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Nordion®
A Sotera Health company

NORDION CLASS 1B FACILITY

License Number: NSPFOL-11A.00/2025

2017 ANNUAL COMPLIANCE AND OPERATIONAL PERFORMANCE REPORT to the Canadian Nuclear Safety Commission for the period JANUARY to DECEMBER 2017 (Amended July, 2018)

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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.00/2025) and demonstrates that Nordion is operating in a safe and responsible manner.

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

- 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 2018 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 was one (1) lost time injury and five (5) medical treatment injuries occurred.
- There were two reportable exceedances of an environmental regulatory limit or action level in 2017 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 2017, 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 33 non-compliances with the NSC Act, the regulations or with Nordion's site license NSPFOL-11A.00/2025. Sixteen (16) of these instances were reportable to the CNSC (refer to Appendix A).

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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 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.

A summary of the organizational structure and key EHS personnel is provided in Section 2.15.

Throughout this report, environmental, health and safety (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 2017, Nordion reported two exceedances of the City of Ottawa Sewer Use by-law (2003-514). The following parameters were identified:

- Petroleum Hydrocarbons
- Biochemical Oxygen Demand (BOD)
- Nonylphenols
- Sulphides
- Suspended Solids

Nordion continues to work closely with the City of Ottawa to identify potential sources of these parameters. In discussions with the City of Ottawa with regards to the parameter nonylphenols, they indicated they are in the processes of reviewing the current by-law limits for this parameter and changing the limits for this parameter. 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 2017, there were five medical treatments and one lost-time incident reported to the WSIB. WSIB may inspect Nordion's Occupational Health and Safety programs at any time; however, no inspections were held in 2017.

In compliance with Part II of the Canadian Labour Code, four disabling injuries were reported to Employment and Social Development Canada (ESDC). 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 did not have any reportable non-conformances to these other regulations in 2017.

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

Modifications and repairs that were carried out in 2017 included:

- Upgraded condenser pump controls for the chilled water system (to Variable Frequency Drives)
- Replacement of dock levers for doors 6-7 and 6-9
- Installation of a new water main at Solandt Road
- Installation of back flow preventers at the KOB, KRMF and Roy Errington (RE) buildings
- Replacement of domestic water line in the KOB Active Area

The only change in designated Active Areas was the replacement of a domestic water supply line. There were no structural changes to designated Active Areas.

1.3.1 Changes to Procedures Related to Operations Safety and Control

In 2017, the following changes were made to procedures related to operational safety and control:

- SE-LIC-001 "Management System for Safety"

  Revised to address CNSC comments related to Nordion's transition to CSA N286-12, "Management system requirements for nuclear facilities", and to address internal audit findings.
- SE-LIC-015 "Radioactive Material Inventory"

  Revised to include instruction that items that may need leak testing are assessed and if required added immediately to AMMS Leak Testing.
- SE-EHS-007 "Fire Protection Program – Nordion Ottawa Site"

  Updated document to align with changes made to SE-LIC-001. Revised to include Building Fire Marshalls in Program, add an organizational chart and include references to other internal procedures.
- SE-OP-079 "Sealed and Unsealed Source Tracking"

  Updated to reflect the disabling of the auto-generation of sealed source reporting transactions at 10 days for Co-60 sealed source even if the export license number is not available and revise the "Export License Number Required" alert timeframe from 14 days to 10 days. Added a new source type to the document.
- SE-HS-007 "Control of Hazardous Energy – Lockout and Tagout Systems"

  Updated to include reference to new document created, "Electrical Safety Program".
- SE-HS-009 "Work Permit Authorization Program"

  Updated to include reference to new document created, "Electrical Safety Program". Revise to reflect that work permits are not issued until the Change Form is approved for the installation of new safety-related Structures, Systems and Components (SSCs) and planned modifications or re-configurations of safety-related SSCs and to provide guidance on when a Change Form is required.
- SE-ERP-002 "Emergency Response Plan (ERP)

  Added minor clarifications and information regarding possible Emergency Operations Centre locations, the use of white boards to log entry of responders entering the hazard zone and additional Site Security responsibilities.

1.4 Operational Challenges

In 2017 the following operational challenges were experienced by Nordon;

- 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 75% 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 May 15, 2017 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 2017 Annual Review:

1. 14 of 15 outstanding actions from the previous meetings were closed. The remaining item involved reviewing with the Facilities department how EHS can be engaged when safety related structures, systems, or components are unexpectedly removed from service. This action has since been closed.
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 2016 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. The findings that contributed to these trends have been addressed with CAPAs.
4. The 2017 Environmental Objectives and Targets were reviewed by the Committee. At the time, the environmental objectives and targets were on track with the exception of the objective and target to potentially reduce particulate matter air emissions from the glass blowing process. The EHS Committee agreed that this objective and target be postponed due to reduced usage of the glass blowing facility.
5. The 2017 EHS Objectives and Targets were reviewed and there were no comments.

6. 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.
7. 13 actions resulted from the meeting and there were five 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 2017, Nordion conducted a total of 20 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 11 health and safety inspections, and 16 environmental and fire inspections.

In 2017, there were 7 audits of Nordion by external parties, and 1 external audit conducted by Nordion of a supplier. Out of a total of 52 EHS related Corrective Actions/Preventative Actions (CAPAs) initiated in 2017, 8 CAPAs were a result of minor findings from internal audits and eight CAPAs were a result of external audits of Nordion. 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 2017:

1. Process Audit of High Specific Activity (HSA) Cobalt
2. EMS Program
3. Business Planning, Organization and Assessment
4. Public Information Program
5. Resources
6. Documentation, Records
7. Problem Identification and Resolution
8. EHS Internal Audit Program
9. Safety Analysis
10. Supply Chain and Purchasing Requirements
11. Audit of a Supplier
12. Supplier Audit Program
13. Non-production Radioactive Material Inventory (NPRMI)
14. Operational Control, Monitoring and Maintenance
15. Safeguarded Material Physical Inventory Taking (PIT)
16. Sealed Source Reporting
17. Sealed Source Export Licenses
18. Research and Development – Cell 25
19. Carrier
20. Process Safety Audit for TheraSphere Packaging and Re-labeling

Refer to Appendix B for a summary of the findings associated with the internal audits conducted in 2017.

2.1.3.2 External Audits of Nordion

The following external audits of Nordion were conducted in 2017:

Date	Description	Result
March 2-3, 2017	The CNSC conducted an inspection of Nordion's Radiation Protection Program	Two action notices
March 20-21, 2017	The CNSC conducted an inspection of Nordion's Environmental Protection Program	One recommendation
April 5, 2017	US Customs & Border Protection – C-TPAT Re-Validation (Security)	Successful revalidation at top tier level.
May 24-26, 2017	A third party conducted a continuing assessment (surveillance) audit against the requirements from the ISO 14001:2004 standard	One minor finding and seven opportunities for improvement.
June 29-31, 2017	The CNSC conducted a Training inspection	Four action notices and seven recommendations
July 6-7, 2017	The IAEA conducted a Complementary Access inspection	There were no outstanding actions. The IAEA report is pending
October 26-27, 2017	The CNSC conducted an inspection of Nordion's Emergency Preparedness Program	Two Action Notices and one recommendation.

2.1.3.3 External Audits Conducted by Nordion

Nordion conducted one EHS audit of a supplier in 2017. There was one corrective action and two opportunities for improvement identified during this audit.

2.1.4 Management System for Safety Program Improvements

In 2017, the Management System for Safety Program was revised to add additional detail as per CNSC comments to further align with the CSA Standard N286-12, "Management system requirement for nuclear facilities".

All other changes or 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.

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. Nordion is 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).

In 2017, EHS personnel were organized into a Gamma Technologies – EHS Compliance Group and a Medical Isotopes – EHS Compliance Group. The personnel of these two groups are outlined below. All of the positions for Gamma Technologies - Compliance are corporate wide functions supporting both businesses, with the exception of the Administrative Assistant. A full list of key EHS personnel is included below:

Gamma Technologies – EHS Compliance

- Director, QA EHS Compliance (retired late January 2017 replaced by Vice-President, QA Regulatory & EHS Compliance)
- Administrative Assistant
- Manager, Corporate Security & Emergency Management
- Contract Security Supervisor
- Contract Security Officers (16)
- Senior Manager, Facility Nuclear Compliance
- EHS Assistant
- Senior Manager, Transportation Licensing & Gamma Radiation Safety
- Nuclear Transportation Specialist
- Senior EHS Compliance Specialist
- Senior Licensing Coordinator
- EHS Compliance Specialist (3)
- EHS Compliance Specialist Term Position (1)
- Training Specialist
- Manager, EHS and Documents & Corporate Records
- Occupational Health & Safety Specialist
- Safety Specialist Term Position (1)

Medical Isotopes – EHS Compliance

- Vice-President, QA Regulatory & EHS Compliance
- Senior Manager, Radiation Safety & Compliance
- Senior Radiation Surveyor (2)
- Radiation Surveyor (4)
- Senior Radiation & Contamination Monitor (3)
- Radiation and Contamination Monitor (3)

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

- In January of 2017, the Director, Quality Assurance (QA) EHS Compliance retired. The Vice-President, QA Regulatory & EHS Compliance has assumed these responsibilities.
- In March of 2017 the term positions of Safety Specialist and EHS Compliance Specialist ended.
- In July of 2017, a new President of Nordion (Canada) Inc. was appointed.

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 document 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. 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 2017, 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 2017, the number of scheduled participants that required safety training was 520, and by the end of the year, 510 of the scheduled participants completed the training, which included refresher training. Therefore, the attendance completion rate in 2017 was 98%. The 10 course not completed represent two employees; one who could not complete 9 courses due to being on extended leave during 2017 and another who completed the required training course in January 2018.

Table 1
2017 Safety Training Programs

Program	Duration	# of Participants Requiring Training in 2017	# of Participants who Completed Training in 2017	# Participants with Overdue Refresher Training at the End of 2017
Nuclear Energy Worker (NEW) Indoctrination[3]	6 Hours	11	11	0
NEW Refresher[3]	Self Study	96	94	1[1] and 1[2]
Radiation Instrumentation Workshop[3]	3 Hours	48	47	1[1]
Radiation Safety Review for Operators[3]	Half Day	18	18	0
Radioiodine Handling[3]	2 Hours	20	19	1[1]
Transport of Dangerous Goods Level I[3]	Self Study	5	5	0
Transport of Dangerous Goods Level II[3]	Self Study	13	13	0
Transport of Dangerous Goods Level III[3]	All Day In-Class	40	39	1[1]
TDG for Contractors[3]	Full Day	23	23	0
Working with BETA[3]	1 Hour	34	33	1[1]
Crane	Half Day	18	18	0
Pallet	Half Day	24	24	0
Forklift	Half Day	12	12	0
Contractor Radiation Safety Protection Training[3]	Half Day	14	14	0
Contractor Radiation Safety Protection Refresher[3]	2 Hours	10	9	1[1]
Contractor EHS Training Level I[3]	2 Hours	40	40	0
HEGS Safety Training	2 Hours	0	0	0
In-Depth Security Awareness[3]	2 Hours	31	31	0
Emergency Response Part 1[3]	2 Hours	18	17	1[1]
Emergency Response Part 2[3]	2 Hours	13	12	1[1]
Emergency Response Part 3[3]	2 Hours	8	8	0
Emergency Response: Security[3]	1 Hour	18	18	0
Emergency Response: Site Security Volunteer[3]	1 Hour	0	0	0
Emergency Response: Monitors[3]	1 Hour	1	1	0
SCBA Part 1[3] & 2[3]	1 Hour	5	4	1[1]
TOTAL		**520**	**510**	**10**

[1] On extended leave
[2] Refresher training completed in January 2018
[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 2017:

- 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 2017, 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 2017:

- There were 11 unplanned events in 2017 for which the root cause was determined to be related to human error or training (9 low and 2 medium significance)
- There was no trend for recurrence (three or more) of the same unplanned event with the same human error or training root cause.

2.2.3 Confirmation of Sufficient Number of Qualified Workers

In 2017, Nordion ensured that at least the minimum number of responsible personnel was available to provide safety during overnight operations and during emergency situations.

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 70 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 Senior Manager Radiation Safety & Compliance (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 2017 EHS program objectives are shown in Table 2. All of the EHS objectives listed in Table 2 were met in 2017 with the exception of Lost Time Incidents, Non-Radiological Releases, and timely closure of EHS CAPAs. The number of Medical Treatment Incidents (five) met the target of ≤6 but the number of Lost Time Incidents (one) exceeded the target of zero. Further details of these incidents can be found in Section 2.8.4.

In 2017, most 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 ergonomic assessments, proper mechanics training, and awareness to Operations groups. Managers engage in regular safety talks 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 (0.0052% of the Derived Release Limit (DRL)) 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 2017. 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 2017. The average CAPA closure rate for 2017 was 75%, with the monthly closure rate ranging from 66% to 79% in 2017.

The remainder of the EHS Targets and Objectives were met for 2017 and Nordion reported diverting 73.5% of waste from landfills, maximum employee dose rates well under the target of ≤ 7.5 mSv/yr and completing a supplier audit by the end of 2017.

Table 3 shows Health and Safety Objectives that Directors and Managers and employees of high risk areas are expected to meet. CAPAs greater than twelve months are reviewed in the QA CAPA Review Board meetings as well as the EHS Committee meetings. They are also reviewed monthly by senior management.

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
2017 EHS Program Objectives and Results

Applicable Nordion Job Function	Objective	Measures and Targets	Result
All Directors and Managers of Operations, Facilities, or Nuclear Energy Worker employees	Minimize the number and extent of occupational injuries, environmental and radiation incidents.	• Number of Medical Treatment Incidents ≤ 6 • Number of Lost Time Incidents = 0	5 Incidents 1 Incidents
	Minimize the use and release of hazardous materials to the environment.	Radioactive materials emissions to < 5.0% of the Derived Release Limits (DRL) (Ottawa) • Zero reportable releases of radioactive or non-radioactive hazardous materials to the environment (sewer, air, etc)	0.0052 % DRL 2 Reportable releases (Non-radiological)
	Maintain radiation doses to employees as per ALARA principle.	• Maximum employee dose rate ≤ 7.5 mSv/yr	2.58 mSv/yr (Medical Isotopes) 5.49 mSv/yr (Gamma Technologies)
	Timely closure of EHS CAPAs	• Target 80% of generated CAPAs within your areas are closed (actions complete, exclude CAPA verifications) within 1 year	Met
	Managers of high risk areas will complete/submit regular self-assessments of their management processes and safety performance.	Perform and complete Mid-Year and Year-End manager self-assessments (semi-annually)	100% Complete
All High Risk Employees	Timely closure of EHS CAPAs	Target 80% of generated CAPAs within your areas are closed (Actions complete, excluding CAPA verifications) within 1 year	75% (average for 2017)

*Average taken over the year.

Table 3
2017 Health and Safety Objectives

Applicable Nordion Job Function	Objective	Measures and Targets
All Directors and Managers of Operations, Facilities, or Nuclear Energy Worker employees	Minimize the use and release of hazardous materials to the environment.	• Reduction in the use of hazardous materials and the generation of waste (hazardous and non-hazardous)
	Manage EHS CAPAs and ensure timely closure of CAPAs	• Meet all CAPA phase target dates • Prioritize high risk EHS CAPAs
	Managers of high risk areas will develop and implement an Incident Reduction Strategy.	• Provide EHS "Safety Focus Talks" and "Hazard ID Training" in team meetings and collect and provide feedback to EHS. • With support from EHS, develop an "Incident Reduction Strategy" based on the incident performance within the area over the prior 24 months. Approval from area Directors required by March 30, 2017 prior to implementation. Once approved provide a strategy descriptions to EHS for review at the EHS Committee. (Note: Sample strategies will be offered by EHS.) • Throughout 2017, area managers will review and modify their Strategy if safety trends are identified.
	Managers of high risk areas will complete/submit regular self-assessments of their management processes and safety performance.	• Perform and complete Mid-Year and Year-End manager self-assessments (semi-annually) • Ensure the departmental job hazard analysis is kept up-to-date.
	Ensure that all managers actively consider the impacts to the environment and health and safety.	• Environment, health and safety impacts are assessed as part of product realization planning and risks are mitigated through application of ALARA and pro-active planning. • Opportunities for minimizing waste (hazardous and non-hazardous) are assessed and implemented whenever possible. • Ensure all near-misses and Hazard ID's are reported in the Velocity EHS tool in a timely manner and appropriate corrective actions are taken. • Maintain control of non-production radioactive material. • Implement appropriate safety improvements as a result of Incidents, Near Miss, and Hazard IDs.
	Communicate monthly with teams about environment, health and safety performance and impacts. Openly evaluate employee environment, health safety concerns and encourage reporting of near misses.	• Environment, health & safety information and concerns are discussed regularly at every team meeting. • Health and safety concerns are assessed with the results of the evaluation communicated to the employee(s). • Deviations, CF's, Non-conformances and Complaints are assessed for EHS risks against targets and reported accordingly. • Routinely invite EHS to team meetings to discuss EHS topics and/or concerns.

Applicable Nordion Job Function	Objective	Measures and Targets
All High Risk Employees	Prioritize working safely at all times.	• It is unacceptable to take risks in order to get the job done. Personal safety is every employee's **highest** responsibility. • Work must follow Nordion EHS training, standards and procedures, and is performed with care and attention to safety principles and policies. • Wear all applicable Personal Protective Equipment (PPE) as necessary. • Bring all safety concerns or questions to the attention of the direct Supervisor or EHS. • Submit all dosimeter(s) and rings for monitoring on time (no later than one month following end of monitoring period without good reason.
	Report all workplace injuries, unsafe conditions and near misses.	• All workplace injuries, suspected injuries, observed hazardous conditions and near misses are reported **IMMEDIATELY** to the direct Supervisor. • Report **ANY** suspected symptoms to your Supervisor or identify potential physical concerns before they become injuries. Do **NOT** take personal safety risks to get the job done.
	Encourage and assist co-workers in adopting safe work practices.	• Following Nordion values and safety policies, coach co-workers who are observed to be working unsafely.
	Safety Talks	• Full participation and engagement during team safety talks and training by asking questions and voicing concerns.
	Reduce environmental impacts	• Identify opportunities for reducing waste, and using less harmful materials wherever possible. • Ensure EHS reviews and approves all new hazardous or environmentally harmful materials prior to ordering as well as any equipment designed to contain these materials.
	Timely closure of EHS CAPAs	• Meet all CAPA target dates • Prioritize high risk EHS CAPAs

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.

2.3.3 Reportable Events

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

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 2017 included the following:

- Conducting a process review incorporating a systematic analysis to ensure identification of all failure modes. Corrective actions have been identified and Nordion is working to address these.

2.3.4.2 Sealed Source Tracking Improvements

In 2017, Nordion made the following improvements to the Sealed Source Tracking process:

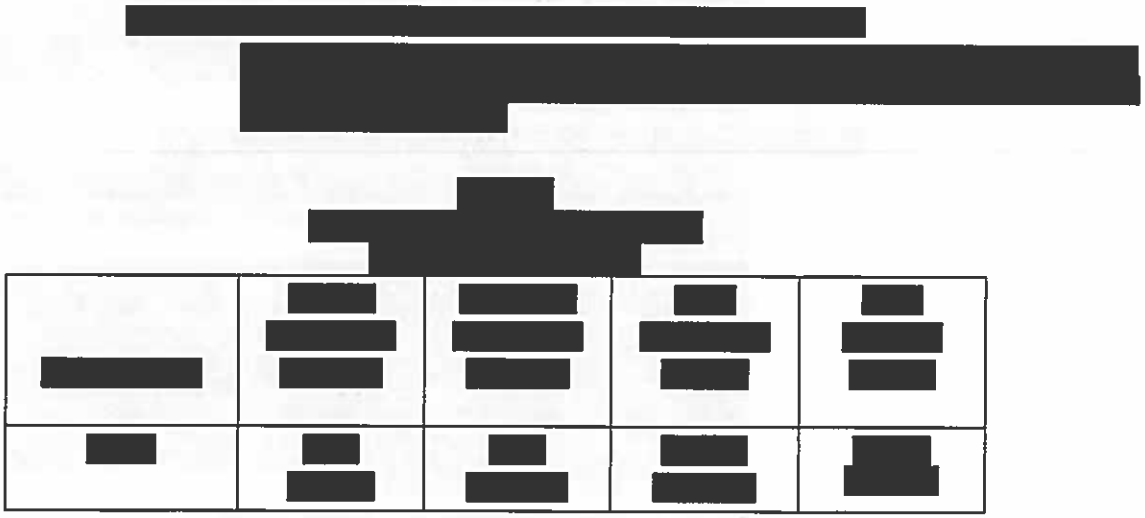
- Modified where the tracking system retrieves the export license number within the electronic database management system preventing duplication and reducing error associated with manual entries
- Implemented a process for reporting amendments to the export license number to the CNSC
- Improved manual reporting process to ensure reporting of all of the required information within the required timeframe

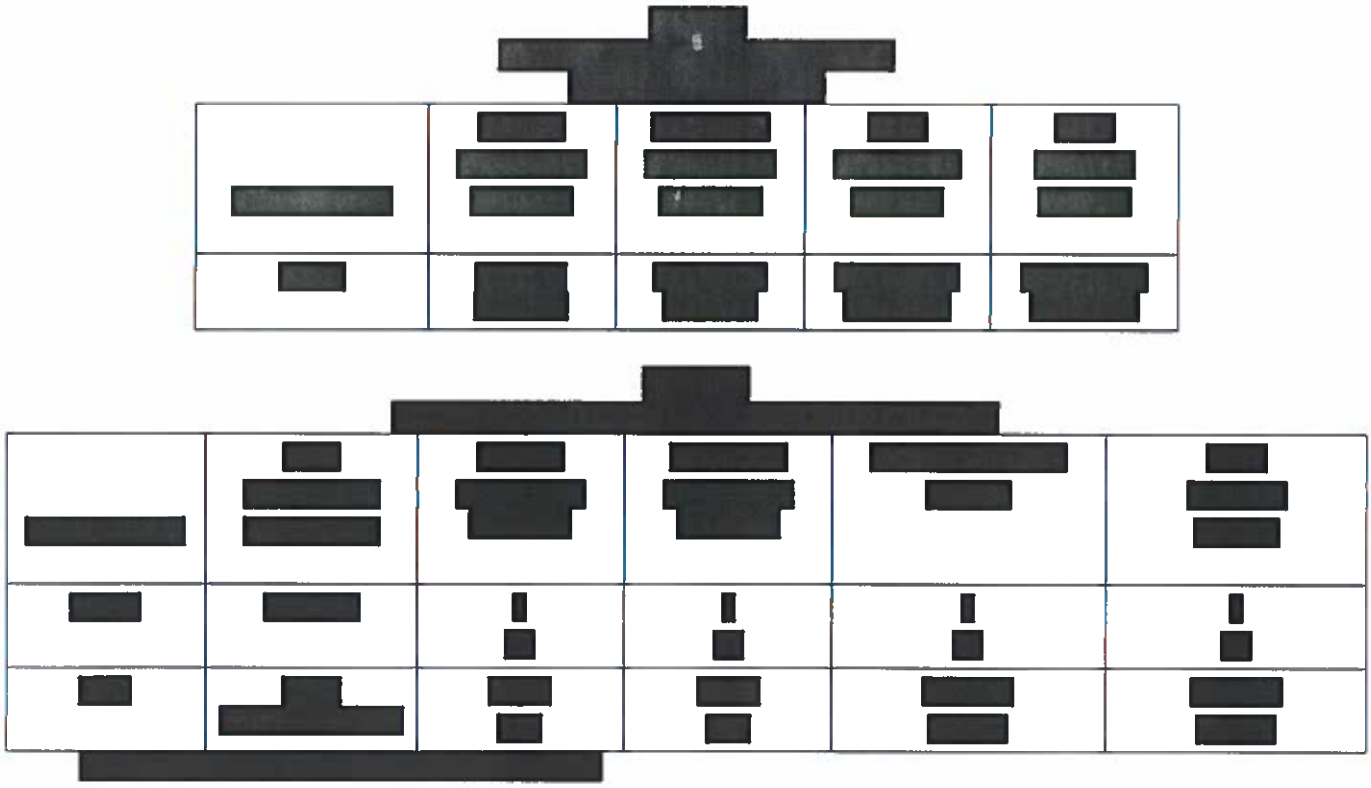
2.3.5 Non-production Sealed and Unsealed Source Inventory

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.00/2025.





