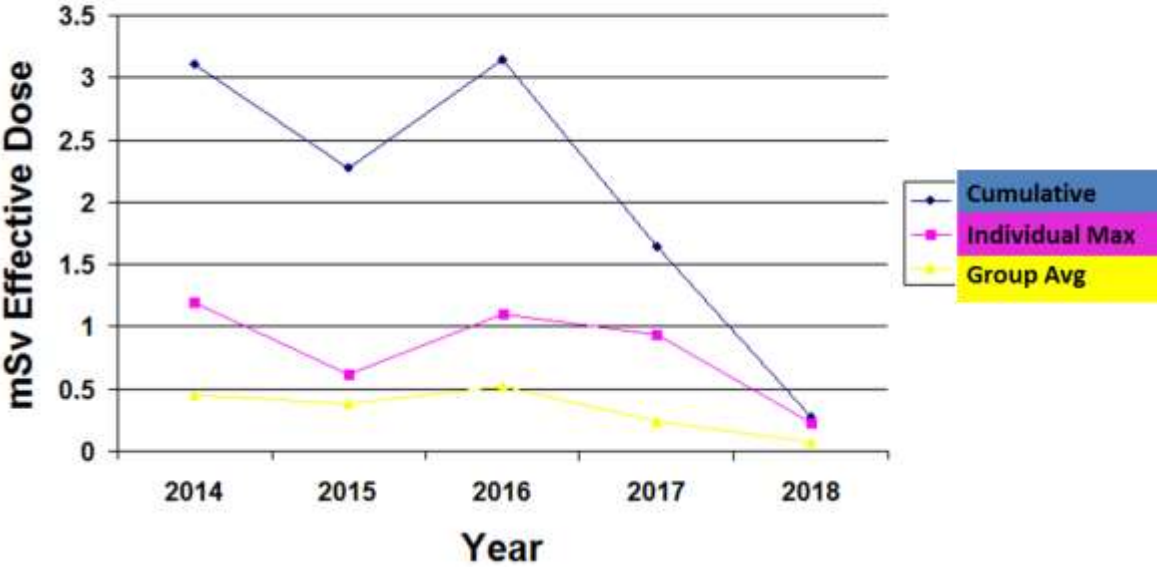


Figure 9: Mo-99, Xe-133 & Sr-82 Production Technicians

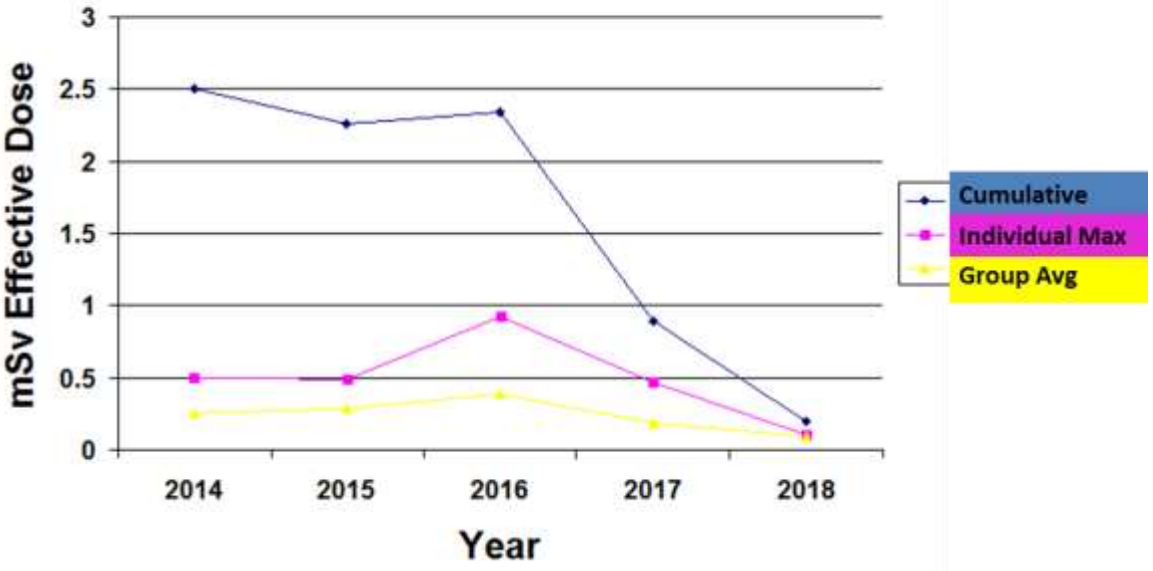


Figure 10: Radiopharm Production Technicians

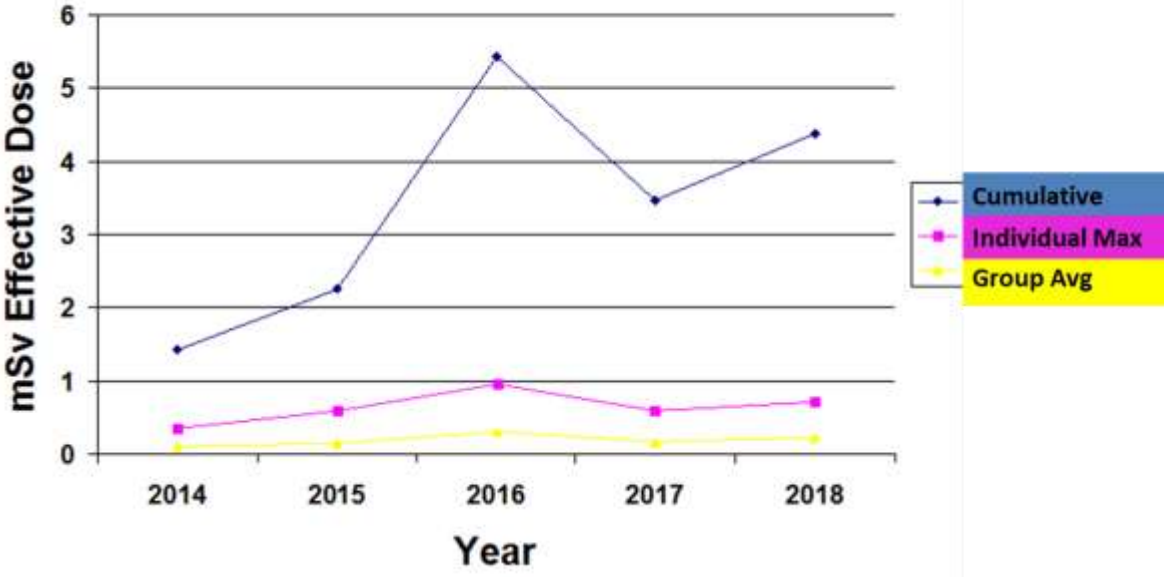


Figure 11: Machinists

