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nordion
SCIENCE ADVANCING HEALTH

# Nordion Class 1B Facility

License Number: NSPFOL-11A.00/2025

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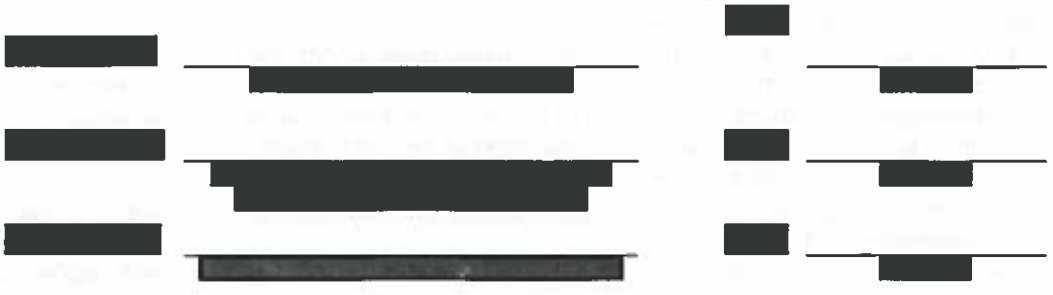
Ottawa, ON, Canada K2K 1X8

## Annual Compliance and Operational Performance Report to the Canadian Nuclear Safety Commission for the period JANUARY to DECEMBER 2015

Submitted: March 31st, 2016

**Signatures**



## 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 and
- 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.

In the fall of 2015, Nordion's Class 1B Nuclear Substance Processing Facility Operating License was renewed by the CNSC until 2025 based on the review of ten years of operating data. In 2005, the CNSC granted Nordion an unprecedented ten year license. Receiving another 10 year license was an accomplishment that Nordion believes is based on the organization's positive compliance history and safety record, and reflects the confidence in Nordion's Environmental Health and Safety standards and the organization's policies and practices as a nuclear business. Nordion has demonstrated that it is capable and qualified to operate in a manner that protects the safety of employees and causes no adverse effects to the public or the environment.

The key points of this report are as follows:

- There was only one major incident in 2015, which was the fire that occurred on the roof of the Kanata Operations Building (KOB) on August 6th. This event was an isolated incident caused by a contractor who was performing renovations to the roof.
- With the exception of the fire, the facility has operated according to all applicable design criteria. There was one physical design change relating to the fire on the roof where the wood was replaced with non-combustible material, otherwise no other changes to any structural areas of the building or changes to the designated Active Areas occurred.
- Several milestones regarding Nordion's Systematic Approach to Training (SAT) program were reached in 2015 and all of the CNSC recommendations from the November audit were addressed. These included implementing a formal process for conducting a Training Needs Analysis, and the adoption of a single change process.
- At the end of 2015, there were 10 out of 813 survey meters past due for the internal frequency requirements, seven of them were due to them requiring repair, one high dose rate meter was sent to an external company for calibration. All of the ten meters have since been calibrated or otherwise accounted for. Testing of all other radiation devices and instrument maintenance was performed at the required frequency and results were satisfactory.
- There was only one piece of equipment (the chiller) with multiple occurrences of non-routine maintenance in 2015 (refer 2.3.4.11).
- The Environment, Health and Safety (EHS) Committee met on a regular basis to review the environmental and safety aspects of the operations and to review and approve Final Safety Analysis Reports (FSARs).

- All measurable radiation doses received by personnel and the public were within the regulatory limits of 50 mSv/yr for NEW personnel and 1 mSv/yr for non-NEW personnel and public, and no internal dose levels or limits were exceeded.
- There were a total of 43 contamination incidents in 2015. All elevated levels of contamination were monitored and contained within the Active Area.
- There were no instances in which there was potential to exceed a regulatory limit or to reach or exceed an action level in 2015.
- Various improvements were made to the Radiation Protection, Conventional Health and Safety, Environmental Protection and Fire Protection Programs. These programs fall within the scope of the Quality Assurance (QA) Program for Safety.
- There were no lost time injuries and four medical treatment injuries in 2015.
- There was one reportable exceedance of an environmental regulatory limit or action level in 2015. It related to a non-radiological release to the sanitary sewer which resulted in by-law limit exceedances. This was identified by Nordion during routine sampling and self-reported to the City of Ottawa.

In 2015, Nordion's Class 1B Facility operated within the requirements of the Nuclear Safety and Control Act, the applicable regulations and the conditions of the operating license issued by the CNSC with the exception of 17 non-compliances with the Act, the regulations or with Nordion's site license NSPFOL-11A.00/2025 (refer to Appendix A).

## TABLE OF CONTENTS

**ABSTRACT** 2

**1. INTRODUCTION** 7

1.1 General Introduction 7
1.2 Facility Operation 9
1.3 Production or Utilization 13
1.4 Facility Modifications 15

**2. SAFETY AND CONTROL AREA** 17

2.1 Management System 17
2.2 Human Performance Management 18
2.3 Operating Performance 20
2.4 Safety Analysis 28
2.5 Physical Design 29
2.6 Fitness for Service 29
2.7 Radiation Protection 30
2.8 Conventional Health and Safety 40
2.9 Environmental Protection 42
2.10 Emergency Management and Fire Protection 49
2.11 Waste Management 53
2.12 Nuclear Security 54
2.13 Safeguards and Non-proliferation 55
2.14 Packaging and Transport of Nuclear Substances 55
2.15 Public Information Program 55
2.16 Site Specific Information 58

**3. FUTURE PLANS AND CONCLUDING REMARKS** 58

3.1 Improvement Plans and Future Outlook 58
3.2 Safety Performance Objectives for Following Year 58
3.3 Concluding Remarks 61

## 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 |
| BMS | Building Monitoring System |
| CAD | Charcoal Adsorber |
| CAM | Continuous Air Monitor |
| CAPA | Corrective Action Preventative Action |
| CBRNE | Chemical Biological Radionuclear Explosive |
| CNSC | Canadian Nuclear Safety Commission |
| COF | Cobalt Operations Facility |
| [redacted] | |
| CSA | Canadian Standards Association |
| DRD | Direct Reading Dosimeter |
| DRL | Derived Release Limit |
| EC | Environment Canada |
| EHS | Environment, Health and Safety |
| EMS | Environmental Management System |
| EMU | Emergency Measures Unit |
| EOC | Emergency On Call |
| EQMS | Electronic Quality Management System |
| ER | Emergency Response |
| FAQ | Frequently Asked Questions |
| FSAR | Final Safety Analysis Reports |
| HEPA | High Efficiency Particulate Air |
| HEPCO | Hospital Emergency Planning Committee of Ottawa |
| HPGe | High Purity Germanium |
| HRSDC | Human Resource Skills Development Centre |
| HVAC | Heating, Ventilation and Air Conditioning |
| ICP | Incident Command Post |
| IMS | Incident Management System |
| KRMF | Kanata Radiopharmaceutical Manufacturing Facility |
| KOB | Kanata Operations Building |
| LLLW | Low Level Liquid Waste |
| MDA | Minimum Detectable Activity |
| MSDS | Material Safety Data Sheet |
| NCSP | Nuclear Critical Safety Program |
| NEW | Nuclear Energy Worker |
| NFPA | National Fire Protection Association |
| NMPF | Nuclear Medicine Production Facility |
| NPRMI | Non-production Radioactive Material Inventory |
| NSC | Nuclear Safety and Control |
| NVS | Nuclear Ventilation System |
| OMIS | Obligated Material Inventory Summary |
| OSL | Optically Stimulated Luminescent |
| 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 |
| R&D | Research & Development |

| | |
|---|---|
| RE | Roy Errington |
| RP | Radiation Protection |
| SAT | Systematic Approach to Training |
| SCBA | Self Contained Breathing Apparatus |
| SOP | Standard Operating Procedures |
| SSTS | Sealed Source Tracking System |
| TDG | Transportation of Dangerous Goods |
| TLD | Thermo-luminescent Dosimeter |
| UPS | Uninterruptible Power Supply |
| WSIB | Workplace Safety Insurance Board |
| IPPAS | International Physical Protection Advisory Service |
| US DOT | United States Department of Transportation |
| IAEA | International Atomic Energy Association |

# 1. INTRODUCTION

## 1.1 General Introduction

Nordion is a business unit of Sterigenics International, 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 and the other involving sealed sources used in cancer therapy and irradiation technologies.

### 1.1.1 Summary of Production and Operational Limits

Nordion's license NSPFOL-11A.00/2025 does not include any production and operational limits.

### 1.1.2 Summary of Performance

In 2015, Nordion's operations were in compliance with the Nuclear Safety and Control (NSC) Act, regulations, and conditions of its site license NSPFOL-11A.00/2025, which was renewed on November 1, 2015, with the exception of 17 noncompliances.

Within the 2015 reporting period there were a total of 21 reportable incidents (refer to Appendix A). Of the 21 incidents:

- One involved an external perimeter security breach (1 Low risk)
- One involved a fire on the roof of the Kanata Operations Building (KOB) (1 High risk)
- Nine were related to transport where the root cause analysis determined the responsible parties to be a carrier, supplier, or customer (9 Low risk)
- Two were historical investigations that involved sealed source reporting and a revision to a maintenance procedure (2 Low risk)
- Seven involved incorrect information on product labels or improper packaging of materials (1 Medium risk, 6 Low risk)
- One involved a missed Post Shipment Verification (PSV) (1 Medium risk)

In 2015, the number of occupational incidents (4) was under the Environment, Health and Safety (EHS) target of less than or equal to six. This is an improvement from the 2014 results of eight occupational injuries. This improvement is attributed to the increase in Nordion's focus related to ergonomics, safety awareness, and Back Safety Training. This training was designed to increase ergonomic safety awareness and will be continued throughout 2016. The details of the four incidents can be found in Section 2.8.4.

The objectives are reviewed yearly at the Annual Joint Environmental Management System (EMS) and Quality Assurance (QA) Program for Safety Review. Refer to Section 2.3.1 for a summary of the EHS Objectives and Targets for 2015.

### 1.1.3 Summary of Activities

A number of facility modifications took place in 2015 including:

- Replacement of a boiler for facility hot water
- Replacement of the KOB lower roof
- Installation of a manual transfer switch for redundancy between the three emergency power generators
- Upgrade of the emergency backup power system for Stack 2

- Emergency backup power provided to a portion of the Radiopharm dehumidification system
- Replacement of breakers and cradles in the KOB electrical power distribution system
- Secure waste bins at the Heating Plant, installation of AC Unit for Computer Room 2292
- Modifications to improve HVAC to Human Resources area
- Ongoing modifications to meet seismic requirements in KOB Mechanical Room

In April, Nordion posted its Annual Compliance and Operational Performance Report to the CNSC for the reporting period of January to December 2014 on its website.

There was only one physical design change to the licensed facility related to the fire on the roof in August where the wood construction was replaced with a non-combustible material. There were no other changes to any structural areas of the building or changes to the designated active areas.

Nordion has begun training on new EHS software which will be used to track and manage incidents, audits, inspections, regulatory commitments, training, risk analysis, performance metrics and corrective actions. The software is also designed to make reporting incidents and near misses easier, more timely and effective. Nordion has developed personnel training for this software and plans to roll it out to the EHS team in 2016 and then the rest of Nordion soon thereafter.

In 2015, Nordion's Systematic Approach to Training (SAT) program continued to progress whereby all of the CNSC recommendations from the November 2014 inspection were addressed. These included implementing a formal process for conducting a Training Needs Analysis, and the adoption of a single change process.

Also, revisions were completed for six radiation safety courses, ten OH&S courses, five Security/Emergency response courses, four Job Task Analysis (JTA) for training programs where the core duties are safety related, and 34 JTAs for positions whose core role is not a safety function but have safety related tasks embedded within them.

For conventional health and safety, Back Safety and Ergonomic training was updated and provided to the Operations groups with an excellent participation rate.

For radiation protection, the use of control charts for the thyroid bioassay unit and both radioxenon monitors was continued throughout 2015.

The Nordion emergency management program redesign was completed and was documented in final draft Emergency Response Plan (ERP) documents. These drafts were provided to the CNSC for review and approval.

Throughout 2015, significant improvements were made to the plan to incorporate required elements of the REGDOC 2.10.1 "Nuclear Emergency Preparedness and Response" and will be submitted to the CNSC for further approval in 2016.

### 1.1.4 Issues and Corrective Actions

There was one major incident in 2015 with regards to the operating facility that occurred on August 6th involving a fire on the roof of the Kanata Operations Building (KOB).

A contractor was using a blow torch to apply a membrane onto the roof which caused the wooden construction under the flashing to light on fire. Due to the KOB ventilation system, which has negative pressure, it drew the fire into the building allowing the combustible materials within the roof's construction to ignite.

Actions that resulted immediately included the following:

- Suspension of all hot work until appropriate measures were put into place.
- Development of an interim measure for reinstating hot work to ensure it is conducted in a safe and controlled manner.

- Replacement of the wood construction under the concealed space of the roof with a non-combustible material.

Additional corrective actions that resulted were:

- Procedure SE-HS-009 "Work Permit Authorization Program" was modified and updated.
- Additional training to applicable staff on methods to assess and identify potential fire hazards was provided.
- Current procedures were modified to ensure Facilities' personnel automatically initiate installation of the drain plug when the KOB Fire Safety Plan is activated.

1.1.5 Reportable Incidents

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

1.1.6 Compliance with Other Regulatory Agencies

Nordion applied to Environment Canada for Precautionary Permits to Charge a Fire Extinguishing System for in-cell fire suppression systems containing halon. These permits were approved and received in April 2014 and permit Nordion to refill halon fire extinguishing systems until March 2016.

Nordion reports to the Workplace Safety Insurance Board (WSIB) whenever a reportable occupational injury or illness occurs. In 2015, there were four medical treatments and two lost-time incidents reported to the WSIB. WSIB may inspect Nordion's Occupational Health and Safety programs at any time; however, no inspections were held in 2015.

In compliance with Part II of the Canadian Labour Code, five disabling injuries were reported to the Human Resource Skills Development Centre (HRSDC).

Nordion must comply with Transport Canada's Transportation of Dangerous Goods Regulations for the shipment of Class 7 Radioactive Material and any other class of dangerous goods that may be shipped. Nordion employees involved in transportation of dangerous goods are trained on all aspects of the regulations that apply.

## 1.2 Facility Operation

1.2.1 Facility Operation

The facility operated according to applicable design criteria in 2015. There were no investigations in 2015 related to facility design.

1.2.2 Personnel Performance

The number and significance of corrective actions related to training would be an indication of how effectively personnel performed compared to their duties and how well personnel followed procedures. During 2015, ten of the 68 EHS corrective action and preventative actions (CAPAs) initiated were related to training. CAPAs typically arise from internal audits, investigations, or external regulatory compliance inspections.

The risk significance of these ten CAPAs is as follows: seven Low, two Medium, and one High. Of the ten CAPAs with a root cause of training, four related to non-production radioactive material inventory. These four CAPAs were all low risk and were the result of the same audit conducted in December 2014. The rest of the CAPAs were unrelated. There was an increase in the total number of corrective actions in 2015 when compared to 2014, as well as an increase in CAPAs related to training, however, upon further review, 40% of those resulted from a focused audit which was conducted the previous year. Aside from the non-production radioactive material inventory CAPAs from the audit conducted in December 2014, there were no other trends identified, therefore, the training of personnel is considered to be effective.

1.2.3 Summary of Modifications and Repairs

Modifications and repairs that were carried out in 2015 included:

- Replacement of a boiler for facility hot water
- Replacement of the KOB lower roof
- Installation of a manual transfer switch for further redundancy between the three emergency power generators
- Upgrade of the emergency backup power system for Stack 2
- Emergency backup power provided to a portion of the Radiopharm dehumidification system
- Replacement of electrical breakers and cradles in the KOB electrical power distribution system
- Securing waste bins at Heating Plant
- Installation of AC Unit for Computer Room 2292
- Modifications to improve heating, ventilation and air conditioning (HVAC) to Human Resources area
- Ongoing modifications to filter banks to meet seismic requirements in KOB Mechanical Room

### 1.2.4 Internal and External Audits

As part of the QA Program for Safety and the Environmental Management System (EMS), Nordion annually conducts internal audits to identify and correct potential environmental, health and safety related issues. In 2015, Nordion conducted a total of 16 internal EHS audits. These audits included an audit of production areas and supporting functions as well as policy and program audits. In addition, Nordion conducted a total of four safety inspections.

In 2015, there were a total of sixteen internal audits, six external audits, and one external audit conducted by Nordion. Out of a total of 68 EHS related corrective actions initiated in 2015, 19 corrective actions were a result of internal audits and 16 were a result of external audits. Aspects of the Radiation Protection Program were audited via audits 1,4,5,7,8 and 14 (see audits listed below). The results indicated that the program is working effectively due to a lack of findings in these areas. A direct audit of the Radiation Protection Program is scheduled for 2016.

#### 1.2.4.1 Internal Audits

The following internal audits were conducted in 2015:

1. Audit of the [redacted] Process. Numerous EMS and QA safety elements were audited. One CAPA was initiated.
2. One EMS Program Audit. The audit included the EHS policy, communications, documentation, monitoring and measurement, evaluation of compliance, management review, environmental aspects, objectives, targets and programs, legal requirements, and emergency preparedness and response. One CAPA was initiated.
3. One QA Safety Program Audit. The following QA Program for Safety elements was reviewed: organization and responsibilities, manager self-assessment, use of experience, and program definition. Four CAPAs were initiated.
4. Physical Inventory Taking (PIT) of Safeguarded Material.
5. Non-production Radioactive Material Inventory (NPRMI) Audit. Five CAPAs were initiated.
6. Internal EHS Audit Program. One CAPA was initiated.
7. Process Safety Audit of the Cobalt Container Storage.