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

[redacted]

2.5 Physical Design

In 2017, 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 2017, 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 2017, 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 7 and 8 provide dosimetry data to the public and with employees grouped in various ranges of exposure. Data on the minimum, maximum and average doses for all employees are shown in Tables 9, 10 and 11. In 2017 there were 141 Active Area personnel monitored, 122 non-Active Area personnel in these tables. Of the 122 non-Active Area personnel, 17 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 7
Personnel Dosimetry

Number of Employees											
Dose Range (mSv)	Whole Body					Skin					Eye
	2013	2014	2015	2016	2017	2013	2014	2015	2016	2017	2017
< 0.2	197	175	170	141	176	184	173	171	127	179	178
0.2 - < 0.5	25	34	40	62	38	37	30	37	59	35	36
0.5 - < 1.0	24	21	19	27	17	25	24	21	32	15	15
1.0 - < 5.0	36	37	34	37	31	36	40	34	48	33	33
5.0 - < 20.0	2	2	1	0	1	2	2	1	1	1	1
20.0 - < 50.0	0	0	0	0	0	0	0	0	0	0	0
> 50	0	0	0	0	0	0	0	0	0	0	0

Number of Employees										
Dose Range (mSv)	Right Hand					Left Hand				
	2013	2014	2015	2016	2017	2013	2014	2015	2016	2017
< 0.2	103	98	108	59	94	102	100	105	53	88
0.2 - < 0.5	6	5	8	20	8	7	2	9	21	11
0.5 - < 1.0	10	10	2	18	7	7	5	3	25	7
1.0 - < 5.0	17	15	18	27	14	19	22	18	24	16
5.0 - < 20.0	4	7	2	3	2	3	5	2	4	3
20.0 - < 50.0	0	0	0	0	0	0	0	0	0	0
> 50	0	0	0	0	0	0	0	0	0	0

Table 8
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
2013	2	0	0	0
2014	2	0	0	0
2015	1	0	0	0
2016	0	0	0	0
2017	1	0	0	0

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

		2013	2014	2015	2016	2017	CNSC Regulatory Limit
NEWs	Average	0.36	0.44	0.39	0.49	0.42	n/a
	Maximum	6.39	6.03	5.24	4.9	5.49	50/yr; 100/5yr
	Minimum	0	0	0	0	0	n/a
	Number of NEWs Monitored	284	269	264	267	263	
Contractors	Average	0.03	0.09	0.03	0.07	0.02	n/a
	Maximum	0.27	0.31	0.13	0.36	0.2	1/yr
	Minimum	0	0	0	0	0	n/a
	Number of Contractors Monitored	57	52	46	53	55	

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

		2013	2014	2015	2016	2017	CNSC Regulatory Limit
NEWs	Average	0.42	0.46	0.42	0.59	0.42	n/a
	Maximum	6.39	6.11	5.21	5.20	5.52	500/yr
	Minimum	0	0	0	0	0	n/a
	Number of NEWs Monitored	284	269	264	267	263	
Contractors	Average	0.03	0.08	0.03	0.07	0.02	n/a
	Maximum	0.28	0.31	0.12	0.39	0.18	50/yr
	Minimum	0	0	0	0	0	n/a
	Number of Contractors Monitored	57	52	46	53	55	

Table 11
Minimum, Maximum and Average Worker Extremity Doses (mSv)

		2013	2014	2015	2016	2017	CNSC Regulatory Limit
NEWs	Average	0.54	0.73	0.46	0.79	0.53	n/a
	Maximum	7.4	9.5	9.3	8.3	16.4	500/yr
	Minimum	0	0	0	0	0	n/a
	Number of NEWs Monitored	139	135	137	128	125	

Table 9 shows an increase in maximum effective dose to NEWs in 2017 compared to 2016. Contractor dosimeters and doses continue to be well managed and controlled. It is worthwhile noting that the seven 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 0.78 - 1.6 mSv, the next highest dose to a Nordion non-Active Area worker was 0.73 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]

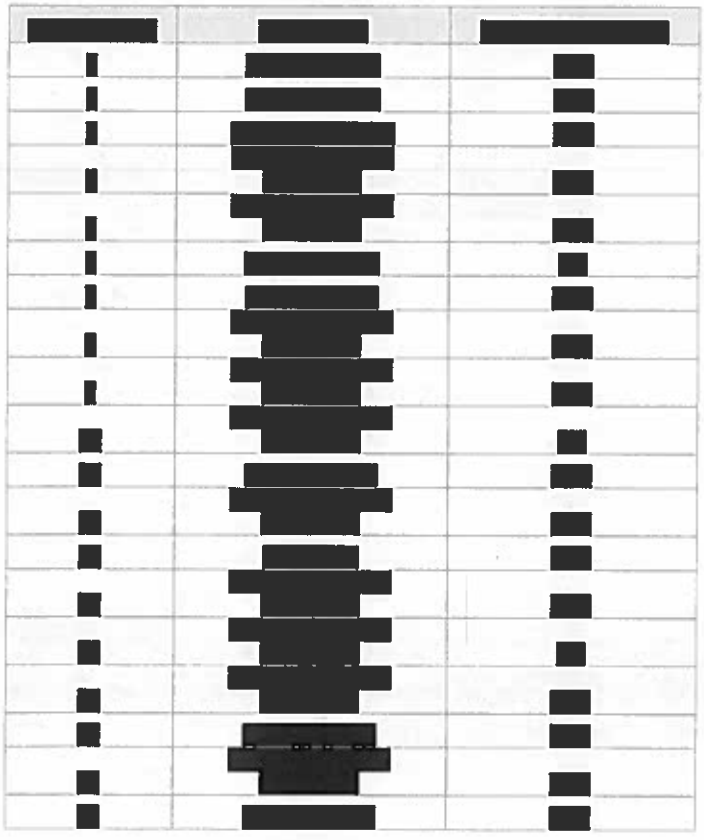


Table 10 shows similar results to Table 9 for skin exposure in 2017. In Appendix D similar values for dose to the lens of the eye are observed.

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 2017, there were no cases of employees exceeding Nordion's administrative investigation level of 1000 Bq I-125 or I-131. 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 performed once in 2017. No urinalysis was required in 2017. In 2017 no internal doses were assigned as no radioactivity was detected during thyroid assay or whole body counting.

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 Facility support groups have had consistently low doses over the last five years where most employees TLDs read under 1 mSv. A detailed analysis, by group, is provided in Table 12.

Maximum doses in the non-active area personnel are from the small subgroup of seven Co-60 installers, whose doses are also accounted for in the Class II servicing licence. [redacted]. Results overall demonstrate continued and consistent high performance of Nordion employees in accordance with ALARA, [redacted]

[redacted]

[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
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[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 13 shows the doses to the public from 2013 - 2017.

Table 13
Dose to Public

Year	(mSv)
2013	0.022
2014	0.010
2015	0.0057
2016	0.0021
2017	0.000052

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 leaving the Active Area is monitored by wipe test and/or direct measurement to provide assurance that it meets administrative and regulatory requirements.

During 2017 operations, there were 14 instances where contamination (above "clean on swipe") was found and subsequently contained within the Active Area. Most were due to routine operations. Of the 14 contamination incidents, 10 were related to contamination found on clothing, 2 to contamination found in limited areas of the facility (i.e. floors or other structures and equipment), and 2 were related to contamination found directly on personnel. No increased dose to personnel was received as a result of any of these incidents.

The distribution of contamination incidents from 2013 to 2017 is shown in Table 14 and 15 and is illustrated in Figure 1.

The number of contamination events in 2017 was less than in each of the previous four years. However, the 5-year rolling average has remained constant at 39 +/- 4 contamination incidents per year. There is no trend in the contamination incidents by month.

[redacted] The number of contamination events listed as "other" isotopes in Table 15 has increased over previous years. These "other" isotopes primarily correspond to various waste isotopes found that related to the [redacted] processes. In 2017, there was increased clean-up activities relating to these processes that would account for the increased number of contamination incidents under this "other" category.

The relative number of contamination incidents at the various contamination levels provide in Table 14, has remain stable over the last 5 years with no discernable trends.

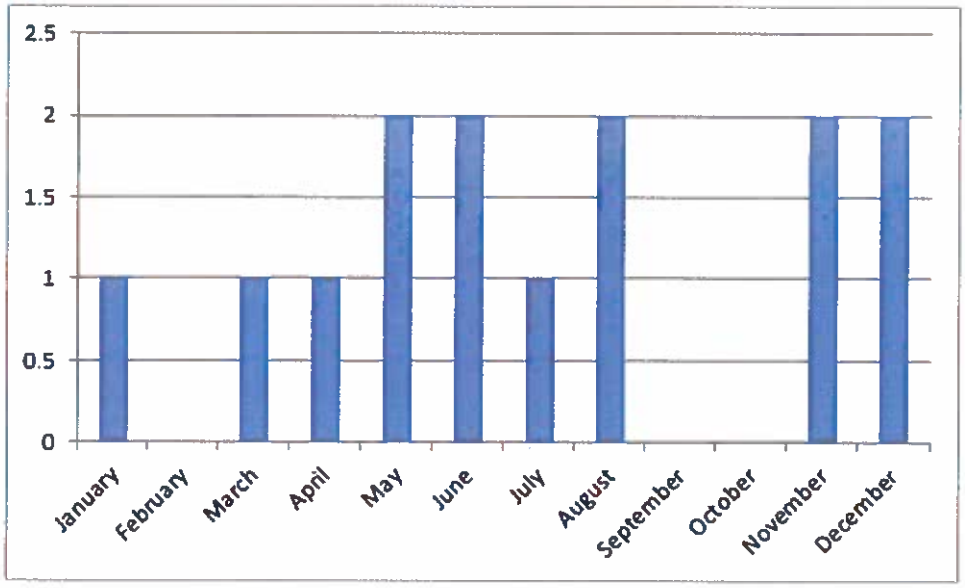
Table 14
Contamination Incidents by Contamination Level

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
2013	0	1	12	8	6	5	32
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

Table 15
Contamination Incidents by Radionuclide

Contamination Radionuclide	2013	2014	2015	2016	2017
Not recorded/unknown	1	1	0	0	2
C-14	0	2	1	0	0
C-60	9	12	12	6	4
I-125	1	3	1	2	0
I-131	9	4	5	6	0
Mo-99	5	13	11	6	0
Y-90	4	7	5	0	2
Ir-192	1	0	1	1	1
In-111	0	0	0	0	0
Xe-133	1	2	4	0	0
Sr-82	0	1	0	0	0
I-123	0	0	0	0	0
Radon	0	0	2	1	0
Other	1	2	1	4	5
Total	32	47	43	26	14

Figure 1: Contamination Incidents by Month in 2017



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 2017.

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 2017, 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 2017. There were no fluctuations of note in 2017 radiological conditions beyond the routine movement of containers which follow a routine process flow. Contamination incidents are discussed and trended in Section 2.7.4.

2.7.6 Exceeding Regulatory Limits or Action Levels

In 2017, 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 2017.

2.7.8 Radiation Protection Program Improvements

Improvements to the RP Program in 2017 included the following:

Design, build and installation of a portable shield for the Cobalt whole-body scanner to lower background radiation levels and increase, sensitivity and reliability of performance.

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 2017. 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). SE-RP-002 was revised in 2017 to reflected the updated action and administrative levels Nordion developed and subsequently approved by the CNSC. 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 2017, all High Efficiency Particulate Air (HEPA) filters were tested at the required frequency. CAD filters were tested once, which meets the minimum testing frequency of once annually.

Table 7 details the results of the NVS Filter testing and replacement. The filters summarized in Table 7 are credited with mitigating releases in Nordion's Safety Analysis reports.

Table 7
NVS Filter Efficiency Testing/Replacements

	Q1/Q2 HEPA	Q1/Q2 CAD	Q3/Q4 HEPA	Q3/Q4 CAD
Filters in fleet	239	73	240	73
Number tested	237	0	238	67
Filters which met specification	237	N/A	238	67
Filters out of specification	0	N/A	0	0
Out of specification filters replaced during test cycle	0	N/A	0	0
Not tested	2	N/A	2	6
Total replaced during this cycle	0	N/A	0	13
Filters (systems) removed from service	0	N/A	0	0
New Filters (systems) Added	0	N/A	1	0

Comments Q1/Q2 HEPA: Two filters were not tested as one of them is not in service and the other is inaccessible.

Comments Q1/Q2 CAD: The CAD testing equipment required unforeseen repairs so testing in the first half of the year could not be performed.

Comments Q3/Q4 HEPA: Two filters were not tested as one of them is not in service and the other is inaccessible. One new HEPA was added to a vacant leg on System #28. This was done to lower the flowrates across the other five legs of System #28 (now all six legs are in use).

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. Thirteen CAD filters were changed out due to their shelf life expiring. An in-situ lab test was performed on twelve of the new filters. The 12 new filters passed their in-situ tests. One trench filter was replaced 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 2017 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 2017 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 2017. 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 2017 was performed at the required frequency and results were satisfactory. All dry systems were tested and verified in good operating condition in 2017 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 2017 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 2017 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 2017 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 2017, a total of 18 work orders were generated for issues that were identified during weekly equipment testing.

Five 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.

Five 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.

Three work orders were generated for an alarm signal not registering at the BMS. The issues were corrected.

Two 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 four other issues which generated work orders. Two were issues with chart recorders; however it is important to note that the BMS has a redundant charting function so no data was lost. Another issue involved the (redundant) alarm panel in Cobalt and the fourth was to report a knocking noise coming from a non-active fresh Air Handling Unit.

Overall the results were very good. There were nine fewer work orders generated in 2017 than 2016.

2.7.11.10 Radiation Survey Instruments

Radiation Survey Instruments are tested on a monthly, bi-annual, or annual basis as required. In 2017, for all of the 800 calibrations performed, the "As Found" results did not constitute a safety or regulatory concern. Testing in 2017 was performed at the required frequency and the results were satisfactory. At the end of 2017, there were two out of 800 survey meters past due for the internal frequency requirements. The two meters past-due were not in use and the frequency to calibrate was simply modified in the database to indicate they 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 along with the number of safety improvements that arose from them, are reported monthly to senior management and are provided to the EHS Committee for review.

The Conventional Health and Safety and Control Area (SCA) 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 2017. Process safety audits are conducted annually

Refer to Section 2.1.3 and Appendix B for a description of audits and inspections for 2017.

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 2017. The KOB Health & Safety Policy Committee met on four occasions in 2017. The accomplishments for 2017 were that the Policy Committee continued to review new or changes to applicable policies and programs (e.g. the newly established Safe Handling of Mercury program and changes to the Right to Refuse Dangerous Work policy). 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 2017 included the following:

- Bi-annual "Safety Focus Talks" were created for managers to provide to their teams. Themes included:
    - "Preventing Cuts and Lacerations" and "Recognizing Hazards in the Workplace".
- Safe Handling of Silica and Mercury programs were established
- Improvements were made to the Asbestos Management Program and an Asbestos Inventory was established.
- Industrial hygiene monitoring was conducted by a third party for:
    - Asbestos
    - Silica (Glass Blowing Lab)
    - Lead and Welding (Machine Shop)
- Nordion's Confined Space Assessment was reassessed and updated in 2017.
- An assessment of onsite chemical spill kits was performed and improvements made
- 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 Awareness training was updated to include reference to WHMIS 2015
- Updates to the Right to Refuse Dangerous Work procedure

2.8.4 Conventional Health and Safety Occurrences

During 2017, there were five (5) medical treatment incidents and one (1) lost time incident. 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 repetitive strain injury to their right hand, wrist, forearm that they related to a data-entry project.	Project was complete, therefore ergonomic assessment completed of workstation, new mouse provided as well as training.
	Employee sustained a mid-back injury when mop got caught in track of ceiling tiles while disinfecting a ceiling, resulting in an over-extension of their back.	Manager reminded employee to slow down movements and keep mop in front of their field of vision to lessen likelihood of an over-extension if mop gets caught in track.
	An employee sustained discomfort to inside of both arms, around elbow area	The need for good body mechanics and to take regular breaks when

	and around front of shoulder/pectoral area and numbing of fingers after disinfecting rooms. This work requires the moving of carts, cages, and tables and washing of surfaces including floors, walls and ceilings.	required to avoid over-exertion was reviewed with the employee.
Sterilization	Bilateral spasms to low back when employee reached to attach chains to an overpack.	New tooling was ordered to reduce the daily strain for shipping work. Discussed the importance of stretching and overall health. Employee also to rotate through the other areas to reduce some of the repetitive motions in shipping.
Corporate Services	Laceration requiring sutures to right index finger when cleaning rust from a CAD filter (large charcoal filter) in the Filter Test Lab. Employee was using a motorized hand tool that was created to clean the narrow channels. Left hand was controlling the trigger and right hand supporting the tool further down. Thinks right index finger was pinched between the moving shaft and the device.	A manual device has been built to replace the powered device. Machine guarding has been installed on the powered device.

Lost Time Incidents:

Business Unit	Lost Time Injury	Action Taken
Sterilization	Right knee injury sustained when employee stepped off a lawn tractor and into a depression in the ground. Grass was long and they couldn't see the depression. 6 days lost time incurred.	Discussion with employee about dismounting from tractor with care to assess footing and surroundings before proceeding.

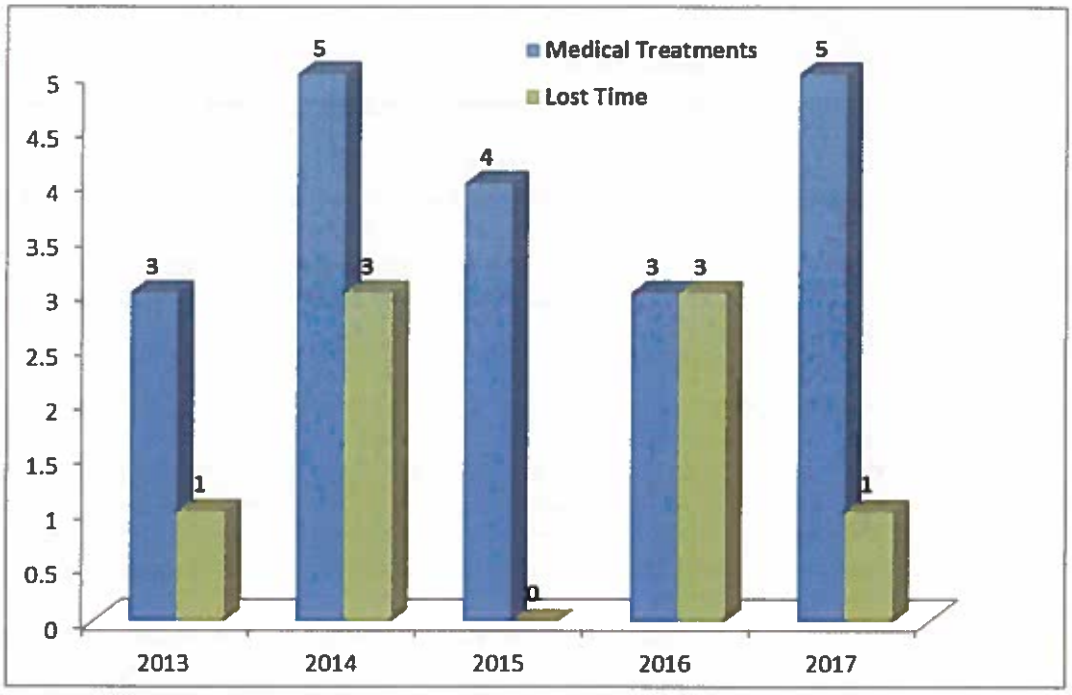


Figure 2: Number of Medical Treatments and Lost Time Incidents by Year

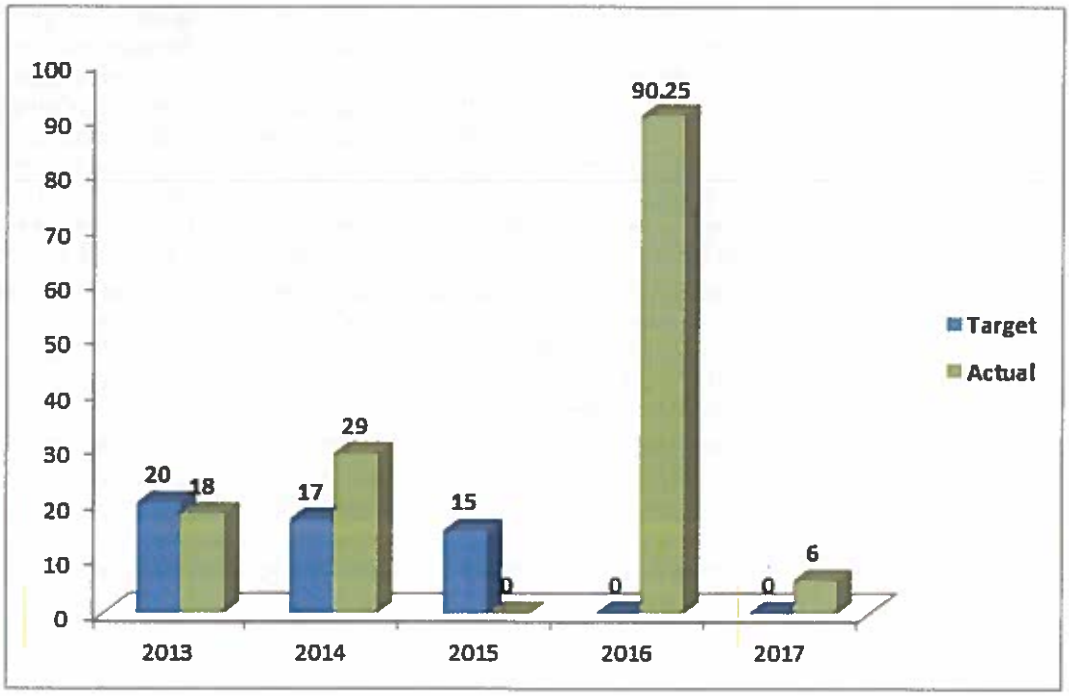


Figure 3: Number of Lost Time Days by Year

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. Also included for comparison are the DRL values from the Nordion report submitted to CNSC in 2016 using Impact software and the most current version of the CSA standard N288.1-14 – "Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities". The CNSC has agreed that the Impact software calculated values will apply for releases from Nordion starting January 2018. Action levels are listed in the LCH and were not exceeded in 2017. A summary of airborne releases is provided in Table 16.

In 2017, the maximum annual release of airborne effluent from any one radionuclide was from Co-60 at 0.0049% of the DRL. The total air release was 0.005% of the DRL. No Action Levels were exceeded in 2017. Dose to public using LCH DRL values is 0.05 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 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.

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)
2013	0.005	0.23	0.39	30,735	28,193	43,383
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
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)	0.0049	0.00002	0.00002	0	0	0

	Co-60	I-125	I-131	Xe-133	Xe-135	Xe-135m
DRL (GBq/yr) 2016-Impact	250	952	686	677,000,000	102,000,000	69,000,000
% DRL (2016-Impact)	0.0014	0.0001	0.0001	0	0	0

2.9.1.2 Liquid Effluent

Two sets of DRL values are listed in Table 17. The values in the LCH are used to calculate dose to public. Also included for comparison are the DRL values from the Nordion report submitted to CNSC in 2016 using Impact software and the most current version of the CSA standard N288.1-14 – "Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities". The CNSC has agreed that the Impact software calculated values will apply for releases from Nordion starting January 2018. 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 2017 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.

In 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
2013	782848	0.288	0.065	0.005	0.009	0.077	0.022	0.0006	0.0006	0.0005
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

	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)	3.21E-04	2.29E-05	1.97E-04	2.56E-05	4.36E-06	1.44E-05	2.54E-07	2.51E-07	4.92E-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) 2016-Impact	763	35,000	1,190	389	10,200	35.4	3,250	2,060	24.8
% DRL (2016-Impact)	2.78E-02	1.38E-04	1.22E-02	1.53E-03	4.79E-04	6.31E-02	4.37E-05	9.13E-05	2.72E-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 6 nSv (compare with 1.1 µSv using the Impact derived DRL values). This value is a conservative over estimate because the critical receptor has been overlooked and the MDA values are used.