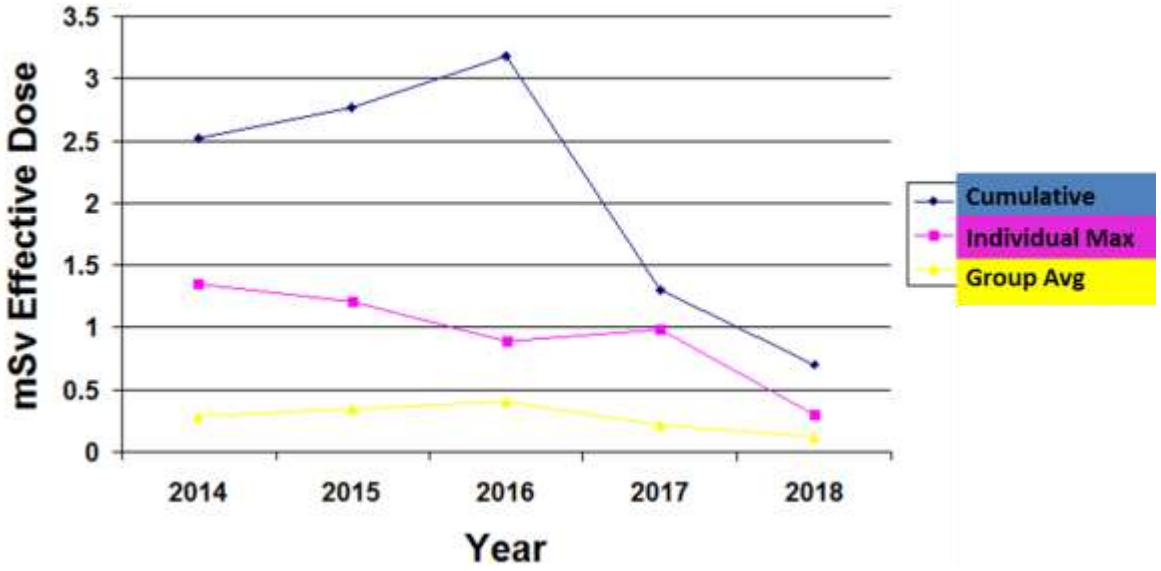


Figure 12: Nuclear Medicine QC

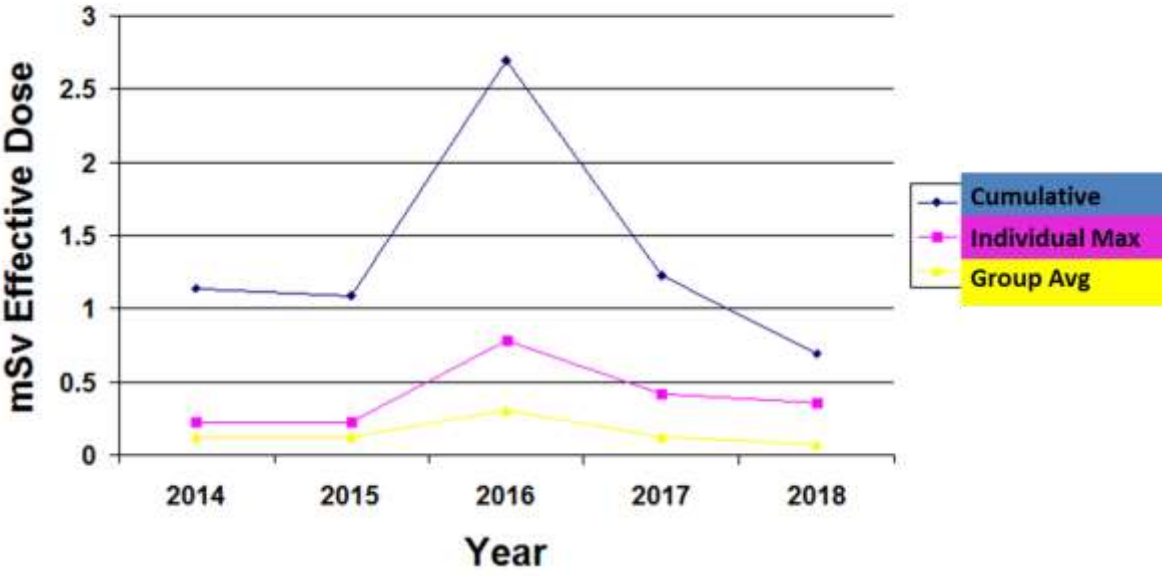


Figure 13: Surveyors

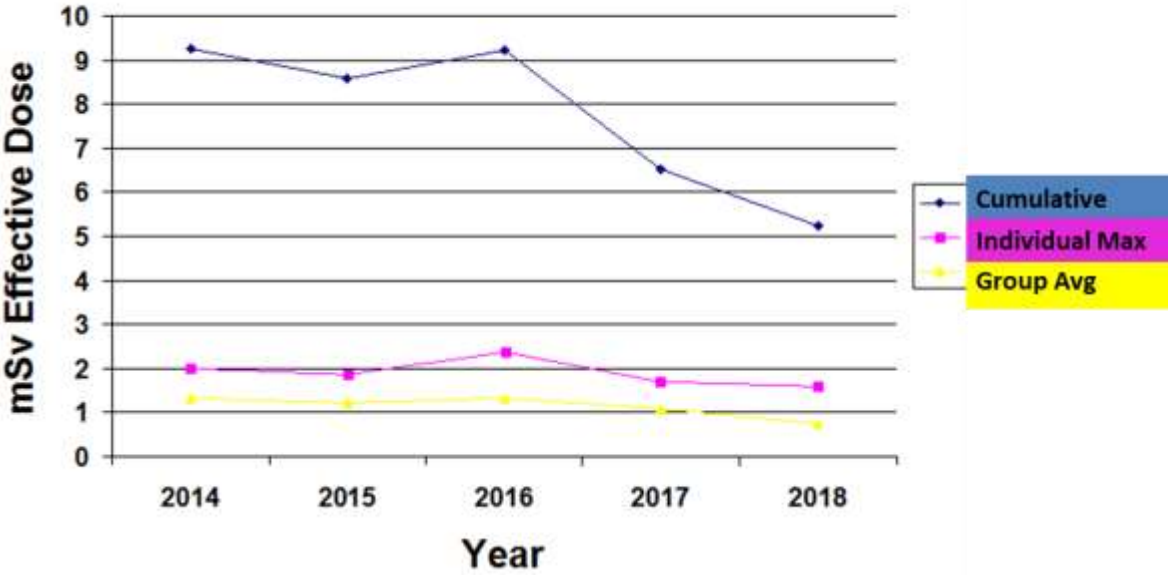


Figure 14: Nuclear Medicine Operators, Helpers

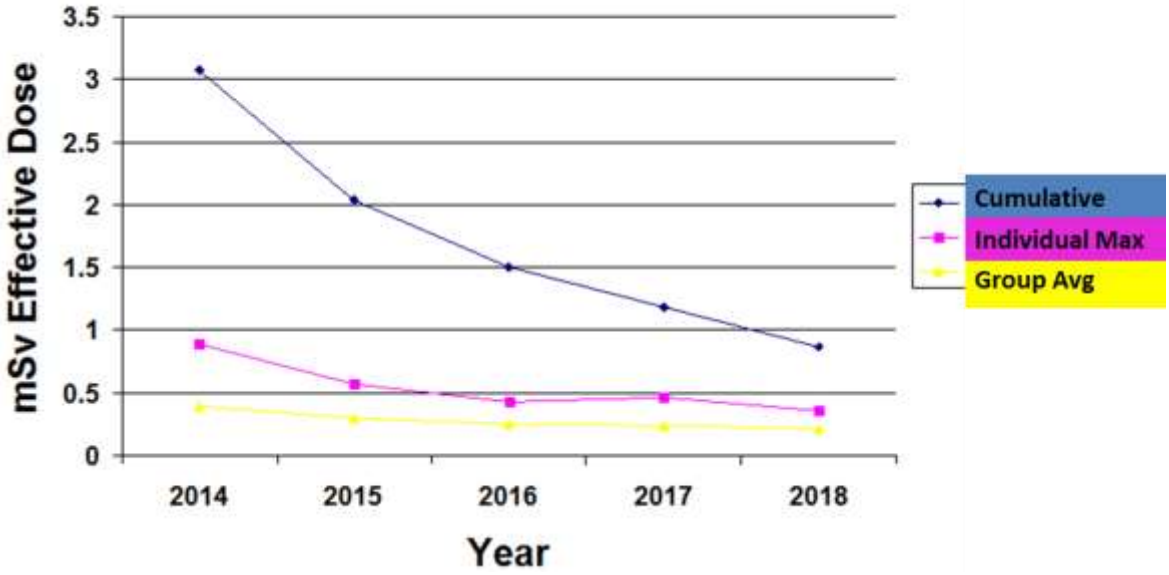