8. Process Safety Audit of the HEGS Process.
9. Access Authorization Program (10CFR37). One CAPA was initiated.
10. Import/Export Controls Program (Cobalt-60 and Iridium-192). Three CAPAs were initiated.
11. Transportation Audit (NRC QA Program Approval Elements – Maintenance, Repair and Use).
12. Procedure Audit of Transportation Labelling and Documentation. Two CAPAs were initiated.
13. QA/EMS Audit of the Environmental Protection Program.
14. QA/EMS Audit of the Waste Program.
15. QA Audit of the Safeguards and Non-proliferation Program. One CAPA was initiated.
16. Audit of the Source Return Statement.

Below is a summary of the CAPAs associated with the internal audits conducted in 2015:

| Audit Title | # of CAPAS | CAPA # | Finding | Corrective Action | Status |
|---|---|---|---|---|---|
| Audit of [redacted] Process | 1 | 160108 | No pre-operation safety check was performed on a lift truck. | TBD | In progress |
| Environmental Management System (EMS) Program Audit | 1 | 151005 | Emergency Response Exercise Review Form (SE-ERP-010 F5) was not completed for the Contact List Drill in 2014. | TBD | In-progress |
| QA Safety Program Audit | 4 | 150414 | Some audit reports were not prepared within a reasonable timeframe following the completion of the audit. | CPM-7-03 "Internal Audit Program" was revised and EHS Auditors retrained. | Closed |
| | | 150415 | Some examples of targets for 2015 are not measurable or quantitative. | EHS Compliance revised procedure SE-LIC-003, "Safety Objectives and Targets" | Closed |
| | | 150403 | Not all managers of high risk areas were performing Self Assessments as required. Also, not enough detail in Self-Assessments. | All high risk managers were identified and are completing Self-Assessments twice a year. Self-Assessment process was revised. | Closed |
| | | 150402 | Insufficient evidence provided in audit reports. | Internal audit program was revised and EHS Auditors were re-trained. | Closed |
| Non-production (NPRMI) Audit | 5 | 150405 | Certain sources were incorrectly listed in Oracle. | Instructor led training on the Non-Radioactive Material Inventory process. | Closed |
| | | 150406 | Certain sources were incorrectly listed in Oracle. | Retrained on the inventory procedure SE-LIC-015 "Radioactive Material Inventory. | Closed |

| | | | | | |
|---|---|---|---|---|---|
| | | 150407 | Cycle counts were being performed inconsistently. | Revised inventory procedure and personnel retrained. | Closed |
| | | 150408 | Certain sources were incorrectly listed in Oracle. | Revised inventory procedure and personnel retrained. | Closed |
| | | 150409 | Lack of communication resulted in material being misplaced. | Applicable documents were revised and applicable personnel retrained. | Closed |
| Internal EHS Audit Program | 1 | 151204 | A recent position was filled without fulfilling the requirements of SE-SC-001 "Trustworthy and Reliability Determination" | TBD | In Progress |
| Procedure Audit of Transportation Labelling and Documentation | 3 | 151205 | Inconsistent documentation practices were noted during maintenance procedures. | TBD | In Progress |
| | | 151206 | Bolt fastening during package loading was performed inadequately. | TBD | In Progress |
| | | 151207 | Reports were not being completed for "pre-approved" repairs as required. | TBD | In Progress |
| QA/EMS Audit of Environmental Protection Program | 3 | 151208 | Soil monitoring reports did not contain required documentation. | TBD | In Progress |
| | | 151209 | Excessive combustible loading was observed. | TBD | In Progress |
| | | 151210 | Nordion's supplier, to which Nordion returns waste fluorescent tubes does not have the required records regarding acceptance and storage of this waste. | TBD | In Progress |
| QA Audit of Safeguards and Non-proliferation Program | 1 | 151102 | Missing signature on inventory list. | Applicable procedure was revised and personnel retrained. | In Progress |

1.2.4.2 External Audits of Nordion

The following external audits of Nordion were conducted in 2015:

1. On January 13-15, 2015 the CNSC conducted a Management System Inspection. There were four action notices and one recommendation identified.
2. On January 21, 2015 the CNSC conducted a Fire Protection Inspection. There were three directives, two action notices and five recommendation identified.
3. On March 9, 2015 the CNSC conducted a Security Inspection. There was one action notice and two recommendation identified.

4. On March 24, 2015 Transport Canada conducted a Transportation of Dangerous Goods Inspection. There were two findings identified.
5. On May 4-8, 2015 a third party conducted a re-registration audit against requirements from the ISO 14001:2004 standard. There was two minor non-conformances and four opportunities for improvement identified.
6. On June 24-25, 2015 the CNSC conducted an Inventory Inspection. There were three observations identified.

1.2.4.3 External Audits Conducted by Nordion

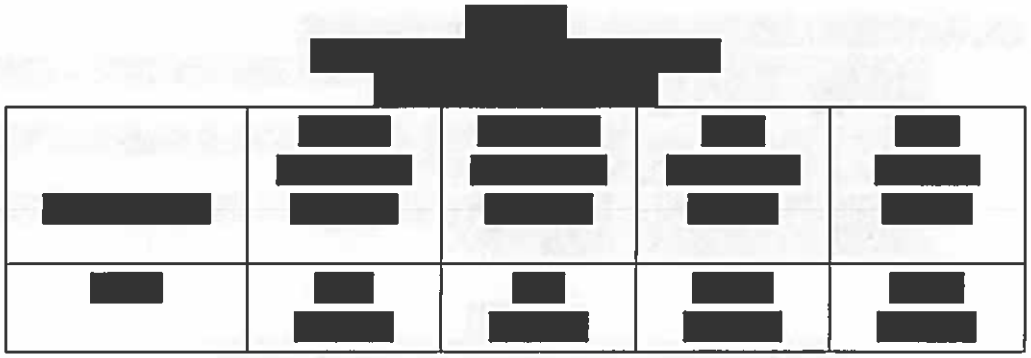
Nordion conducted one EHS Audit of a supplier in 2015. There were no corrective actions identified during this audit.

## 1.3 Production or Utilization

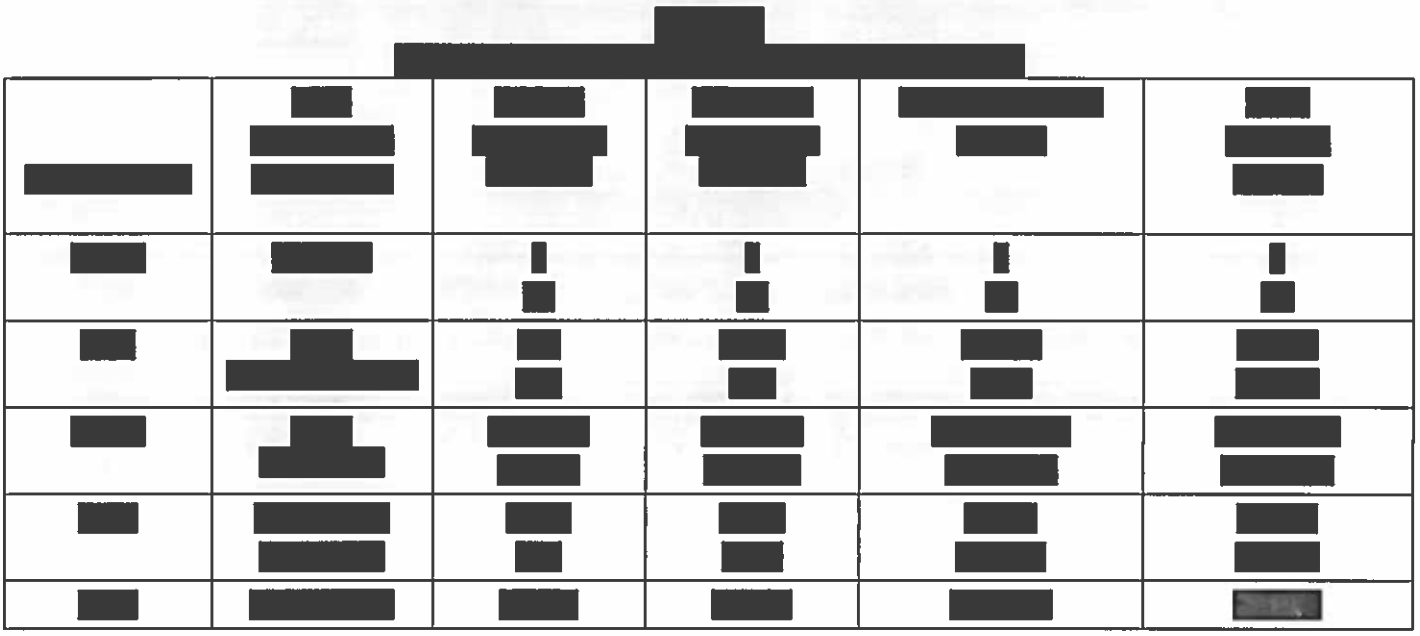
Activities conducted in the Kanata Operations Building (KOB) relating to the procurement, possession, processing and shipping of radioactive materials are conducted under Nuclear Substance Processing Facility Operating Licence, NSPFOL-11A.00/2025. The facility is comprised of the KOB, which houses the Nuclear Medicine Production Facility (NMPF) the Cobalt Operations Facility (COF), and the Kanata Radiopharmaceutical Manufacturing Facility (KRMF).

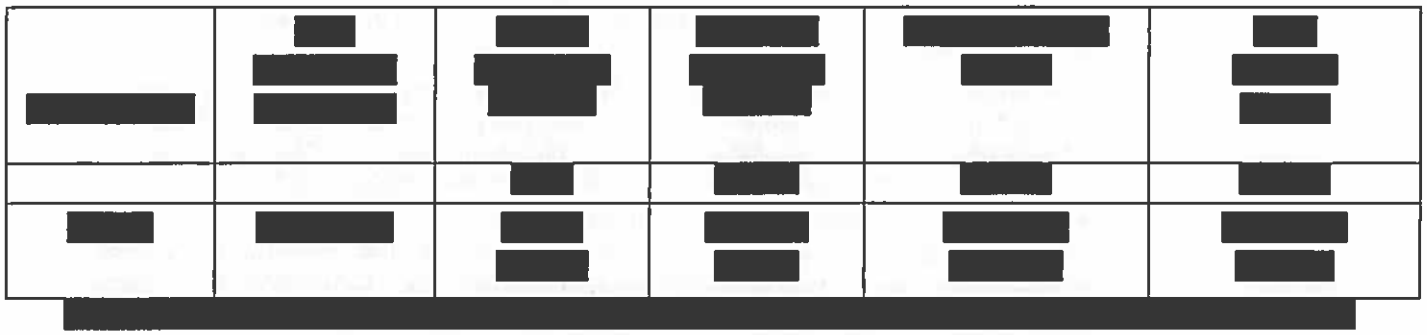
1.3.1 Sealed Source Manufacturing/Radioisotope Processing

[redacted]



[redacted]





## 1.4 Facility Modifications

### 1.4.1 Changes to the Facility Buildings, Processes and Equipment

#### 1.4.1.1 Changes to Designated Active Area

In 2015, Nordion made no changes to designated Active Areas.

#### 1.4.1.2 Structural/Functional Changes Affecting Emissions

In 2015, Nordion made no structural/functional changes that affected the emissions of the facility.

#### 1.4.1.3 Structural/Functional Changes Affecting Active Area Ventilation

In 2015, Nordion completed work involving the decommissioning and removal of C-14 fume-hoods and glove-boxes. One glove box was removed from Room 1307 and eight glove boxes and three fume-hoods were removed from Room 1356. The EHS Committee met twice to discuss the potential impact that this work would have regarding the ventilation in the active area and also identified potential risks associated with the work. The potential for workers to be exposed to contamination as well as employee exposure via inhalation of harmful materials was considered. When the work was completed, air balancing of the ventilation system was performed to mitigate these risks. Upon completion of the project, there were no unintended negative impacts observed.

#### 1.4.1.4 Structural/Functional Changes Affecting the Active Liquid Waste System

In 2015, Nordion made no changes that affected the active Liquid Waste System.

### 1.4.2 Changes to Procedures Related to Operations Safety and Control

In 2015, the following changes were made to procedures related to operational safety and control:

- SE-LIC-015 "Radioactive Material Inventory"
  Document revised to reflect improvements to the Leak Testing program.
- SE-OP-053 "Nonconformance and Corrective and Preventative Action"
  A process that initiates a Training Needs Analysis for any high or medium risk nonconformances related to training was included.

Refer to Sections 2.7.7 and Section 2.8.3 for additional changes to procedures related to Radiation Protection Program.

### 1.4.3 Changes to the Organizational Structure and Key Personnel

Nordion has two primary businesses: Gamma Technologies and Medical Isotopes, supported by centralized corporate functions.

In September of 2015, the new position of Senior Manager, Transportation, Licensing, and Gamma Radiation Safety was created and filled in EHS.

In December of 2015, the President, Gamma Technologies and Corporate Services became the President of Nordion (Canada) Inc. The position of President of Medical Isotopes was eliminated and the new position of General Manager, Medical Isotopes was created. The GM, Medical Isotopes reports directly to the President of Nordion.

EHS personnel are 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
- 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
- Safety Manager
- Manager, EHS and Documents & Corporate Records
- Occupational Health & Safety Specialist

**Medical Isotopes – EHS Compliance**

- Vice-President, QA Regulatory & EHS Compliance
- Administrative Assistant
- Senior Manager, Radiation Safety & Compliance
- Senior Radiation Surveyor (2)
- Radiation Surveyor (4)
- Senior Radiation & Contamination Monitor (3)
- Radiation and Contamination Monitor (5)

### 1.4.4 Changes to the Training Programs

There were changes to three of Nordion's existing EHS training programs in 2015. They are listed below with a brief description of the change:

- SE-TRN-001 (Training Program)
  Reference to procedures for Nuclear Medicine Monitors was added and the radiation and contamination and monitoring training form was updated.
- SE-TRN-006 (Systematic Approach to Training)
  Key emergency response courses, organizational analysis, an exemption clause for instructors and a training needs analysis form were added.

- CO-MD OP-0028 (Cobalt Monitor on-the-job training program)
  Addition of Just in Time (JIT) training requirements for Cobalt Monitors and document revision.

Nordion released one new EHS self-directed training course on Security Awareness for all new employees.

As a result of a CNSC inspection in November 2014, a formal process for conducting a Training Needs Analysis as well as a single change process was created in 2015. Also, in 2015 revisions were made to:

- Six radiation safety courses
- Ten key Occupational Health & Safety (OH&S) courses
- Seven key Security/Emergency Response courses
- 34 Job Task Analysis for roles that have embedded safety related tasks, but core role is not a safety function

# 2. SAFETY AND CONTROL AREA

## 2.1 Management System

### 2.1.1 Review of Quality Assurance/Management Program Activities

In 2015, Nordion conducted a total of 16 internal EHS audits. A summary of these audits and their findings can be found in Section 1.2.4.1.

### 2.1.2 Review of Quality Assurance/Management Program Effectiveness

The annual management review of the Environmental Management System and the QA Program for Safety was conducted October 30, 2015.

The management review involves the evaluation of actions from the previous meeting, the Environment, Health & Safety Policy (CPM-6-06), adequacy of resources, environmental health and safety objectives and targets, changing circumstances and recommendations for improvement.

Results of the 2015 Annual Review:

1. 17 out of the 19 outstanding actions from the previous meetings had been completed and closed. One of the remaining items was related to the implementation of an Electronic Quality Management System (EQMS) Corrective Action Preventative Action (CAPA) module. The EHS Committee noted that this is a continuous improvement item and not a deficiency, and therefore, removed it from the action list. The other involved a review process of changing regulations to ensure Nordion is kept current and up-to-date.
2. The Environment, Health and Safety Policy (CPM-6-06) was reviewed and it was determined that the policy did not require further review and update.
3. The 2014 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. Three trends were identified, one in the Management System SCA involving shipments delivered to incorrect locations and two in the Operating Performance SCA involving sealed source reporting and pre and post shipment verifications. The findings that contributed to these trends have been addressed with CAPAs being initiated as a result.

4. The 2015 EHS Objectives and Targets were reviewed and it was determined that they were on track at the time of the meeting.
5. The new 2016 EHS Objectives and Targets were discussed.
6. Resource requirements for the Environmental Management System and QA Program for Safety were discussed. The Committee agreed that the most critical issues are resourced adequately. Financial and specialized skills resources were felt to be adequate.

There were 8 new actions identified during the meeting. The EHS Committee had no further recommendations for improvement. As such, the Committee concluded that the EHS management system (the Environmental Management System and the QA Program for Safety) is effective.

### 2.1.3 Summary of Quality Assurance/Management Program Improvements

In 2015, changes or revisions were made to the Radiation Protection Program, Conventional Health and Safety Program, and the Environmental Protection Program as discussed in Sections 2.7.7, 2.7.9, 2.8.3 and 2.9.6, respectively.

In 2015, the QA Program for Safety and the internal audit program were expanded to include other program areas following CNSC guidance.

### 2.1.4 Manager Self-Assessments

Managers of High Risk Areas are required to regularly assess the management processes for which they are responsible. They are also responsible for assessing their effectiveness at establishing, promoting and achieving safety objectives and targets (nuclear safety, OH&S, and environmental).

Self-Assessments are required to be completed and submitted to EHS at least semi-annually in accordance with SE-LIC-003. In 2015, Nordion properly identified all managers of High Risk areas to include all managers for nuclear licensed activities and required them to complete these assessments. Also, the Self-Assessments had been revised to better define and guide managers on how to evaluate the work that they are responsible for.

In 2015, 100% of the managers completed the required self-assessments for a total of 50 assessments submitted. 22 managers filled out two self-assessments each and two managers completed three each. The managers who completed more than two assessments did so because a newly revised Self-Assessment was released after they had already completed their second assessment for the year.