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. Because 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. This change accounts for the increase in the I-125 liquid release from 2013 onward. 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 on in Appendix G and listed in Table 18. The Environmental TLD results are shown in Table 18 and presented in Figure 4. 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 2017 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 TLD Results

Location	2013 (mSv)	2014 (mSv)	2015 (mSv)	2016 (mSv)	2017
16	0.105	0.088	0.094	0.133	0.032
17	0.240	0.192	0.177	0.241	0.169
18	-0.019	-0.046	-0.024	0.035	-0.052
19	0.048	0.014	0.065	0.128	0.037
20	0.068	0.078	*	0.078	0.061
32	0.017	0.04	0.02	0.037	-0.041
33	0.025	*	-0.02	0.003	-0.057
57	0.070	0.075	-0.008	0.004	-0.047
58	0.106	0.09	0.065	0.149	0.046

* missing TLD

ND = not deployed

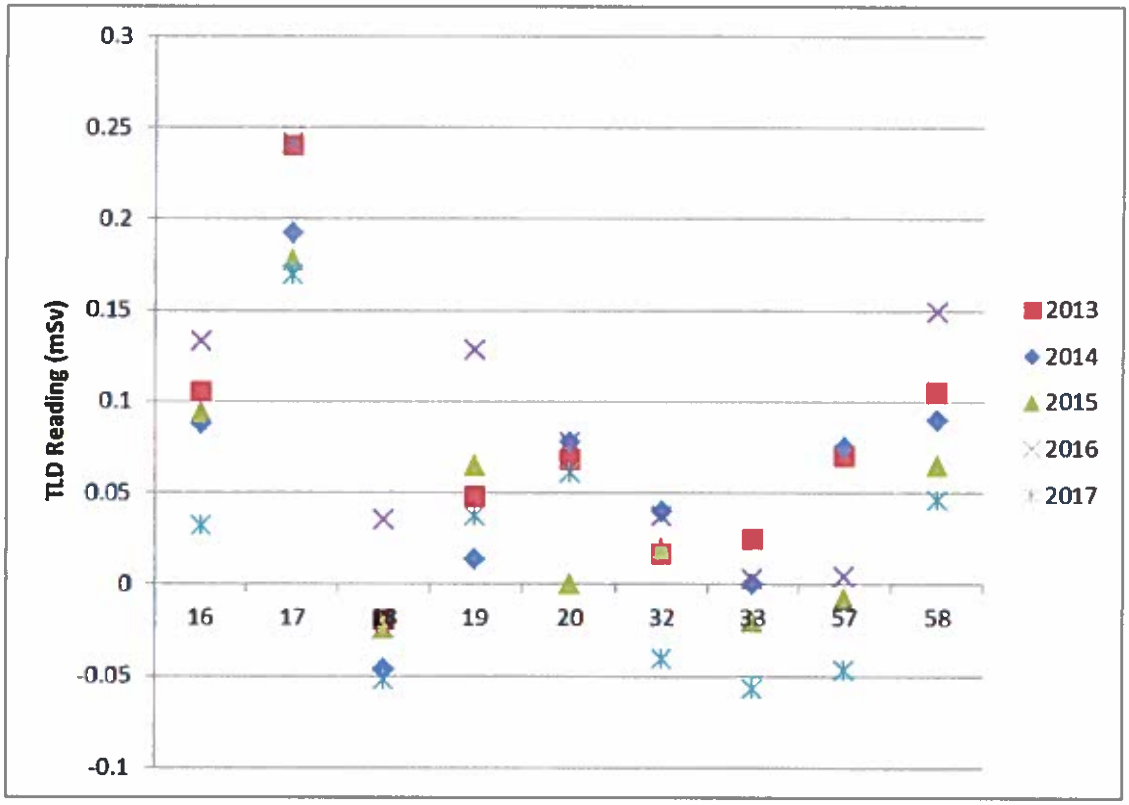


Figure 4: Environmental TLD Results (mSv)

2.9.2 Significance of Air and Water Release Monitoring Results

[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. 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.

2.9.3 Exceeding Regulatory Limits or Action Levels

There were no instances of exceeding CNSC environmental regulatory limits or action levels in 2017.

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 2017, this review was held during the Annual EHS Program Review on May 15, 2017. The results of the review are summarized in Section 2.1.2 items 3, 4, 5 and 6.

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 2017 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 a maintenance audit of Nordion's ISO 14001 certification One minor nonconformance and two opportunities for improvement were identified during the course of this audit

2.9.6 Environmental Protection Program Improvements

In 2017, Nordion made the following improvements to the Environmental Protection Program:

- Addressed CNSC comments related to the implementation of the Environmental Risk Assessment (ERA), Derived Release Limits (DRLs) and the Environmental Monitoring Program implemented to meet CSA standards N288.4, N288.5, and N288.6.
- Initiated 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

2017 Environmental Objectives

Objective	Result / Outcome
Reduce non-hazardous waste to landfill (target of 68% by the end of 2017).	A diversion rate of 73.5% was achieved in the 2017 waste audit.
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 2017.
Investigate energy reduction opportunities	A total of 80,000 kWh was saved through the implementation of the following initiatives: • Installing 4 variable frequency drives on air handling units • Changing out old incandescent lights for LED lights in various locations within the facility • Managing our load during peak load periods (timing of A/C start and stop, pool temp, etc).
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
2018 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 2017.
Investigate energy reduction opportunities	Estimated savings of 70,000 kWh per year
Assess opportunities to reduce releases to water	Investigate and implement (as feasible) opportunities to reduce releases to water from Cobalt

2.9.8 Well and Soil Sampling and Measuring/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 2017. 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.

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 October 6, 2017. Results, including those from the recent analysis, from five years previous and from the original sampling in 2005 are provided in Appendix C 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 2017 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 2013, 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. However, continuous improvement opportunities have been identified based on internal and external feedback to exercises and discussion with Ottawa first responders. As a result, Nordion management chose to re-develop the program.

This included the complete revision of the Emergency Response Plan and all sub-plans. These changes are to align the plan with Incident Management Systems (IMS) and to incorporate other continuous improvements identified.

A full-scale exercise under the new plan was conducted and inspected by the CNSC in 2016. The exercise included Ottawa Fire Services participation and the exercise objectives were successfully met. Minor areas of improvement were identified internally and by the CNSC. Management deemed the revised program effective.

Nordion completed all of its scheduled activities for 2017.

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 2017, a number of Emergency Response (ER) exercises were conducted to test these emergency response plans and response personnel.

Activities which took place in 2017 included:

- Fire extinguisher training was provided to staff by Ottawa Fire Services
- Fire Department orientation sessions were held with personnel from Ottawa Fire Services.
- Designing and implementing minor revisions to the program to address items identified during the 2016 major exercise
- Designing and implementing a two-way radio training program for responders
- Providing orientation visits to all fire fighters (90+) from the two responding stations
- Onboarding 3 new Incident Managers
- Creating refresher training courses
- Testing of the Fire Safety Plan in each of the three buildings (KOB, RE Building, and Heating Plant), including alarm activation and full evacuation. The KOB test included a scenario to exercise the first 30 minutes of an Incident Command Post (ICP) led response and first aid activation.
- Testing of the ER Contact List to ensure accuracy of telephone numbers listed, to determine availability of personnel, and to estimate response times
- Hosting a CNSC Emergency Management Program inspection.

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 2017.

2.10.4 Emergency Preparedness Program Improvements

In 2017, 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 a two-way radio training program for responders
- Providing orientation visits to all fire fighters (90+) from the two responding stations
- Onboarding 3 new Incident Managers
- Creating refresher training courses

2.10.5 Fire Protection Program Effectiveness

Fire drills/evacuations were conducted in the Heating Plant, the RE Building and the KOB in 2017. 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 2017. An annual facility condition inspection was conducted by a third party in 2017 with eight recommendations identified.

2.10.6 Fire Protection Program Activities

Activities that took place in 2017 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 eight recommendations noted
- Development of a Fire Response Needs Analysis
- Completing a fire response training needs analysis for the Fire Protection Program

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 2017 included:

- Completing a fire response training needs analysis for the Fire Protection Program
- Completing a Fire Response Needs Analysis to meet requirements of CSA standard N393, "Fire protection for facilities that process, handle, or store nuclear substances"
- Implementing Fire Extinguisher Training for applicable staff

There were no changes to training, methods, instrumentation, or equipment in 2017.

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 two years, increasing diversion rates from 64% in 2015 to 73.5% in 2017. 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 2017, there were no shipments to [redacted] of radioactive liquid waste by Nordion.

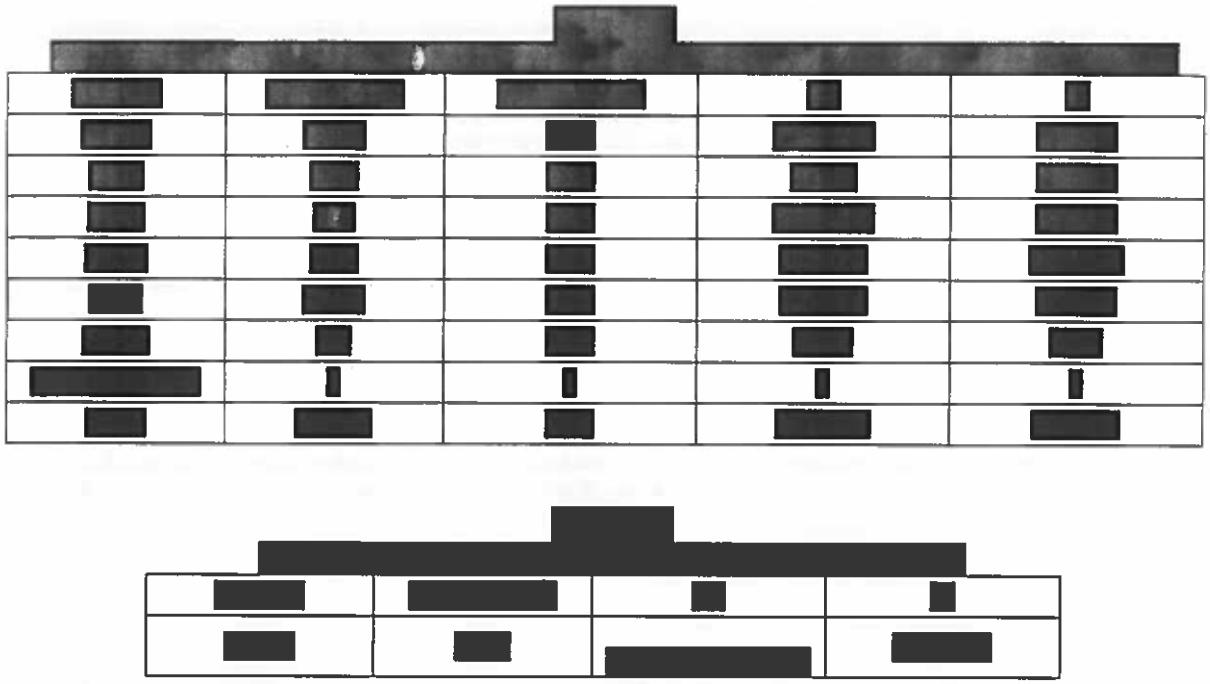
[redacted]

In 2017, approximately [redacted] of solid and liquid hazardous (chemical) waste was disposed of by Nordion via a licensed waste disposal company.

In 2017, [redacted] kg of waste that met CNSC unconditional clearance levels was disposed of to landfill as part of the waste diversion program.

[redacted]

[redacted]			



2.11.4 Waste Management Program Performance

- Performance relative to EHS objectives and targets for waste minimization – Nordion exceeded the target of 68% waste diversion by 2017, by achieving a 73.5% diversion rate in the 2017 annual waste audit.
- The amount of non-hazardous waste diverted from landfill – Nordion diverted an estimated [redacted] of waste from landfill in 2017.
- The amount of waste diverted from licensed radioactive waste facilities – [redacted] of waste that met CNSC unconditional clearance levels was disposed of to landfill as part of the waste diversion program.

The waste management program was last audited in 2015 and is on a three year frequency for auditing. It will be audited again in 2018. Annually Nordion has a waste audit conducted by a third party (non-hazardous waste only). The results of this audit are summarized below:

- 73.5% diversion rate
- 95%+ diversion rate for:
  - Aluminum food/beverage cans & foil
  - Scrap Metal
  - Cardboard
  - Fine Paper
  - Glossy magazines, flyers/posters
  - Newsprint/Packing Paper
  - Glass food/beverage bottles
  - Wood/Skids
  - Spent lighting tubes/bulbs/ballasts
  - Shredded Paper

2.11.5 Waste Management Program Improvements

Improvements to the Waste Management Program in 2017 included the following:

- Nordion worked with the waste service provider to include coffee cups in the organics waste stream, reducing the demand on landfills

- Nordion replaced non-radiological waste diversion program signage throughout the facilities in an effort to improve program performance
- Reduction in the amount of waste from the Ir-192 process sent to CNL. Several small projects completed to reduce Ir-192 process wastes and to optimize filling of the waste package. This work is related to a Nordion initiative to reduce Ir-192 process wastes and implement the practice of storing Ir-192 process waste for decay and then sending to Energy Solutions Inc. as low-level waste (versus continuing to send to CNL).
- 46.27E+3 TBq (1,250 kCi) of returned Cobalt was recycled into new source manufacturing.
- 23.8 TBq (629 kCi) of returned Cobalt was added to inventory in 2017 to support the recycling program.

2.12 Nuclear Security

Details of Nordion security and all of the security improvements of 2016 were provided in the Nordion Physical Security Report and Security Plan for 2016, submitted in March 2017. These safeguards and improvements are prescribed information and were reviewed and accepted by CNSC Security as part of the 2017 Type II Security Inspection.

2.13 Safeguards and Non-proliferation

2.13.1 Safeguards Program Effectiveness

Nordion has a program in place for the management of safeguarded material at the Nordion Ottawa site. The program meets the safeguards requirements of the CNSC regulatory document RD-336, "Accounting and Reporting of Nuclear Material", 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 2017, Nordion performed accounting and reporting of nuclear material as required by RD-336. Nordion completed a PIT of safeguarded material from which there were two opportunities for improvement (refer to Appendix B).

In 2017, the IAEA conducted a Complementary Access inspection at Nordion. There were no outstanding actions. The IAEA inspection report is pending. The CNSC did not conduct a Physical Inventory Taking - Evaluation (PIT-E) in 2017.

2.13.3 Safeguards Program Improvements

The safeguards program was revised to remove the requirement for submission of two nuclear material accountancy reports following CNSC confirmation that some of the reporting requirements in RD-336 could be reduced.

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 (sealed and unsealed) 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 2017, 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 (2012 Edition), US DOT 49 CFR, and US NRC 10 CFR part 71.

In 2017, Nordion reported ten 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 ten 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.

There were no non-compliances with the TDG regulations in 2017.

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 2017, 48,761 unique users visited Nordion.com 63,864 times looking at a total of 146,608 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.

Nordion engages community leaders as part of its Community Café event every two years. In 2017 Nordion conducted the following community outreach activities;

- On February 14, 2017, Nordion hosted a tour and held a meeting for Lisa Macleod, who was then the key Progressive Conservative caucus member for the Ottawa area at Queen's Park. Jack Maclaren, the local Provincial MMP for Kanata was also invited but unable to attend.

- On July 13, 2017, Nordion met with Kanata Councillor Marianne Wilkinson and her advisor Amy Zhou to discuss community issues including the agreement with KNL to expand the culvert on Nordion's campus, an early heads-up on Nordion's plan to sell off land and a building on Nordion's campus, and to discuss the new President who was about to start that week.

- Only July 17, 2017, Nordion contacted Councillor Marianne Wilkinson to brief her on a road accident involving a transport truck carrying cleaned and empty Gamma containers and another vehicle.

- In preparation a crisis simulation drill on September 19, 2017, Nordion contacted Councillor Wilkinson, the Ottawa Citizen/Sun, Kanata Kourier and CFRA News to notify them that a drill would be happening in case they had calls.

In 2017, Nordion published the following information in their "Public Disclosure" web page:

- January 4: Nordion published a comprehensive report of the Nordion Community Café that was held in October 2016.
- February: Q4 2016 Event Report.
- June: Annual Compliance and Operational Performance Report 2016.
- June: Q1 2017 Event Report.
- August: Q2 2017 Event Report.
- July 6: Nordion announced that at approximately 7:30 am on that day, a truck owned and operated by a Nordion service provider was involved in a traffic accident on March Road in Kanata while transporting four cleaned and empty transport packages away from the facility. At the time of the accident, the truck

was stopped at a traffic light, where it was struck from behind by another vehicle. In keeping with established safety protocols, the package was examined on the scene by a Nordion radiation specialist who confirmed that no adverse effects to the packages or their securement had occurred, and no radiation contamination was detected. Repairs to the truck trailer were completed on scene and it resumed its route by 9:45 am.

- November: Q3: 2017 Event Report
- September 15: Nordion announced that the Ottawa Fire Services would be visiting Nordion for site familiarity meetings and tours over the next two weeks.

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 gather how the public would like the program to evolve. Twenty-one (21) unique users visited the survey. Zero surveys were completed. A copy of the feedback survey form is provided in Appendix D.

Nordion also conducted a public survey in 2016.

Nordion regularly issues news releases to inform the public of company initiatives, achievements, and issues that the business may be facing. In 2017, 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 2017, there were neither negative comments pertaining to events nor questions related to environment, health and safety.

On December 14, 2017, Nordion published an ad in the *Kanata Kourier-Standard EMC*, a free weekly distribution newspaper that had a circulation of approximately 23,400, and serves the communities surrounding Nordion's Kanata site. 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 by way of nordion.com.

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

One (1) request for information related to Nordion's waste management program and radiation protection program was received by email from a member of the general public. A representative from Nordion spoke by phone with the individual and learned that the individual was working on behalf of Northwatch, a regional coalition of environmental organizations, community groups and individual members in northeastern Ontario. Northwatch was gathering the same type of information on all the CNSC-licensed facilities included in the CNSC annual report on performance and would be submitting a written intervention to the CNSC. The Nordion representative then followed up with an email providing information to the individual.

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.

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 2017, Nordion submitted written notification of changes to programs and documents to the CNSC with two exceptions. Two procedures were made effective without providing written notification to the CNSC of the changes to the documents 30 days prior to implementation as per Nordion's License Conditions Handbook (LCH). The root causes of the missed notifications were management system and procedure. EHS replaced manual monitoring of the effective dates of procedures that are pending CNSC approval and the manual review of documents that require written notification with electronic solutions. The missed notifications were not reportable to the CNSC.

In 2017, there were three events with regard to sealed source reporting:

- A discrepancy in the serial numbers of returned sealed sources was undetected. The root causes were procedure and management system. The applicable procedure was revised to contain the appropriate detail for important steps. The importance of revising records only after verification is performed was discussed with personnel.
- Incorrect customer addresses were reported to the CNSC Sealed Source Reporting System (SSTS). The root cause was management system as the methods for creating Sales Orders for the different countries/jurisdictions was inconsistent. Nordion is investigating improvements to the entry of the address of the recipient's or importer's authorized location. Containment was put in place to ensure the customer address is clearly indicated on the applicable paperwork.
- The import of a sealed source not reported within required timeframe. The root cause was communication. The situation was reviewed with applicable personnel and processes were reviewed to determine if changes could be made to reduce future errors. EHS Compliance will ensure that for non-routine reporting written plans are supplied to all relevant staff and their back-ups.

These instances were not reportable to the CNSC. There were no trends identified in 2017 with regard to SSTS-related events, or over a three-year period from 2015-2017. In 2014, Nordion conducted a process review of sealed source reporting and implemented some improvements. In 2016, as indicated in Section 2.3.4.1, Nordion repeated the process review incorporating a different analysis method to ensure all avenues for error were identified. The review has since concluded and Nordion is working toward addressing all identified continuous improvement actions and corrective actions.

Nordion complied with all other site-specific reporting requirements. In 2017, there were no exceedances of action levels. Nordion reported on August 30, 2017 to the CNSC on the status of the financial guarantee.

3. FUTURE PLANS AND CONCLUDING REMARKS

3.1 Improvement Plans and Future Outlook

Nordion will continue to focus on the new Molybdenum-99 program to resume supplying key customers with products and customer service. 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]

- [redacted]
- License amendment and approvals as per the LCH of the EHS program changes if the potential sale of the RE Building and vacant land at the 447 March Road site proceeds/

3.2 Safety Performance Objectives for 2018

Nordion's 2018 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
2018 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
Minimize the number and extent of occupational injuries, environmental and radiation incidents.	• The number of Medical Treatment Incidents ≤ 6 • 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. 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 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.

***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
16-Dec-08	**17-01**	A low activity non-production sealed source could not be located.	Reportable under Section 27(b)(i) of the NSCA.	There was no procedure regarding the packaging of the check source. Training, labeling and housekeeping need improvement.	A lock box was procured for secure storage of packaged sources. Work instructions will be created for non-production source packaging and training was provided. Job Task Analysis will be revised to include source packaging.
17-Mar-04	**17-07**	Two Type A packages 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.	Packages did not make their connecting flight and temporarily could not be located within the carrier's systems.	The packages were located by the carrier. No action required by Nordion.
16-Dec-08	**17-08**	An employee sustained a right shoulder injury, requiring surgery from loosening a socket head cap screw while repairing cell manipulators.	Reportable under Section 29(1)(h) of the GNSCR.	Training – the task of performing rebuilds of manipulators had not been included in the Job Hazard Analysis and Risk Assessment. Human Engineering – the task required fair amount of force. Work Direction – Ergonomic hazards had not been evaluated as part of the work package for manipulator rebuilds.	Nordion reviewed the thread locker products in use and the tools that could be used to reduce the force required for tasks that require the application of force. The Job Hazard and Risk Assessment will be reviewed including a review of ergonomic hazards.
17-May-23	**17-10**	A Type A package was damaged in transit at the carrier depot.	Reportable under Section 37(1) of the PTNSR as event is a dangerous occurrence as per Section 35(b) of the PTNSR.	Not applicable; root cause determination is responsibility of carrier.	Nordion staff was dispatched to the scene and retrieved the damaged package. The inner package material remained fully intact during the incident and there was no release of contamination.

Date of Occurrence	Incident No.	Description	Regulation/Requirement to which the Event is Non-compliant and/or Reporting Requirement	Causes	Corrective Actions
17-May-31	17-11	A shipping skid used for transport of Type B packages from end users to Nordion was found to have a well contained area of contamination greater than the reportable limit.	Reportable under Section 37(1) of the PTNSR as event is a dangerous occurrence as per Section 35(f) of the PTNSR.	Not applicable; root cause determination is responsibility of consignor.	Nordion informed the consignor. Consignor is responsible for corrective action. There was no impact to the public or the environment.
17-Jun-24	17-14	While in transit, the passenger side window on a contract carrier's truck was struck by an object, shattering the window. The co-driver was injured by the glass.	Reportable under Section 37(1) of the PTNSR as the event is a dangerous occurrence as per Section 35(a) of the PTNSR.	Not applicable; root cause determination conducted by local police.	There was no impact to the package or radioactive material. Local police were notified and investigated.
17-May-10	17-15	A detector unit containing a tritium source was shipped to the vendor for repairs and calibration without a CNSC export license.	Non-compliance with Section 26(a) of the NSCA. Reportable under Section 27(b)(ii) of the NSCA.	The incorrect procedure and associated Form were used to ship an item from the Active Area. The Radiation Surveyors and Procurement are not trained on the "Shipment of Packages" procedure.	The training requirements for the procedures used to ship items from Nordion will be reviewed and broaden to include the Radiation Surveyors and Procurement. Improvements to the "Requisition to Ship" form are being implemented.
17-Jul-06	17-16	Conveyance containing four empty Nordion transport containers was involved in an accident. The vehicle was hit from behind by another vehicle while stopped at a traffic light.	Reportable under Section 37(1) of the PTNSR as event is a dangerous occurrence as per Section 35(a) of the PTNSR.	Not applicable; root cause determination conducted by local police.	There was no damage to the transport containers. They remained secured and there was no contamination found. Local emergency personnel responded.
17-Jul-06	17-17	A Type B package was received by a consignee with a damaged identification plate. The identification plate was not fully secured to the package.	Reportable under Section 37(1) of the PTNSR as event is a dangerous occurrence as per Section 35(b) of the PTNSR.	Package was damaged in transit.	Nordion followed up with the package handlers and carriers. No further action was required by Nordion.
17-Jul-11	17-18	A Type A package was reported damaged when picked up at a carrier site. There was a slight depression in the top corner of the cardboard box.	Reportable under Section 37(1) of the PTNSR as event is a dangerous occurrence as per Section 35(b) of the PTNSR.	Package was damaged in transit.	Nordion notified the carrier. No further action was required by Nordion.

Date of Occurrence	Incident No.	Description	Regulation/Requirement to which the Event is Non-compliant and/or Reporting Requirement	Causes	Corrective Actions
17-Aug-09	**17-23**	Export of controlled nuclear information without an export license.	Disclosure as per REGDOC-2.13.2 Nuclear Non-proliferation Import and Export Control Regulations	Lack of system-based labels, warning and/or displays to inform employees that they are handling export controlled information. Corrective actions needs improvement.	System-based labels, warning, displays and other controls will be assessed and implemented in order to better inform employees and/or implement access controls to export controlled information at Nordion.
17-Sep-01	**17-24**	Two Type B packages were dropped from a fork lift during handling/transfer at a Canadian airport. Damage was noted on the packages.	Reportable under Section 37(1) of the PTNSR as event is a dangerous occurrence as per Section 35(b) of the PTNSR. (reported by carrier)	Not applicable: root cause determination conducted by airport authority.	Nordion advised there was no negative impact on the radiation fields as a result of the event. No further action was required by Nordion as the event occurred at the airport.
17-Oct-06	**17-27**	Two contract carrier vehicles were involved in a minor accident on Nordion's site. One vehicle was carrying Class 7 material. There was no impact to the Class 7 material.	Reportable under Section 37(1) of the PTNSR as event is a dangerous occurrence as per Section 35(a) of the PTNSR.	Not applicable: root cause determination is the responsibility of carriers.	No action was required by Nordion.
17-Oct-31	**17-28**	A Type B transport package was received at Nordion with damage to the upper half. Damage was restricted to the exterior of the package only.	Reportable under Section 37(1) of the PTNSR as event is a dangerous occurrence as per Section 35(b) of the PTNSR.	Package was damaged in transit.	Nordion followed up with customer. No further action was required by Nordion.
17-Oct-26	**17-29**	Export of [redacted] sealed sources to a location without an export license. The location was not authorized as per an export license.	Non-compliance with Condition 1.1 of export license.	End-users changed destinations mid-shipment to another location authorized by their Competent Authority. Procedures and training need further improvement to address such situations.	Nordion will review and update procedures and training.