Figure 15: Nuclear Medicine Radiation and Contamination Monitors

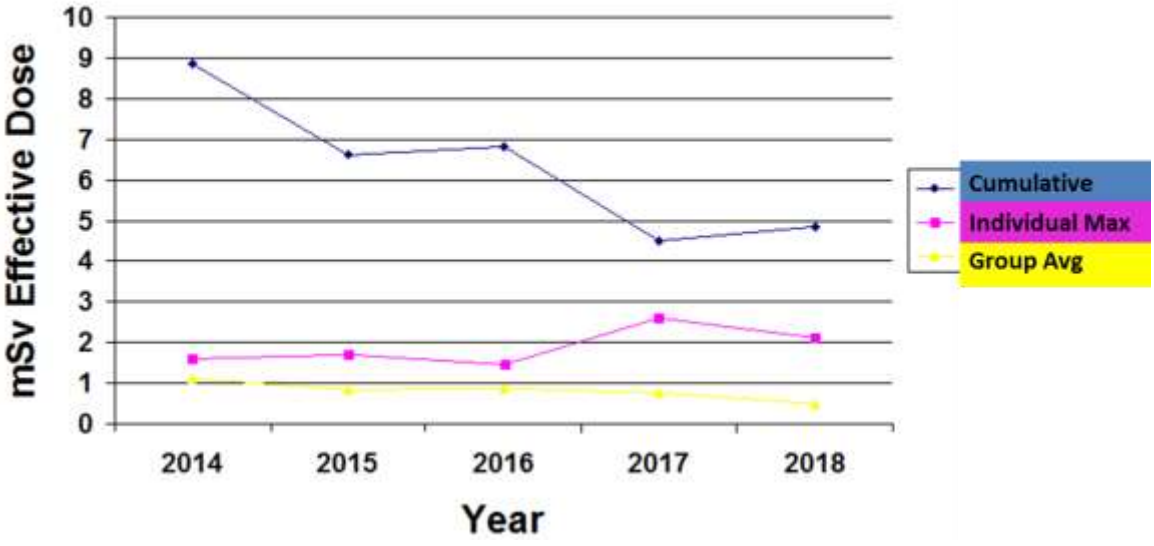


Figure 16: Facilities, Motor Pool

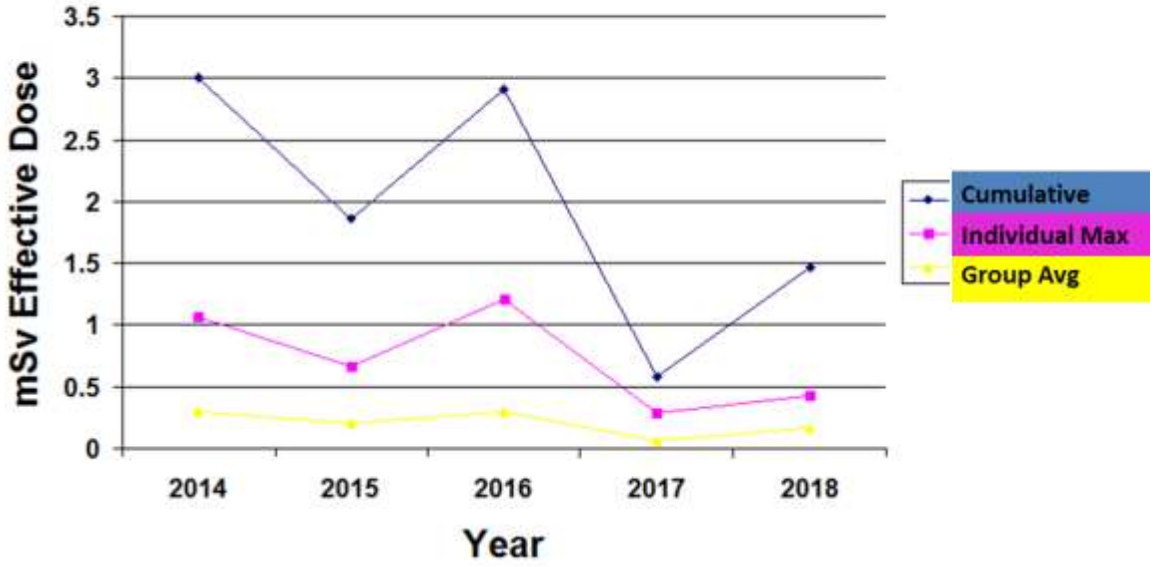


Figure 17: Facilities, Mechanical

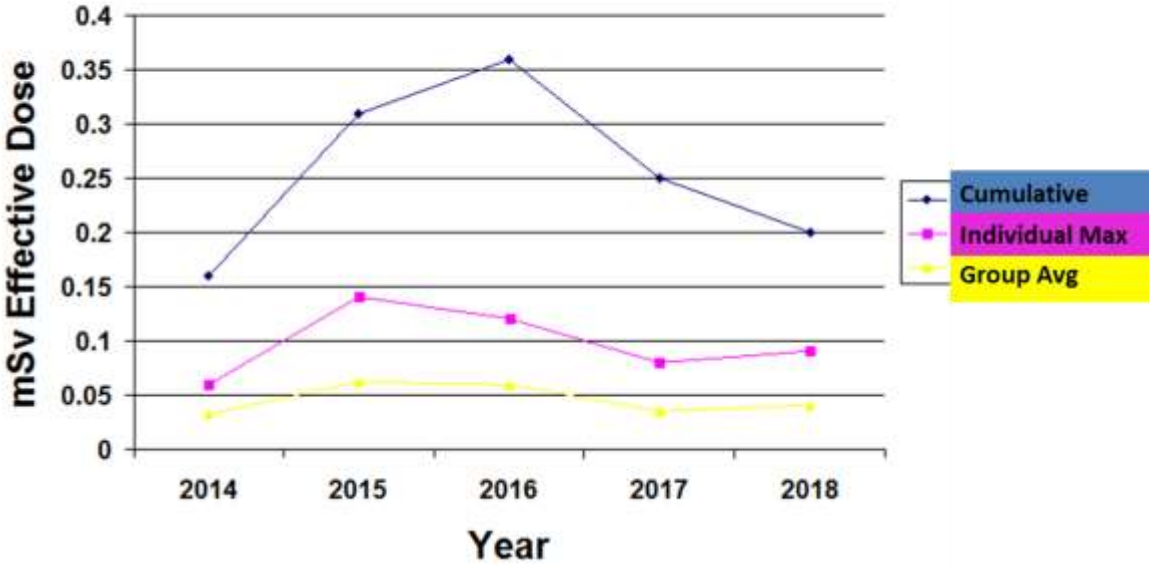