## 2.2 Human Performance Management

### 2.2.1 Training Program Effectiveness

In 2015, the number of scheduled participants for internal safety training was 505, and by the end of the year, 501 of the scheduled participants completed the training, which included refresher training. Therefore, the attendance completion rate in 2015 was 99% with details shown in Table 4. In 2015, 100% of the personnel passed their required training programs and there were no rescheduled tests due to failed attempts. This demonstrates the effectiveness of these training programs as all trainees were able to pass on their first attempts.

Nordion designed and maintains a variety of radiation safety training courses. New employees who are not classified as Nuclear Energy Workers (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 2015, there were no radiation safety incidents nor were there any anomalous TLD readings. 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 such topics as "Working with Radioiodines", emergency response awareness, care and use of respirators, material handling training, and working safely with fume-hoods. A summary of the training programs and the number of participants is provided in Table 4.

Employees who transport, handle, or offer dangerous goods for transport are trained in the Transportation of Dangerous Goods (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.

**Table 4**
**Safety Training Programs – 2015**

| Program | Duration | Number of Participants | Refresher Training Overdue at end of 2015 |
|---|---|---|---|
| Nuclear Energy Worker Indoctrination | 6 Hours | 21 | Not Applicable |
| Health, Safety and Environment Level II | Self Study | 80 | 0 |
| Radiation Instrumentation Workshop | 3 Hours | 81 | 0 |
| Radiation Safety Review for Operators | Half Day | 19 | 2** |
| Safe Handling of Radioiodines | 2 Hours | 34 | 1* |
| Transport of Dangerous Goods Level I | Self Study | 2 | 0 |
| Transport of Dangerous Goods Level II | Self Study | 9 | 0 |
| Transport of Dangerous Goods Level III | All Day In-Class (Once Upon Employment Self Study thereafter) | 29 | 0 |
| TDG for Contractors | Full Day | 55 | 0 |
| Working with BETA | 1 Hour | 54 | 1* |

| | | | |
|---|---|---|---|
| Crane | Half Day | 51 | 0 |
| Pallet | Half Day | 28 | 0 |
| Forklift | Half Day | 12 | 0 |
| Contractor Radiation Safety Training | Half Day | 14 | 0 |
| Contractor Radiation Safety Update Training | 2 Hours | 13 | 0 |
| HEGS Safety Training | 2 Hours | 0 | 0 |
| In-Depth Security Awareness | 2 Hours | 3 | 0 |
| TOTAL | | 505 | 4 |

* Employee is on leave

** Employee completed refresher training in January 2016

2.2.2 Verification of Minimum Number of Responsible Personnel During Operations and Similar Activities

Nordion has ensured that the minimum number of responsible personnel is 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 80 Fire Wardens and Marshalls and over 80 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 2.10.4).

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.

## 2.3 Operating Performance

2.3.1 Effectiveness of Licensed Activities

The licensed activities were carried out according to Nordion's programs and procedures. Nordion had one significant unplanned event which was categorized as a high risk nonconformance. A fire on the KOB roof occurred on August 6th, 2015. Details of this event can be found in Appendix A (Table of Incidents) under Incident No. 15-12. This event did not have any effect on the licensed activities and employees returned to work the next day. Despite the evacuation of employees during the Emergency Response, this event did not result in a significant interruption of facility operation or disruption to business.

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.

Summaries of the 2015 EHS Program Objectives and Health and Safety Objectives are shown in Tables 5 and 6. All of the EHS Objectives listed in Table 5 were met in 2015 with the exception of thyroid bioassay attendance. The number of occupational incidents (5) was less than the target (six). There were no lost time incidents and four medical treatment incidents in 2015. The details of these incidents can be found in Section 2.8.4.

With the majority of the incidents involving back injuries or repetitive strain, Nordion continues to provide increased focus on ergonomic assessments, proper mechanics training, and awareness to Operations groups. The main focus of Back Safety training, which was presented in 2015, was on Operations groups where the likeliness of back injury is more probable due to the physical nature of these roles. From these groups, there was an excellent participation rate.

Severity rate was at 3.92 which is lower than Nordion's target of 4 and is calculated using lost time over the last three years. The rate of 3.92 is less than the previous year and reflects the zero lost time that occurred in 2015. Thyroid attendance was also below the target of 90% at 86% overall for the year. This objective has improved since inception in January 2015.

Table 6 shows Health and Safety Objectives that Directors and Managers and employees of high risk areas are expected to meet. A system is in place to ensure that the performance reviews are completed. 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.

The completion of manager self-assessments is audited annually. Deviations, Change Forms and complaints are reviewed yearly at the Annual Joint Environmental Management System and QA Program for Safety review.

**Table 5**
**2015 EHS Program Objectives and Results**

| Applicable Nordion Job Function | Objective | Measures and Targets | Result |
|---|---|---|---|
| All Directors and Managers<br><br>All Directors and Managers of Operations, Facilities, or Nuclear Energy Worker | Minimize the number and extent of occupational injuries, environmental and radiation incidents. | The number of Incidents ≤ 6<br>• Lost Time Accident Rate ≤ 0.5 per 200,000 hours worked (3-yr rolling)<br>• Severity Rate ≤ 4 days per 200,000 hours worked (3-yr rolling) | 4 Incidents<br><br>0<br><br>3.92 |

| Applicable Nordion Job Function | Objective | Measures and Targets | Result |
|---|---|---|---|
| employees | Minimize the use and release of hazardous materials to the environment. | • Radioactive materials emissions to ≤ 5.0% of the Derived Release Limits (DRL) | 1.06 % DRL |
| | | • No Noncompliant Releases (Radiological or Non-Radiological) | 1 Noncompliant release (Non-radiological ) |
| | | • Reduce non-hazardous waste to landfill | 64% Waste was diverted from landfill |
| | | • Audit one supplier whose goods/services could impact the environment | Audited supplier on Dec 15, 2015 |
| | | • Reduce Energy – Proposed project estimates annual savings of 67,000 KWh | VFD on 800T cooling tower and LED lighting replacement project completed. |
| | Maintain radiation doses to employees as per ALARA principle. | • Maximum employee dose rate ≤ 7.5 mSv/yr (12 mon rolling) | 1.85 mSv/yr (MI)<br>5.24 mSv/yr (GT) |
| | | • Thyroid Testing attendance > 90% (MI) | 86% |

*Based on fiscal year.

## Table 6
## 2015 Health and Safety Objectives

| Applicable Nordion Job Function | Objective | Measures and Targets |
|---|---|---|
| All Directors and Managers | Timely closure of EHS CAPAs. | • Meet all CAPA target dates.<br>• Ensure timely closure of EHS CAPAs. |
| All Directors and Managers of Operations, Facilities, or Nuclear Energy Worker employees | Ensure all managers of high risk areas conduct / document regular self-assessments of their management processes and safety performance. | • Mid-Year and Year-End performance reviews.<br>• 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.<br>• Opportunities for minimizing waste (hazardous and non-hazardous) are assessed and implemented whenever possible.<br>• Ensure all near-misses are reported in a timely manner and appropriate corrective |

| Applicable Nordion Job Function | Objective | Measures and Targets |
|---|---|---|
| | | action(s) are taken.<br>• Maintain control of non-production radioactive material. |
| | Communicate monthly with teams about environment, health and safety performance and impacts.<br><br>Openly evaluate employee environment, health safety concerns and encourage reporting of near misses. | • Environment, health & safety information and concerns are discussed regularly at team meetings.<br>• Health and safety concerns are assessed with the results of the evaluation communicated to the employee(s).<br>• Deviations, CF's, Non-conformances and Complaints are assessed for EHS risks against targets and reported accordingly.<br>• Routinely invite EHS Representatives to team meetings to discuss EHS topics and/or concerns. |
| 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 ever employee's highest responsibility.<br>• Work must follow Nordion's EHS training, standards and procedures, and is performed with care and attention to safety principles and policies.<br>• Wear all applicable personal protective equipment (PPE) as necessary.<br>• Bring all safety concerns or questions to the attention of the direct Supervisor or EHS.<br>• Submit all dosimeter(s) and rings for monitoring on time (no later than one month) following end of monitoring period. |
| All High Risk Employees | Report all workplace injuries, unsafe conditions and near misses. | • All workplace injuries, suspected injuries, observed unsafe conditions and near misses are reported immediately to the direct Supervisor.<br>• Report any suspected symptoms to your Supervisor or identify problems before they become injuries. |
| | 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 by asking questions and voicing concerns. |
| | Reduce environmental impacts. | • Identify opportunities for reducing waste, and using less harmful materials wherever possible.<br>• 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. |

| Applicable Nordion Job Function | Objective | Measures and Targets |
|---|---|---|
| | Timely closure of EHS CAPAs. | • Target 80% of generated CAPAs are closed within 1 year<br>• Meet all CAPA target dates.<br>• Prioritize high risk EHS CAPAs. |

2.3.2 Effectiveness in Implementing Operational Controls

EHS operational controls are documented in a specific series of documents (SE-OP series) and added to routine production documents for safety critical steps. These procedures are routinely updated using Nordion's change control process when safety improvements are identified.

2.3.3 Summary of Safety Inspections and Audits

Refer to Section 1.2.4 for a summary of the safety inspections and audits.

2.3.4 Radiation Devices and Instruments Maintenance

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.

2.3.4.1 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 2015, all 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 Nuclear Ventilation System 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 | 74 | 239 | 73 |
| Number tested | 237 | 0 | 237 | 67 |
| Filters which met specification | 237 | N/A | 237 | 61 |
| Filters out of specification* | 0 | 0 | 0 | 6 |
| Out of specification filters replaced during test cycle | 0 | 0 | 0 | 6 |
| Not tested | 2 | 74 | 2 | 6 |
| Total replaced during this cycle | 4 | 0 | 0 | 8 |
| Filters (systems) removed from service | 0 | 0 | 0 | 1 |
| New Filters (systems) Added | 0 | 0 | 0 | 0 |

* The CAD filters that were out of specification were on System 13. The failures did not result in any apparent increase to releases.

Comments Q1/Q2 HEPA: Two filters were not tested because they were not in service. Four filters in Cobalt were replaced due to flow issues and had successful in-situ tests performed afterwards.

Comments Q1/Q2 CAD: In early 2014 it was apparent that there were technical problems with the CAD testing equipment. The column was ageing and in need of repair, and the injection collar required replacement. A decision was made to upgrade the column to one ideally suited for the challenge agent Nordion uses. Another upgrade to the equipment that was deemed necessary was an upgrade to the data storage connections. The repair/upgrade was done at one location and calibration at another. Due to the time required for these repairs/upgrades it was not possible to perform the 1st half of the years testing.

Comments Q3/Q4 HEPA: Two filters were not tested because they were not in service.

Comments Q3/Q4 CAD: Six trench filters were not tested, but are changed every three years as per procedure. One CAD filter on System 5 that is not tested as it is not in use was removed, bringing the total in-situ CAD fleet to 73. Six CAD filters did not meet the testing criteria. These filters were replaced and the new filters had successful in-situ tests performed afterwards. Two CAD filters were changed out due to their shelf life expiration. An in-situ/lab test was performed after/prior to installation of the new filter and was successful.

Nuclear Medicine in-cell charcoal roughing filters are on a preventative maintenance schedule and replaced by Technicians typically every 6 months. A summary of the replacement of these filters is shown in Table 8. These filters are not credited with mitigating releases in Nordion's Safety Analysis reports.

**Table 8**
**Roughing Filter Change-outs**

| Filter Type | Total Number of Filters | Results |
|---|---|---|
| Nuclear Ventilation System Roughing Filters | 145 roughing<br>51 charcoal/roughing/HEPA<br>34 in-cell roughing | 98 roughing filter replacements<br>53 charcoal/roughing/HEPA filter replacements |
| Cobalt Production In-cell Filters | 8 in-cell HEPA<br>23in-cell roughing | 16 in-cell HEPA filters replacements<br>60 in-cell roughing filters replacements |

2.3.4.2 Back-up Power Facilities

The emergency generators, which supply emergency power to the KOB, KRMF and the Heating Plant are tested monthly. Testing in 2015 was performed at the required frequency. In 2015, there was one breakdown of the KOB generator. A voltage regulator failed, and a replacement was found with 4 weeks delivery. A portable emergency power generator was rented and was on site during the period in question. .

2.3.4.3 Radiation Evacuation Alarms

Radiation evacuation alarms are tested weekly and quarterly by the Radiation Surveyors. They are additionally tested annually by Facilities. Testing in 2015 was performed at the required frequency and results were satisfactory. .

2.3.4.4 Radiation Alarms

The radiation alarms are scheduled for testing on a weekly basis and were tested every week in 2015. The tests verify that the alarms sound at the preset 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.

2.3.4.5 Sprinkler System Fire Alarms

The sprinkler system fire alarms in KOB, KRMF and the Heating Plant are tested every month. Testing in 2015 was performed at the required frequency and results were satisfactory. All dry systems were tested and verified in good operating condition in 2015 as required by the National Fire Protection Association (NFPA).

2.3.4.6 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 2015 was performed at the required frequency and results were satisfactory.

2.3.4.7 Contamination Monitoring Equipment

Handheld contamination monitoring equipment is maintained twice a year. Area monitors are checked on a daily basis. Testing in 2015 was performed at the required frequency and results were satisfactory..

2.3.4.8 Contamination Control Equipment

The hand and foot monitors are calibrated twice a year, checked daily, 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 2015 was performed at the required frequency and the results were satisfactory.

2.3.4.9 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. There were issues discovered during a 13 week period which generated 14 work orders in 2015.

Eight involved issues with barrier monitors and air sampling pumps, however the pumps issues were at locations considered to be of secondary importance and do not alarm upon failure on the building monitoring system. Air sampling pumps accounted for five of the work orders. Barrier monitors (Hand and Foot or Whole Body Contamination Monitors) accounted for 3 of the work orders (down from 10 in 2014). In the event that a barrier monitor is malfunctioning, Nordion employees will perform checks using an adjacent barrier monitor or a handheld contamination monitor.

Four work orders were generated due to an alarm signal not coming in at the building monitoring system (BMS).

These four issues appeared to occur as a result of a lag between the device alarming in the field and the alarm latching on the building monitoring system which required the Surveyor to hold the radioactive check source for a few seconds longer than it takes to alarm the device locally. The Surveyor has since been informed of the correct length of time required to alarm not just locally, but also on the BMS.

The remaining two items were broken equipment (a PGM tube and an airflow needle) on secondary systems which do not alarm on the building monitoring system.

Overall the results were very good. Device failures found on weekly testing were at locations where the likelihood of a real alarm is low and there is no necessity, based on safety, to have these devices on the BMS. Examples of these low priority device failures include pump failures in the Cobalt fresh air intake and rooms where traditionally there is never or extremely rarely airborne contamination.

2.3.4.10 Radiation Survey Instruments

Radiation Survey Instruments are tested on a monthly, bi-annual, or annual basis as required. There were no instruments in 2015 that tested outside of the acceptable range. Testing in 2015 was performed at the required frequency and the results were satisfactory. At the end of 2015, there were 29 out of 813 survey meters past due for the internal frequency requirements, some due to them requiring repair. These past-due meters were not in use. The majority of meters are calibrated every 6 months. The regulatory requirement for calibration frequency is 12 months, and though Nordion employees are not to use meters past the calibration due date (typically 6 months), only two of the 29 meters where past due for longer than 12 months. All of the 29 meters have since been calibrated or otherwise accounted for.

2.3.4.11 Trends

There was only one piece of equipment (the chiller) with multiple occurrences of non-routine maintenance in 2015, however, these occurrences were not indicative of any malfunction of the major hardware or components of the systems. The chiller was taken out of service to allow for pre-emptive repairs on the condenser purge unit. There were no interruptions to service as a result of these repairs.

2.3.5 Non-Production Sealed and Un-Sealed Source Inventory

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

2.3.6 Effectiveness of the Nuclear Criticality Safety Program (NCSP)

Not applicable.

2.3.7 Emergency Drills Related to Nuclear Criticality

Not applicable.

## 2.4 Safety Analysis

Nordion has an established EHS Committee comprised of senior management and technical professionals and is chaired by the Director, Quality Assurance Environment Health and Safety Compliance, or designate. The EHS Committee reviews new/amended processes which might have an impact on health, safety, and environment. Activities that relate specifically to CNSC licensing and the radiation protection of workers, the public and the environment, are addressed in the EHS Committee meetings typically held on a bi-monthly basis with ad hoc meetings arranged as required. Typical agendas include Safety Analysis Reports, Operational Experience (OPEX) significant changes (repairs/modifications) to existing facilities, Radiation Incident Report reviews, safety procedures, and review of CNSC licensing requirements (radiation monitoring, As Low As Reasonable Achievable (ALARA) program, emissions, dosimetry, project approval, etc.).

In 2015, the EHS Committee met on 10 occasions (six regular meetings and three ad hoc meetings).

Final Safety Analysis Reports (FSARs) are prepared by EHS and/or project leaders to encompass risk analysis and safety and environment reviews. FSARs must be approved by the EHS Committee before a new process goes into full production. Primary focus is placed on the Nuclear Medicine Production Facility (NMPF) FSAR, the Cobalt Operations FSAR, and the Cobalt Pools FSAR since these are three main documents covering the production operations. Revisions to these documents are reviewed and approved internally, and submitted to the CNSC for approval. Secondary FSARs (for each individual production process and operational support areas) are reviewed and approved internally as per an established review schedule.

[redacted]

Summaries of the activities and modifications and repairs are provided in Sections 1.1.3 and 1.2.3 respectively.

[redacted]

## 2.5 Physical Design

In 2015, Nordion did not make any modifications to the physical design. 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 2015, there were no significant design issues identified through these reviews. Overall, Nordion's facility design has been maintained and continues to be effective with no planned changes or upgrades in the future.

## 2.6 Fitness for Service

The management structure of Nordion's Preventative Maintenance Program was not altered in 2015. Nordion continues to use an "Advanced Maintenance Management System" (AMMS) to control Nordion's maintenance activities. Maintenance performance is reviewed monthly for outstanding activities and is acted on by team leaders. This continues to prove effective as during 2015, there were no major equipment failures.