Date of Occurrence	Incident No.	Description	Regulation/Requirement to which the Event is Non-compliant and/or Reporting Requirement	Causes	Corrective Actions
17-Nov-11	17-32	First low-water level alarm activated for Nordion storage pool, indicating reduced, but sufficient, pool water level.	Reportable under Section 29(1)(d) of the GNSCR.	Water level floats did not operate as planned due to debris caught in the mechanism.	Water level floats will be checked and cleaned on a monthly basis. Additional measures to assess water levels will be reviewed.

Appendix B
Summary of Corrective Actions Associated with the Internal Audits Conducted in 2017

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 Audit of High Specific Activity (HSA) Cobalt	1 Minor Finding	CAPA 171006	Waste etchant used to inspect test welds was not properly labeled or stored as per Nordion's chemical handling and storage procedure.	TBD	Open
2	EMS Audit	2 OFIs	n/a	2 out of 354 employees had not completed training on the EHS Policy document.	Have the 2 employees complete the required training.	Closed.
			n/a	Form SE-ERP-010 F5 is not used at all times as some exercises are documented on external parties' documents.	Change SOP to indicate this form "may" be used.	Closed
		1 Observation	AC-CMP-20180201-004	One case was found where monitoring and measurement equipment was not calibrated in accordance with applicable procedures.	EHS to establish a method for verifying functionality of the meters and to have them added to AMMS.	Open
3	Business Planning, Organization, Assessment	1 Minor Finding	CF 8273	Accountability is not defined in the context of the CSA N286-12 standard in the Management System for Safety and clarification regarding accountability is needed for positions having key roles.	Revise Management System for Safety to define worker accountabilities.	Closed

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
	Business Planning, Organization, Assessment (cont'd)	3 OFIs	CF 8273	Internal and external interfaces are not described in the Management System for Safety, where the applicable standard is mentioned.	Revise Management System for Safety document to describe internal and external interfaces.	Closed.
			CF 8273	There are discrepancies between the organization chart and the roles listed in the Management System for Safety and Nordion's actual organizational structure and position titles.	Revise Management System for Safety document to update organizational charts and management titles.	Closed
			CHR-2616-NUM	The Suggestions/Improvements section and name or title information was not completed on some self-assessment forms.	Revise the self-assessment forms: add a checkbox to indicate no suggestions/improvements and two separate lines for name/title and signature.	Open
4	Public Information Program	2 OFIs	AC-CMP-20170918-001	Two Annual Compliance Reports (ACRs), the 2014 CNSC Review of Nordion's Performance and two event reports are not available in the applicable sections of Nordion's website.	Update the corporate website to provide all links to the ACRs, Performance Reports and event reports in the public disclosure section.	Open
			AC-CMP-20170918-002	The Nordion Public Information Program procedure refers to the position of Communications and Government Relations. This position is no longer staffed.	Update the Public Information Program procedure to reflect current practice.	Open

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
5	Resources	3 Minor Findings	CAPA 170605	The backup of training records as per the Electronic Quality Management System (EQMS) administration procedure has not been completed.	Review the requirements of CPM-7-04 and ensure they are completed as required.	Effectiveness Verification
			CAPA 170606	The read and understand training requirements for Surveyors in the training document and in the EQMS do not match. Two "Training Requirements and Completion Records" were not fully completed andone training record could not be located.	Review the Surveyor read and understand training requirements and update the EQMS and the training procedure to reflect training needs. Locate training record or document and file an explanation if the record is not located.	Open
			CAPA 170607	Read and Understand training for Security Guards is not tracked and several Security Guards were not up to date on Read and Understand training.	Develop a system for tracking Read and Understand training and refresher training for Security Guards.	Effectiveness Verification
		7 OFIs	AC-CMP-20170524-001	The minutes of the Annual Joint Environmental Management System and Management System for Safety meetings should contain more specific information to demonstrate all aspects of resources were discussed.	Determine measures to ensure future meeting minutes include all aspects of resources discussed. i.e. personnel resources, financial resources, and specialized skills for maintaining the program.	Open

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
5	Resources (cont'd)		CHR-2206-NUM	Nordion's competency criteria document is missing performance requirements for some roles.	Enter a change request into the EQMS to revise the performance requirement criteria of the EHS competence criteria document to ensure alignment with responsibilities in the Management System for Safety document.	Open
			AC-CMP-20170523-002	A regular review of training courses (current and new) should be done to ensure courses critical to supporting nuclear safety, security and/or emergency response are added to the list of key EHS training courses in Nordion's systematic approach to training document as needed.	Create a recurring task in the EHS compliance obligations software to review if new key EHS training courses need to be added to the Systematic Approach to Training document every 6 months.	Closed
			AC-CMP-20170608-001	Three trainers for courses listed in the Systematic Approach to Training document did not have the Train the Trainer refresher training requirement. A regular review of trainers training requirements should be completed to ensure required trainers have the refresher training requirement.	Create a recurring task in the EHS compliance obligations software to review trainers to ensure required trainers have the refresher training requirement	Closed

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
	Resources (cont'd)		AC-CMP-20170523-003	Nordion is currently transitioning to a new corporate Performance Management Program. Nordion's performance expectations and behavior expectations still remain through various means including the company website, the intranet site, policies and bulletin boards. While the new program is not complete, expectations have remained.	At the end of the year, confirm with corporate management that the new Performance Management Program has been implemented.	Open
			CHR-2188-NUM	The training program and management system document contains an incorrect reference.	Enter a change request into the EQMS for the training program and management system document to correct the document reference.	Open
			CHR-2186-NUM	The "Target Employees" column for two courses listed in the EHS training document is incomplete.	Enter a change request into the EQMS for the EHS training document to update the "Target Employees" column.	Open
6	Documentation, Records	7 OFIs	AC-CMP-20180220-002	For the Calibration Sheet (R-6-57), for the Eberline Ratemeter, it is unclear if the equipment passed the calibration check.	Update the calibration sheet to identify calibration status, i.e. pass/fail.	Open
			AC-CMP-20180220-003	Good Documentation Practices (GDP) should be used to cross out un-needed sections of "Radiometric Calibration Form, SE-CA-002 F1".	Review GDP's with team.	Open
			AC-CMP-20180220-004	Good Documentation Practices (GDP) should be used to cross out un-needed sections of "Cobalt Calibration Form 3, CO-QC/CA-0017 F3".	Review GDP's with team.	Open

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
6	Documentation, Records (cont'd)		AC-CMP-20180220-005	Certain records, such as sealed source registrations, CNSC licenses, transportation licenses and other records currently listed in "Quality and EHS Records", CPM-7-09 should be reviewed for applicability. Licenses and other regulatory approvals are not subject to the same requirements as Nordion generated documents and records.	Conduct a review of sealed source registrations, CNSC licenses, transport licenses and other records to determine if they should remain in CPM-7-09. Revise CPM-7-09 as required.	Open
			AC-CMP-20180220-006	Form 1 of "C188 Capsule Cutting Procedure", CO-C5/OP-0001 F1, requires revision as there is no space on the form to record who performed/recorded the measurements.	Revise form as required.	Open
			AC-CMP-20180220-007	"Cobalt 60 Capsule Requisition" Form, CO-C4/MP-0001 F1, records have a single signature when it is clear that more than one person is required to complete the form.	Revise the form as required.	Open
7	Problem Identification and Resolution	1 Minor Finding	CAPA 171110	A superseded form from a controlled procedure was used by two technicians for three months. A CAPA was not initiated as required by the Deviation procedure when evidence existed that a deviation was the result of a quality system failure.	TBD	Open

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
7	Problem Identification and Resolution (cont'd)	6 OFIs	CHR-2480-NUM	It is unclear in the complaints procedure which procedure to use for the root cause analysis.	Enter a change request into the EQMS for the complaints procedure.	Open
			AC-CMP-20171117-002 CHR-2477-NUM	The near-miss form should contain a field to indicate the incident risk rating. Some investigation reports contain location, date and time the incident occurred, and name(s) of the person(s)/company involved (by position title only) in the description of the incident; however, this is not indicated as required content in the investigation procedure.	Determine a method to capture incident risk rating for near-miss reports. Enter a change request into the EQMS for the investigation procedure.	Open
			CHR-2481-NUM	The completed by and verified by fields were signed by the same person for two Complaints forms. The verification should not be performed by the same person to ensure accuracy of the verification.	Enter a change request was entered into the EQMS for the complaints procedure.	Open
			CF# 8563	The non-conformance and corrective and preventive action procedure refers to the Operational Deficiency Database. This database is no longer being used, and instead operational deficiencies are logged as near-misses.	Revise the non-conformance and corrective and preventive action procedure.	Closed

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
7	Problem Identification and Resolution (cont'd)		CHR-2481-NUM	Additional information was collected from the customer following the initiation of some complaints; however, the complaint initiation form was not reissued. The complaints procedure does not clearly state what type of additional information from the customer would warrant a re-issuance.	Enter a change request was entered into the EQMS to revise the complaints procedure.	Open
			CHR-2482-NUM	There is no survey in Medical Isotopes that confirms that customers are satisfied. Only issues (i.e. negative feedback) are logged.	Enter a change request into EQMS for the customer satisfaction procedure to implement additional methods in Medical Isotopes to collect data related to customer satisfaction – both positive and negative.	Open
8	EHS Internal Audit Program	2 Observations	AC-20180129-004	Radiation Surveyors are not trained in auditing as currently required by procedure.	Procedure will be updated to reflect the current process.	Open
			AC-20180129-005	The Internal Audit Program indicates that observations are classified as Major/Minor or Opportunity for Improvement (OFI), but an EHS audit report had findings that were labelled as "Observations".	Update the audit report to label findings appropriately.	Open
		5 OFIs	AC-20180129-001	During the process safety audits when OFI's are identified, a person responsible should be identified for the OFI.	TBD	Open

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
8	EHS Internal Audit Program (cont'd)		AC-20180129-002	The "Internal Audit Procedure" indicates that when an audit is deferred a reason for the deferral should be noted on the audit schedule. The EHS Audit Schedule indicates reasons for deferrals to another year, but not when the audit is moved to a different quarter of the same year.	Clarify the requirements in the "Internal Audit Procedure".	Open
			AC-20180129-003	Suggested to add a revision number to the EHS audit schedule for traceability.	Add revision number to the EHS audit schedule.	Open
			n/a	When an external auditor's ausit results were summarized for SE-EHS-05 there was no reference to the audit number.	This was corrected during the audit as the number was added to the audit report in questions.	Closed
			n/a	Regarding the EHS Summary Report, suggest adding details on the form in CPM-7-03 or consider discontinuing the use of the form as the EHS audit reports are very detailed.	This was addressed during the audit through an update to the EHS Summary Report form and an email to the required auditors at Nordion.	
9	Safety Analysis	2 Major Findings	CHR-2497-NUM CHR-2506-NUM	Two secondary FSARs are missing sections as detailed in the safety analysis procedure.	Enter a change request into the EQMS for the safety analysis procedure to indicate that the CSARs and FSARs are to be prepared with the listed titled sections, as applicable.	Open
			CHR-2498-NUM	The change forms for two FSARs were not approved by the relevant Directors. The Directors also did not approve the document in the EQMS.	Enter a change request into the EQMS for the safety analysis procedure to specify that the Director approval is required for the change form.	Open

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
10 11	Supply Chain and Purchasing Requirements Supplier Audit Program	2 Minor Findings	CAPA 180106	There is no version or form/procedure reference on the SPD that is used for on boarding suppliers.	TBD	Open
			CAPA 180107	On-Boarding evaluation and reassessment does not adequately address the risk requirements of ISO 13485:2016 Sections 7.4.1 and 7.4.3.	TBD	Open
		7 OFIs	CHR-2611-NUM	P-310 should point to SE-ENV-019 for requirement regarding audits, as sometimes audits are required as part of the on-boarding process.	Make changes to P-310 document to address findings.	Open
			AC-20180116-001	Director of Corporate Compliance approval was not obtained prior to on-boarding a supplier as required by procedure.	Improvements to the internal process(es) for obtaining the required approvals.	Open
			CHR-2612-NUM and CHR-2613-NUM	Procurement is only using the criteria of spending to establish Tier (criticality) of suppliers, without inclusion of Quality and EHS reassessments.	Update internal procedures to clearly indicate the purpose and responsibilities for supplier reassessments, including Quality and EHS requirements.	Open

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
10 11	Supply Chain and Purchasing Requirements (cont'd) Supplier Audit Program (cont'd)		AC-20180116-002	It is not evident that the results of procurement or EHS reassessments are being considered as input when determining the extent or frequency of inspection/verification/audits.	Update internal procedure to ensure these reassessments are considered as required.	Open
			CHR-2525-NUM	Appendix A of SE-LIC-001 does not correlate with the actual sections of the document.	Update the document sections/Appendix A to correlate.	Open
			AC-20180116-003	There was no evidence that the scope of the supplier audit was communicated to the supplier as required by procedure.	Provide evidence of this communication to the audit file.	Open
			AC-20180116-004	EHS Suppliers list does not have "last audited date" information tracked, which will make the audit frequency requirements for each supplier difficult to track going forward.	Implement tracking audit dates and update required frequency/next audit date as required.	Open
12	Non-production Radioactive Material Inventory (NPRMI)	1 Minor Finding	CAPA 171111	Five new non-production sources were located in the Quality Control area. Two non-production sources were not found in the location as indicated in the inventory database.	TBD The location in the database was corrected.	Open

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
12	Non-production Radioactive Material Inventory (NPRMI) (cont'd)	3 Observations	n/a	Two non-production sources were not found in the location as indicated in the inventory database. It was determined that the location listed in the database was incorrect.	The database was corrected.	Closed
			n/a	A legacy non-production source was located.	The source was added to inventory.	Closed
			AC-CMP-20171127-003	Less than two months notification was provided to EHS Compliance for the planned purchase of nuclear material that requires safeguards reporting.	TBD	Open
		2 OFIs	AC-CMP-20171127-004	The location of one non-production source was not updated in the database.	A new locator was created in the database and the source was added to inventory.	Closed
			AC-CMP-20171127-005	The cycle count for one group was not performed in February.	TBD	Open
13	Operational Control, Monitoring and Maintenance	1 Minor Findings	CAPA 171012	A number of issues were identified with filling out various fields and filing of work permits.	TBD	Open
		7 Observations	AC-CMP-20171122-001	One event was reported to the CNSC Directorate and not to the Duty Officer, as specified in in Nordion's reporting procedure.	Discuss non-compliance and review requirements for reporting transport incidents to the Duty Officer with applicable personnel.	Closed

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
13	Operational Control, Monitoring and Maintenance (cont'd)		AC-CMP-20171123-002	Red lock-out tags are used by the Electricians and green lock-out tags are used by the Mechanics. The work permit procedure indicates that red tags are to be used.	Discontinue use of Green Tags for Tag Out.	Closed
			AC-CMP-20171124-001	Entries in the Roof Access Database were absent for two work permits.	TBD	Open
			AC-CMP-20171124-002	One security contractor performed fire watch duties and their training was overdue.	TBD	Open
			AC-CMP-20171122-003	The identification of key production equipment for new processes is not a requirement of the change control procedure.	Revise the change control procedure to include an assessment of equipment for new processes, to identify key production equipment so that they can be added to the AMMS system.	Open
			AC-CMP-20171123-003	The identification of key production equipment for new processes is not a requirement of the design control procedure.	Revise the design control procedure to include an assessment of equipment for new processes, to identify key production equipment so that they can be added to the AMMS system.	Open
			AC-CMP-20171123-004	Radiation survey instruments that are not to be used are not labelled as per the Survey Meter Maintenance and Repair procedure.	TBD	Open

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
13	Operational Control, Monitoring and Maintenance (cont'd)	13 OFIs	AC-CMP-20171023-006	Four additional reports that are submitted to environmental agencies were noted. These reports are not listed in Nordion's reporting procedure.	Add these reports and any other additional reports that are not currently listed to the Environmental Agencies Reporting Timetable in the reporting procedure.	Open
			AC-CMP-20171023-007	There is one Read and Understand requirement missing from the security officer training.	Update the security officer training program.	Open
			AC-CMP-20171023-008	Training for contractors is described in three different documents. The Environmental Training for Employees and Contractors is not in EQMS. Emergency Alarms and Procedures, Fire Prevention and Safety, Fire Watch and IMS Emergency Response Training are not included in the EHS training document.	Review contractor training to assess if the training can be described in one document, update applicable documents and formally control the Environmental Training for Employees and Contractors.	Open
			CF 8465	The work permit procedure refers to the incorrect position title.	Revise the work permit procedure.	Closed
			n/a	Two work permits were logged incorrectly logged incorrectly in the work permit database.	Correct the work permit database.	Closed
			n/a	An expired work permit was posted and had not been replaced with the new work permit.	Replace the work permit.	Closed

	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
13	Operational Control, Monitoring and Maintenance (cont'd)		AC-CMP-20171023-009	All equipment for fire watch duties was available at the work site with the exception of the floor plans.	Add a check to the Fire Watch Log Sheet to confirm required equipment for fire watch duties is available at a work site.	Open
			AC-CMP-20171023-010	The description of the EHS evaluation of corrective maintenance requests in the preventive and corrective maintenance procedure does not reflect current practice.	Update the procedure.	Open
			AC-CMP-20171023-010	The description of the investigation of corrective maintenance requests in the preventive and corrective maintenance procedure does not reflect current practice.	Update the procedure.	Open
			CHR-2441-NUM	The source measurement procedure refers to a role that is no longer staffed.	Revise the procedure.	Open
			AC-CMP-20171023-012	The survey meter calibration procedure indicates a humidity range. Even if the humidity is outside of the range indicated, it is accounted for in the calculation.	Review the humidity range and remove from the calibration procedure if it is not required.	Open
			AC-CMP-20171023-012	A calibration procedure that is no longer was identified.	Obsolete the document.	Open
			AC-CMP-20171023-012	The Direct Reading Dosimeters (DRD) testing procedure indicates an incorrect limit for placement of the dosimeters.	Revise the testing procedure to reflect current practice.	Open
14	Safeguarded Material Physical	2 OFIs	AC-20171020-001	The label on a safeguarded container was illegible.	Replace label on container.	Closed

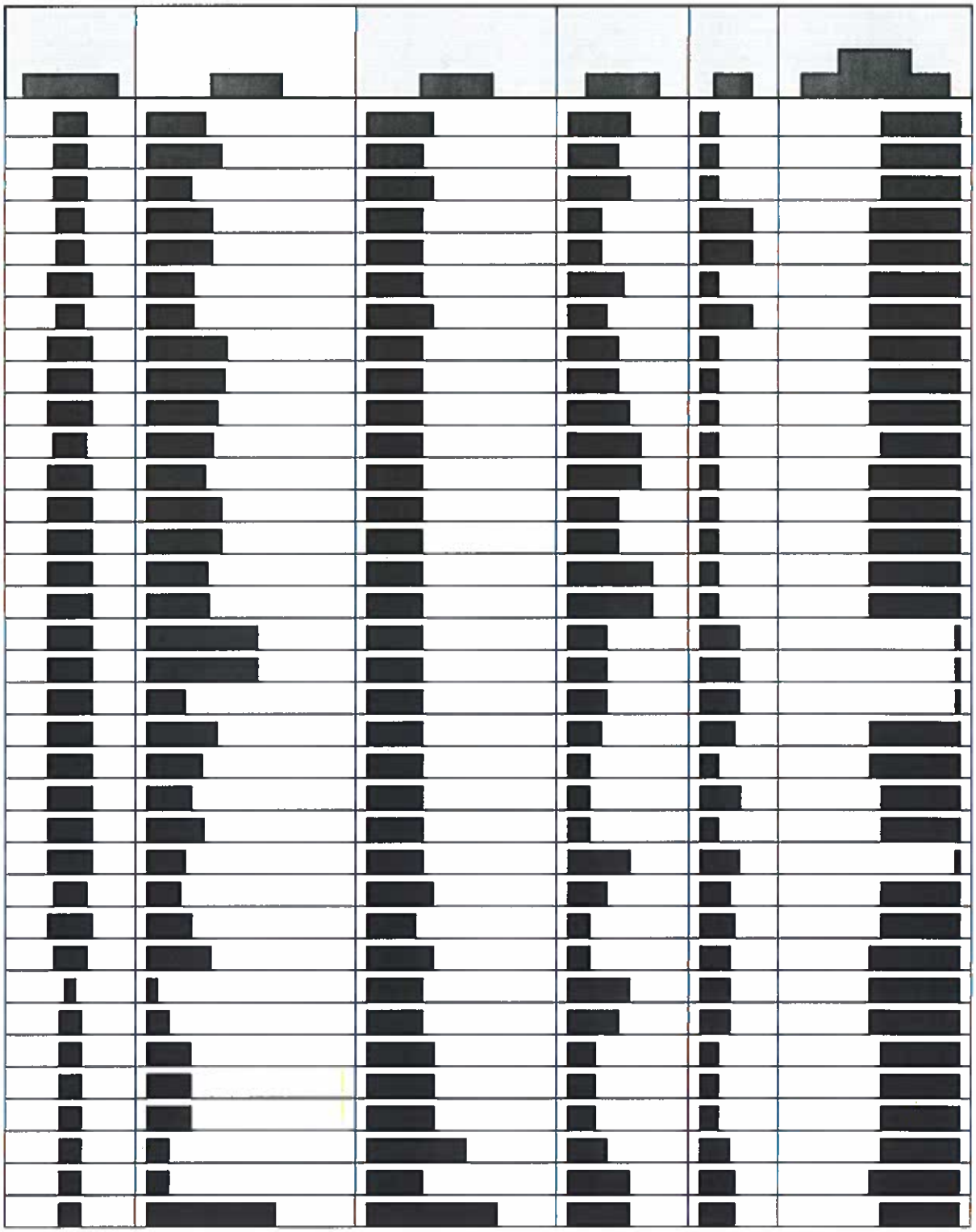
	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
	Inventory Taking (PIT)		AC-20171020-002	The description on the label for two non-production sources was different from the description in the safeguarded material record.	Update the safeguarded material record.	Closed
15	Sealed Source Reporting	2 Minor Findings	CAPA 170802	There were no date entries in the reporting tool confirming resolution of bulk upload errors for four exports.	Develop an alert fir EHS Compliance when these dates are not entered within three days.	Open
			CAPA 170802	Nordion has not been receiving CNSC confirmation that "end-of-life" sources are made "inactive" in the SSTS.	Revise the procedure to remove the requirement for confirmation.	Open
		6 OFIs	CF 8569	The 48 hour timeframe for reporting imports is currently not being formally tracked.	Further develop the process for monitoring the reporting timeframe for imports.	Open
			AC-CMP-20170822-002	Currently EHS Compliance uses an Excel spreadsheet to track and log the resolution of errors. This is an informal Excel spreadsheet and is not being updated/used consistently.	Formalize this process to keep track of ongoing and resolved errors.	Open
			CHR-2291-NUM	Individual EHS Compliance personnel are copied on notification emails from Forecasting & Planning to the CNSC.	Implement an email distribution group for EHS Compliance and update the procedure.	
			CHR-2291-NUM	The Operations Manager for Ir-192 production does not review and file the Daily Sealed Source Shipments Monitoring Report as outlined in the sealed source reporting procedure.	Update the sealed source reporting procedure to reflect current practice.	Closed