Figure 18: Radiopharm QC

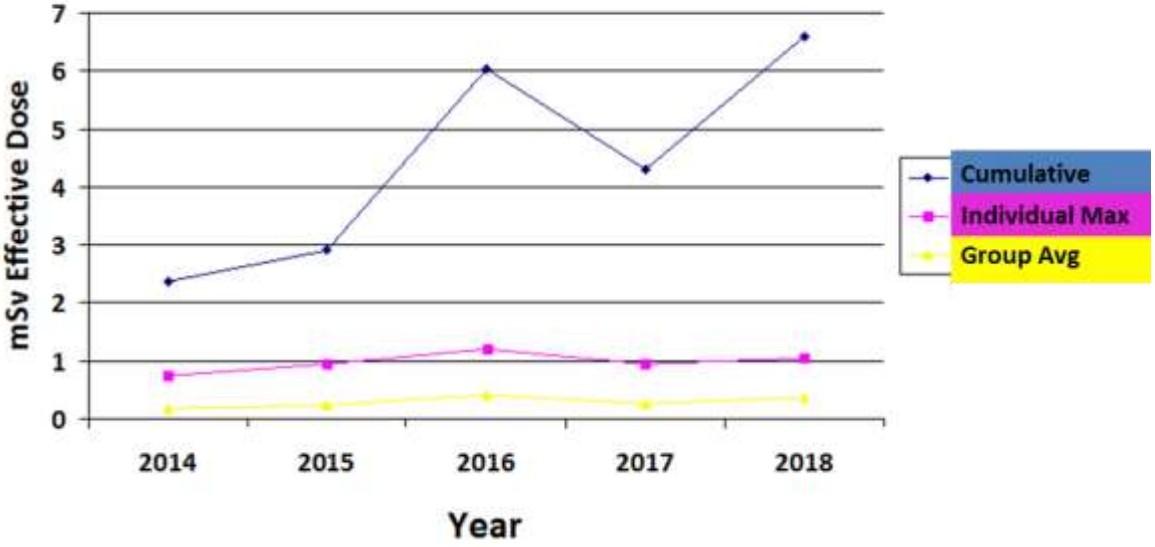
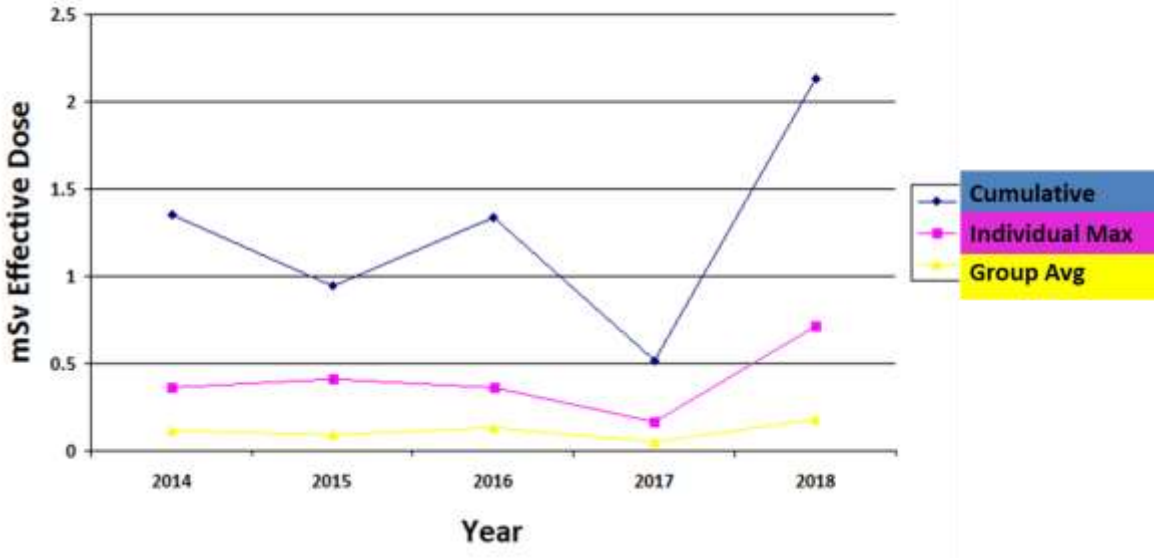


Figure 19: Facilities, Electricians & Electronic Calibration Lab



Appendix F
Groundwater Sampling (Non-radiological)
Borehole #1 (2005-BH1)