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. Projects are prioritized into three categories and funds are allocated as required to approved projects. 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.

The work identified during the 2015 review included the following:

- Replacement of the KOB generator
- Upgrade of the computerized Building Management System (BMS)
- Rebuild of the 600 ton chiller including installation of a variable frequency drive
- Rebuild of the 800 ton chiller including installation of a variable frequency drive
  Continuation of the KOB roof replacement program
- Installation of an additional Miura Boiler to service the Cobalt area
- Securing of external institutional waste bins
- Installation of additional fire suppression for the Information Technology Rooms
- Resurfacing of Active Area floors
- Seismic Upgrade of Nuclear Ventilation System
- Replacement of manual transfer switch for stack 2 back-up power

When approved, the work identified during the aging equipment review is executed as a project.

In 2015, the required equipment was available to perform its intended design function when needed. Refer to Section 2.3.4.1-2.3.4.11

## 2.7 Radiation Protection

### 2.7.1 Dose Control Data

#### 2.7.1.1 Occupational External Dosimetry

Tables 9 and 10 provide dosimetry data with employees grouped in various ranges of exposure. Data on the minimum, maximum and average doses for all employees are shown in Tables 11, 12 and 13. In 2015 there were 150 Active Area personnel monitored, 114 non-Active Area personnel in these tables. Of the 114 non-Active Area personnel 12 support industrial irradiators (containing Co-60) at customer sites, these are included in the Class 1B licence dosimetry as they may also receive dose from work at KOB during the dosimetry year.

**Table 9**
**Personnel Dosimetry**

| Number of Employees | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Dose Range (mSv) | Whole Body | | | | | Skin | | | | |
| | 2011 | 2012 | 2013 | 2014 | 2015 | 2011 | 2012 | 2013 | 2014 | 2015 |
| < 0.2 | 192 | 187 | 197 | 175 | 170 | 180 | 186 | 184 | 173 | 171 |
| 0.2 - < 0.5 | 39 | 41 | 25 | 34 | 40 | 48 | 40 | 37 | 30 | 37 |
| 0.5 - < 1.0 | 30 | 28 | 24 | 21 | 19 | 30 | 30 | 25 | 24 | 21 |
| 1.0 - < 5.0 | 49 | 36 | 36 | 37 | 34 | 52 | 36 | 36 | 40 | 34 |
| 5.0 - < 20.0 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 |
| 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 |
| Number of Employees | | | | | | | | | | |
| Dose Range (mSv) | Right Hand | | | | | Left Hand | | | | |
| | 2011 | 2012 | 2013 | 2014 | 2015 | 2011 | 2012 | 2013 | 2014 | 2015 |
| < 0.2 | 111 | 105 | 103 | 98 | 108 | 110 | 106 | 102 | 100 | 105 |
| 0.2 - < 0.5 | 15 | 15 | 6 | 5 | 8 | 12 | 15 | 7 | 2 | 9 |
| 0.5 - < 1.0 | 9 | 5 | 10 | 10 | 2 | 15 | 4 | 7 | 5 | 3 |
| 1.0 - < 5.0 | 28 | 16 | 17 | 15 | 18 | 28 | 15 | 19 | 22 | 18 |
| 5.0 - < 20.0 | 8 | 5 | 4 | 7 | 2 | 5 | 4 | 3 | 5 | 2 |
| 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 10
## 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 |
| 2011 | 1 | 0 | 0 | 0 |
| 2012 | 1 | 0 | 0 | 0 |
| 2013 | 2 | 0 | 0 | 0 |
| 2014 | 2 | 0 | 0 | 0 |
| 2015 | 1 | 0 | 0 | 0 |

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

| | | Active Area Personnel (NEWs) | Non-Active Area Personnel (NEWs) | Non-NEWs (Contractors) |
|---|---|---|---|---|
| Minimum | 2011 | 0 | 0 | 0 |
| | 2012 | 0 | 0 | 0 |
| | 2013 | 0 | 0 | 0 |
| | 2014 | 0 | 0 | 0 |
| | 2015 | 0 | 0 | 0 |
| Average | 2011 | 0.64 | 0.06 | 0.05 |
| | 2012 | 0.56 | 0.13 | 0.03 |
| | 2013 | 0.59 | 0.12 | 0.03 |
| | 2014 | 0.65 | 0.14 | 0.09 |
| | 2015 | 0.56 | 0.16 | 0.03 |
| Maximum | 2011 | 5.08 | 0.79 | 0.45 |
| | 2012 | 5.19 | 1.36 | 0.21 |
| | 2013 | 6.39 | 1.48 | 0.27 |
| | 2014 | 6.03 | 1.73 | 0.31 |
| | 2015 | 5.24 | 1.88 | 0.13 |
| CNSC Regulatory Limits | | 50/yr; 100/5yr | 50/yr; 100/5yr | 1/yr |

## Table 12

## Minimum, Maximum and Average Skin Exposure Doses (mSv)

| | | Active Area Personnel (NEWs) | Non-Active Area Personnel (NEWs) | Non-NEWs (Contractors) |
|---|---|---|---|---|
| Minimum | 2011 | 0 | 0 | 0 |
| | 2012 | 0 | 0 | 0 |
| | 2013 | 0 | 0 | 0 |
| | 2014 | 0 | 0 | 0 |
| | 2015 | 0 | 0 | 0 |
| Average | 2011 | 0.72 | 0.12 | 0.05 |
| | 2012 | 0.61 | 0.12 | 0.04 |
| | 2013 | 0.60 | 0.15 | 0.03 |
| | 2014 | 0.69 | 0.15 | 0.07 |
| | 2015 | 0.58 | 0.16 | 0.03 |
| Maximum | 2011 | 6.09 | 1.58 | 0.48 |
| | 2012 | 5.19 | 1.41 | 0.23 |
| | 2013 | 6.39 | 2.89 | 0.28 |
| | 2014 | 6.11 | 1.78 | 0.31 |
| | 2015 | 5.21 | 1.90 | 0.12 |
| CNSC Regulatory Limits | | 50/yr; 100/5yr | 50/yr; 100/5yr | 1/yr |

## Table 13

## Minimum, Maximum and Average Extremity Doses (mSv)

| | | Active Area Personnel (NEWs) | Non-Active Area Personnel (NEWs) | Non-NEWs (Contractors) |
|---|---|---|---|---|
| Minimum | 2011 | 0 | 0 | N/A |
| | 2012 | 0 | 0 | |
| | 2013 | 0 | 0 | |
| | 2014 | 0 | 0 | |
| | 2015 | 0 | 0 | |
| Average | 2011 | 1.14 | 0 | |
| | 2012 | 0.54 | 0 | |
| | 2013 | 0.54 | 0 | |
| | 2014 | 0.73 | 0 | |
| | 2015 | 0.48 | 0 | |
| Maximum | 2011 | 12.3 | 0 | |
| | 2012 | 10.3 | 0 | |

| | | | | |
|---|---|---|---|---|
| | **2013** | 7.4 | 0 | |
| | **2014** | 9.5 | 0 | |
| | **2015** | 9.3 | 0 | |
| **CNSC Regulatory Limits** | | 500/yr | 500/yr | |

Table 11 shows a decrease in maximum effective dose to Active Area personnel in 2015 compared to 2014. Contractor dosimeters and doses continue to be well managed and controlled. [redacted]

At times, the dosimeters of Nordion employees who travel are inadvertently x-rayed in the airport security scanning system and results in doses that are inconsistent with the Direct Reading Dosimeter results for these employees. These dose results are not the subject of requests for revision at the National Dose Registry.

Table 12 shows similar results to Table 11 in 2015.

Table 13 shows continued good performance in maximum extremity dose. [redacted] processing has the potential to cause high extremity doses in a short period of time. The continued low extremity doses speaks to the strong safety culture at Nordion.

The above analysis of trends demonstrates continuously improving performance at Nordion and adherence to the ALARA principle in the execution of duties by Nordion personnel.

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 2015, there were no cases of employees exceeding Nordion's administrative investigation level of 1000 Bq I-125 or I-131.

Whole body counting was performed once in 2015 on seven Nordion employees as Special Bioassay. This was as a result of the investigation into an ALARA incident (ALR 15-17) where airborne Co-60 creation was deemed possible though intake was unlikely. No internal contamination was detected.

No urinalysis was required in 2015.

There were no employees who recorded internal doses exceeding any of the dose limits in Sections 13 and 14 of the Radiation Protection Regulations.

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 Figures 1 to 19 at the end of this report. 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 QA Program for Safety Review. There are a few general observations in the trend data: Comparing 2014 and 2015 data for Cobalt (Gamma Technologies) groups have either stable or decreasing doses, however over the five years the trend is increasing. Medical Isotope production doses are either stable or trending downward. [redacted] 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 14.

[redacted]

[redacted]

[redacted]. It is significant to note that because of ALARA investments put in place in 2014 we note a decrease in doses to Shipping and Monitoring and Decontamination personnel in 2015.

Another very significant performance indicator is Monitoring and Decontamination personnel in Medical Isotopes have maintained extremity doses year over year to the same level [redacted] Nordion personnel working with Y-90 are re-trained every two years on the safety aspects of how to work with this high energy beta emitter, including the correct orientation of ring dosimeters. Radiopharm QC Technicians have likewise maintained low extremity (ring) doses.

Results overall demonstrate continued and consistent high performance of Nordion employees in accordance with ALARA, [redacted] The highest effective doses received in 2015 by employee role are listed below in Table 15. This demonstrates that the higher dose work at Nordion mainly involves personnel dedicated to Co-60 production activities. The 20 employees with the highest effective doses account for 46.2% of the cumulative dose at Nordion in 2015.

[redacted]

2.7.3 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 2015 operations, there were instances where contamination (above "clean on swipe") was found and subsequently contained within the Active Area. Most were due to routine operations such as the replacement of cell manipulators and associated boots, decontamination of materials/equipment and shielding containers, and tracking of contaminants from a cell, glove-box, or fume-hood when product or samples were being removed. Of the 43 contamination incidents in 2015, 29 were contamination found on clothing, 5 related to the facility (i.e. floors or other structures), and 9 were related to contamination found directly on personnel. All contamination was found and contained within the active areas. No increased dose to personnel was received as a result of any of these incidents.

There were a total of 43 contamination incidents in 2015 (Table 16).

The distribution of contamination incidents in 2015 is shown in Table 16 and 17 and is illustrated in Graph 1.

There does not appear to be a discernible trend in the contamination incidents by month.

**Table 16**
**Contamination Incidents by Contamination Level**

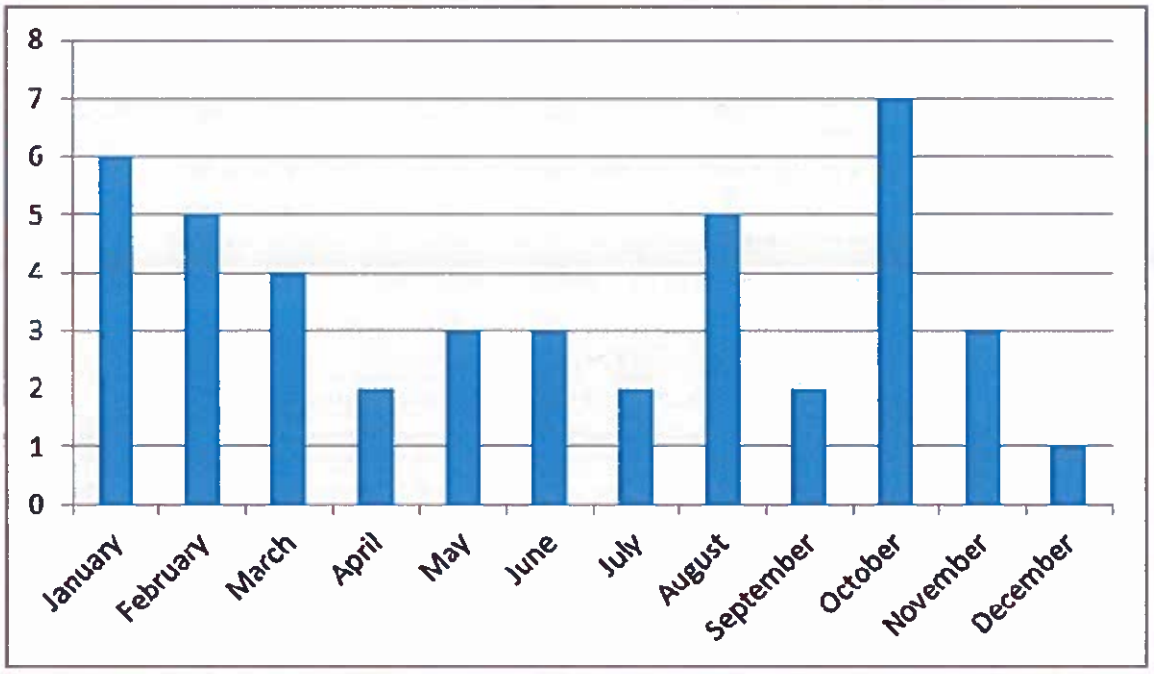
| Year | Not recorded | <500 cpm | >500 cpm, <2,000 cpm | >2,000 cpm, <10,000 cpm | > 10,000 cpm, < 50,000 cpm | >50,000 cpm | Annual Total |
|---|---|---|---|---|---|---|---|
| **2011** | 0 | 11 | 11 | 9 | 3 | 3 | 37 |
| **2012** | 1 | 1 | 7 | 13 | 6 | 4 | 32 |
| **2013** | 0 | 1 | 12 | 8 | 6 | 5 | 32 |
| **2014** | 1 | 2 | 16 | 12 | 12 | 4 | 47 |
| **2015** | 1 | 2 | 15 | 12 | 6 | 7 | 43 |

**Table 17**
**Contamination Incidents by Radionuclide**

| Radionuclide | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|
| **Not recorded** | 1 | 1 | 1 | 0 | 2 |
| **C-14** | 0 | 0 | 0 | 2 | 1 |
| **C-60** | 7 | 5 | 9 | 12 | 12 |
| **I-125** | 3 | 2 | 1 | 3 | 1 |
| **I-131** | 6 | 7 | 10 | 5 | 5 |

| | | | | | |
|---|---|---|---|---|---|
| **Mo-99** | 12 | 10 | 5 | 13 | 8 |
| **Y-90** | 3 | 5 | 4 | 7 | 5 |
| **Decayed Mo-99** | 0 | 0 | 0 | 2 | 2 |
| **Ir-192** | 0 | 1 | 1 | 0 | 1 |
| **In-111** | 2 | 0 | 0 | 0 | 0 |
| **Lu-177** | 2 | 0 | 0 | 0 | 0 |
| **Xe-133** | 0 | 0 | 1 | 2 | 4 |
| **Sr-82** | 6 | 0 | 0 | 1 | 0 |
| **I-123** | 2 | 1 | 0 | 0 | 0 |
| **Eu-152** | 1 | 0 | 0 | 0 | 0 |
| **Total** | 37 | 32 | 32 | 47 | 43 |

**Graph 1: Contamination Incidents by Month in 2015**




2.7.4 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 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 2015.

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 2015, all breathing air sampling was performed in accordance with procedures and results indicated that processes were in control.

2.7.5 Exceeding Regulatory Limits or Action Levels

There were no incident investigations completed where a regulatory limit was exceeded or an action level was reached or exceeded in 2015.

2.7.6 Radiation Protection Program Effectiveness

The Radiation Protection (RP) Program is reviewed by conducting process audits and process safety audits. Refer to Section 1.2.4.1. Data and performance of the Radiation Protection Program is also reviewed regularly at EHS Committee meetings. A dedicated audit of the Radiation Protection program is scheduled to take place in 2016 and every three years thereafter.

2.7.7 Radiation Protection Program Improvements

Improvements to the RP Program in 2015 included the following:

- Installation of new airflow monitoring detectors to measure stack flow at air release compliance monitoring sampling points.
- Creating a new procedure SE-CA-009, "Electronic Calibration certificate System" to outline the necessary steps to maintain and use Nordion's database for creating calibration certificates for the over 800 radiation detector calibrations performed annually. Besides improving accuracy of certificates this system relieves the strain of hand writing certificates which was an important ergonomic concern.
- Efforts to monitor and track unreturned dosimeters continued in 2014, including maintaining awareness with employees and Managers. The submission of dosimeters has improved by 83% (from 24 dosimeters returned later than one month in 2013 to four in 2014 and 1 in 2015).

2.7.8 Radiation Protection Program Performance

The objectives, goals and targets of the Radiation Protection Program are shown in Table 5 of Section 2.3.1. The targets average and maximum NEW dose and environmental releases were met in 2015. 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 QA Program for Safety Review. Refer to Section 3.2 Table 24 for a summary of the initiatives and targets for the upcoming year.

2.7.9 Continuous Improvements Under ALARA Performance

ALARA objectives and performance is reviewed at EHS Committee meetings and all activities in the ALARA program. This procedure was followed in 2015, and performance against targets is demonstrated in Table 5 of Section 2.3.1.

2.7.10 Radiation Protection Training Program and Effectiveness

Refer to Section 2.2.1.

## 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 Management Committee sets targets each fiscal year in the areas of Medical Treatment Incidents, Lost Time Incidents and Severity Rates. The figures below (1a, 2a) illustrate the number of incidents and lost days over the last five years.

Refer to Sections 1.2.4.1 and 1.2.4.2 for a description of audits and inspections for 2015.