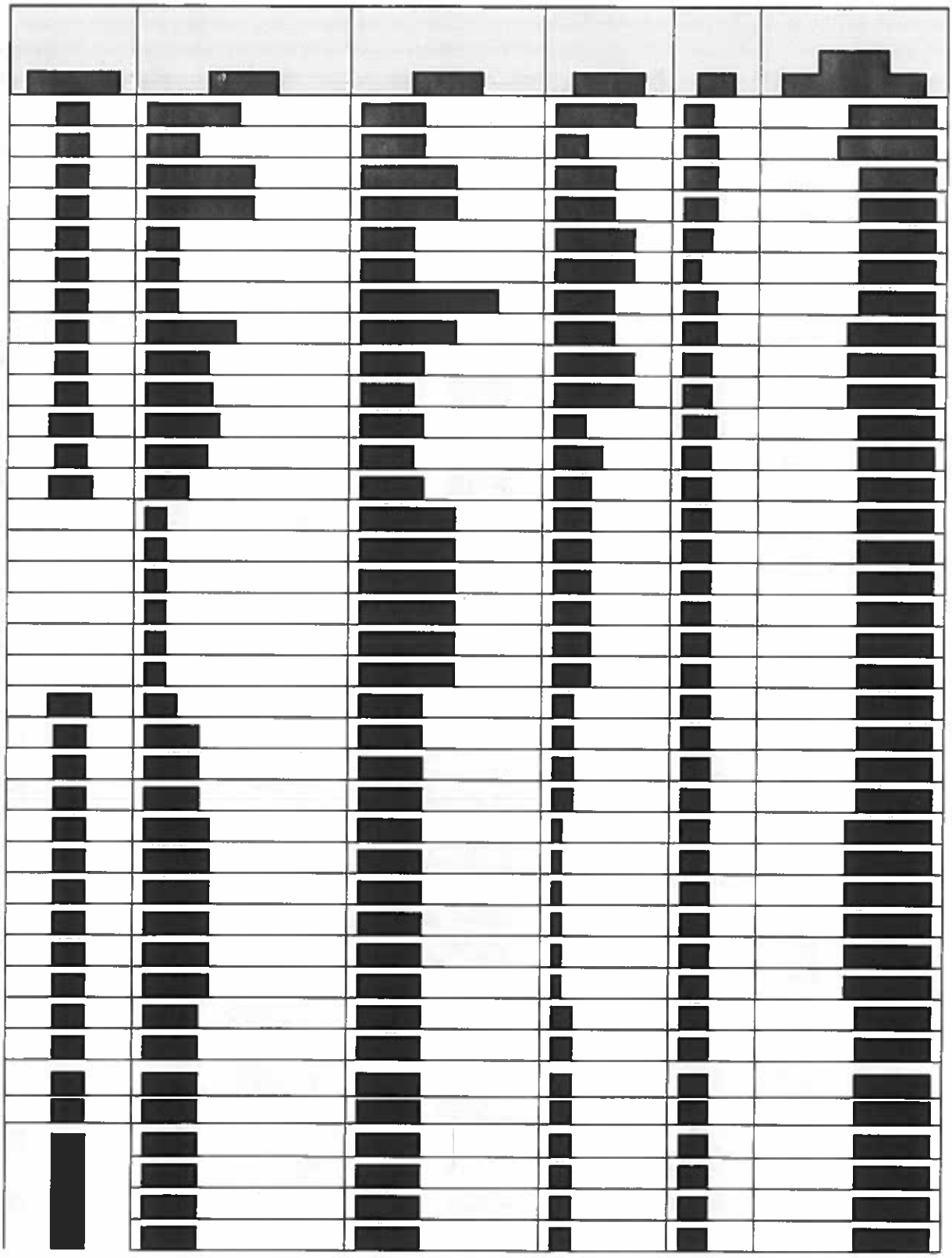
	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
15	Sealed Source Reporting (cont'd)		CHR-2291-NUM	The email distribution group for the discussion of sealed source reporting issues is not being used as indicated in the procedure.	Update the Sealed Source Tracking procedure to indicate that issues are to be flagged to the applicable department as well as the EHS email distribution group.	Closed
			CHR-2291-NUM	The procedure for sealed source reporting requires minor revisions to reflect current practice for where electronic files are saved and to remove the reporting requirement for unsealed sources of TheraSphere for Belgium as this is no longer done by Nordion.	Update the sealed source reporting procedure to reflect current practices.	Closed
16	Sealed Source Export Licenses	1 Observation	AC-20180206-002	For 27 of 38 Ir-192 orders, the CNSC PSN Acknowledgement email was not filed electronically in the CBS Facility. Hard copies were filed with the Sales Order Files.	Issue a reminder to Customer Service that the PSN Acknowledgement email is to be stored electronically in the CBS Facility in addition to as a hard copy in the Sales Order File.	Closed.
17	Research and Development	3 Minor Findings	CAPA 171012	A number of issues were identified with filling out various fields of work permits.	TBD	Open
			CHR #2479	One change form exceeded the Target Closure Date and there was no "extension memo" in the CF file as required by the change control procedure.	Clarify in the Change Control procedure when an extension memo is required.	Open
			CHR #2486	Design review meeting minutes were not recorded using the design review meeting minutes form.	Revise Design Control document to allow for the completion of minutes using the form or a memo.	Open

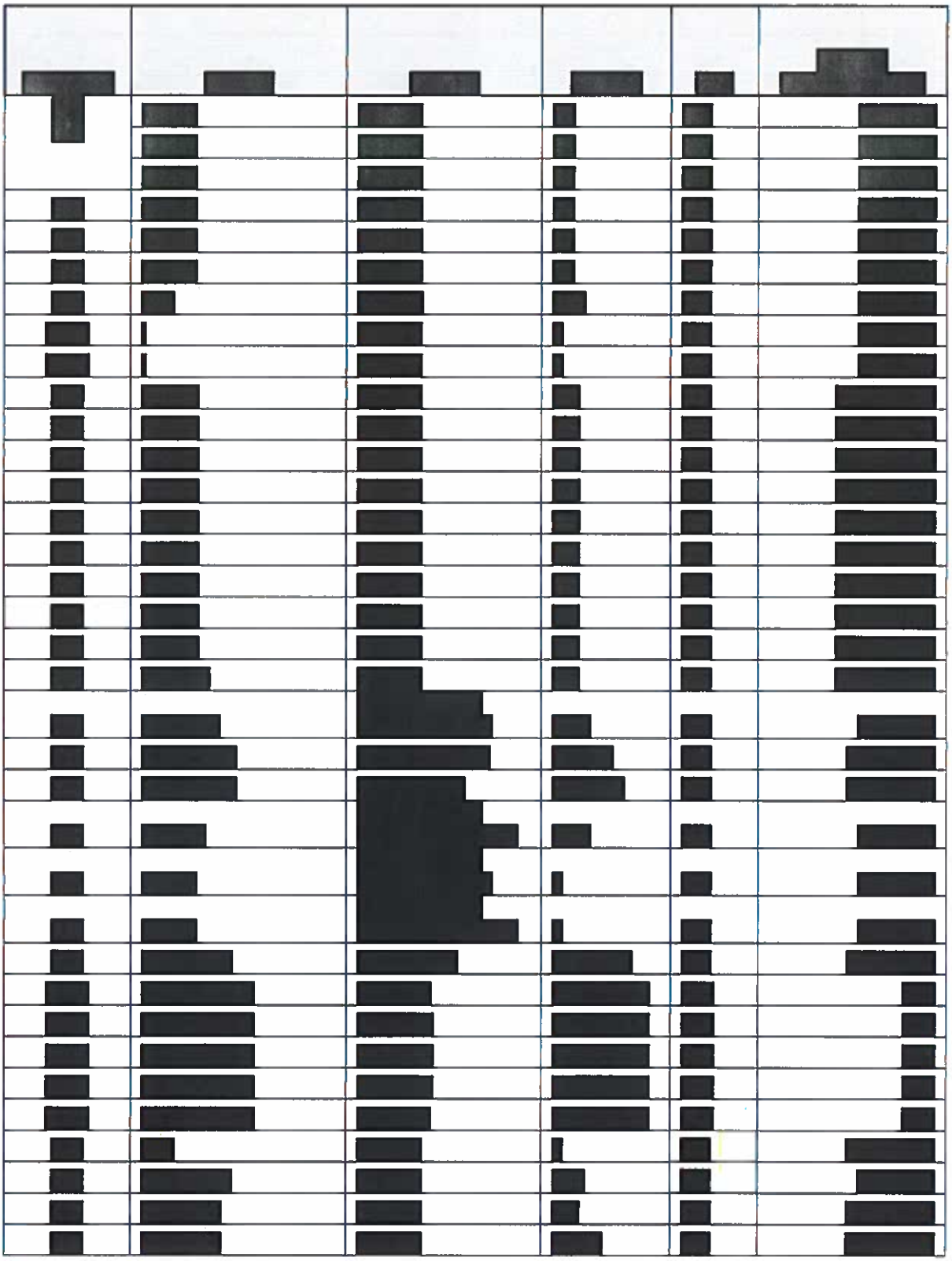
	Audit Title	# of Findings/ OFIs	CAPA/CF/ VEHS#/CR/WR No.	Finding/Observation/OFI	Corrective Action	Status
17	Research and Development cont'd	2 OFIs	D&PE Work Request #482	The results of the Operational Qualification (OQ) for one project could not be readily located.	Update documentation to clearly indicate where the results of the OQ are located.	Open
			D&PE Work Request #482	The results of the re- were imbedded in the Performance Qualification Summary Report.	Revise the Master Validation Plan (MPV) to clearly indicate where to locate the re-commissioning results.	Open
18	Process Safety Audit for TheraSphere Packaging and Re-labeling	Two OFIs	n/a	Final Safety Analysis Report (FSAR) for the KRMF Manual Packaging Facility is out of date.	The FSAR for the KRMF Manual Packaging Facility was revised in October 2017.	Closed
			AC-CMP-20180124-002	Time/distance of Technicians in areas of dose could be improved as per ALARA.	Consider performing a dose study and/or using DRDs for shipments of TheraSphere.	Open

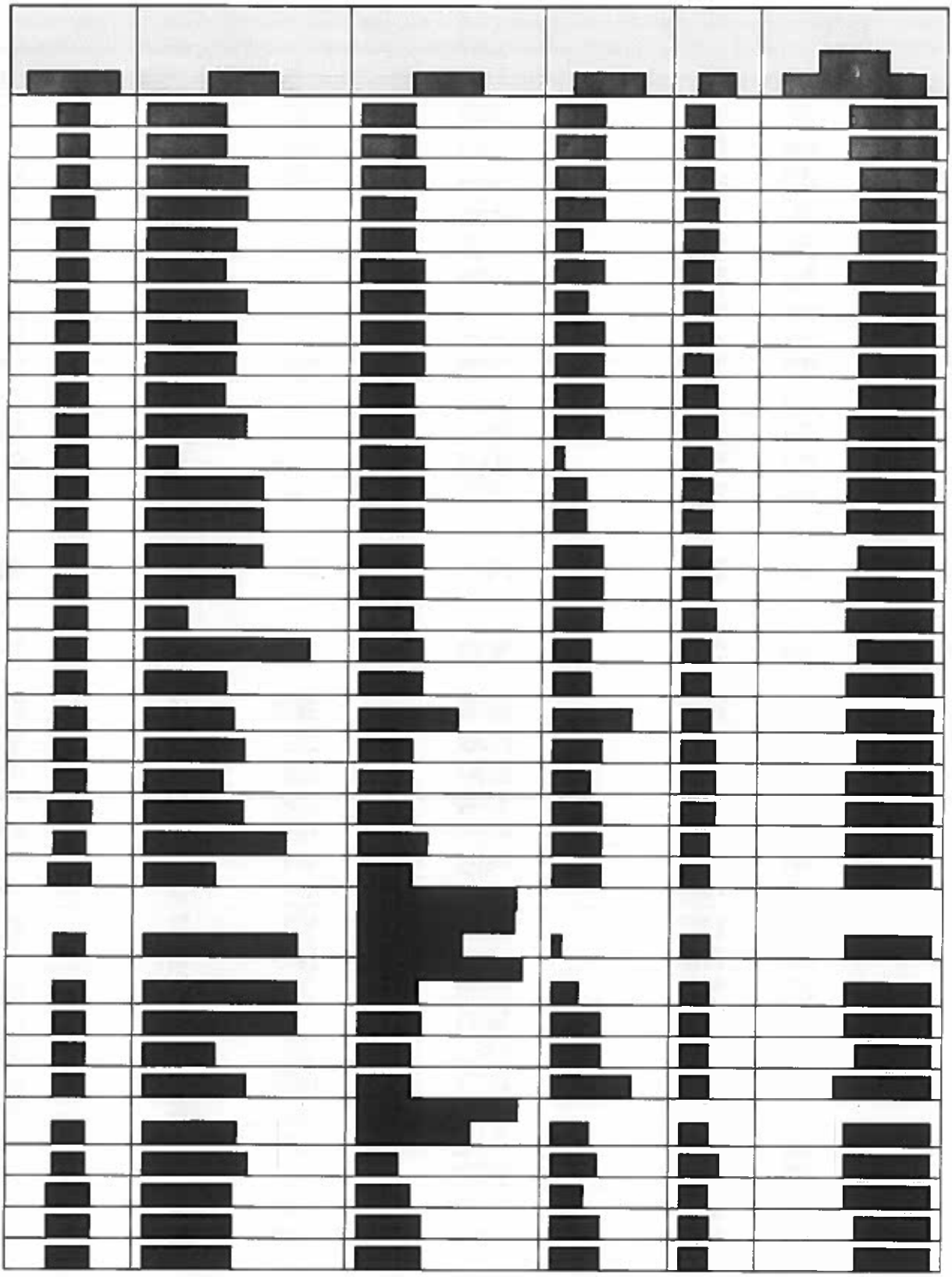
NOTE: The actions from the Supplier and Carrier audits (listed in Section 2.1.3.1) have not been included in the above table; however findings are being managed in accordance with internal procedures.

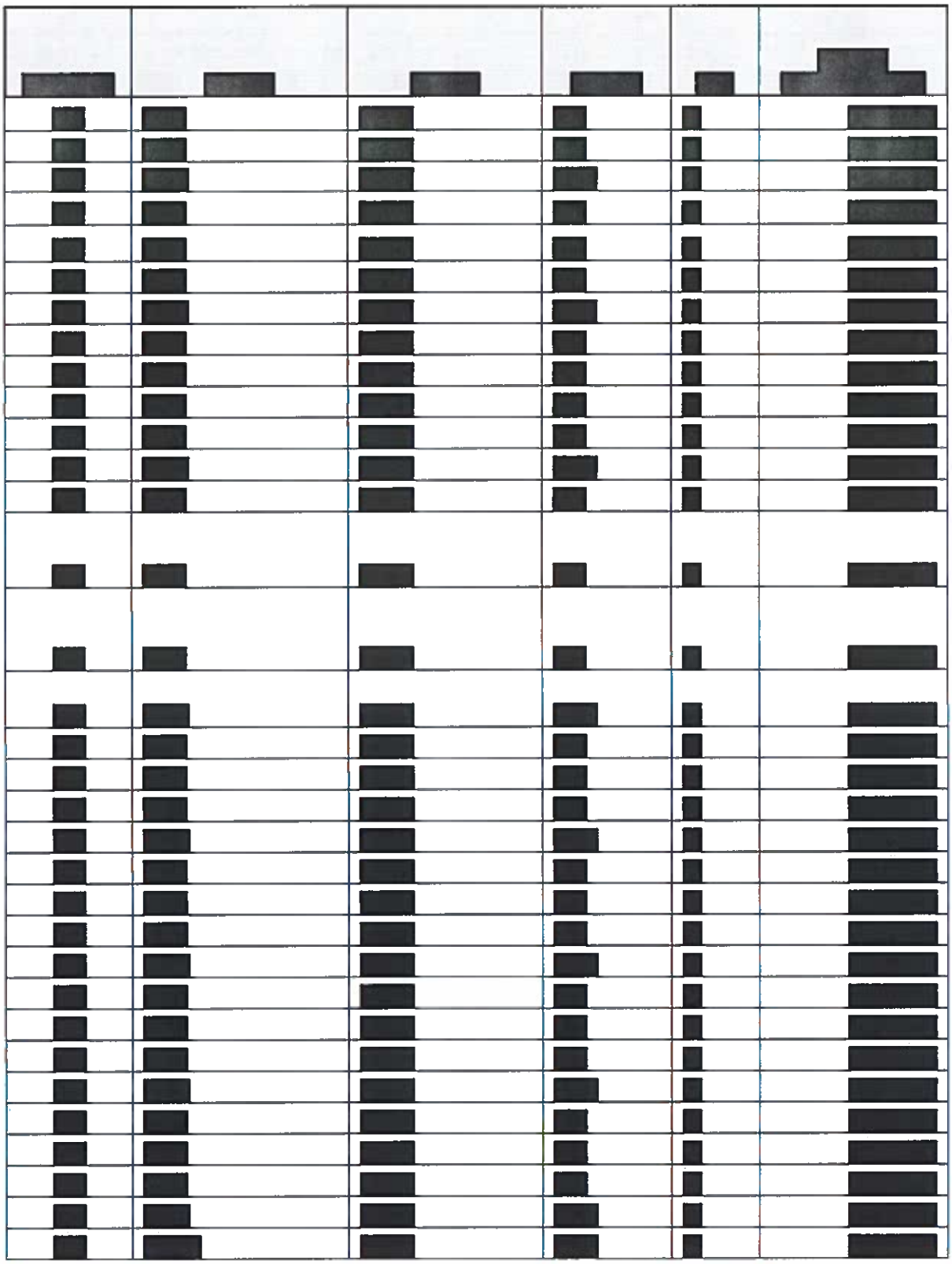
Appendix C
Non-Production Sealed and Unsealed Source Inventory