		Sample Date:	2018-06-08	2017-10-06	2016-11-02	2015-10-05	2014-10-29	2013-09-18	2005-04-07 (initial Sample)
		Sample ID:	**2005-BH1**	**2005-BH1**	**2005-BH1**	**2005-BH1**	**2005-BH1**	**2005-BH1**	**2005-BH1**
Parameter	**UNITS**	**MDL**							
Alkalinity as CaCO3	mg/L	5	440	448	336	337	329	314	278
Biochemical Oxygen Demand	mg/L	1	<3	<3	<3	<1	<1	1	<1
Chemical Oxygen Demand	mg/L	5	<5	83	<5	9	8	<5	7
Chloride (Cl)	mg/L	1	48	68.2	176	141	139	89	40
Conductivity	µS/cm	5	1010	1110	1200	1100	1080	888	676
Dissolved Organic Carbon	mg/L	0.5	2.3	5.0	0.7	2.8	2.2	1.6	1.6
N-NH3 (Ammonia)	mg/L	0.02	0.03	0.05	<0.01	<0.025	0.13	0.08	0.02
N-NO3 (Nitrate)	mg/L	0.1	<0.05	<0.05	1	0	0	0	0.53
pH			8.02	7.96	7.88	7.77	7.96	7.82	7.71
Sulphate (SO4)	mg/L	1	51	35	25	24	24	23	22
TDS (COND - CALC)	mg/L	5	623	634	816	715	702	577	439
Total Suspended Solids	mg/L	2	304	<3	<3	81	58	24	1390
Calcium (Ca)	mg/L	1	125	133	134	124	125	97	80
Magnesium (Mg)	mg/L	1	53.2	61.3	50	48	44	37	29
Sodium (Na)	mg/L	2	70.8	54.4	47	36	38	30	18
Barium (Ba)	mg/L	0.01	0.190	0.195	0.02	0.03	0.02	0.02	0.02
Boron (B)	mg/L	0.01	0.054	0.084	0.01	0.03	0.03	0.03	0.07
Iron (Fe)	mg/L	0.03	2.12	1.82	0.09	0.62	0.27	0.24	<0.01
PHC F1 (C6-C10)	mg/L	0.2	<0.02	<0.02	<0.02	<0.2	<0.2	<0.1	<0.2
PHC F2 (C10-C16)	mg/L	0.2	<0.05	<0.05	<0.05	<0.2	<0.2	<0.1	<0.2
PHC F3 (C16-C34)	mg/L	0.5	<0.4	<0.4	<0.4	<0.5	<0.5	<0.2	<0.2
PHC F4 (C34-C50)	mg/L	0.5	<0.4	<0.4	<0.4	<0.5	<0.5	<0.2	<0.2

* Note: The initial sample from 2005-BH1 taken September 18, 2013 indicated 0.5 mg/L of F3 (hydrocarbon). As a result, a second sample was taken from 2005-BH1 November 16, 2013. Results from the second sample indicated that F3 was below detectable limits (< 200 µg/L).

Borehole #2 (2005-BH2)
(Background Well)

Sample Date:			2018-06-08	2017-10-06	2016-11-02	2015-10-05	2014-10-29	2013-09-18	2005-04-07 (initial Sample)
Sample ID:			2005-BH2	2005-BH2	2005-BH2	2005-BH2	2005-BH2	2005-BH2	2005-BH2
Parameter	**UNITS**	**MDL**							
Alkalinity as CaCO3	mg/L	5	322	322	336	337	329	314	278
Biochemical Oxygen Demand	mg/L	1	<3	<3	<3	<1	<1	1	<1
Chemical Oxygen Demand	mg/L	5	<5	<5	<5	9	8	<5	7
Chloride (Cl)	mg/L	1	184	139	176	141	139	89	40
Conductivity	µS/cm	5	1200	1140	1200	1100	1080	888	676
Dissolved Organic Carbon	mg/L	0.5	0.8	1.9	0.7	2.8	2.2	1.6	1.6
N-NH3 (Ammonia)	mg/L	0.02	<0.01	<0.01	<0.01	<0.025	0.13	0.08	0.02
N-NO3 (Nitrate)	mg/L	0.1	0.950	1	1	0	0	0	0.53
pH			7.94	7.96	7.88	7.77	7.96	7.82	7.71
Sulphate (SO4)	mg/L	1	27	21	25	24	24	23	22
TDS (COND - CALC)	mg/L	5	651	581	816	715	702	577	439
Total Suspended Solids	mg/L	2	5	<3	<3	81	58	24	1390
Calcium (Ca)	mg/L	1	137	126	134	124	125	97	80
Magnesium (Mg)	mg/L	1	51	49	50	48	44	37	29
Sodium (Na)	mg/L	2	51	46	47	36	38	30	18
Barium (Ba)	mg/L	0.01	0.02	0.03	0.02	0.03	0.02	0.02	0.02
Boron (B)	mg/L	0.01	0.02	0.03	0.01	0.03	0.03	0.03	0.07
Iron (Fe)	mg/L	0.03	0.194	0.81	0.09	0.62	0.27	0.24	<0.01
PHC F1 (C6-C10)	mg/L	0.2	<0.02	<0.02	<0.02	<0.2	<0.2	<0.1	<0.2
PHC F2 (C10-C16)	mg/L	0.2	<0.05	<0.05	<0.05	<0.2	<0.2	<0.1	<0.2
PHC F3 (C16-C34)	mg/L	0.5	<0.4	<0.4	<0.4	<0.5	<0.5	<0.2	<0.2
PHC F4 (C34-C50)	mg/L	0.5	<0.4	<0.4	<0.4	<0.5	<0.5	<0.2	<0.2