**Figure 1a: Number of Incidents by Year**

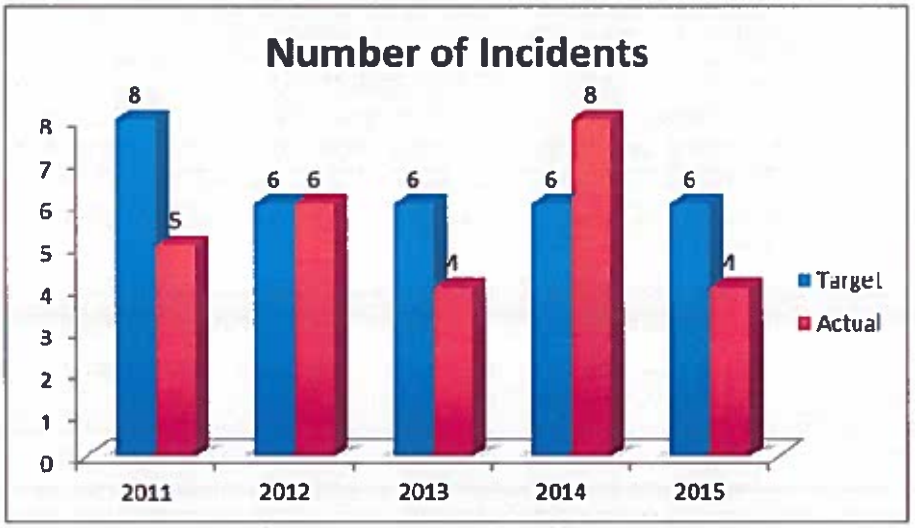
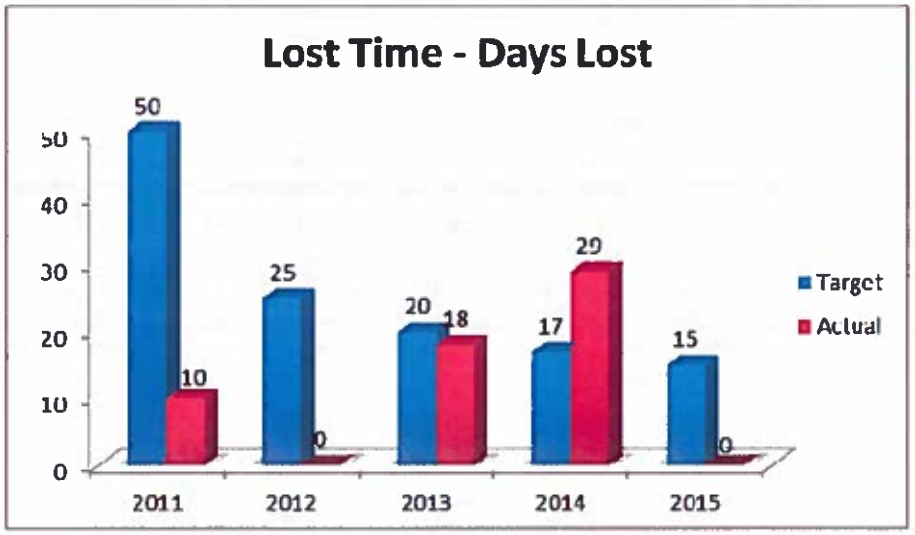



**Figure 2a: Number of Days Lost by Year**



2.8.2 Conventional Health and Safety Committee Performance

The Kanata Operations Building (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 nine times in 2015. The KOB Health & Safety Policy Committee met on five occasions in 2015. The accomplishments for 2015 were that the Policy Committee continued to review the Hazard Prevention Program and participated in the review of the Safety Objectives and Targets. 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 2015 included the following:

- A Back Awareness Training Challenge took place through half of 2015. Departments were challenged to complete three activities related to back injury awareness and prevention. The majority of Operations Managers completed the challenge with their teams.
- A new document was created to outline biosafety guidelines
- A Special Edition of our quarterly newsletter NEWSS 4 You highlighted Accident Prevention, covering the topics of: Safety Culture, Hazards, Near Misses, Injuries and Prevention strategies.
- A series of stretch videos were created to help teach employees about various stretches that they can perform at various times throughout their shift.

2.8.4 Hazardous Occurrences

During 2015, there were no lost time injuries four medical treatment injuries. These injuries are summarized below.

Medical Treatment Injuries:

1) An employee required physiotherapy for a sore left elbow attributed from work in Cobalt (manipulators/pool work)
2) An employee required physiotherapy and modified duties for left upper arm, elbow and forearm discomfort attributed from working with manipulators or pool work.
3) An employee required chiropractic therapy and modified duties for low back pain that occurred as a result of them lifting a 40lb piece of lead shielding.
4) An employee required sutures when they sustained lacerations to left fingers after using an improper tool to stabilize a lug in the drill press.

## 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 (which is performed every two years and was performed in 2012 and 2014).

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 NVS has been designed and is maintained to prevent the unnecessary release of radioisotopes to the atmosphere.

#### 2.9.1.1 Airborne Effluent

Allowable releases to the environment are limited to the values in SE-OP-029 (4), "Derived Release Limits". A revised version of SE-OP-029 (5) was submitted to the CNSC for approval, and these values had been used to compare releases of radionuclides which were not in SE-OP-029(4). In January 2015, a new version of SE-OP-029(6) was submitted to the CNSC which followed most aspects of CSA N288.1-08. Air release values in version 6 are similar to those contained in version 5. Nordion first submitted draft SE-OP-029 (6) to the CNSC in 2013, however an external contractor has been hired by Nordion to submit DRL values using Impact software and the newest version of N288.1. Version 4 & 5 values will be compared in this report to be consistent with reporting Nordion has done since 2007. A summary of airborne releases is provided in Table 18.

In 2015, the maximum annual release of airborne from any one radionuclide was from Xe-135m at 0.36% of the Derived Release Limit (DRL). The total air release was 0.57% of the DRL. No Action Levels were exceeded in 2015.

Releases of radioxenons have lowered in 2014, in part due to new calibration factors. Calibration factors used in 2012 and 2013 were more conservative, indicating higher releases. In 2014 and 2015, new calibration equipment was used to calibrate radioxenon monitors which resulted in slower releases with dead times in the same range as releases from Xe-133 and Mo-99 production. The previously used calibration apparatus could allow for sudden, rapid release with significant dead times and the calibration values were not corrected for dead time.

The year over year change in releases of radioxenons [redacted]

**Table 18**
**Airborne Releases**

| Year | C14 (GBq/yr) | Co-60 (GBq/yr) | I-125 (GBq/yr) | I-131 (GBq/yr) | Xe-133 (GBq/yr) | Xe-135 (GBq/yr) | Xe-135m (GBq/yr) |
|---|---|---|---|---|---|---|---|
| 2011 | 67.9 | 0.006 | 0.38 | 0.29 | 34,967 | 17,239 | 27,688 |
| 2012 | 15.7 | 0.006 | 0.46 | 0.4 | 36,153 | 23,943 | 39,498 |
| 2013 | N/A* | 0.005 | 0.23 | 0.39 | 30,735 | 28,193 | 43,383 |
| 2014 | N/A* | 0.005 | 0.14 | 0.46 | 15,018 | 13,075 | 18,170 |
| 2015 | N/A* | 0.005 | 0.12 | 0.15 | 11,916 | 8,237 | 10,758 |

| | C14 | Co-60 | I-125 | I-131 | Xe-133 | Xe-135 | Xe-135m |
|---|---|---|---|---|---|---|---|
| DRL (GBq/yr) Using SE-OP-029 (4) | * | 78 | 990 | 1110 | 2.90E+07 | * | * |
| % DRL (2015) | * | 0.01% | 0.01% | 0.01% | 0.04% | * | * |
| % Action Level (2015) | * | 0.01% | 0.02% | 0.03% | 0.08% | * | * |

* No limit established for these isotopes in SE-OP-029 (4)

| | C14 | Co-60 | I-125 | I-131 | Xe-133 | Xe-135 | Xe-135m |
|---|---|---|---|---|---|---|---|
| DRL (GBq/yr) Using Draft SE-OP-029 (5) | 9.95E+04 | 1.17E+04 | 1.22E+03 | 1.13E+03 | 4.27E+07 | 5.00E+06 | 3.00E+06 |
| % DRL (2015) | N/A** | 0.00% | 0.01% | 0.01% | 0.03% | 0.16% | 0.36% |
| % Action Level (2015) | N/A** | 0.00% | 0.02% | 0.03% | 0.06% | 0.33% | 0.72% |

** C-14 production stopped toward the end of 2008, and measurement of C-14 was stopped in 2012.

2.9.1.2 Liquid Effluent

Allowable liquid effluent releases to the environment are also limited to values in SE-OP-029 (4), "Derived Release Limits". The five year variation in activities released is listed in Table 19. No Action Levels or Administrative Levels were exceeded in 2014. 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 19.

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 HPGe (high purity germanium) detector. The low energy window HPGe detector has lower efficiency than the obsolete NaI(Tl) detector. 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 to 2014.

**Table 19**
**Liquid Releases (GBq/yr)**

| Year | Litres | β<1MeV | β>1MeV | I-125 | I-131 | Mo-99 | Co-60 | Nb-95 | Zr-95 | Cs-137 |
|---|---|---|---|---|---|---|---|---|---|---|
| 2011 | 1024391 | 0.395 | 0.088 | 0.007 | 0.013 | 0.116 | 0.027 | 0.0010 | 0.0010 | 0.0004 |
| 2012 | 720821 | 0.261 | 0.060 | 0.005 | 0.009 | 0.075 | 0.017 | 0.0002 | 0.0003 | 0.0004 |
| 2013 | 782848 | 0.288 | 0.065 | 0.005 | 0.009 | 0.077 | 0.022 | 0.0006 | 0.0006 | 0.0005 |
| 2014 | 600162 | 0.209 | 0.050 | 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 | 0.0010 | 0.0010 | 0.0004 |
| | | | | | | | | | | |
| | | β<1MeV* | β>1MeV* | I-125 | I-131 | Mo-99 | Co-60 | Nb-95* | Zr-95* | Cs-137* |
| DRL (GBq/yr) | | 7,780 | 105,000 | 14,700 | 10,800 | 467,000 | 64,100 | 64,100 | 64,100 | 64,100 |
| % DRL (2015) | | 2.46E-03 | 4.19E-05 | 7.55E-04 | 5.56E-05 | 1.28E-05 | 2.96E-05 | 1.56E-06 | 1.56E-06 | 6.24E-07 |
| % Action Level | | 4.91E-03 | 8.38E-05 | 1.51E-03 | 1.11E-04 | 2.57E-05 | 5.93E-05 | 3.12E-06 | 3.12E-06 | 1.25E-06 |

* The DRL for Sr-90 is used for β<1MeV and the DRL for Y-90 is used for β>1MeV. Nb-95, Zr-95 and Cs-137 are contaminants which are expected to be present in small quantities or non-detectable. Although Nordion does not formally monitor for these contaminants, their presence was detected by the analysis method used to check the liquid effluent samples for Nordion's major isotopes. DRLs are required for only the major isotopes Co-60 values were used for Nb/Zr-95 and Cs-137.

The majority of the recorded releases are the minimum detectable activities being conservatively reported as real values instead of using zero. [redacted] although I-125 was not actually detected in samples.

The increase is actually due to a change in measurement technique. An NaI(Tl) scintillator plus multi-channel analyzer was used to measure for I-125 releases in liquid, however due to the age of the detector this measurement was changed to a low energy window HPGe detector plus MCA part way through the 2014 calendar year. The low energy window HPGe detector has lower efficiency than the obsolete NaI(Tl) detector.

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 are also noted., however even assuming these releases are real they only represent nSv's 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 Figures 20 and 21 and listed in Table 20. The Environmental TLD results are shown in Table 20 and presented in Graph 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.

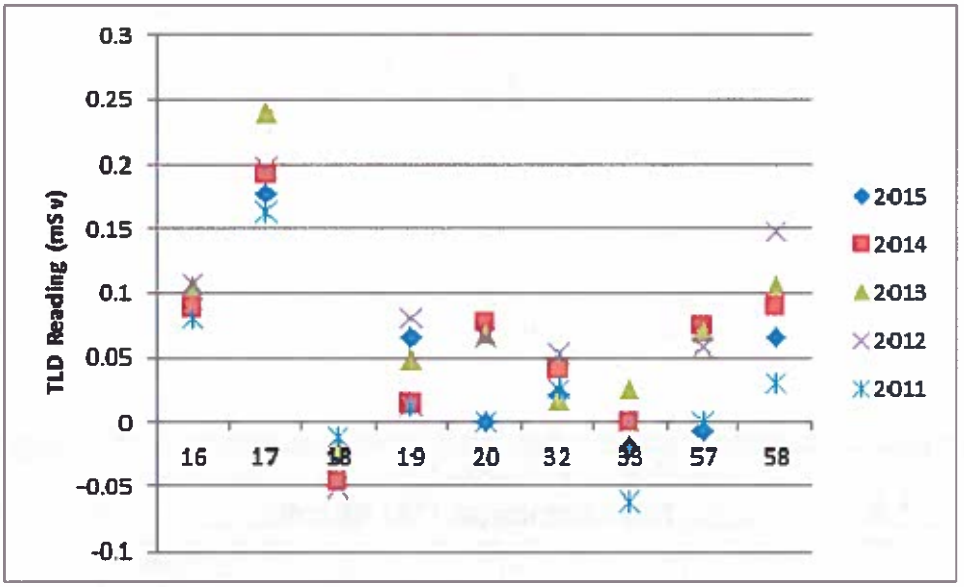
Locations 17 and 20 are locations that are representative of the model population for air effluent from the facility. Soil samples at these locations have not shown any radionuclides attributable to Nordion's licensed activities. The similarity in the recorded dose in these locations year over year, 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 20**
**Environmental TLD Results**

| Location | | Totals | | | | |
|---|---|---|---|---|---|---|
| | | 2015 (mSv) | 2014 (mSv) | 2013 (mSv) | 2012 (mSv) | 2011 (mSv) |
| 16 | R.E. BUILDING, ROOM 5511 | 0.094 | 0.088 | 0.105 | 0.107 | 0.08 |
| 17 | POLE, NORTH CORNER | 0.177 | 0.192 | 0.240 | 0.197 | 0.163 |
| 18 | HEATING PLANT, ROOF | -0.024 | -0.046 | -0.019 | -0.051 | -0.0124 |
| 19 | HYDRO POLE, SOUTH-WEST | 0.065 | 0.014 | 0.048 | 0.08 | 0.012 |
| 20 | TREE, EAST CORNER | * | 0.078 | 0.068 | 0.065 | 0.0 |
| 32 | RESIDENCE | 0.02 | 0.04 | 0.017 | 0.053 | 0.025 |
| 33 | RESIDENCE | -0.02 | * | 0.025 | ND | -0.061 |
| 57 | RESIDENCE | -0.008 | 0.075 | 0.070 | 0.058 | ND |
| 58 | LOCAL BUSINESS | 0.065 | 0.09 | 0.106 | 0.147 | 0.03 |

* missing TLD
ND = not deployed

**Graph 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 roughly 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 2015 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 2015.

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 2015, this review was held during the Annual Joint Environmental Management System and QA Program for Safety Review on November 27, 2015. The results of the review are summarized in Section 2.1.2 items 3, 4, 5 and 6.

Refer to Section 1.2.4 for a summary of internal and external inspections, audits and reviews.

2.9.5 Environmental Protection Program Activities

Activities which took place in 2015 included the following:

- Conducting a total of 16 fire and environmental inspections to identify areas for improvement and/or concerns. These were completed as part of a process to conduct routine environmental inspections implemented in 2011. Significant improvements have been observed as a result of these inspections.
- Conducting a supplier audit of a supplier whose goods/services could have a significant impact on the environment.
- Nordion was subject to a re-registration audit for Nordion's ISO 14001 certification. Two minor non-conformances and three opportunities for improvement were identified during the course of this audit.

2.9.6 Environmental Protection Program Improvements

There were no significant changes or updates to the Environmental Protection Program in 2015.

2.9.7 Environmental Protection Program Performance

A description of the Environmental Protection Program Initiatives is provided in Table 21, along with the results/outcomes.

A summary of initiatives and targets for the upcoming year is provided in Table 22.

**Table 21**
**2015 Environmental Objectives**

| Objective | Result / Outcome |
|---|---|
| Reduce non-hazardous waste to landfill | 64% Waste was diverted from landfill as of 2014/2015 annual waste audit |
| Audit one Supplier whose goods and/or services could have a significant impact on the environment | Completed one supplier audit in accordance with SE-ENV-019 "External Supplier Environmental Audits |
| Reduce Energy | Variable frequency drive on the 800 tonne cooling tower and LED lighting replacement project completed. Energy Audit conducted by a Third Party in 2015. |

**Table 22**
**2016 Environmental Objectives and Targets**

| Objective | Target |
|---|---|
| Reduce non-hazardous waste to landfill. | Increase waste diversion rate to 68% by the end of 2017 (baseline year – 2015 waste audit results). |
| 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 2016. |
| Reduce Energy | Investigate opportunities for reducing energy |
| Reduce particulate matter air emissions | Reduce particulate matter air emissions from the glass blowing process |

2.9.8 Well and Soil Sampling and Measuring/Monitoring

2.9.8.1 Soil Sampling

Soil sampling is conducted every two years to determine the presence or absence of radioactive materials in the soil. It was last performed in 2014. No radionuclides attributable to licensed activities were detected in the soil samples.

2.9.8.2 Groundwater Sampling

Figure 22 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 22.

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 in October 2015. 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 2015 compared to past years. This indicates that Nordion's operations have not affected 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 were taken in November 2014 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. The results from both 2014 and 2015 were submitted to the CNSC.

## 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 has chosen to re-develop the program.

In 2015, Management continued efforts to redevelop the Emergency Management Program focusing on a revision of the incident management governance model. 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 and to incorporate other continuous improvements identified.