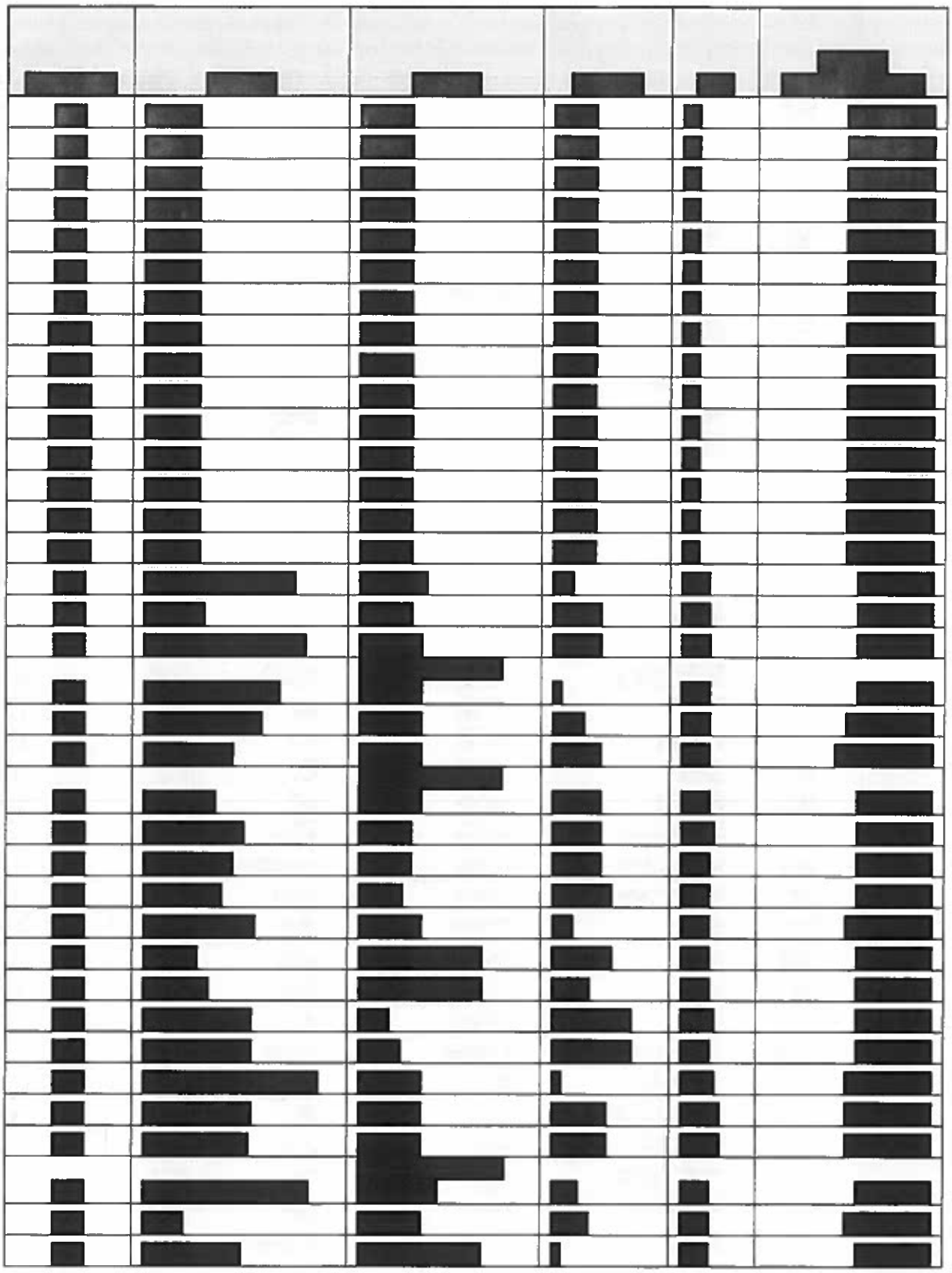


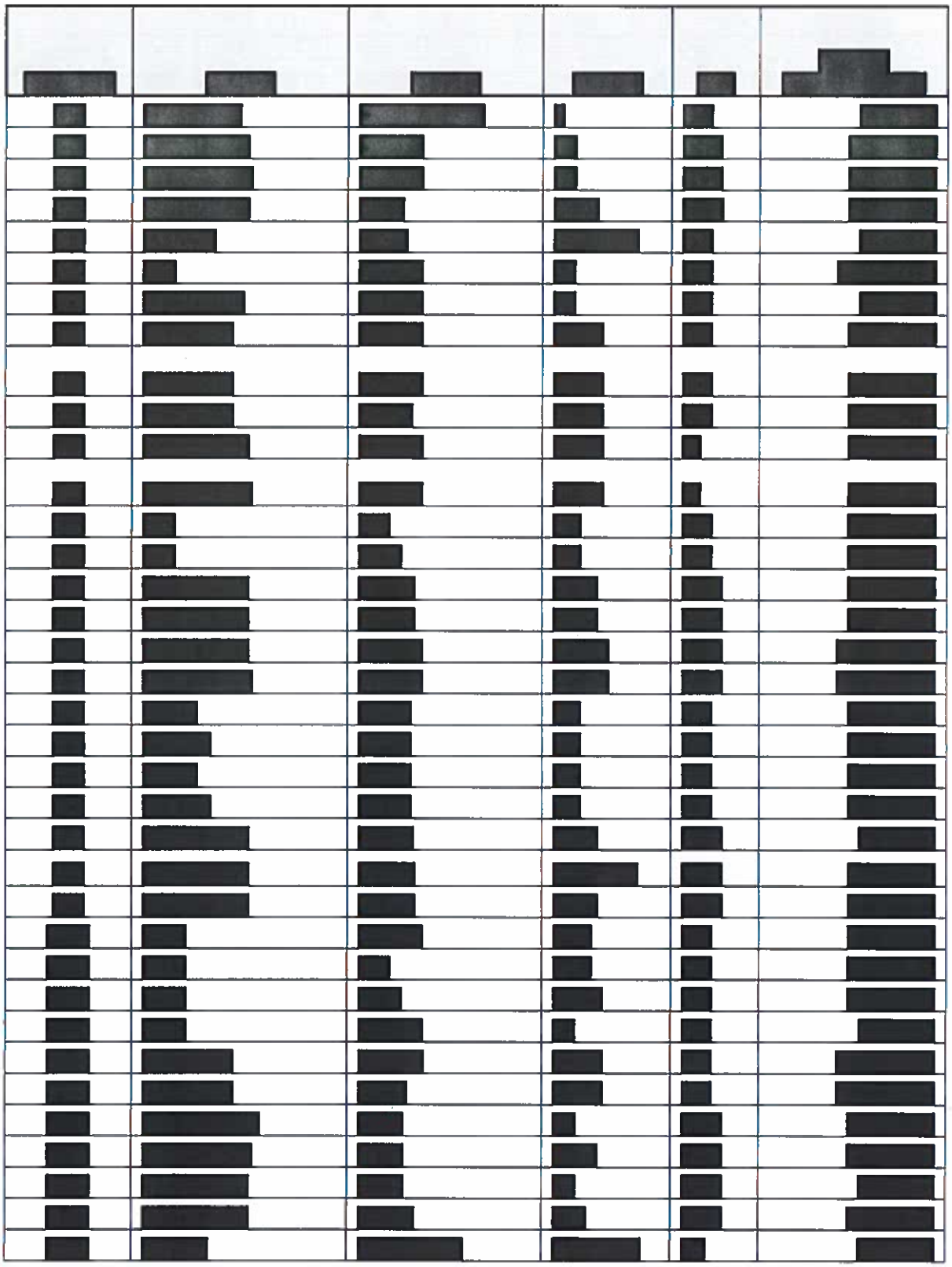


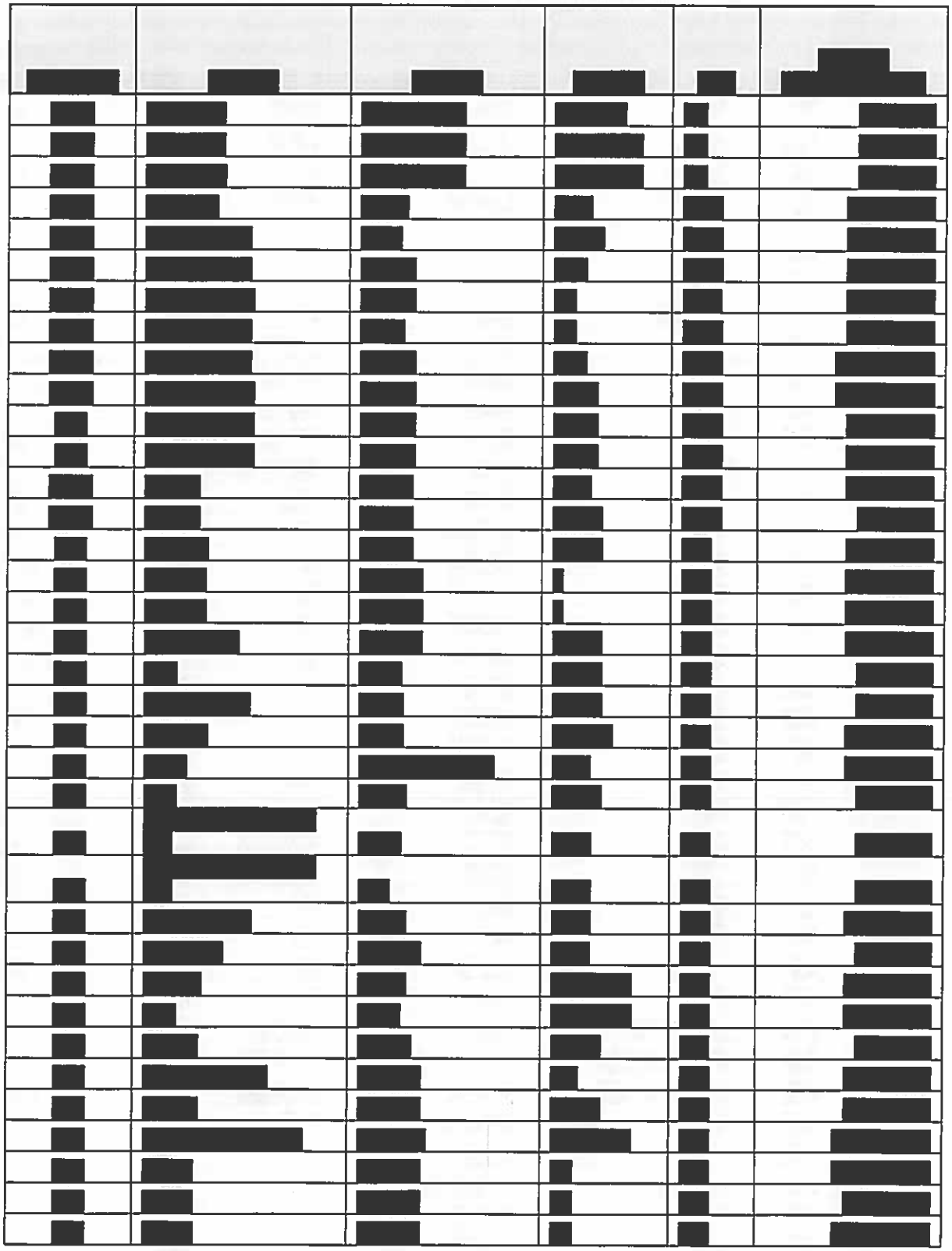


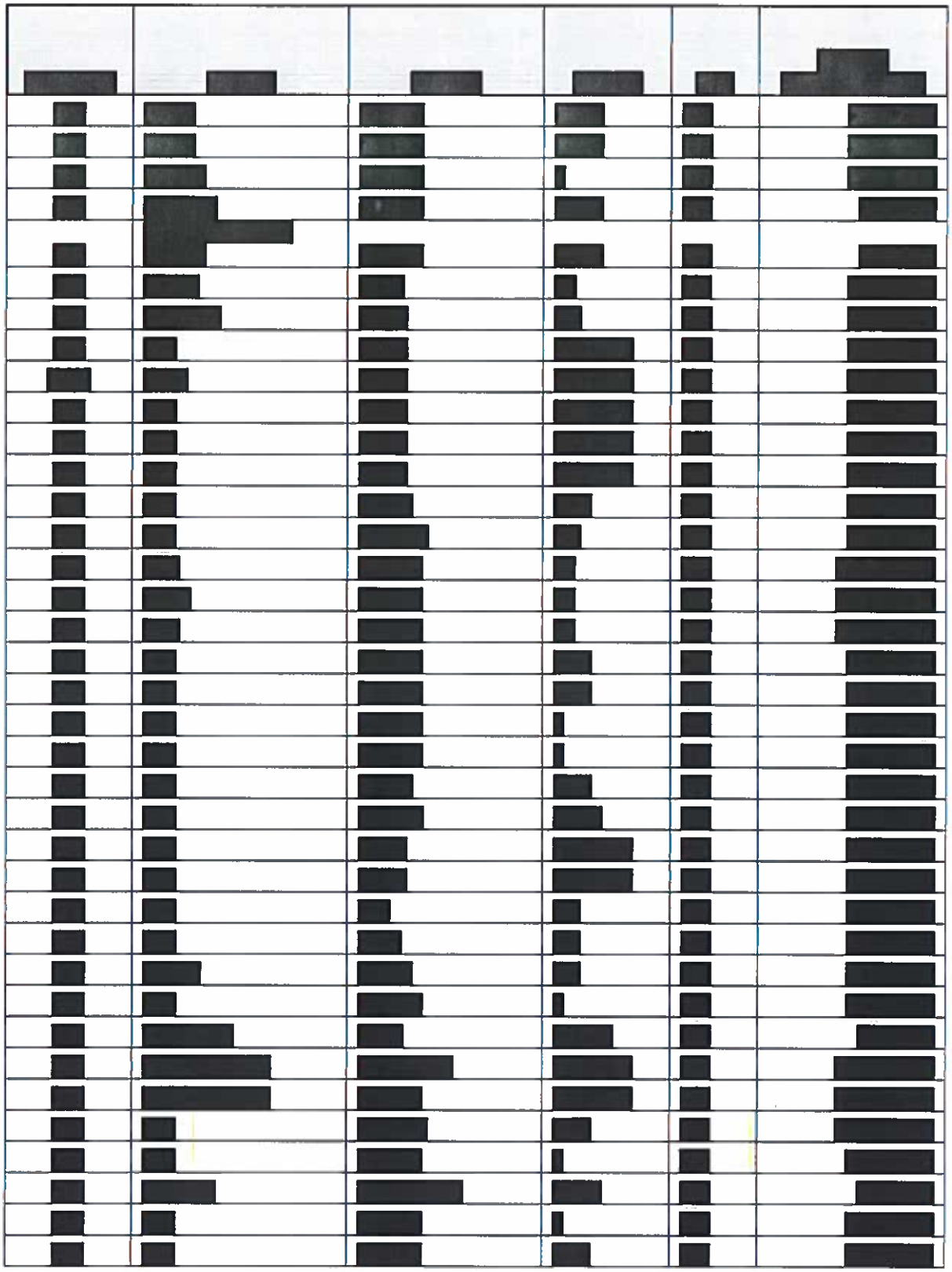


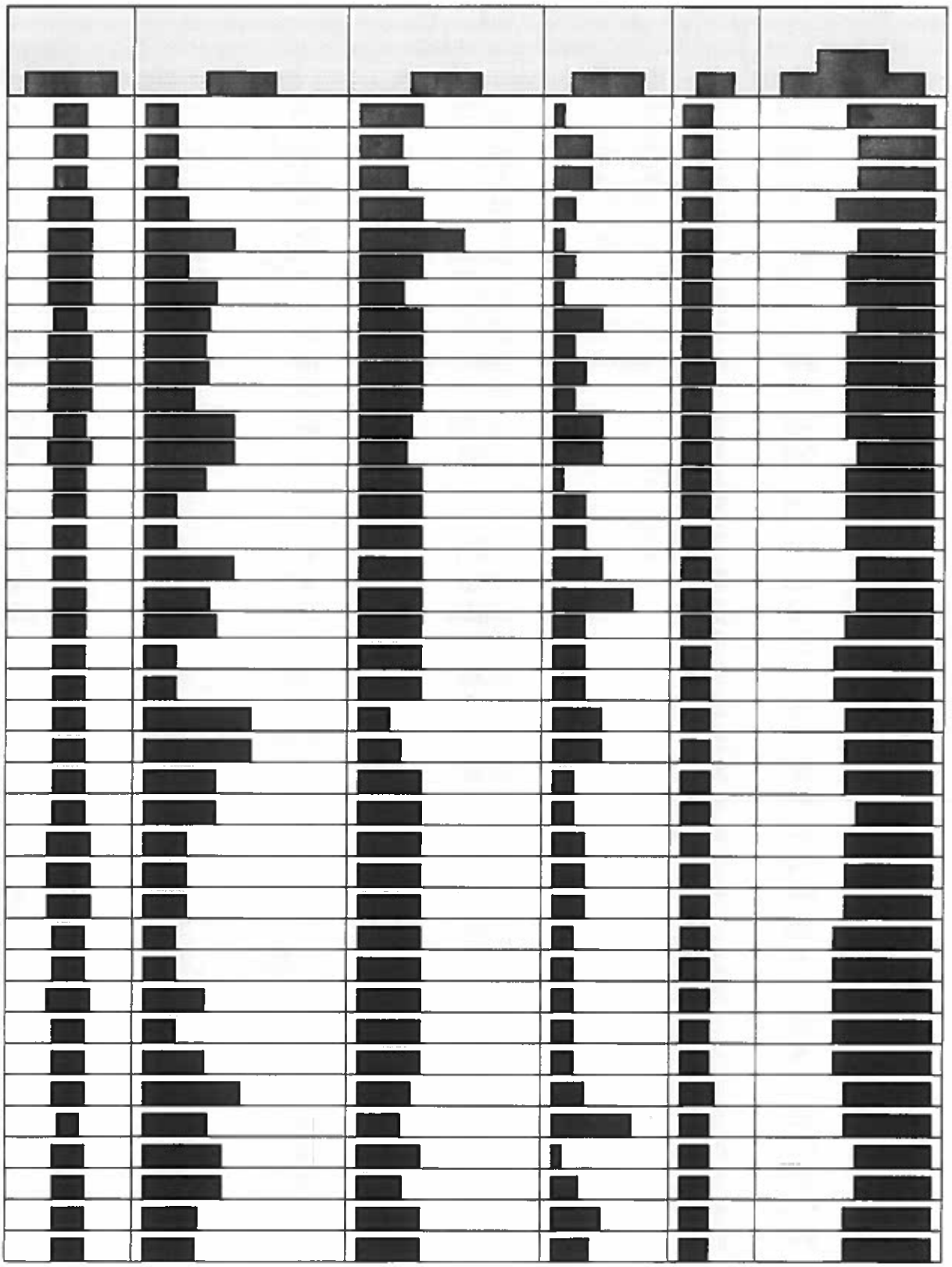


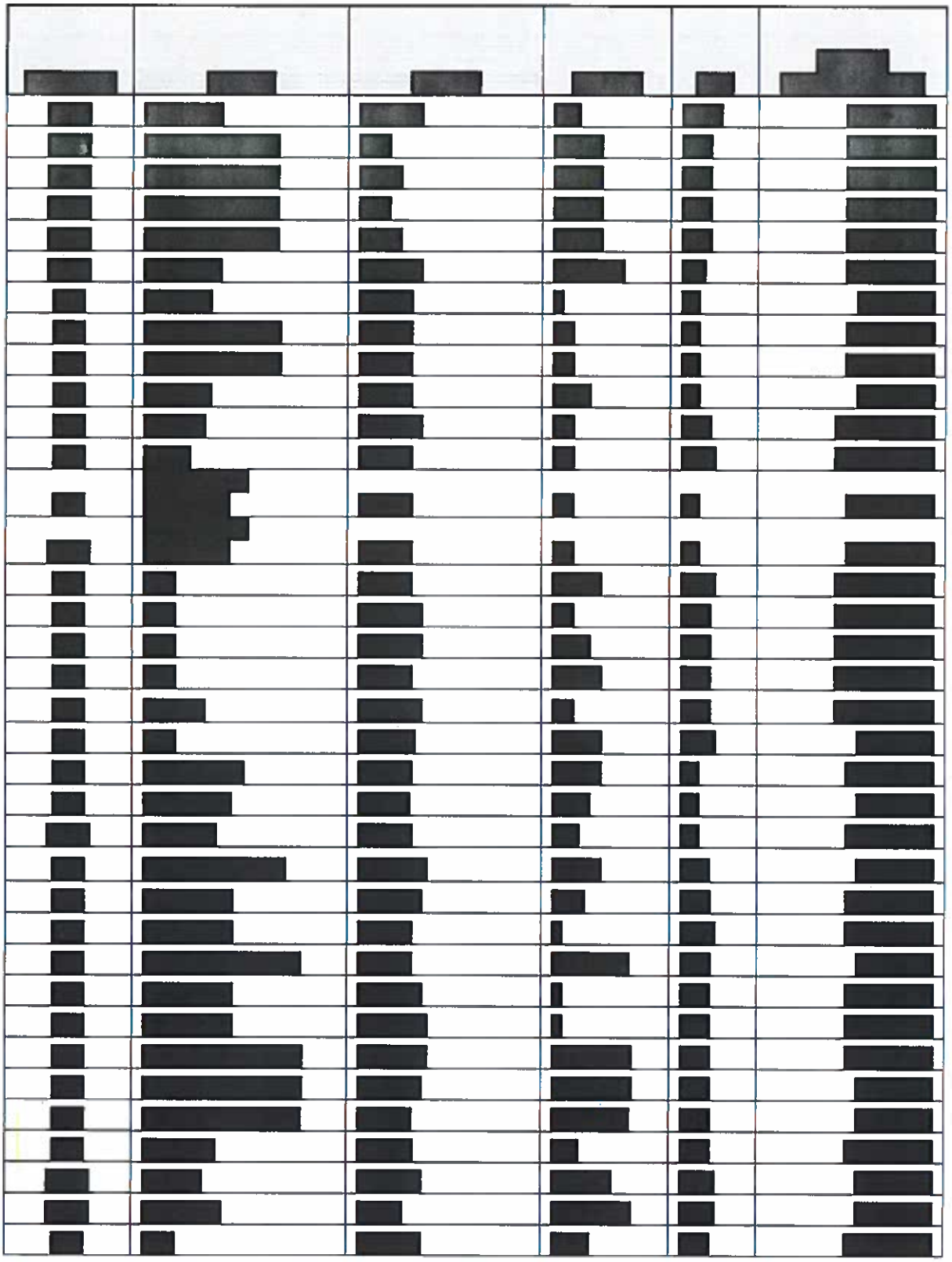


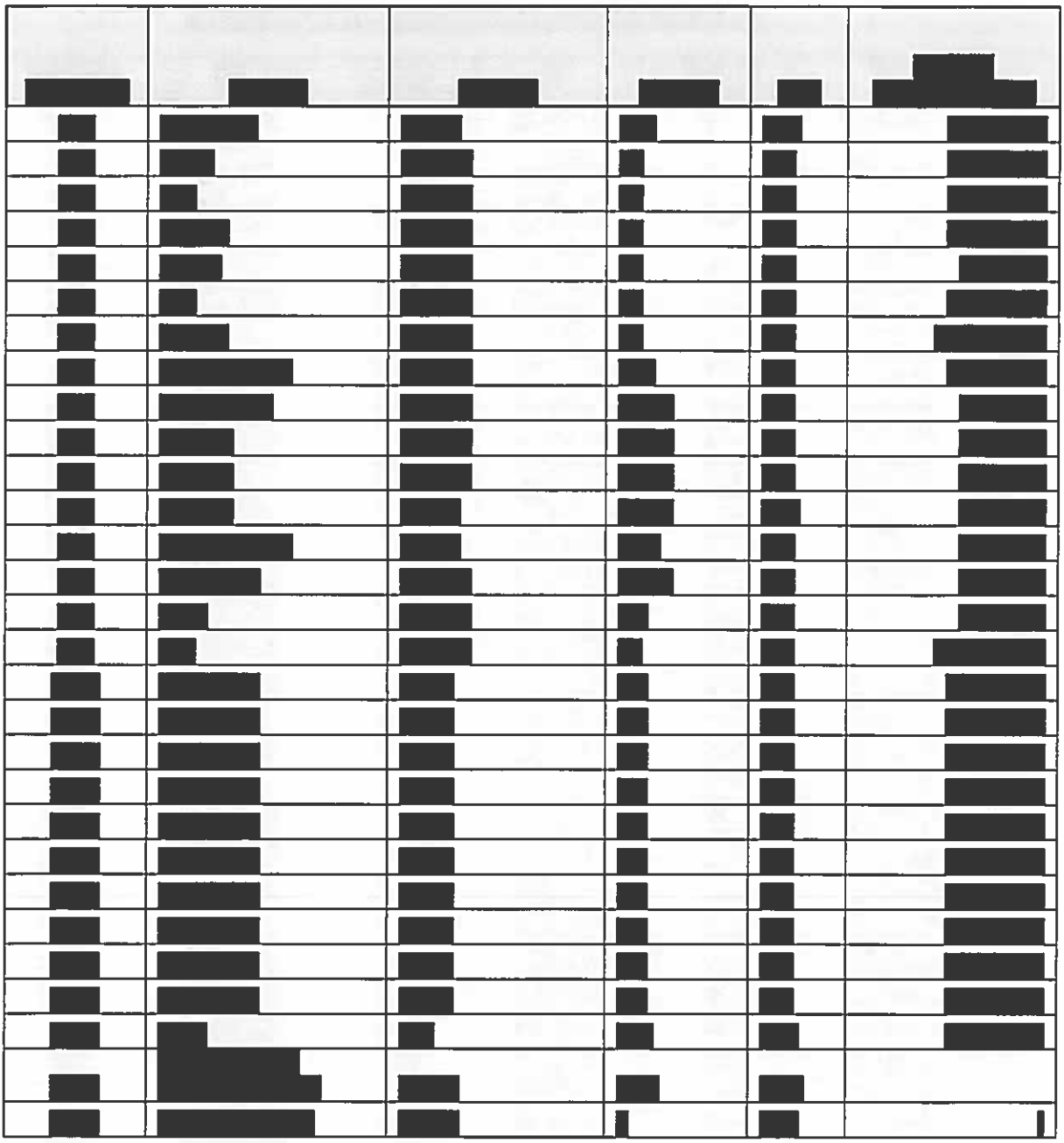












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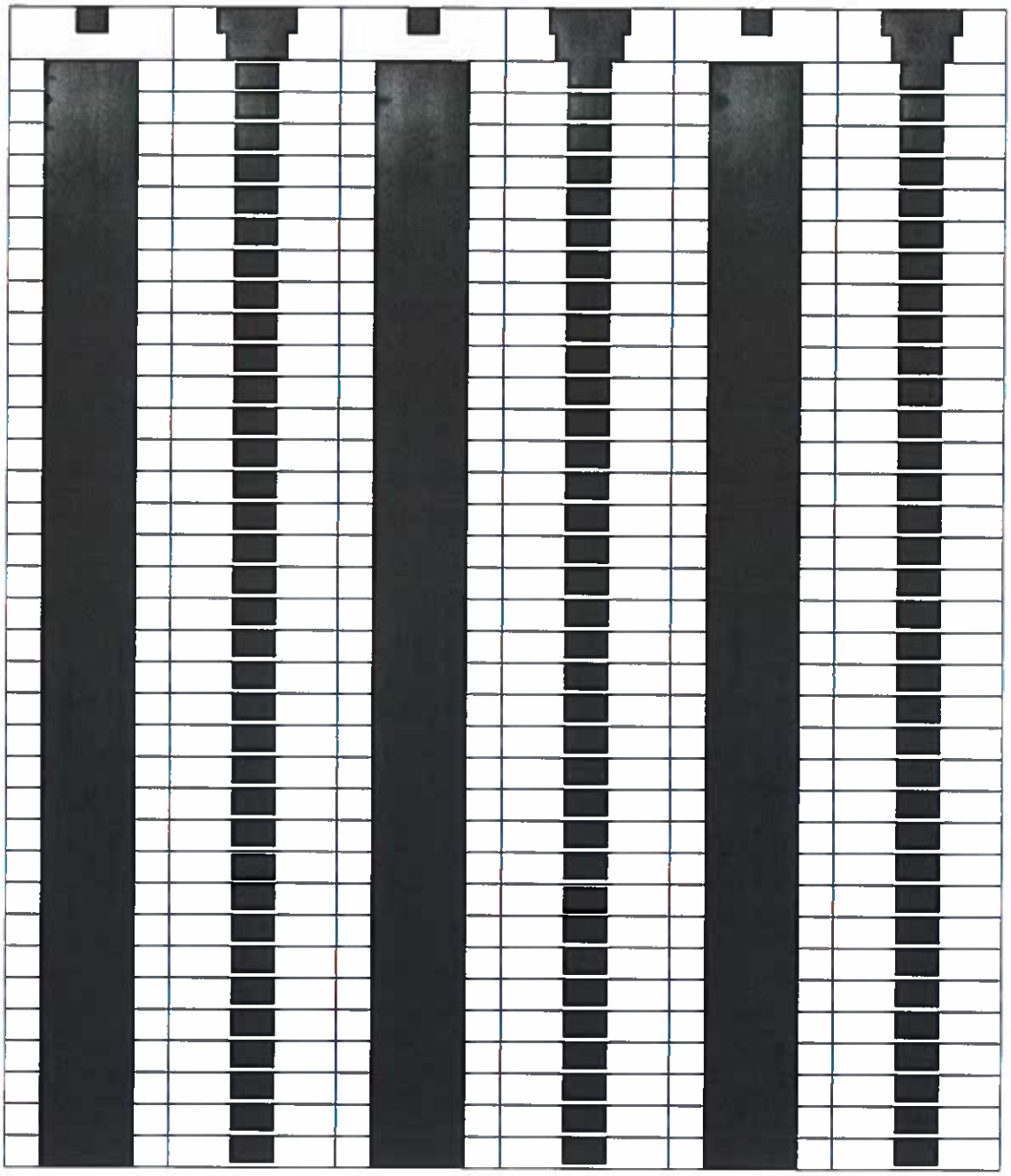
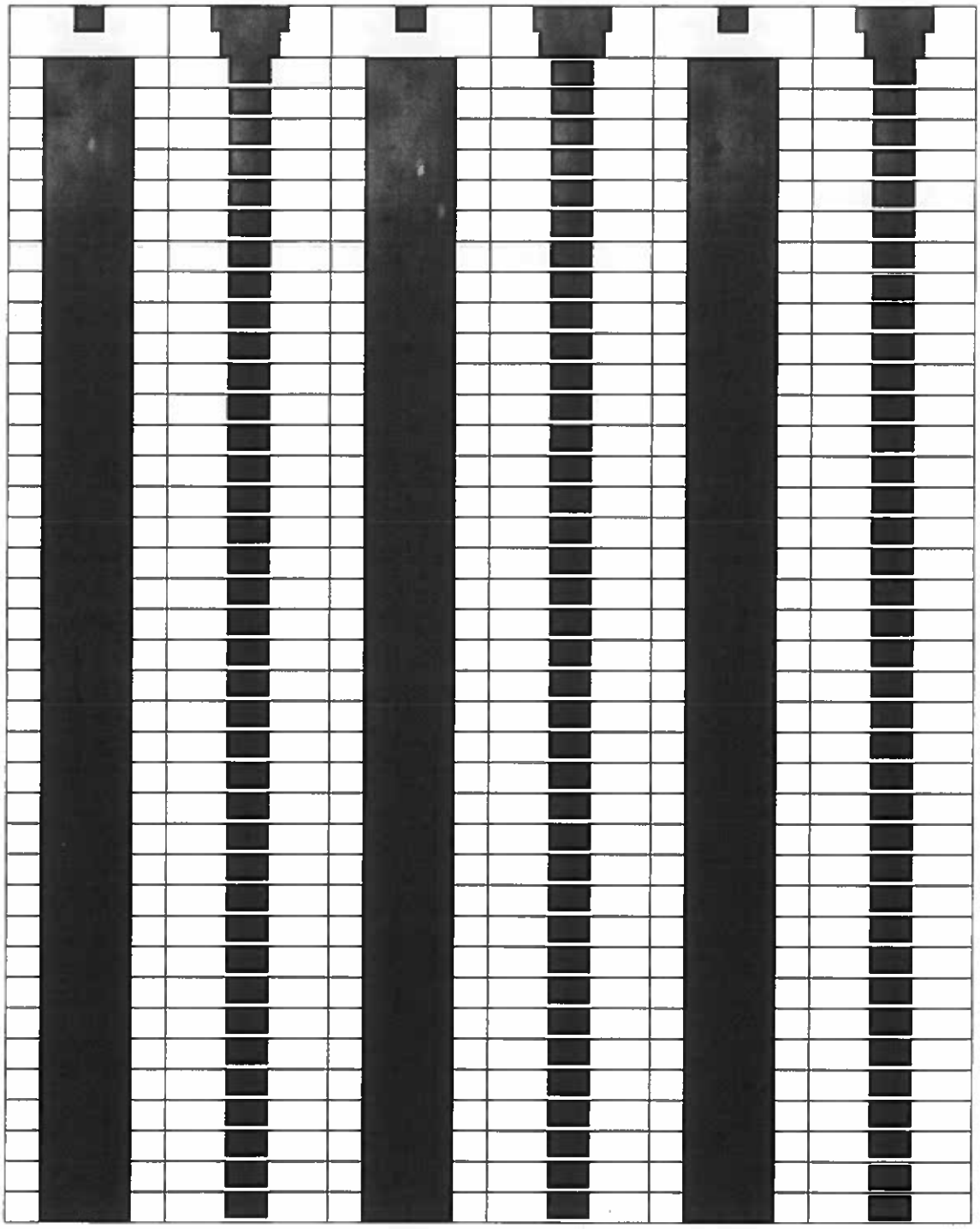
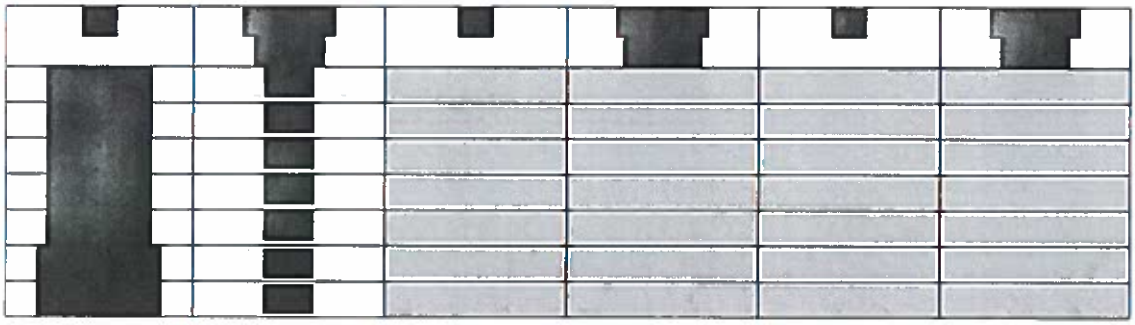