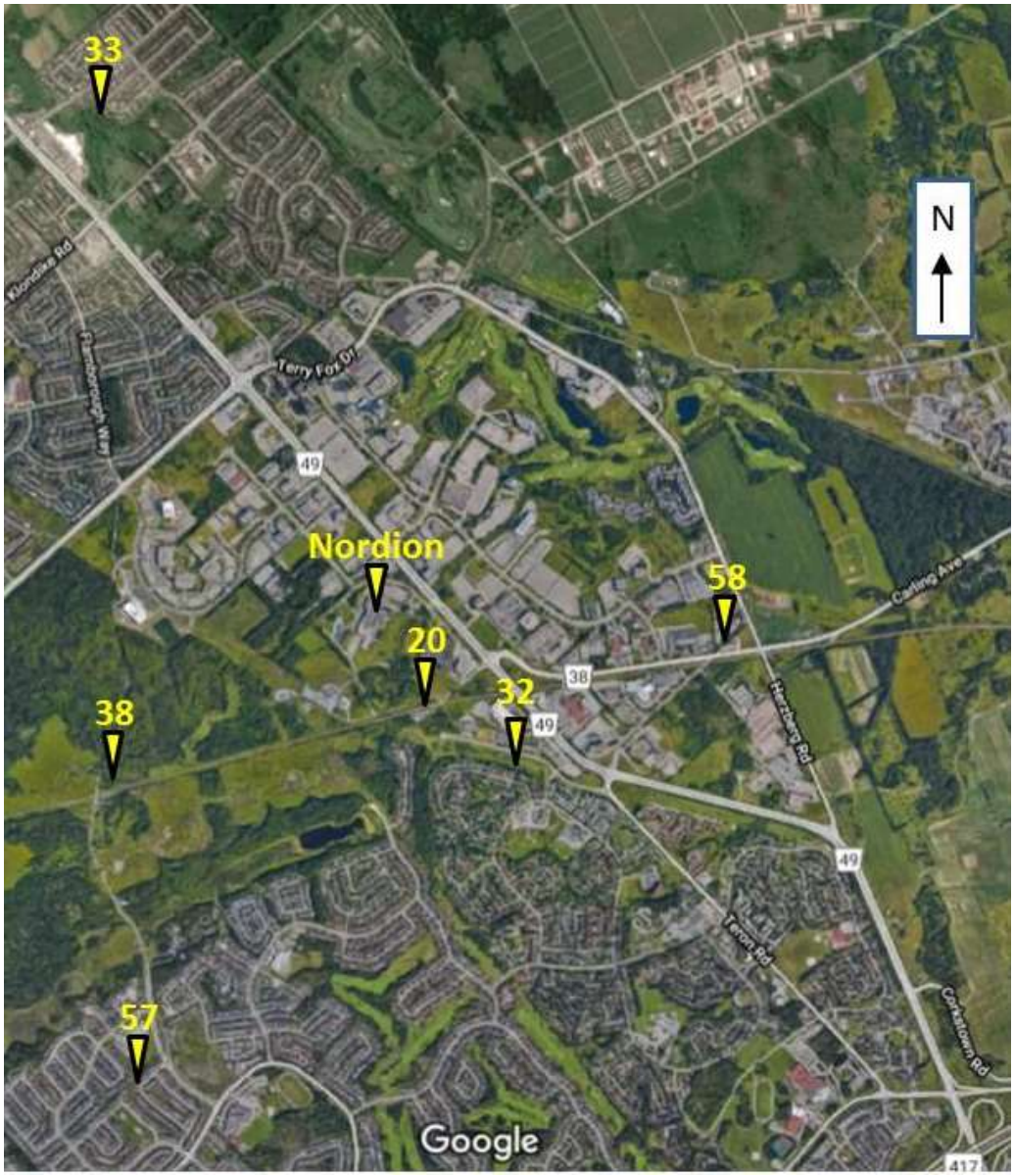
Borehole #3 (2005-BH3)

Sample Date:			2018-06-08	2017-10-06	2016-11-02	2015-10-05	2014-10-29	2013-09-18	2005-04-07 (initial Sample)
Sample ID:			**2005-BH3**	**2005-BH3**	**2005-BH3**	**2005-BH3**	**2005-BH3**	**2005-BH3**	**2005-BH3**
Parameter	**UNITS**	**MDL**							
Alkalinity as CaCO3	mg/L	5	474	467	493	484	481	471	471
Biochemical Oxygen Demand	mg/L	1	<3	<3	<3	2	<1	2	<1
Chemical Oxygen Demand	mg/L	5	6	6	<5	12	11	8	10
Chloride (Cl)	mg/L	1	76	60	63	69	66	59	64
Conductivity	µS/cm	5	1180	1160	1170	1150	1170	1140	1170
Dissolved Organic Carbon	mg/L	0.5	2.7	4.4	2.5	4.6	3.2	3.0	3.3
N-NH3 (Ammonia)	mg/L	0.02	0.03	0.13	<0.01	0.07	0.26	0.06	0.09
N-NO3 (Nitrate)	mg/L	0.1	0.82	0.55	0.40	0.31	0.35	<0.10	<0.10
pH			8.02	7.98	7.94	7.81	8.00	7.81	7.49
Sulphate (SO4)	mg/L	1	66	56	73	63	70	77	81
TDS (COND - CALC)	mg/L	5	693	653	796	748	760	741	761
Total Suspended Solids	mg/L	2	6	<3	<3	22	18	8	496
Calcium (Ca)	mg/L	1	122	119	114	109	112	97	121
Magnesium (Mg)	mg/L	1	57	56	52	50	47	45	51
Sodium (Na)	mg/L	2	77	72	85	84	87	84	63
Barium (Ba)	mg/L	0.01	0.07	0.09	0.08	0.08	0.09	0.09	0.06
Boron (B)	mg/L	0.01	0.193	0.21	0.24	0.24	0.28	0.25	0.14
Iron (Fe)	mg/L	0.03	0.067	0.14	0.05	0.07	0.12	0.04	<0.01
PHC F1 (C6-C10)	mg/L	0.2	<0.02	<0.02	<0.02	<0.2	<0.2	<0.1	<0.2
PHC F2 (C10-C16)	mg/L	0.2	<0.05	<0.05	<0.05	<0.2	<0.2	<0.1	<0.2
PHC F3 (C16-C34)	mg/L	0.5	<0.4	<0.4	<0.4	<0.5	<0.5	<0.2	<0.2
PHC F4 (C34-C50)	mg/L	0.5	<0.4	<0.4	<0.4	<0.5	<0.5	<0.2	<0.2

Borehole #4 (2005-BH4)

Sample Date:			2018-06-08	2017-10-06	2016-11-02	2015-10-05	2014-10-29	2013-09-18	2005-04-07 (initial Sample)
Sample ID:			2005-BH4	2005-BH4	2005-BH4	2005-BH4	2005-BH4	2005-BH4	2005-BH4
Parameter	**UNITS**	**MDL**							
Alkalinity as CaCO3	mg/L	5	263	259	297	271	272	264	279
Biochemical Oxygen Demand	mg/L	1	<3	<3	<3	1	2	2	<1
Chemical Oxygen Demand	mg/L	5	5	9	<5	11	13	<5	6
Chloride (Cl)	mg/L	1	25	22	25	28	22	18	15
Conductivity	µS/cm	5	663	665	670	701	665	657	646
Dissolved Organic Carbon	mg/L	0.5	2.2	3.6	3.3	3.2	3.4	2.5	2.1
N-NH3 (Ammonia)	mg/L	0.02	0.17	0.14	0.06	0.18	0.35	0.29	0.17
N-NO3 (Nitrate)	mg/L	0.1	<0.05	<0.05	<0.1	<0.10	<0.10	<0.10	<0.10
pH			8.18	8.03	7.99	7.85	8.10	7.97	7.84
Sulphate (SO4)	mg/L	1	49	43	54	56	58	55	41
TDS (COND - CALC)	mg/L	5	395	371	450	456	432	427	420
Total Suspended Solids	mg/L	2	4	<3	<3	<2	4	<2	175
Calcium (Ca)	mg/L	1	41	45	49	54	45	36	39
Magnesium (Mg)	mg/L	1	18	20	21	22	18	16	18
Sodium (Na)	mg/L	2	96	75	71	70	78	81	76
Barium (Ba)	mg/L	0.01	0.07	0.08	0.08	0.08	0.08	0.07	0.07
Boron (B)	mg/L	0.01	0.26	0.26	0.20	0.21	0.27	0.22	0.19
Iron (Fe)	mg/L	0.03	0.48	0.48	0.43	0.69	1.26	0.29	0.16
PHC F1 (C6-C10)	mg/L	0.2	<0.02	<0.02	<0.02	<0.2	<0.2	<0.1	<0.2
PHC F2 (C10-C16)	mg/L	0.2	<0.05	<0.05	<0.05	<0.2	<0.2	<0.1	<0.2
PHC F3 (C16-C34)	mg/L	0.5	<0.4	<0.4	<0.4	<0.5	<0.5	<0.2	<0.2
PHC F4 (C34-C50)	mg/L	0.5	<0.4	<0.4	<0.4	<0.5	<0.5	<0.2	<0.2