Objectives for 2015 included:

- Maintaining baseline preparedness under the current program by executing emergency response exercises and drills. In 2015, fire evacuation drills were conducted for all buildings as well as an emergency fan-out exercise.
- Completing the redevelopment and rewrite of the Emergency Response Plan and sub-plans for submission to the CNSC for review. Throughout 2015, significant improvements were made to the new draft Emergency Response Plan model to incorporate the required elements of the REGDOC 2.10.1 "Nuclear Emergency Preparedness and Response.
- Nordion met the majority of their scheduled activities for 2015. Some activities were delayed as the revised Emergency Response Plans were under CNSC review and the implementation of the new program was proposed for June 2016. Some emergency response drills were re-scheduled to be conducted in 2016 upon approval of the revised plans.

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 2015, a number of Emergency Response (ER) exercises were conducted to test these emergency response plans and provide employees having responsibilities within the plans the opportunity to practice. In addition, the August roof fire was an effective, real-event test of the plans and responders.

Activities which took place in 2015 included:

- Testing of the Fire Safety Plan in each of the three buildings (KOB, Roy Errington (RE) Building, and Heating Plant), including alarm activation and full evacuation.
- Testing of the Emergency Response Contact List to ensure accuracy of telephone numbers listed, to determine availability of personnel, and to estimate response times.
- On-going emergency response training (refer to Section 2.10.3 for additional information).
- Completion of a review of the roof fire response with the assistance of a third party consulting firm.

On August 6th, 2015, Nordion experienced a fire on the roof of the licensed facility. This event involved the response of multiple fire departments (as per department protocol for roof fires) and other city response agencies, such as Police, Paramedics, OC Transpo (for evacuated employees comfort), etc. Nordion effectively responded alongside city responders and the situation was brought under control without any injuries or radiological contamination or release. The August roof fire was an effective, real-event test of the plans and responders.

2.10.3 Emergency Preparedness Program Improvements

In 2015, Nordion completed further revisions of the draft Emergency Program documents which included:

- Emergency Preparedness Program
- Emergency Response Plan
- Emergency Response Checklists
- Incident Management System (IMS) Forms for the Incident Command Post (ICP) and the Emergency On Call (EOC)

These documents and the revised sub-plans were submitted to the CNSC for review in December 2014. These revisions incorporated comments received by the CNSC on a previous draft submission. In June, 2015, the CNSC noted that the revised program documentation incorporates the elements of REGDOC 2.10,1 "Nuclear Emergency Preparedness and Response".

2.10.4 Emergency Preparedness Program Performance

The emergency preparedness program performance was tested during the response to the August 2016 roof fire. As noted in the previous section, Nordion executed an effective response and demonstrated good interoperability with city first responders.

In 2015, equipment checks and work conducted to ensure readiness related to the Emergency Management Program included:

| Equipment | Minimum Frequency |
|---|---|
| Emergency Response Kit Inspections | Quarterly |
| Emergency Generators Test | Monthly |
| Communications Emergency On Call (EOC) Test | Quarterly |
| Radiation Evacuation Test | Annual |
| Self-Contained Breathing Apparatus (SCBAs) Hydrostatic Testing | Every 5 years |
| SCBA Air Replacement | Once/year |
| SCBA Annual Inspection | Once/year |

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

There were no impairments to the Emergency Management Program systems in 2015.

2.10.5 Emergency Preparedness Training Program Effectiveness

All new employees and contractors are provided with emergency response training prior to being issued a security badge.

During 2015, the following emergency response training was provided to employees and those working on behalf of Nordion:

- Fire Warden and Marshall Training – 82 Participants
- ER Personnel – 48 Participants
- New Employee/Contractors Emergency Alarm and Response Training – 69 Participants
- Emergency Alarms & Response Training – 23 Participants
- Fire Watch Training – 20 Participants

As a result of the pending initiation of Nordion's revised Emergency Response Program and the implementation of SAT, training requirements for the Emergency Preparedness Program are currently under review. In the interim, existing training program requirements are being maintained.

2.10.6 Fire Protection Program Effectiveness

Nordion has undertaken a thorough review of all emergency response plans, including the fire safety plans with the goal of aligning these plans with an Incident Management System model.

Fire drills/evacuations were conducted in the Heating Plant, the RE Building and the KOB in 2015. There were no significant findings identified as a result of these drills.

In 2015, Management review of the Emergency Management Program focused on the redevelopment of the incident management governance model and revision of the Site Emergency Response Plan. The sub-plans, including the Fire Safety Plans, will be modified to align with these changes and will be made effective in 2016.

On August 6$^{th}$, the Emergency Response Program was initiated as a result of a fire on the KOB roof. The program was determined to be effective as employees demonstrated their understanding of the program requirements by activating the emergency alarm, when smoke was detected, as per the Fire Safety Plan. Employees evacuated in a safe and timely manner. During the evacuation, there were no injuries. Fire Wardens and Marshals performed their duties and all employees gathered at their designated meeting

areas to verify their attendance by checking into Nordion's external badge reader located outside of the RE building.

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 2015.

2.10.7 Fire Protection Program Activities

Activities that took place in 2015 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.
- Providing inspection training to all personnel conducting fire and environmental inspections.
- Continuing work on the project to replace halon fire suppression in hot cells with argon, or in some instances, removing in cell fire suppression.

2.10.8 Fire Protection Program Improvements

Improvements to the Fire Protection Program in 2015 included:

- Revising Nordion's Fire Safety Plan (SE-ERP-001) to align with Incident Management System protocols.
- Developing training on Fire Prevention and Safety which will be rolled out in 2016. There were no changes to training, methods, instrumentation, or equipment in 2015.
- Developing a Transient Combustible Materials Management Program with the assistance from a third party.
- Revising documents and practices to be compliant with N393-13, "Fire Protection for Facilities that Process, Handle, or Store Nuclear Substances".
- Developing training for all employees on fire prevention and safety which will be initiated in 2016.
- Providing Fire Watch Training to applicable staff
- Initiating changes to Nordion's Work Permit Authorization procedure which included, but were not limited to:
    - The addition of a requirement to conduct inspections as necessary following work under a work permit for high caution areas
    - A pre-hot work checklist for all hot work
    - EHS approval of all work permits
    - Clarifying responsibilities for Nordion Sponsors

There were no changes to training, methods, instrumentation, or equipment in 2015.

2.10.9 Fire Protection Program Performance

In 2015, equipment checks and work conducted to ensure readiness related to the Fire Protection Program included:

| Equipment | Frequency |
|---|---|
| Fire Pump Test | Monthly |
| Sprinklers Inspection | Monthly |
| Fire Extinguishers Inspection | Monthly |
| Fire Protection System Verification | Annual |

(Third Party)

Overall, compliance with the Fire Protection Program is satisfactory.

Fire suppression in cells containing $CO_2$ systems were impaired (locked-out) as a result of a third party compliance review against NFPA 12 requirements. Some deficiencies were identified in these systems. Currently, Nordion is working to have third party approval to remove the $CO_2$ systems or have them modified to use a different agent for fire suppression.

## 2.11 Waste Management

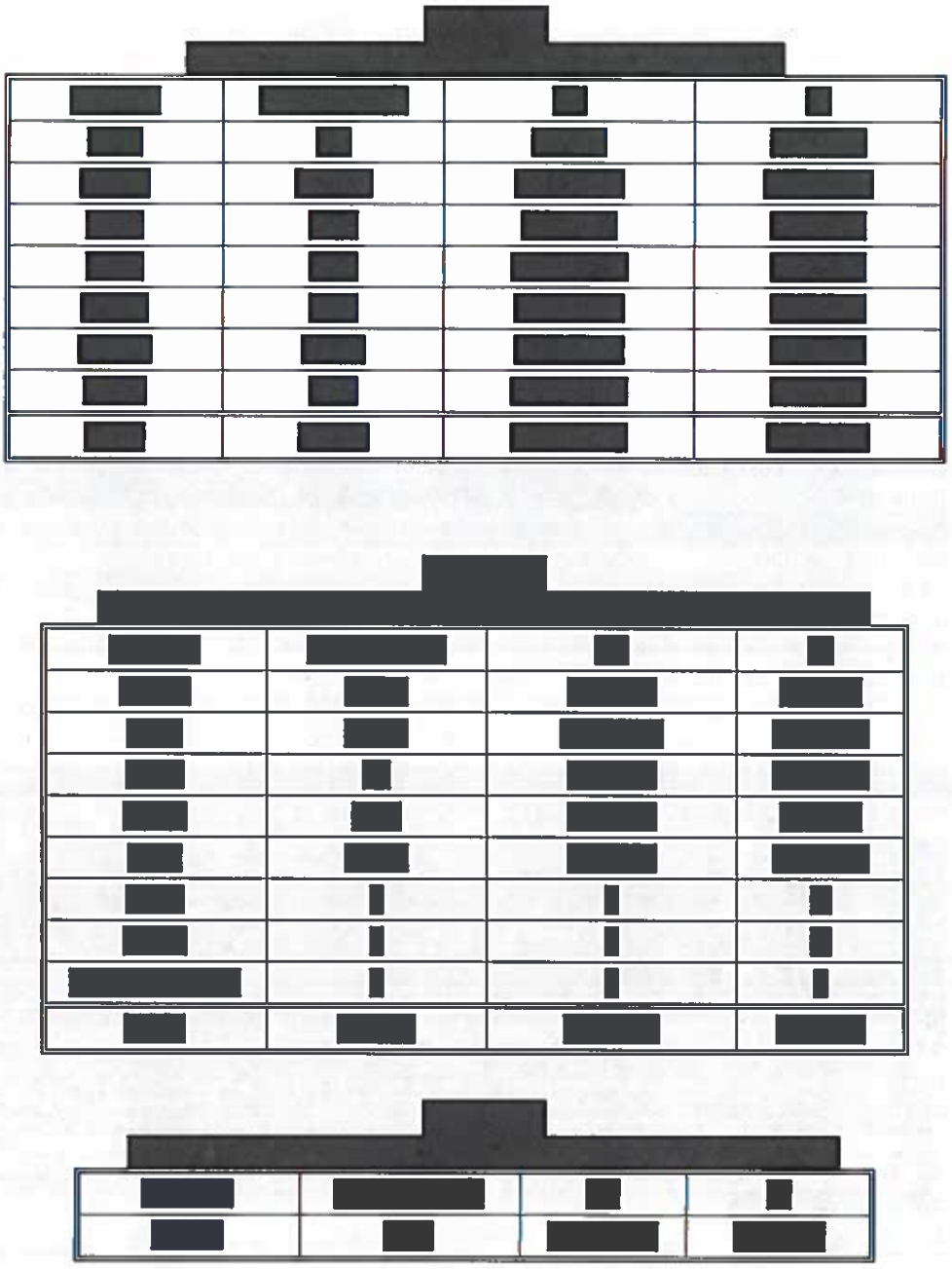
Nordion production facilities have been designed and operated in a manner to prevent radioactive waste being released to municipal garbage or sewer systems and to ensure that releases to the environment via air or water emissions are within limits approved by the CNSC. All radioactive waste that was generated through the production operations was 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 long term 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 the [redacted] facility, 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.

In 2015, the laboratory where C-14 production resided (decommissioned in 2014), which consisted of lab benches, cabinets and shelving was dismantled and disposed of. The associated non-routine waste was shipped to licensed nuclear waste disposal facilities.

In 2015, [redacted] of waste that met CNSC unconditional clearance levels was disposed of to landfill as part of the waste diversion program. Nordion frequently reviews the waste diversion program to increase opportunities for reducing waste sent for active waste disposal.

In 2015, there were no shipments of radioactive low-level liquid waste by Nordion. In 2015, approximately [redacted] of hazardous liquid waste was disposed of by Nordion via a licensed waste disposal company.



## 2.12 Nuclear Security

Details of Nordion security and all of the security improvements of 2014 were provided in the Nordion Physical Security Report and Security Plan for 2014, submitted in 2014. These safeguards and improvements are prescribed information and were reviewed and accepted by CNSC Security as part of the 2015 Type II Security Inspection. Additional enhancements were made in 2015 following the inspection that will be reviewed by CNSC Security in 2016. In 2015 Nordion participated in the IAEA International Physical Protection Advisory Service (IPPAS) mission as one of the four licensee sites visited and reviewed.

## 2.13 Safeguards and Non-proliferation

Nordion has a program in place for the management of safeguarded material at the Nordion Ottawa site. The program meets the safeguards requirements of specified license conditions, 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*.

In 2015, Nordion performed accounting and reporting of nuclear material as required by RD-336. Nordion completed a Physical Inventory Taking (PIT) of safeguarded material from which there were no findings.

The scope of the CNSC Compliance Inspection conducted in September 2015 included the safeguards and non-proliferation safety and control area. Two recommendations regarding depleted uranium inventory resulted from the inspection.

In 2015, the International Atomic Energy Agency (IAEA) conducted an inspection at Nordion on October 1-2, 2015. The results were deemed satisfactory. There was one follow-up item regarding a minor revision to Nordion's Design Information Questionnaire (DIQ).

## 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.

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 2015, Nordion reported 14 non-conformances related to packaging and transport of nuclear substances. Nine of the fourteen reportable non-conformances were reported as "dangerous occurrences" pursuant to subsection *37(1) of the Packaging and Transportation of Nuclear Substances Regulations*. The remaining five events were reported as required by the facility operating licence. Nine of the reported non-conformances were external to Nordion's control (packaging errors, damaged packages or lost package). Of the non-conformances that fell within Nordion's control, the issues were due to packaging errors (2), improper labelling (1), component failure (1), and maintenance (1). Refer to Appendix A for further information regarding these incidents.

There were no non-compliances with the TDG regulations in 2015.

## 2.15 Public Information Program

### 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 2015, 23,472 unique users visited Nordion.com

35,440 times looking at a total of 72,897 pages. On average, the duration of a visit was two minutes and ten seconds.

In 2015, Nordion published the following public disclosures:

- January 29: Q4 2014 Event Report
- May 4: Q1 2015 Event Report
- May 21 and June 18: License Renewal 2015 – Nordion's public hearing for the renewal of Nordion's Class 1B Nuclear Substance Processing Facility Operating Licence was August 19, 2015. Prior to the hearing, Nordion placed ads in the Kanata Kourier on May 21 and June 18 to invite community members to put forward letters and/or presentations to convey an opinion or show support towards the re-licensing and, on June 18, sent a permission-based email to members of the local community.
- July 29: Q2 2015 Event Report
- July 29: Nordion Security called Ottawa police and paramedics for a member of the public who had collapsed on Nordion's property adjacent to March Road. A Nordion Occupational, Health and Safety employee did attend to the individual while awaiting the arrival of emergency services. The patient was then left in the care of the police and paramedics to determine next steps.
- August 6: Fire at the Nordion Operations Building – At approximately 10:15 am, an alarm was triggered and a fire confirmed in the Operations Building at Nordion's facility in Kanata. As a result, Nordion implemented its Emergency Response Plan (ERP). All employees were evacuated from the facility while Ottawa Fire, Police and emergency services dealt with the situation. No employees were injured or required medical attention.
- August 6: Update on Fire at the Nordion Operations Building – Ottawa Fire Services extinguished the fire on the roof of the Operations Building. No employees were injured or required medical attention. Ottawa Police, Paramedics, and Fire Services responded quickly and ensured that the situation was safe before finally leaving the premises for the evening. Employees returned to work during regular working hours the following day.
- September 30: Announcement of the successful renewal of Nordion's Class 1B Nuclear Substance Processing Facility Operating License.
- October 20: False alarm reported – At approximately 10:38 am, a false fire alarm from the fire system was reported at the Nordion facilities in Kanata. It was caused by a false alarm from a duct smoke detector in an air handling unit in one of the Kanata buildings. This resulted in a brief evacuation of the facility in line with the company's standard procedures for dealing with such situations.

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. Fifty-seven (57) unique users visited the survey. Zero surveys were completed. A copy of the feedback survey form is provided in Appendix D.1.

In 2015, Nordion sponsored 3 events:

- March 6: Nordion was the title sponsor of the 12$^{th}$ Annual Inspiration Awards Gala raising funds for mental health care and research at The Royal Ottawa Heath Care Group.
- October 25: Nordion was the title sponsor of the Rattle Me Bones Race Event raising funds and awareness for bone cancer on behalf of the Ottawa Hospital Foundation.

- December 4: Nordion was the title sponsor of the Annual Ottawa Hospital Gala raising money for research.

Nordion regularly issues news releases to inform the public of company initiatives, achievements, and issues that the business may be facing. In 2015, 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.

Fourteen (14) media outlets covered the August 6th rooftop fire. The few comments about the fire on social networks (see the next paragraph) indicate neutral public opinion. Nordion's public relations agency that monitored and analysed the media indicated that stories were factual as a result of Nordion being forthcoming and transparent with the information.

Nordion uses social media such as Facebook, Twitter, and LinkedIn to inform the public of the company's initiatives. In 2015, there were neither negative comments pertaining to events nor questions related to environment, health and safety.

Nordion published ads in the May, June and December 2015 issues of the *Kanata Kourier*, a free weekly distribution newspaper that has a distribution of 27,408 papers, and serves the communities surrounding Nordion's Kanata site. Copies of the May and June ad and the December ad are provided in Appendix D.2a and D2b.

The ads placed in May and June were specific to the re-licensing of the site and invited the public to learn more about the re-licensing effort.

The ad placed in December:

- Conveyed Nordion's ongoing commitment to protect the safety of employees, the community, and the environment.
- Stated that Nordion is certified to ISO 14001, an international standard for environmental management systems.
- Invited the public to contact Nordion through nordion.com and provide feedback to help ensure Nordion is providing information that is timely, useful, and relevant to them.

In both ads, the Kanata facility was referred to as a "Class 1B nuclear facility."

Nordion plans to conduct public opinion polls every two years. Public Information Program Improvements

On January 19th of 2015 Nordion updated the Social Responsibility content on Nordion.com and gave the section greater prominence in the navigation. The Social Responsibility section:

1. Complies with CNSC regulations by explicitly referring to the Kanata facility as a Class 1B nuclear facility.
2. Delivers content more visually and concisely.
3. Gives the feedback survey more prominence (i.e. by offering the survey on every page within the Public Information Program section).
4. Improves the navigation so that the public will find information more easily.
5. Presents the information in a manner that is more easily understood using plain language, images and info-graphics.