Appendix D
Additional Radiation Dose Data – Effective and Equivalent Dose and Lens of the Eye

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

		2013	2014	2015	2016	2017	CNSC Regulatory Limit
Active Area Personnel (NEWs)	Average	0.59	0.65	0.56	0.75	0.67	n/a
	Maximum	6.39	6.03	5.24	4.9	5.49	50/yr; 100/5yr
	Minimum	0	0	0	0	0	n/a
	Number Monitored					141	
Non-Active Area Personnel (NEWs)	Average	0.12	0.14	0.16	0.2	0.13	n/a
	Maximum	1.48	1.73	1.88	2.06	1.5	50/yr; 100/5yr
	Minimum	0	0	0	0	0	n/a
	Number Monitored					122	

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

		2013	2014	2015	2016	2017	CNSC Regulatory Limit
NEWs	Average	0.42	0.46	0.42	0.59	0.42	n/a
	Maximum	6.39	6.11	5.21	5.2	5.5	500/yr
	Minimum	0	0	0	0	0	n/a
	Number Monitored	284	269	264	267	263	
Contractors	Average	0.03	0.07	0.03	0.07	0.02	n/a
	Maximum	0.28	0.31	0.12	0.39	0.18	50/yr
	Minimum	0	0	0	0	0	n/a
	Number Monitored	57	52	46	51	55	
Active Area Personnel (NEWs)	Average	0.6	0.69	0.58	0.92	0.67	n/a
	Maximum	6.39	6.11	5.21	5.2	5.5	500/yr
	Minimum	0	0	0	0	0	n/a
	Number Monitored					112	
Non-Active Area Personnel (NEWs)	Average	0.15	0.15	0.16	0.22	141	n/a
	Maximum	2.89	1.78	1.9	2.09	1.59	500/yr
	Minimum	0	0	0	0	0	n/a
	Number Monitored					122	

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

		2013	2014	2015	2016	2017	CNSC Regulatory Limit
NEWs	Average	0.54	0.73	0.46	0.79	0.53	n/a
	Maximum	7.4	9.5	9.3	8.3	16.4	500/yr
	Minimum	0	0	0	0	0	n/a
	Number Monitored	139	135	137	128	125	
Active Area Personnel (NEWs)	Average	0.54	0.73	0.48	0.86	0.58	n/a
	Maximum	7.4	9.5	9.3	8.3	16.4	500/yr
	Minimum	0	0	0	0	0	n/a
	Number Monitored					109	
Non-Active Area Personnel (NEWs)	Average	0	0	0	0.24	0.20	n/a
	Maximum	0	0	0	0.8	1.8	500/yr
	Minimum	0	0	0	0	0	n/a
	Number Monitored					16	

Note: Contractors are not monitored for extremity dose.

Table D.4

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

		2017	CNSC Regulatory Limit
NEWs	Average	0.42	n/a
	Maximum	5.52	50/yr; 100/5yr
	Minimum	0	n/a
	Number Monitored	263	
Contractors	Average	0.022	n/a
	Maximum	0.2	
	Minimum	0	n/a
	Number Monitored	55	
Active Area Personnel (NEWs)	Average	0.67	n/a
	Maximum	5.52	50/yr; 100/5yr
	Minimum	0	n/a
	Number Monitored	141	
Non-Active Area Personnel (NEWs)	Average	0.13	n/a
	Maximum	1.61	50/yr; 100/5yr
	Minimum	0	n/a
	Number Monitored	122	