[redacted]



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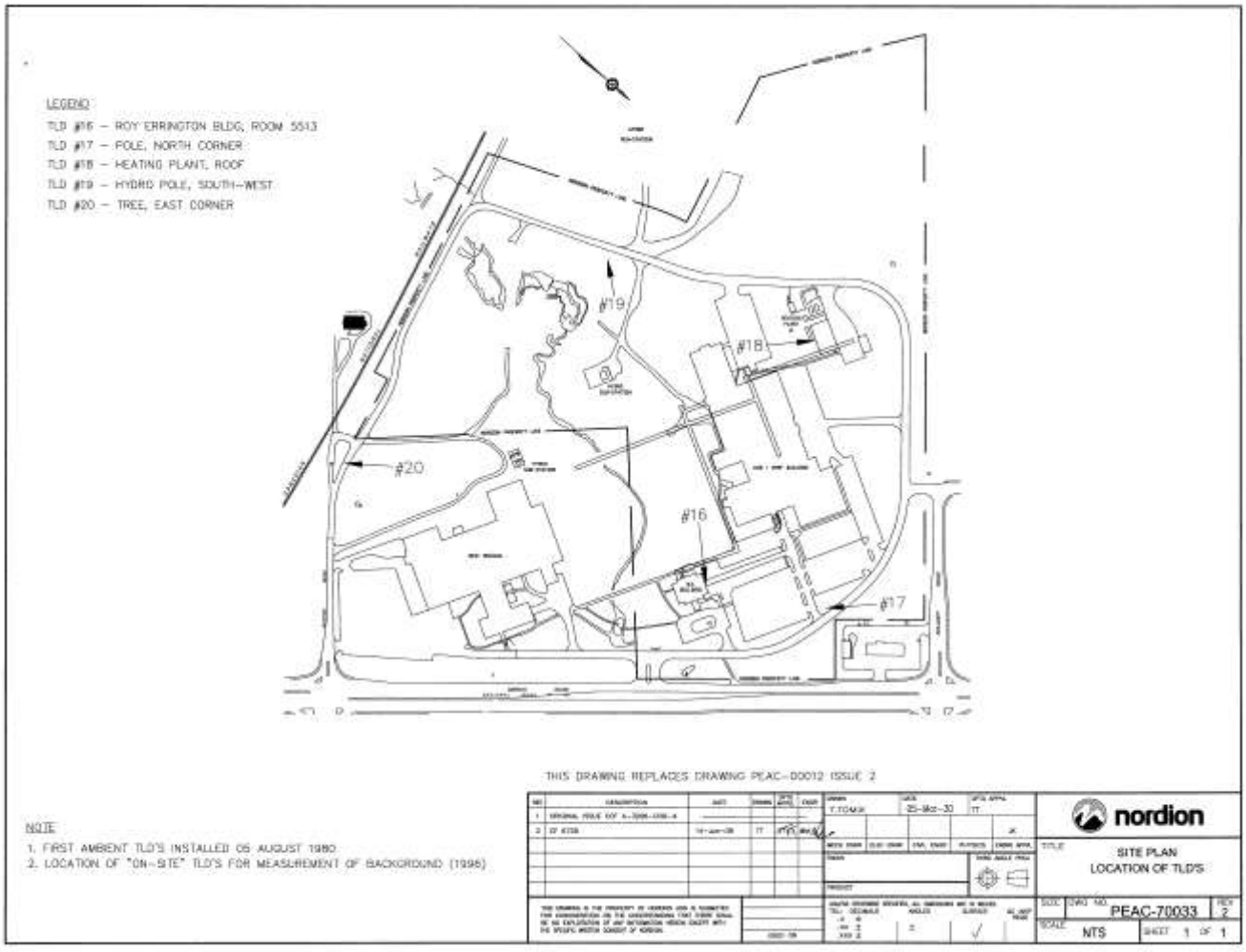
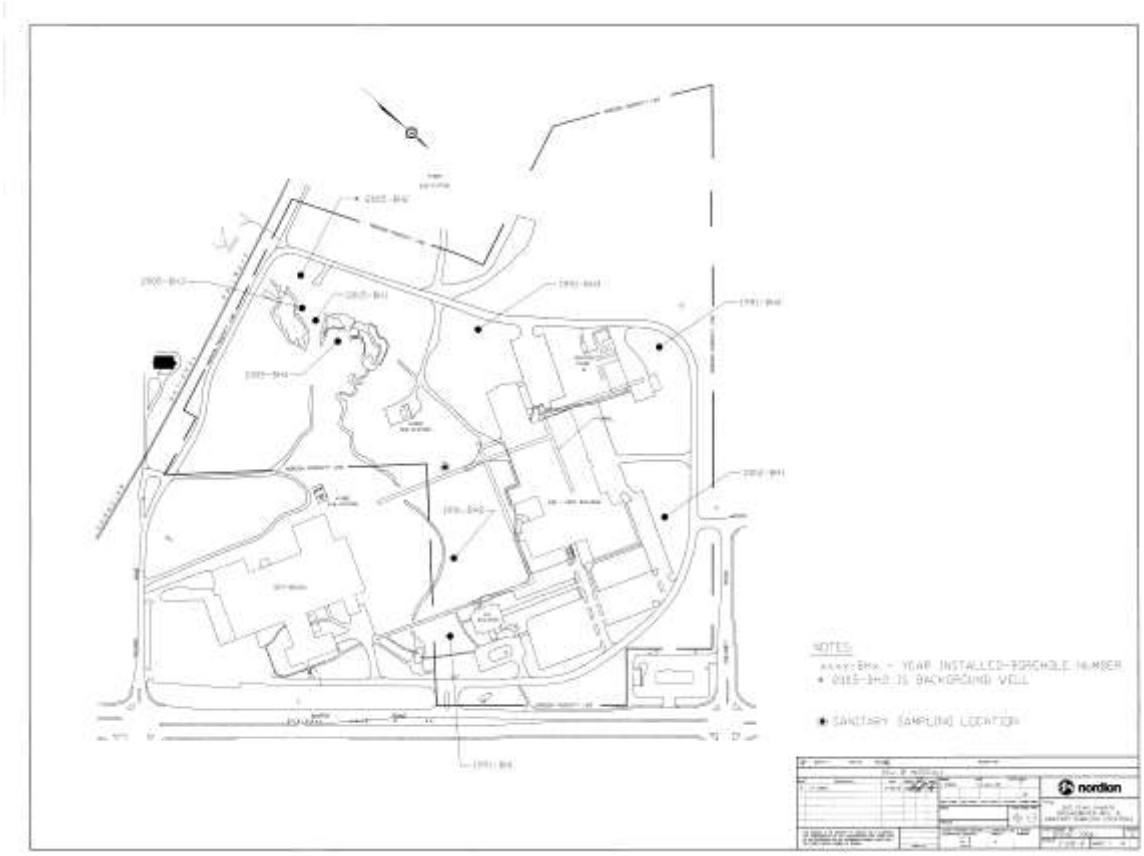
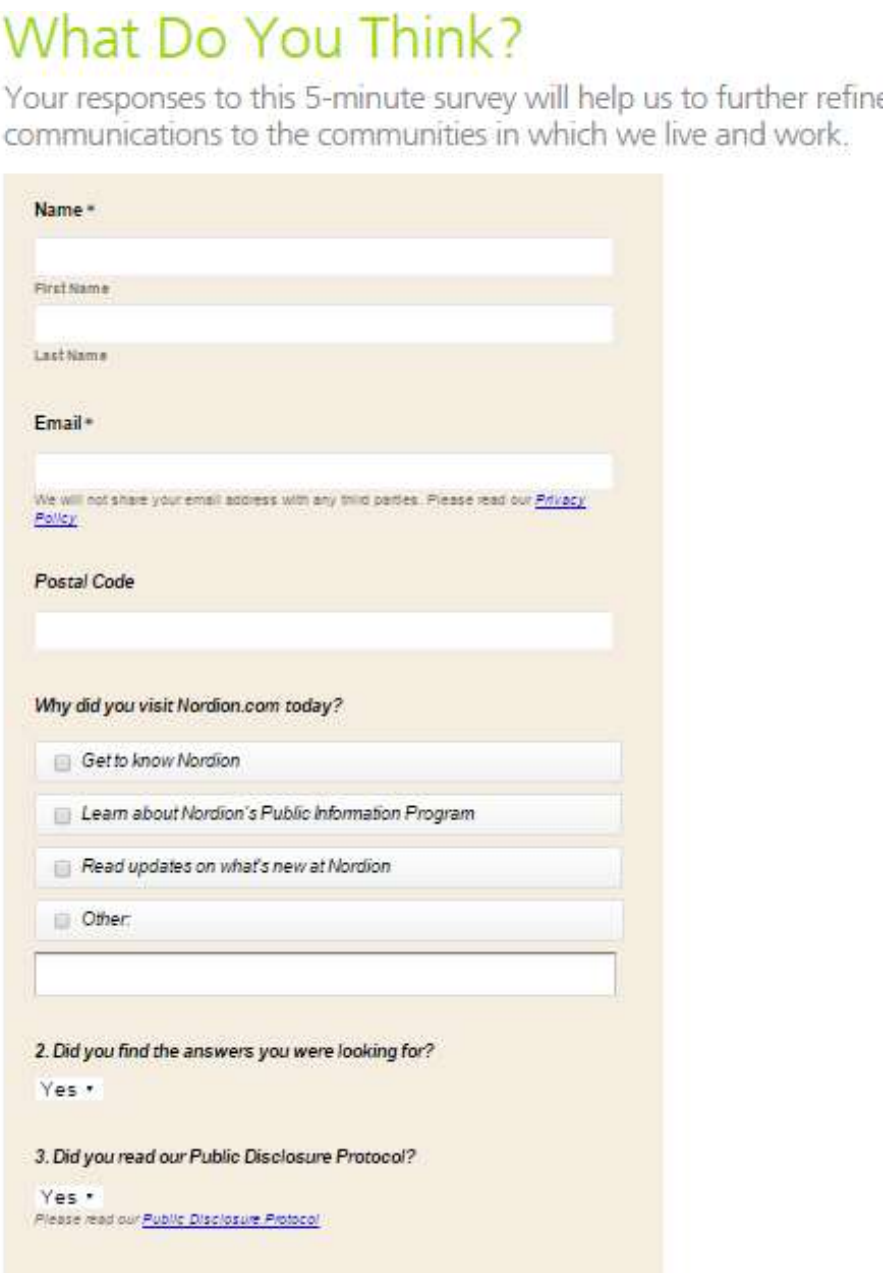