A refreshed Nordion.com home page includes a "Highlights" area. Nordion used this area to provide updates about the re-licensing effort and the August 6th rooftop fire. Visitors simply click on the highlight to read more detailed content.

During the December 2014 Nordion Community Café, the public requested that Nordion add a section to its website about emergency preparedness. The Emergency Preparedness section was published to Nordion.com in June 2015.

### 2.16 Site Specific Information

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

- Nordion shall prepare and submit to the Commission an Annual Compliance Report by March 31st of each year.
- Nordion shall make and submit reports to the Commission regarding safeguarded material in accordance with RD-336, "Accounting and Reporting of Nuclear Material".
- Nordion shall annually update and submit the Annual Physical Security Report by March 31, of the following calendar year.
- Nordion shall report the transfer, receipt, export or import of sealed sources if the activity exceeds the threshold limits as indicated in the site license and within the specified timeframes as detailed in the site license.

Nordion complied with all other site-specific reporting requirements.

The Financial Guarantee, as approved by the Commission and based on the Facility's Decommissioning Plan, is still valid.

## 3. FUTURE PLANS AND CONCLUDING REMARKS

### 3.1 Improvement Plans and Future Outlook

In 2016, Nordion plans to implement new EHS software to track and manage incidents, audits, inspections, regulatory commitments, training, risk analysis, performance metrics and corrective actions. The software is also designed to make reporting incidents and near misses easier, more timely and effective. Nordion has developed training and its implementation is planned for early this year.

[redacted]

Nordion continues to work towards aligning the existing health and safety management system with OHSAS 18001, the standard for Occupational Health and Safety Management Systems, and best practices.

### 3.2 Safety Performance Objectives for Following Year

There are no projected changes to the EHS organizational structure for 2016. There are also no projected changes regarding operational procedures.

Nordion's 2016 EHS Program Objectives and Targets and Health and Safety Objectives are shown in Tables 26 and 27. For 2016, the following changes were made:

- The 2016 EHS Objectives and Targets included a change regarding the way Incidents are tracked. They will now be divided into Medical Treatment Incidents and Lost Time Incidents where targets were set to ≤ 6 and 0 respectively.

- Other changes for 2016 EHS Objectives and Targets include no longer setting targets for Average Active Area dose rate or Radiation Incidents. Due to exceptional past performances in these areas, the EHS Committee decided that target setting was no longer necessary for these metrics although they will continue to be monitored and evaluated. Also, EHS will start providing managers with prepackaged quarterly "Safety Talks", that will deliver the content covered in their team meetings to personnel. The intention is to focus on key safety issues, encourage participation and open discussion regarding important safety matters.
- The other targets remain unchanged for the 2016 fiscal year.

## Table 26
## 2016 EHS Program Objectives and Targets

| Applicable Nordion Job Function | Objective | Measures and Targets |
|---|---|---|
| All Directors and Managers<br><br>All Directors and Managers of Operations, Facilities, or Nuclear Energy Worker employees | Minimize the number and extent of occupational injuries, environmental and radiation incidents. | • The number of Medical Treatment Incidents ≤ 6<br>• Lost time Incidents = 0 |
| | Minimize the use and release of hazardous materials to the environment. | • Radioactive materials emissions to ≤ 5.0% of the Derived Release Limits (DRL)<br>• No non-compliant releases of radioactive or non-radioactive hazardous materials to the environment (sewer, air, etc.)<br>• Reduction in the use of hazardous materials and the generation of waste (hazardous and non-hazardous) |
| | Maintain radiation doses to employees as per ALARA principle. | • Maximum employee dose rate ≤ 7.5 mSv/yr<br>• Thyroid testing attendance >90% (Medical Isotopes) |
| | Manage EHS CAPAs and ensure timely closure of CAPAs | • Target 80% of generated CAPAs within your areas are closed (Actions complete, excluding CAPA verifications) within 1 year<br>• Meet all CAPA target dates<br>• Prioritize high risk EHS CAPAs |

## Table 27
## 2016 Health and Safety Objectives

| Applicable Nordion Job Function | Objective | Measures and Targets |
|---|---|---|
| All Directors and Managers<br><br>All Directors and Managers of Operations, Facilities, or Nuclear Energy Worker employees | Ensure all managers of high risk areas conduct / document regular self-assessments of their management processes and safety performance. | • Mid-Year and Year-End performance reviews (semi-annually)<br>• Ensure the departmental job hazard analysis is kept up-to-date. |
| | Ensure all managers actively consider 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.<br>• Opportunities for minimizing waste (hazardous and non-hazardous) are assessed and implemented whenever possible.<br>• Ensure all near misses are reported in a timely manner and appropriate corrective actions(s) are taken.<br>• Maintain control of non-production radioactive material. |
| | 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 team meetings.<br>• Health and safety concerns are assessed with the results of the evaluation communicated to the employee(s).<br>• Deviations, CFs, Non-conformances and Complaints are assessed for EHS risks against targets and reported accordingly.<br>• Routinely invite EHS Representatives to team meetings to discuss EHS topics and/or concerns. |
| 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.<br>• Work must follow Nordion EHS training, standards and procedures, and is performed with care and attention to safety principles and policies.<br>• Wear all personal protective equipment (PPE) as necessary.<br>• Submit all dosimeter(s) and rings for monitoring on time (i.e. no later than one month) following end of monitoring period |

| | | |
|---|---|---|
| | Report the occurrence of workplace injuries, unsafe conditions and near misses. | • All workplace injuries, suspected injuries, observed unsafe conditions and near misses are reported immediately to the direct Supervisor.<br>• Report any suspected symptoms to your Supervisor or identify problems before they become injuries. |
| | 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 by asking questions and voicing concerns |
| | Reduce environmental impacts | • Identify opportunities for reducing waste, and using less harmful material wherever possible.<br>• Ensure EHS review 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 | • Target 80% of generated CAPAs within your areas are closed (Actions complete, excluding CAPA verifications) within 1 year<br>• Meet all CAPA target dates<br>• Prioritize high risk EHS CAPAs |

### 3.3 Concluding Remarks

In the fall of 2015, Nordion's Class 1B Nuclear Substance Processing Facility Operating License was renewed by the CNSC until 2025 based on the review of ten years of operating data. In 2005, the CNSC granted Nordion an unprecedented ten year license. Receiving another 10 year license was an accomplishment for Nordion that Nordion believes is based on the organization's positive compliance history and safety record, and reflects the confidence in Nordion's Environmental Health and Safety standards and the organization's policies and practices as a nuclear business.

Nordion has demonstrated that it is capable and qualified to operate in a manner that protects the safety of employees and causes no adverse effects to the public or the environment.

The key points of this report are as follows:

- There was one major incident in 2015 with regards to the operating facility which involved a fire on the roof of the KOB. There were no medical treatment injuries, releases or impacts to the environment as a result of this incident nor was there any lost production time or impacts to customers.
- As a result of the fire, small amounts of wood used in the existing construction of the roof, where the fire occurred, has been replaced with non-combustible material. Also, SE-HS-009, the "Work Permit Authorization Program" was revised to include more thorough instructions for fire prevention, including a guideline for conducting inspections. All applicable staff were provided additional training on how to identify and assess potential fire hazards, and finally a procedure to automatically install the storm drain plug upon activation of the KOB safety plan was implemented.
- Nordion's Systematic Approach to Training (SAT) program continues to improve and all of the CNSC recommendations from November 2014 were addressed. Also, a formal process for conducting a Training Needs Analysis with a single change process was implemented, and numerous training programs revisions were completed.

- At the end of 2015, there were 29 out of 813 survey meters past due for the internal frequency requirements, some due to them requiring repair. All of the 29 meters have since been calibrated or otherwise accounted for. Testing of all other radiation devices and instrument maintenance was performed at the required frequency and results were satisfactory.
- There was one piece of equipment (the chiller) with multiple occurrences of non-routine maintenance in 2015 (refer to Section 2.3.4.11) These occurrences were not indicative of any malfunction of the major hardware or components of the systems because they were related to the replacement of consumables, the replacement of parts due to regular wear, and inconsequential faults. It was taken out of service to allow for pre-emptive repairs on the condenser purge unit. There were no interruptions to service as a result of these repairs.
- The Environment, Health and Safety (EHS) Committee met on a regular basis to review the environmental and safety aspects of the operations and to review and approve seven Final Safety Analysis Reports (FSARs).
- All measurable radiation doses received by personnel and the public were well within the regulatory limits of 50 mSv/yr for NEW personnel and 1 mSv/yr for public and non-NEW personnel. No internal dose levels or limits were exceeded.
- There were a total of 43 contamination incidents in 2015. All elevated levels of contamination were monitored and contained within the Active Area.
- There were no instances in which there was potential to exceed a regulatory limit or to reach or exceed an action level in 2015.
- Various improvements were made to the Radiation Protection, Conventional Health and Safety, Environmental Protection and Fire Protection Programs. These programs fall within the scope of the Quality Assurance (QA) Program for Safety.
- There were no lost time injuries and four medical treatment injuries in 2015.
- There were no instances of exceeding environmental regulatory limits or action levels in 2015. The maximum annual release of airborne from any one radionuclide was Xe-135m at 0.71% of the DRL.
- Nordion did not receive any EHS related external communications from anybody.
- Nordion complied with each site-specific reporting requirement.
- In 2015, Nordion's Class 1B Facility operated within the requirements of the Nuclear Safety and Control Act, the applicable regulations and the conditions of the operating license issued by the CNSC with the exception of 17 non-compliances with the Act, the regulations or with Nordion's site license NSPFOL-11A.00/2025 (refer to Appendix A)