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

Figure E.1 Cobalt Production Technicians

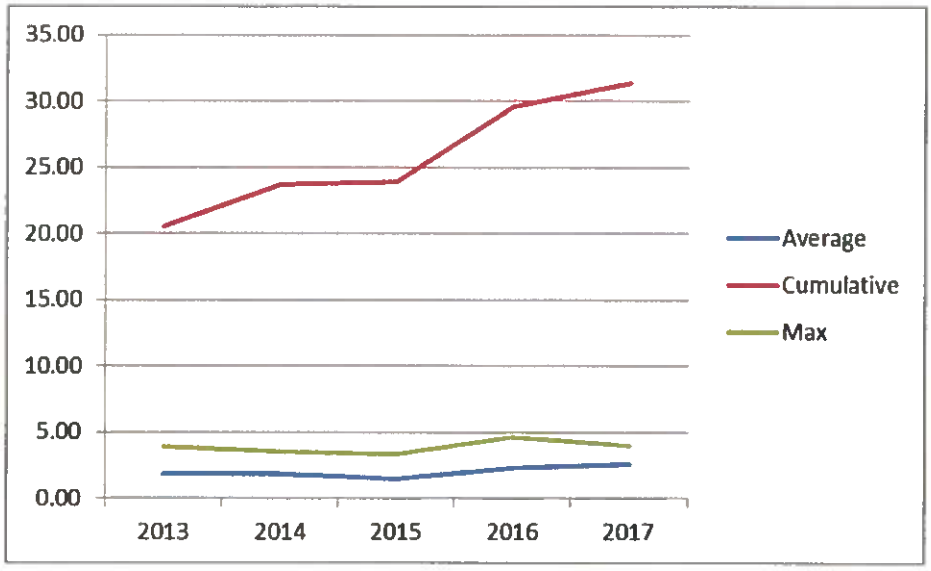


Figure E.2 Cobalt Monitoring, Decontamination and Shipping

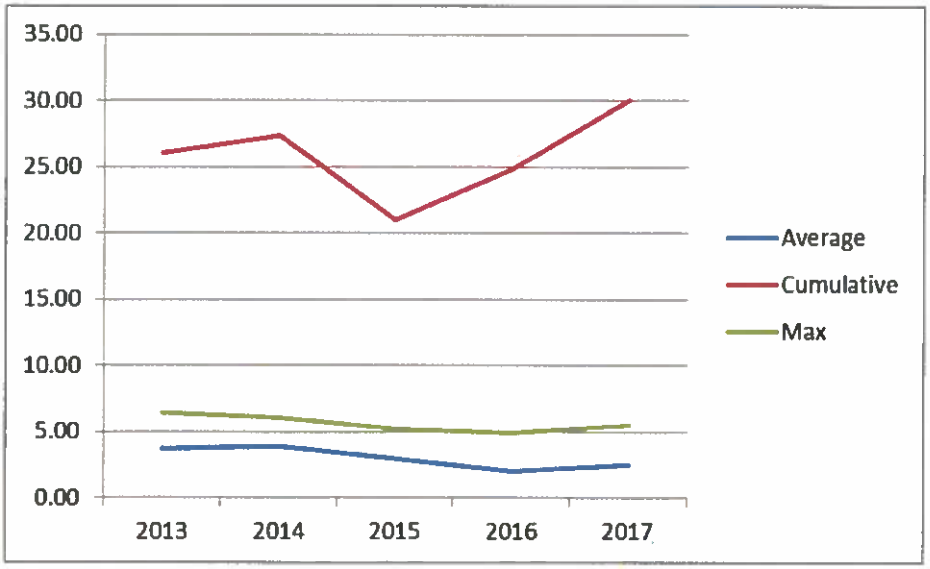


Figure E.3 Cobalt Development

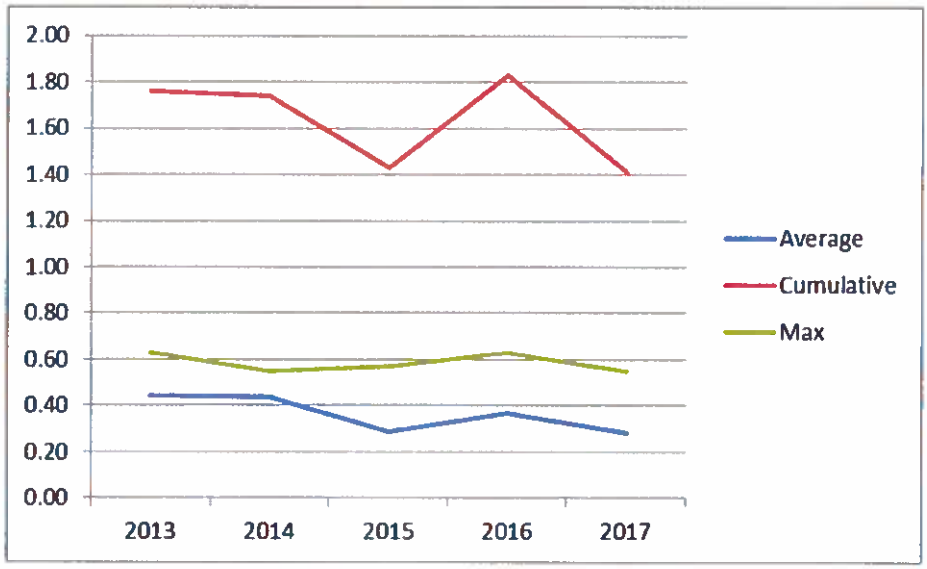


Figure E.4 Cobalt QC

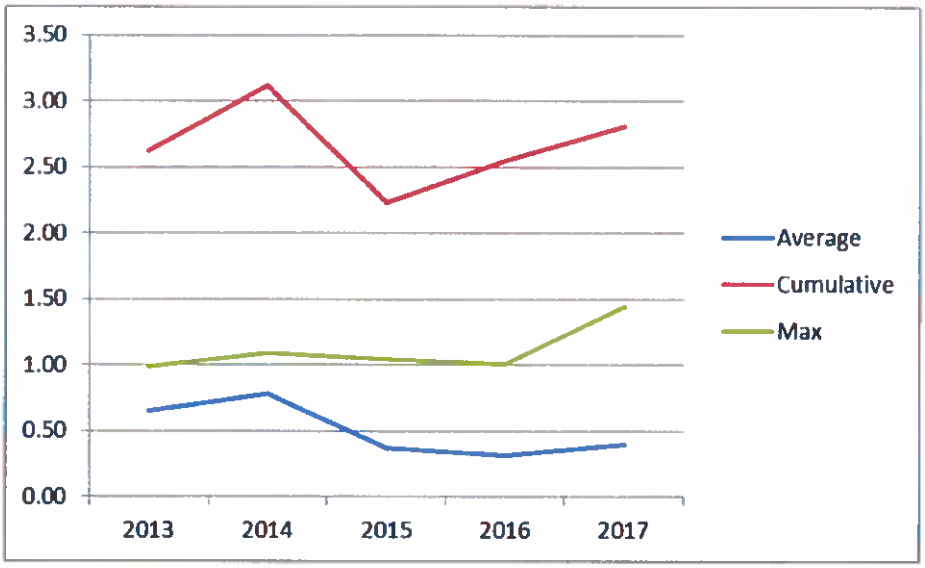


Figure E.5 Radiopharmaceutical Development

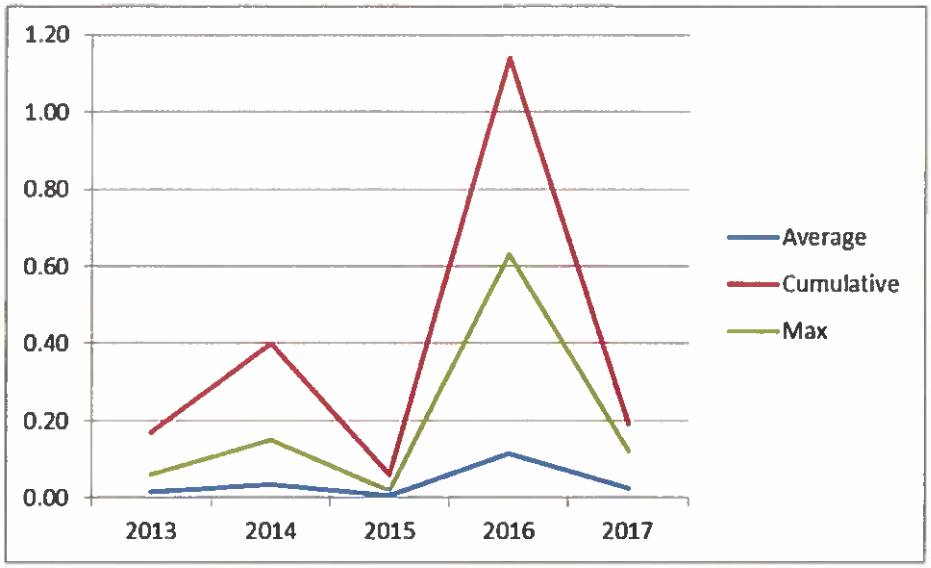


Figure E.6 Technical Support

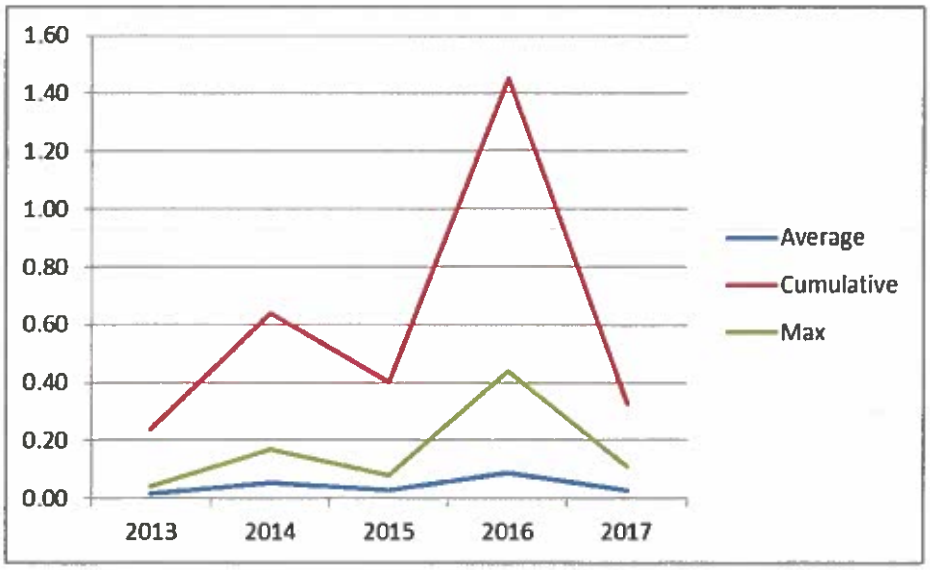


Figure E.7 Nuclear Medicine Shippers, Waste, Containers

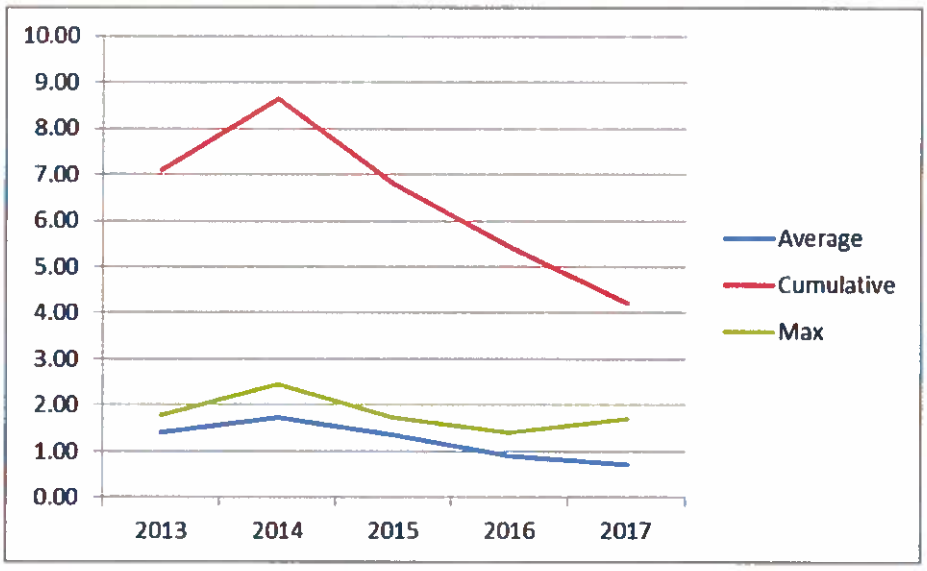


Figure E.8 I-125, I-131 & Ir-192 Production Technicians

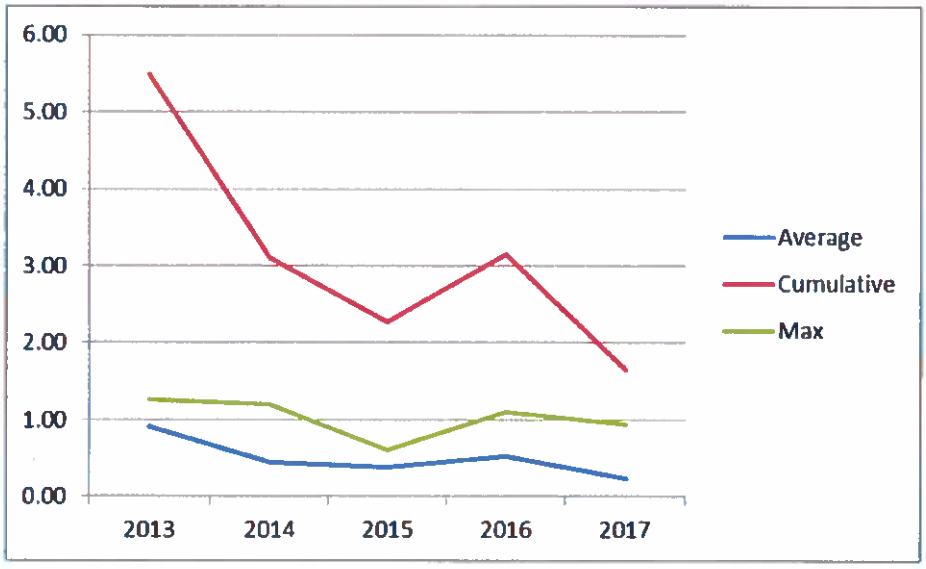


Figure E.9 Mo-99, Xe-133 & Sr-82 Production Technicians

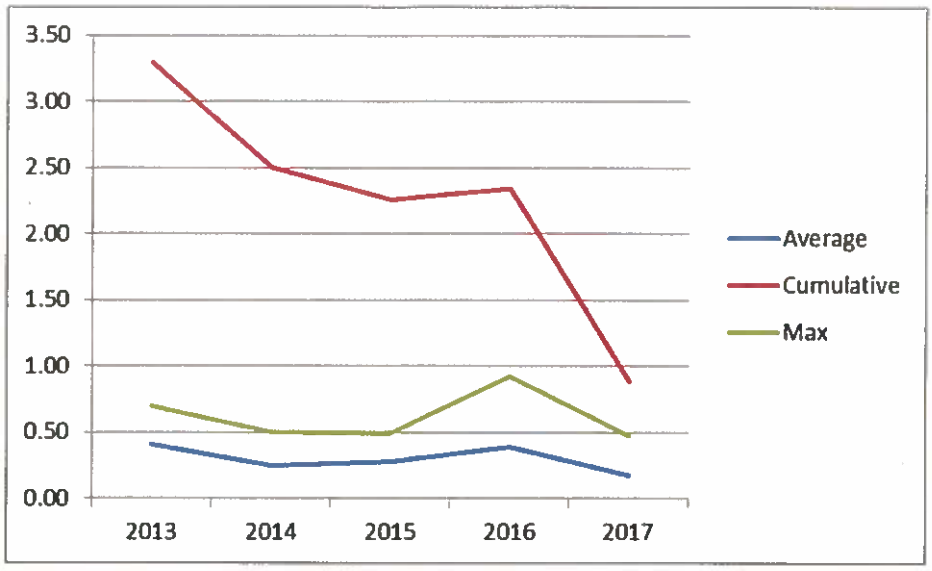


Figure E.10 Radiopharmaceutical Production Technicians

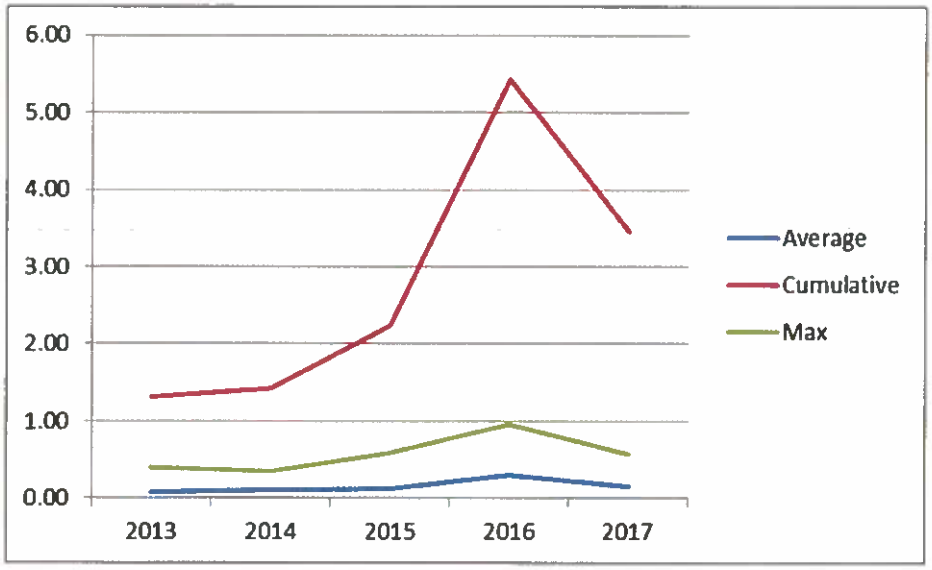


Figure E.11 Machinists

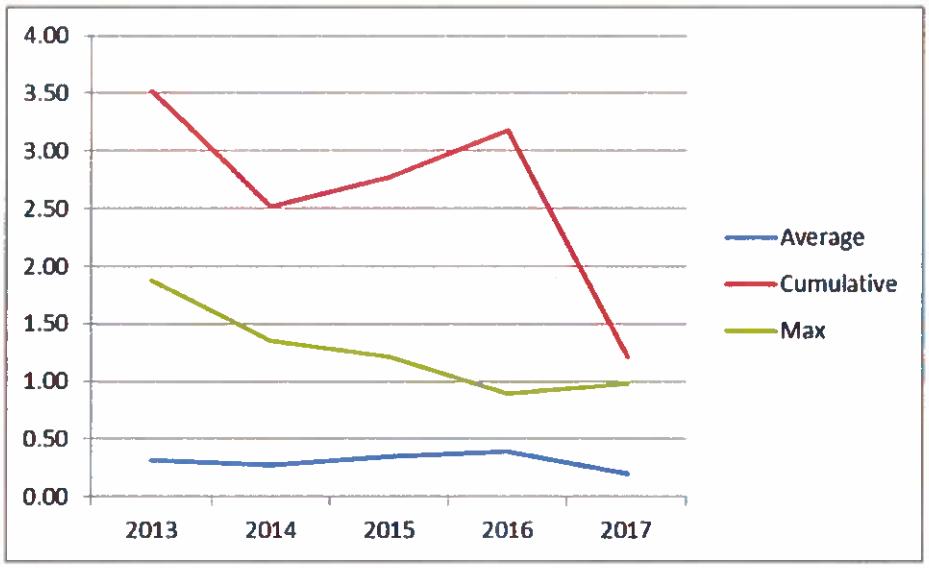


Figure E.12 Nuclear Medicine QC

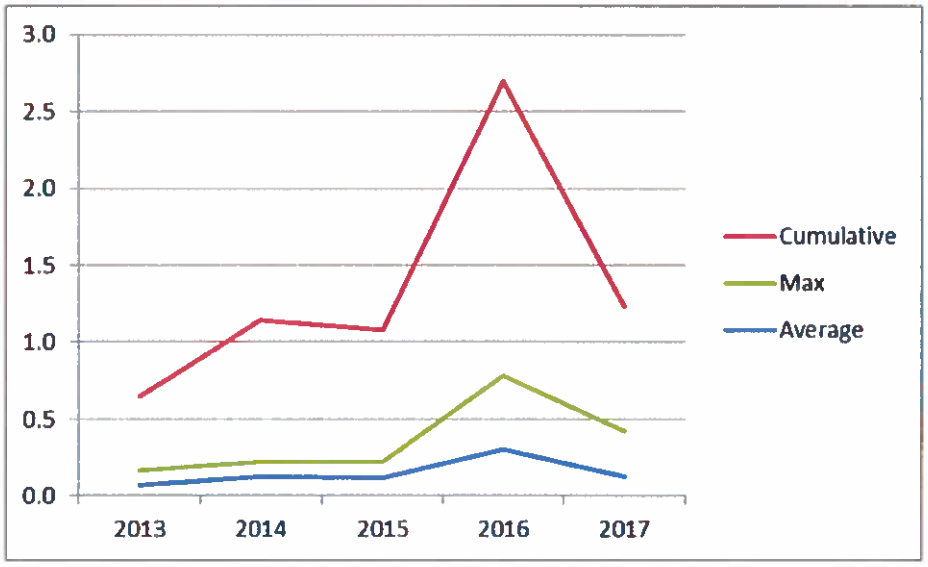


Figure E.13 Surveyors

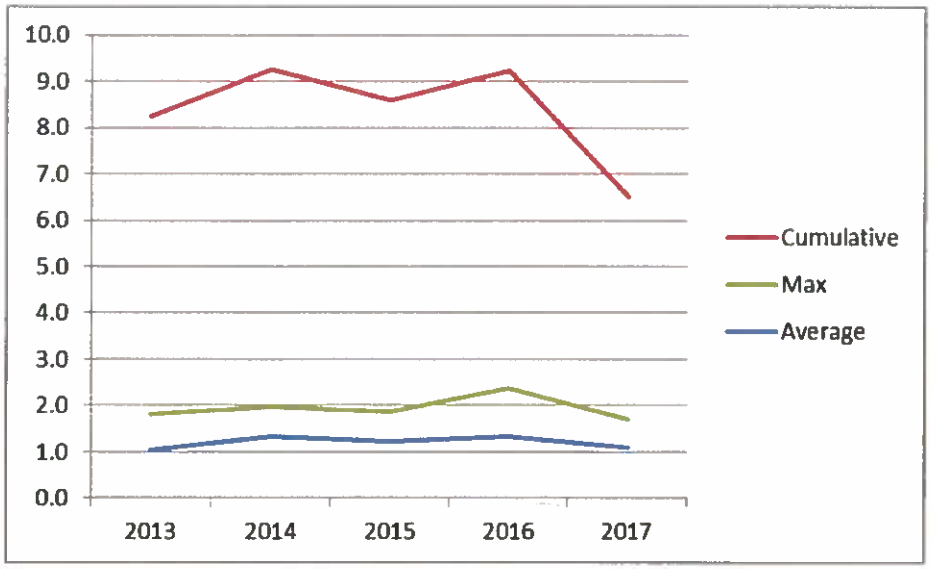


Figure E.14 Nuclear Medicine Operators, Helpers

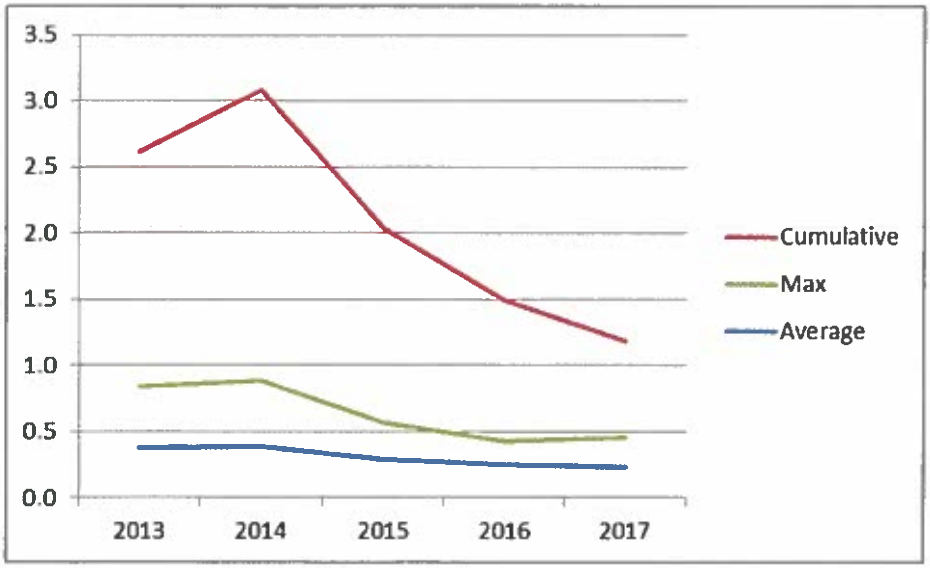


Figure E.15 Nuclear Medicine Radiation and Contamination Monitors

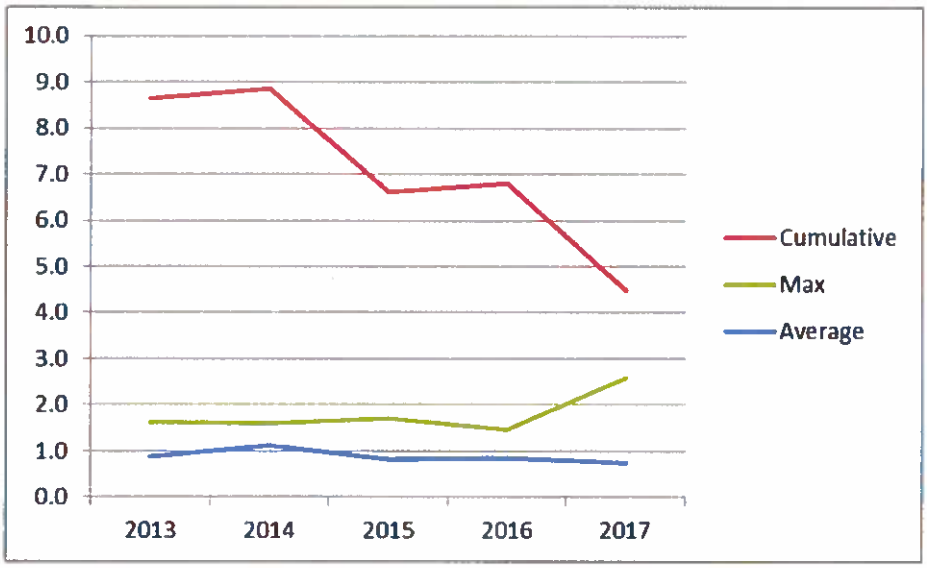


Figure E.16 Facilities, Motor Pool

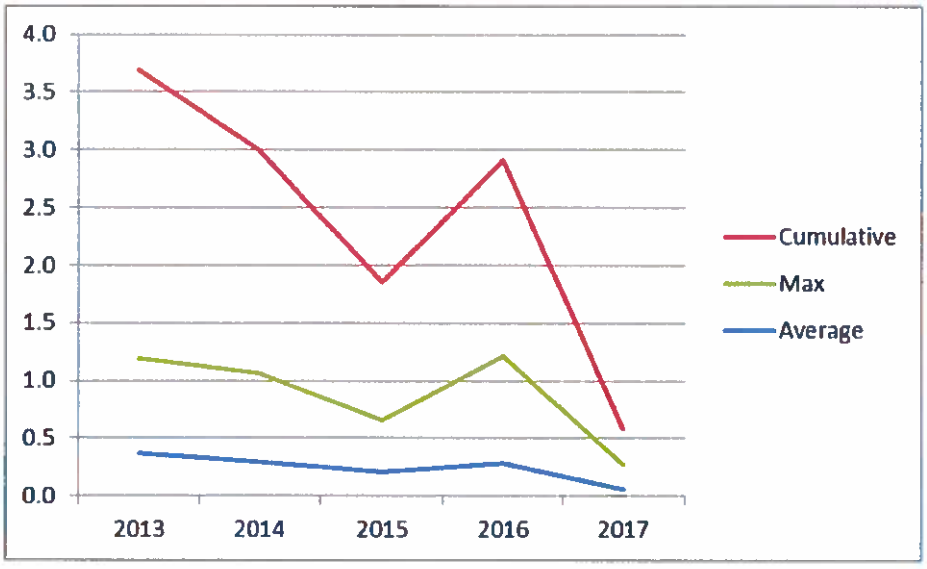


Figure E.17 Facilities, Mechanical

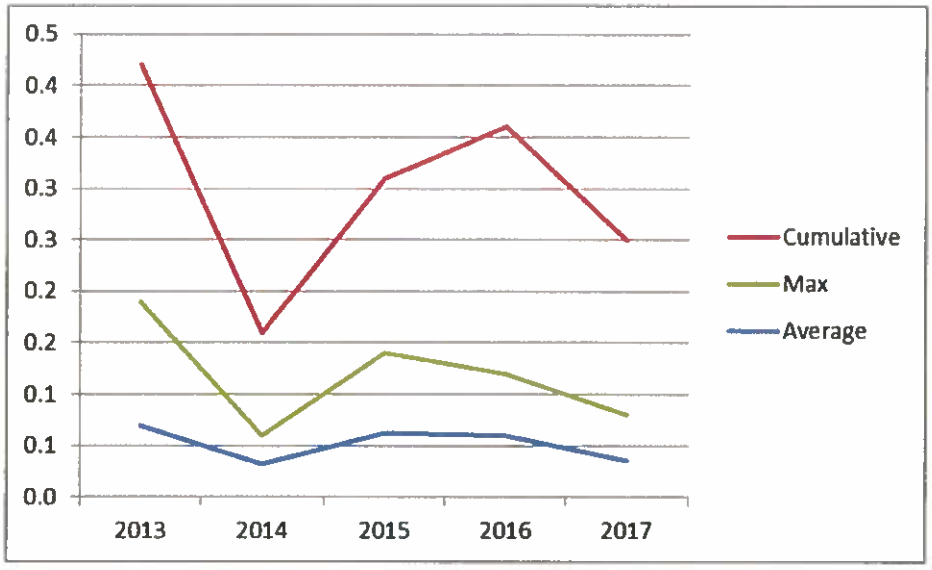


Figure E.18 Radiopharmaceutical QC

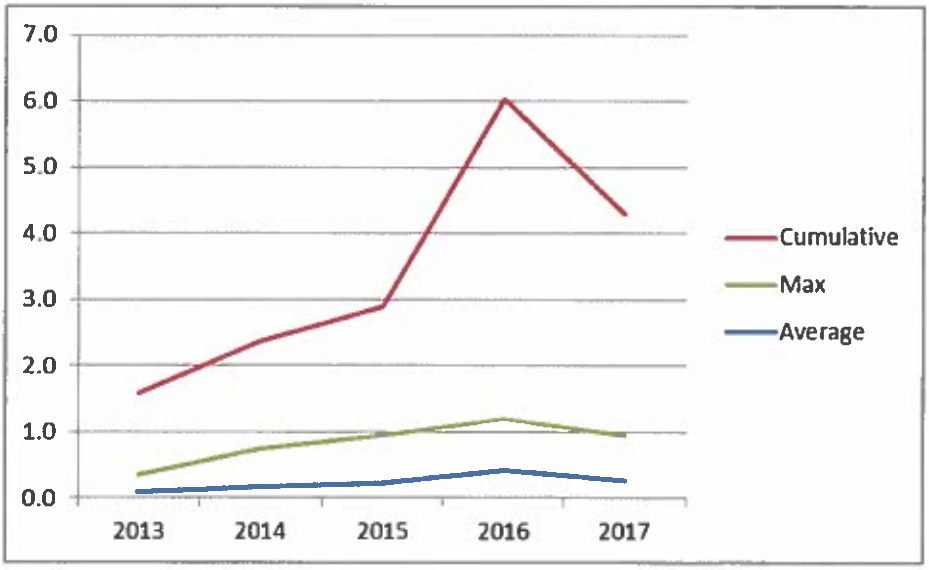
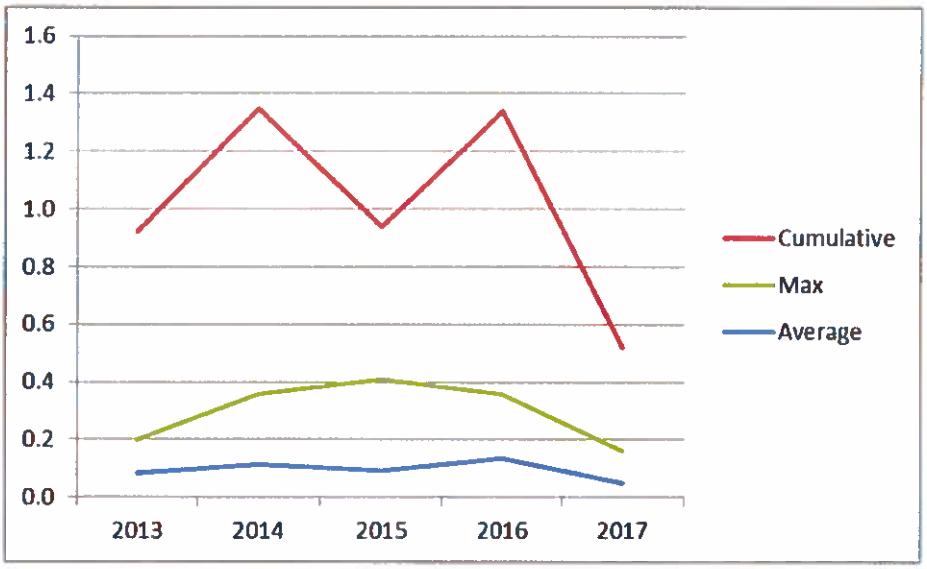


Figure E.19 Facilities, Electricians & Electronic Calibration Lab



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

			Sample Date:	2017-10-06	2016-11-02	2015-10-05	2014-10-29	2013-09-18	2012-11-16	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		448	336	337	329	314	308	278
Biochemical Oxygen Demand	mg/L	1		<3	<3	<1	<1	1	8	<1
Chemical Oxygen Demand	mg/L	5		83	<5	9	8	<5	29	7
Chloride (Cl)	mg/L	1		68.2	176	141	139	89	76	40
Conductivity	µS/cm	5		1110	1200	1100	1080	888	834	676
Dissolved Organic Carbon	mg/L	0.5		5.0	0.7	2.8	2.2	1.6	5.7	1.6
N-NH3 (Ammonia)	mg/L	0.02		0.05	<0.01	<0.025	0.13	0.08	<0.02	0.02
N-NO3 (Nitrate)	mg/L	0.1		<0.05	1	0	0	0	0	0.53
pH				7.96	7.88	7.77	7.96	7.82	7.80	7.71
Sulphate (SO4)	mg/L	1		35	25	24	24	23	23	22
TDS (COND - CALC)	mg/L	5		634	816	715	702	577	542	439
Total Suspended Solids	mg/L	2		<3	<3	81	58	24	18	1390
Calcium (Ca)	mg/L	1		133	134	124	125	97	92	80
Magnesium (Mg)	mg/L	1		61.3	50	48	44	37	33	29
Sodium (Na)	mg/L	2		54.4	47	36	38	30	29	18
Barium (Ba)	mg/L	0.01		0.195	0.02	0.03	0.02	0.02	<0.01	0.02
Boron (B)	mg/L	0.01		0.084	0.01	0.03	0.03	0.03	0.03	0.07
Iron (Fe)	mg/L	0.03		1.82	0.09	0.62	0.27	0.24	0.19	<0.01
PHC F1 (C6-C10)	mg/L	0.2		<0.02	<0.02	<0.2	<0.2	<0.1	<0.1	<0.2
PHC F2 (C10-C16)	mg/L	0.2		<0.05	<0.05	<0.2	<0.2	<0.1	<0.1	<0.2
PHC F3 (C16-C34)	mg/L	0.5		<0.4	<0.4	<0.5	<0.5	<0.2	<0.2	<0.2
PHC F4 (C34-C50)	mg/L	0.5		<0.4	<0.4	<0.5	<0.5	<0.2	<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:			2016710-06	2016-11-02	2015-10-05	2014-10-29	2013-09-18	2012-11-16	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	336	337	329	314	308	278
Biochemical Oxygen Demand	mg/L	1	<3	<3	<1	<1	1	8	<1
Chemical Oxygen Demand	mg/L	5	<5	<5	9	8	<5	29	7
Chloride (Cl)	mg/L	1	139	176	141	139	89	76	40
Conductivity	µS/cm	5	1140	1200	1100	1080	888	834	676
Dissolved Organic Carbon	mg/L	0.5	1.9	0.7	2.8	2.2	1.6	5.7	1.6
N-NH3 (Ammonia)	mg/L	0.02	<0.01	<0.01	<0.025	0.13	0.08	<0.02	0.02
N-NO3 (Nitrate)	mg/L	0.1	1	1	0	0	0	0	0.53
pH			7.96	7.88	7.77	7.96	7.82	7.80	7.71
Sulphate (SO4)	mg/L	1	21	25	24	24	23	23	22
TDS (COND - CALC)	mg/L	5	581	816	715	702	577	542	439
Total Suspended Solids	mg/L	2	<3	<3	81	58	24	18	1390
Calcium (Ca)	mg/L	1	126	134	124	125	97	92	80
Magnesium (Mg)	mg/L	1	49	50	48	44	37	33	29
Sodium (Na)	mg/L	2	46	47	36	38	30	29	18
Barium (Ba)	mg/L	0.01	0.03	0.02	0.03	0.02	0.02	<0.01	0.02
Boron (B)	mg/L	0.01	0.03	0.01	0.03	0.03	0.03	0.03	0.07
Iron (Fe)	mg/L	0.03	0.81	0.09	0.62	0.27	0.24	0.19	<0.01
PHC F1 (C6-C10)	mg/L	0.2	<0.02	<0.02	<0.2	<0.2	<0.1	<0.1	<0.2
PHC F2 (C10-C16)	mg/L	0.2	<0.05	<0.05	<0.2	<0.2	<0.1	<0.1	<0.2
PHC F3 (C16-C34)	mg/L	0.5	<0.4	<0.4	<0.5	<0.5	<0.2	<0.2	<0.2
PHC F4 (C34-C50)	mg/L	0.5	<0.4	<0.4	<0.5	<0.5	<0.2	<0.2	<0.2

Borehole #3 (2005-BH3)

Sample Date:			2017-10-06	2016-11-02	2015-10-05	2014-10-29	2013-09-18	2012-11-16	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	467	493	484	481	471	481	471
Biochemical Oxygen Demand	mg/L	1	<3	<3	2	<1	2	>21	<1
Chemical Oxygen Demand	mg/L	5	6	<5	12	11	8	61	10
Chloride (Cl)	mg/L	1	60	63	69	66	59	57	64
Conductivity	µS/cm	5	1160	1170	1150	1170	1140	1150	1170
Dissolved Organic Carbon	mg/L	0.5	4.4	2.5	4.6	3.2	3.0	9.5	3.3
N-NH3 (Ammonia)	mg/L	0.02	0.13	<0.01	0.07	0.26	0.06	0.06	0.09
N-NO3 (Nitrate)	mg/L	0.1	0.55	0.40	0.31	0.35	<0.10	0.15	<0.10
pH			7.98	7.94	7.81	8.00	7.81	7.88	7.49
Sulphate (SO4)	mg/L	1	56	73	63	70	77	78	81
TDS (COND - CALC)	mg/L	5	653	796	748	760	741	748	761
Total Suspended Solids	mg/L	2	<3	<3	22	18	8	8	496
Calcium (Ca)	mg/L	1	119	114	109	112	97	104	121
Magnesium (Mg)	mg/L	1	56	52	50	47	45	46	51
Sodium (Na)	mg/L	2	72	85	84	87	84	87	63
Barium (Ba)	mg/L	0.01	0.09	0.08	0.08	0.09	0.09	0.07	0.06
Boron (B)	mg/L	0.01	0.21	0.24	0.24	0.28	0.25	0.28	0.14
Iron (Fe)	mg/L	0.03	0.14	0.05	0.07	0.12	0.04	<0.03	<0.01
PHC F1 (C6-C10)	mg/L	0.2	<0.02	<0.02	<0.2	<0.2	<0.1	<0.1	<0.2
PHC F2 (C10-C16)	mg/L	0.2	<0.05	<0.05	<0.2	<0.2	<0.1	<0.1	<0.2
PHC F3 (C16-C34)	mg/L	0.5	<0.4	<0.4	<0.5	<0.5	<0.2	<0.2	<0.2
PHC F4 (C34-C50)	mg/L	0.5	<0.4	<0.4	<0.5	<0.5	<0.2	<0.2	<0.2

Borehole #4 (2005-BH4)

Sample Date:			2017-10-06	2016-11-02	2015-10-05	2014-10-29	2013-09-18	2012-11-16	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	259	297	271	272	264	245	279
Biochemical Oxygen Demand	mg/L	1	<3	<3	1	2	2	5	<1
Chemical Oxygen Demand	mg/L	5	9	<5	11	13	<5	18	6
Chloride (Cl)	mg/L	1	22	25	28	22	18	15	15
Conductivity	µS/cm	5	665	670	701	665	657	611	646
Dissolved Organic Carbon	mg/L	0.5	3.6	3.3	3.2	3.4	2.5	4.7	2.1
N-NH3 (Ammonia)	mg/L	0.02	0.14	0.06	0.18	0.35	0.29	0.12	0.17
N-NO3 (Nitrate)	mg/L	0.1	<0.05	<0.1	<0.10	<0.10	<0.10	<0.10	<0.10
pH			8.03	7.99	7.85	8.10	7.97	7.92	7.84
Sulphate (SO4)	mg/L	1	43	54	56	58	55	56	41
TDS (COND - CALC)	mg/L	5	371	450	456	432	427	397	420
Total Suspended Solids	mg/L	2	<3	<3	<2	4	<2	10	175
Calcium (Ca)	mg/L	1	45	49	54	45	36	36	39
Magnesium (Mg)	mg/L	1	20	21	22	18	16	14	18
Sodium (Na)	mg/L	2	75	71	70	78	81	78	76
Barium (Ba)	mg/L	0.01	0.08	0.08	0.08	0.08	0.07	0.05	0.07
Boron (B)	mg/L	0.01	0.26	0.20	0.21	0.27	0.22	0.24	0.19
Iron (Fe)	mg/L	0.03	0.48	0.43	0.69	1.26	0.29	0.71	0.16
PHC F1 (C6-C10)	mg/L	0.2	<0.02	<0.02	<0.2	<0.2	<0.1	<0.1	<0.2
PHC F2 (C10-C16)	mg/L	0.2	<0.05	<0.05	<0.2	<0.2	<0.1	<0.1	<0.2
PHC F3 (C16-C34)	mg/L	0.5	<0.4	<0.4	<0.5	<0.5	<0.2	<0.2	<0.2
PHC F4 (C34-C50)	mg/L	0.5	<0.4	<0.4	<0.5	<0.5	<0.2	<0.2	<0.2

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 2017 issue of the *Kanata Kourier*

Nordion.
A Sotera Health company

OUR LIFE'S WORK

Nordion, a Sotera Health company, is a leading provider of gamma technologies and medical isotopes used for the prevention, diagnosis and treatment of disease. Our products benefit the lives of millions of people in more than 40 countries around the world.

CORE COMMITMENT

Nordion makes a distinctive contribution to the health and well-being of people. This extends to protecting the safety of our employees, our neighbours and the environment. For 70 years, we have been an industry leader in safe work practices and environmental protection. Located in Kanata, Nordion's Class 1B nuclear facility is certified to ISO 14001, an international standard for environmental management systems. Nordion is regulated by the Canadian Nuclear Safety Commission, which regularly reviews Nordion's performance under our Nuclear Substance Processing Facility Operating License.

Throughout the year we share relevant and timely information regarding our facility operations with the communities in which we live and work. To provide your feedback or for more information, please visit **nordion.com**

Wishing You
a Joyous & Safe
Holiday Season