LEGEND
TLD #16 – ROY ERRINGTON BLDG, ROOM 5513
TLD #17 – POLE, NORTH CORNER
TLD #18 – HEATING PLANT, ROOF
TLD #19 – HYDRO POLE, SOUTH–WEST
TLD #20 – TREE, EAST CORNER
#19
#18
#20
#16
#17
THIS DRAWING REPLACES DRAWING PEAC–00012 ISSUE 2
NOTE
1. FIRST AMBIENT TLD'S INSTALLED 05 AUGUST 1980
2. LOCATION OF "ON–SITE" TLD'S FOR MEASUREMENT OF BACKGROUND (1996)
nordion
SITE PLAN
LOCATION OF TLD'S
PEAC-70033
NTS
1 OF 1

[redacted]


NOTES:
YYYY-BHX - YEAR INSTALLED-BOREHOLE NUMBER
2005-BH3 IS BACKGROUND WELL
SANITARY SAMPLING LOCATION
nordion

[redacted]

Appendix H
Copy of Nordion Feedback Survey on nordion.com - Public Disclosure Protocol Consultation



What Do You Think?

Your responses to this 5-minute survey will help us to further refine communications to the communities in which we live and work.

Name *

First Name

Last Name

Email *

We will not share your email address with any third parties. Please read our Privacy Policy

Postal Code

Why did you visit Nordion.com today?

- Get to know Nordion
- Learn about Nordion's Public Information Program
- Read updates on what's new at Nordion
- Other:

2. Did you find the answers you were looking for?

Yes

3. Did you read our Public Disclosure Protocol?

Yes

Please read our Public Disclosure Protocol

4. If you answered "Yes" to #3, was there anything you think we could add or change to make the information more clear?

5. What was your level of understanding of Nordion's Public Information Program before you visited Nordion.com today?

High

6. What was your level of understanding of Nordion's Public Information Program before you visited Nordion.com today?

High

7. How do you prefer to receive updates from Nordion?

- *Twitter*
- *Facebook*
- *Nordion.com*
- *Email*
- *Any of the above*
- *Other:*

8. Please provide any additional comments you have on our Public Information Program.

Appendix I
Annual Advertisement to the General Public

Copy of ads placed in the December 2018 issue of the *Community Voice*.