**Figure 1: Cobalt Production Technicians**

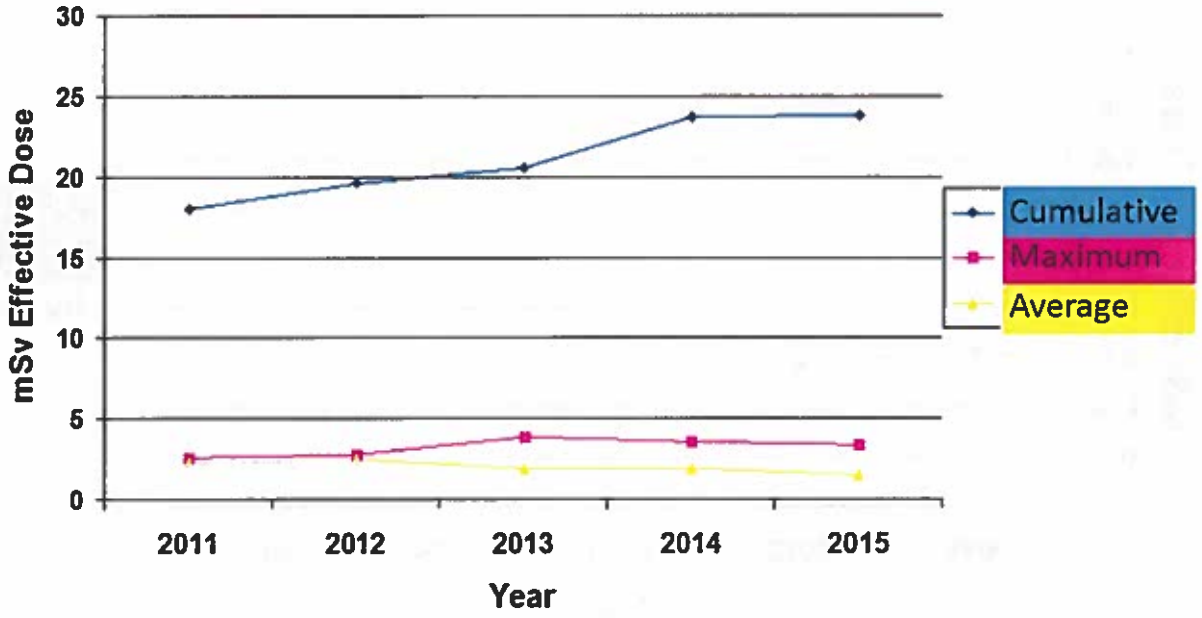



**Figure 2: Cobalt Monitoring, Decontam and Shipping**

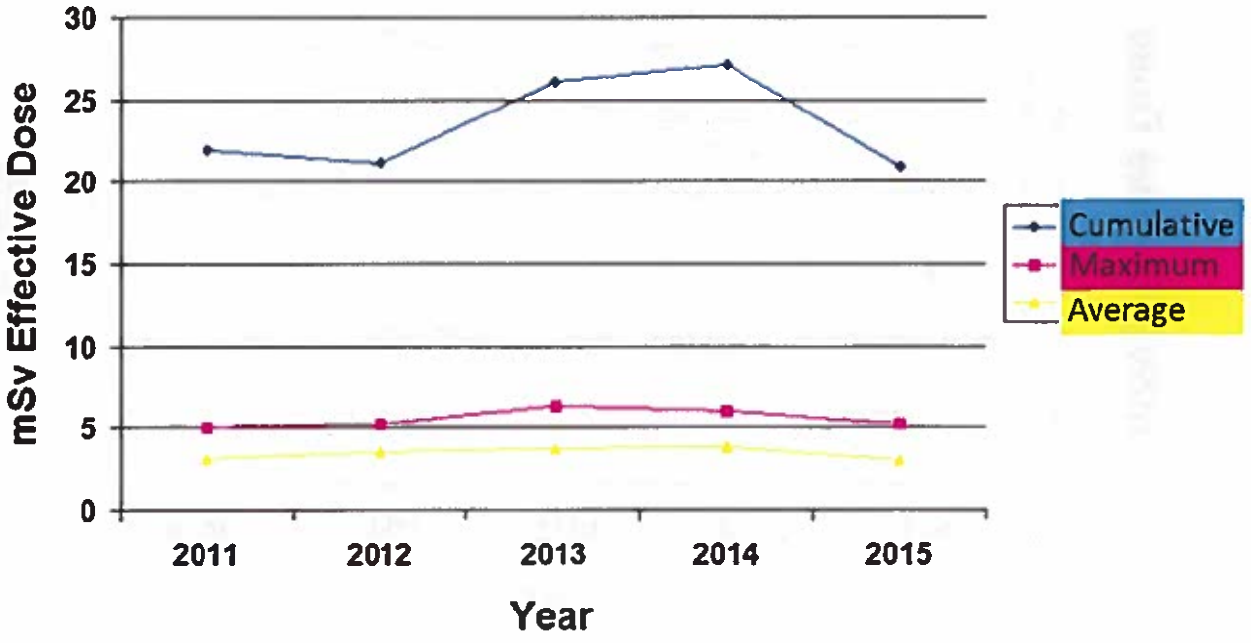


**Figure 3: Cobalt Development**

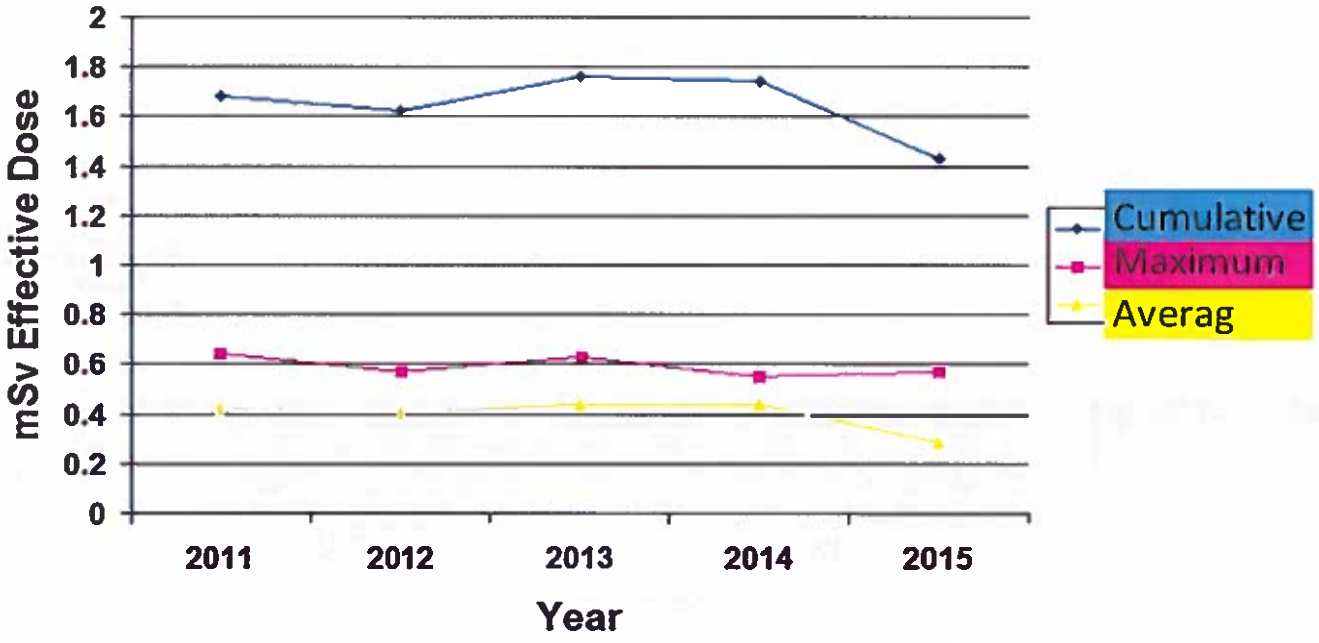



**Figure 4: QC Cobalt**

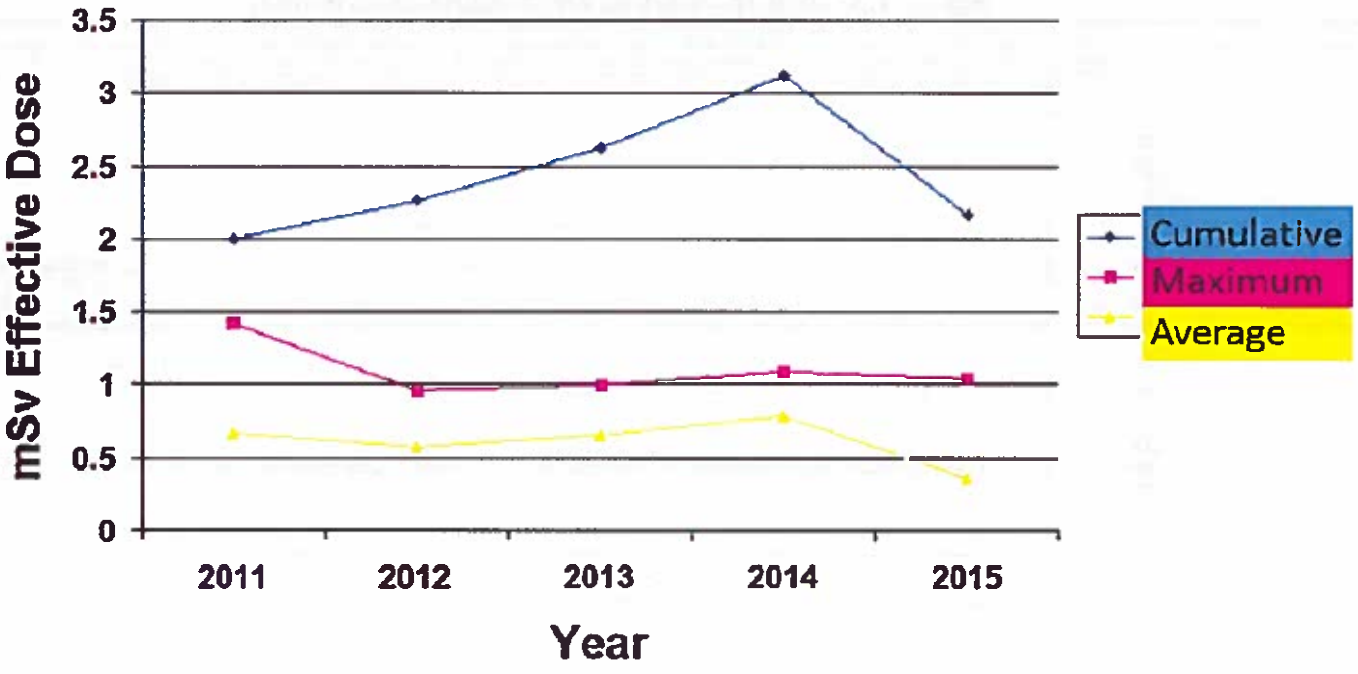


**Figure 5: Radiopharm Development**

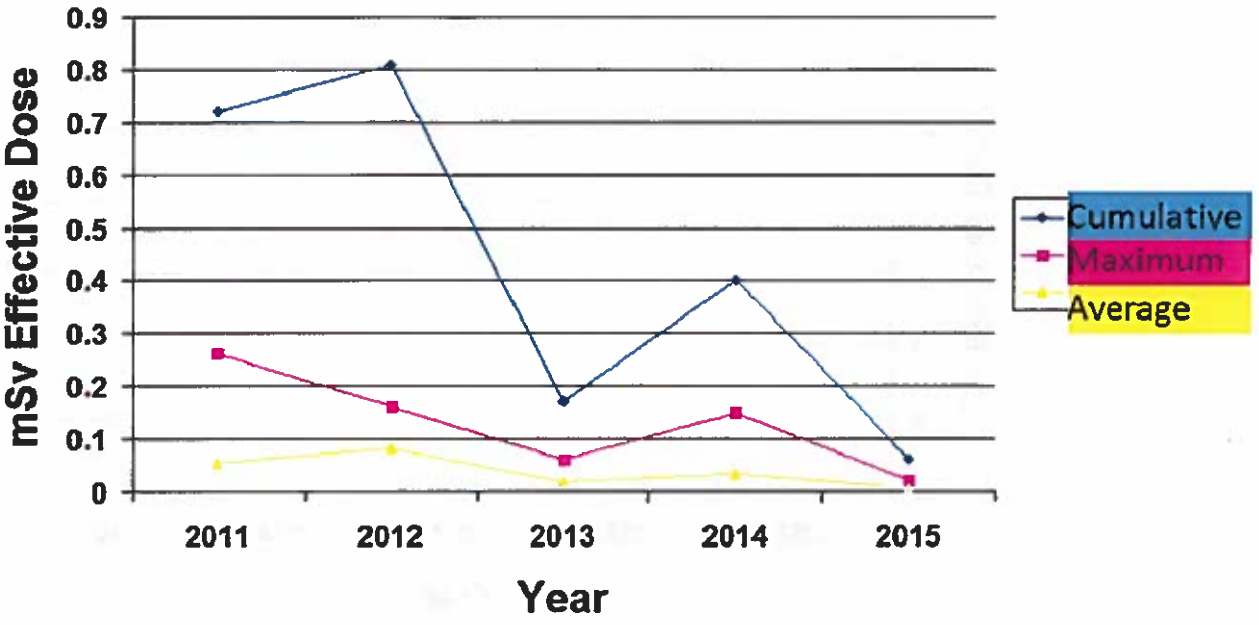



**Figure 6: Technical Support**

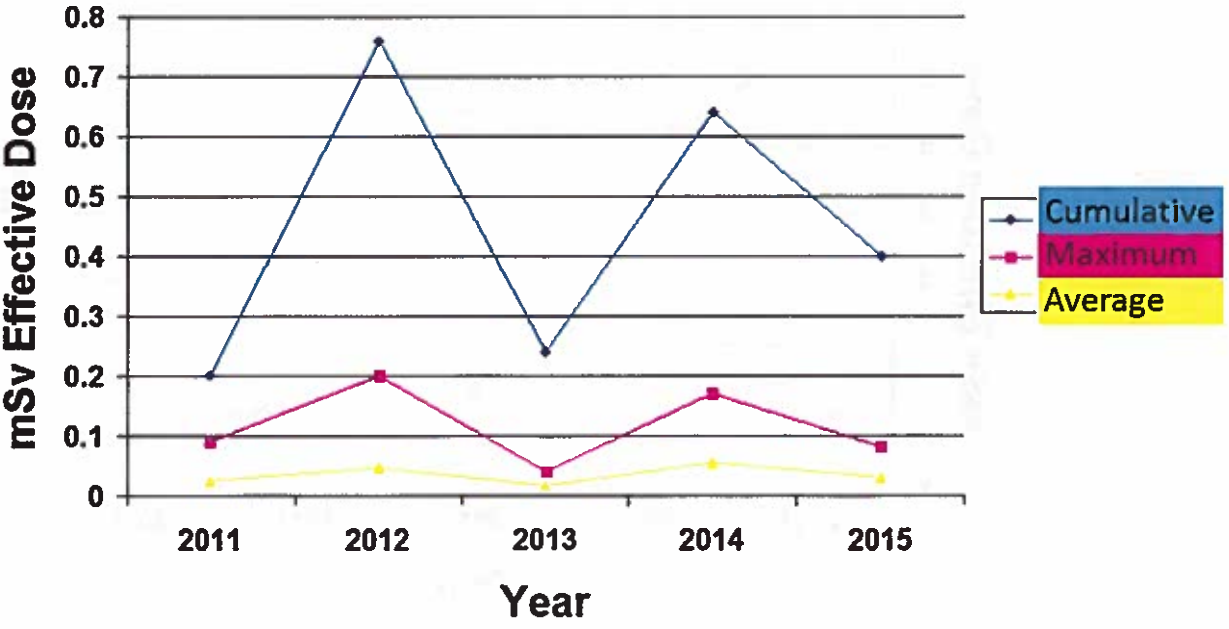


Figure 7: Nuclear Medicine Shippers, Waste, Containers

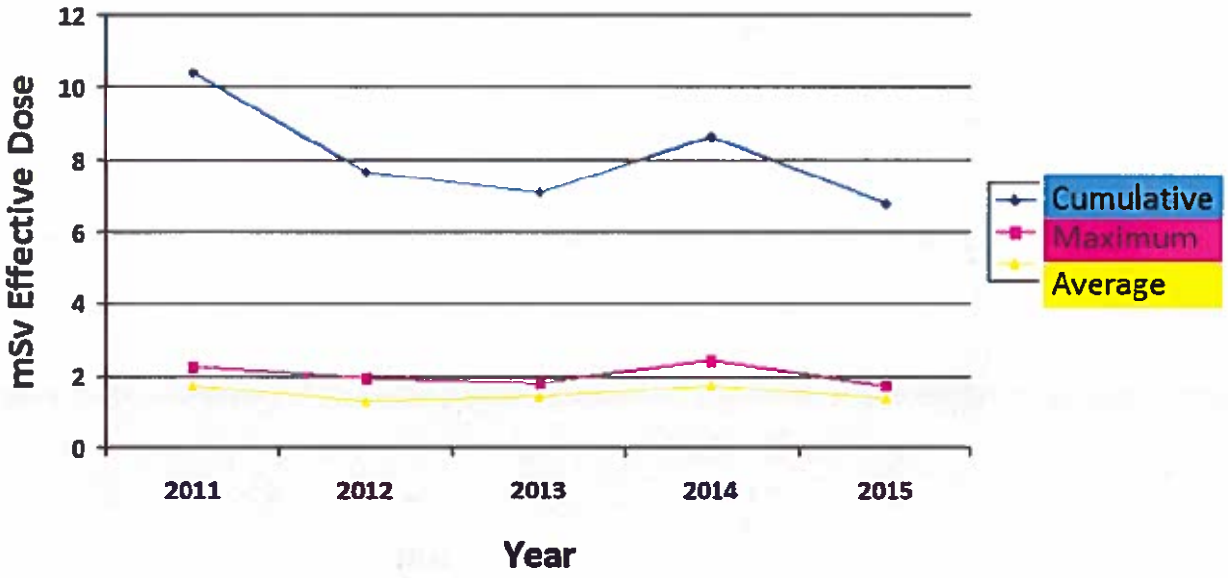



Figure 8: I-125, I-131 & Ir-192 Production Technicians

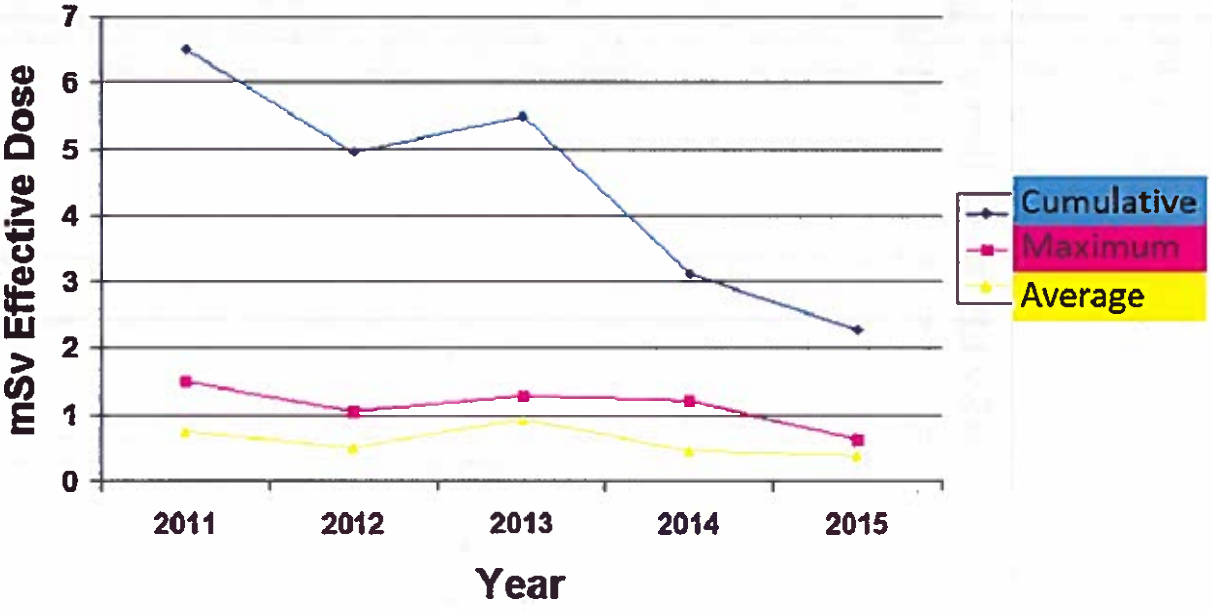


**Figure 9: Mo-99, Xe-133 & Sr-82 Production Technicians**

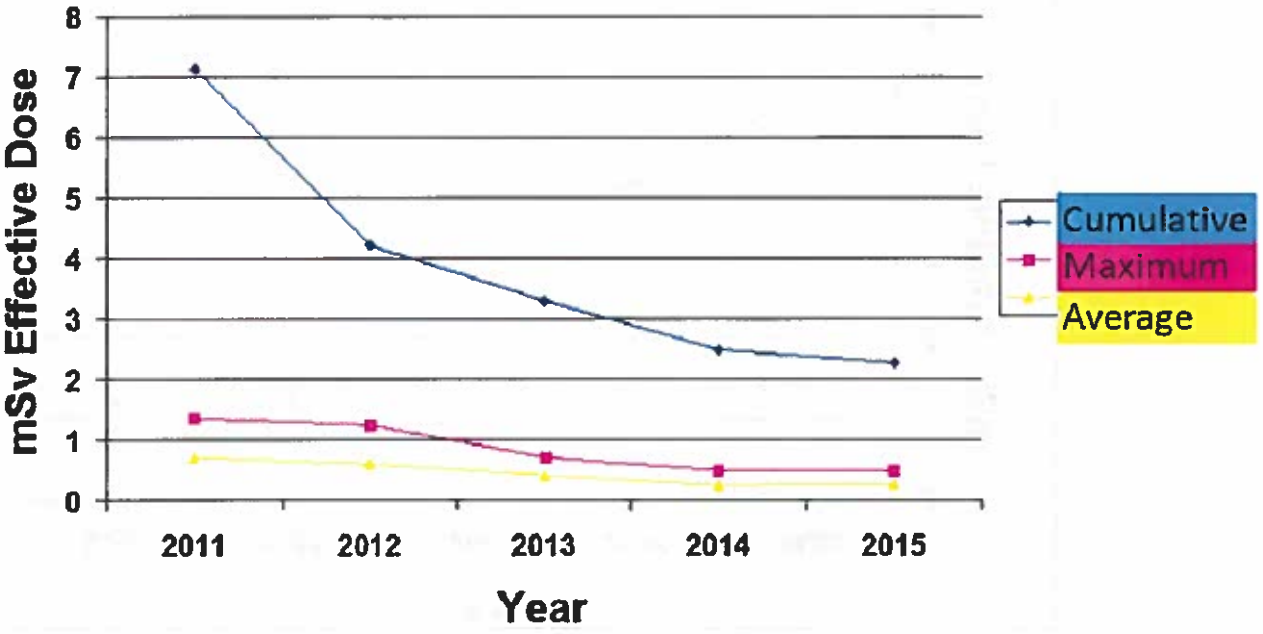



**Figure 10: Radiopharm Production Technicians**

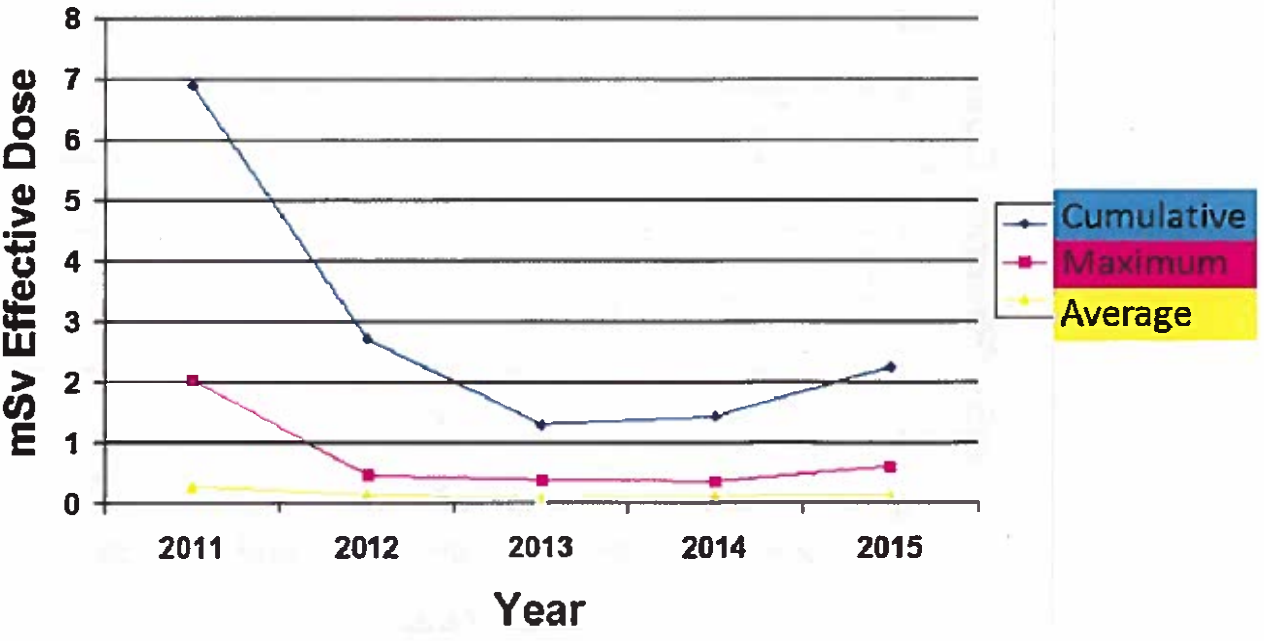


**Figure 11: Machinists**

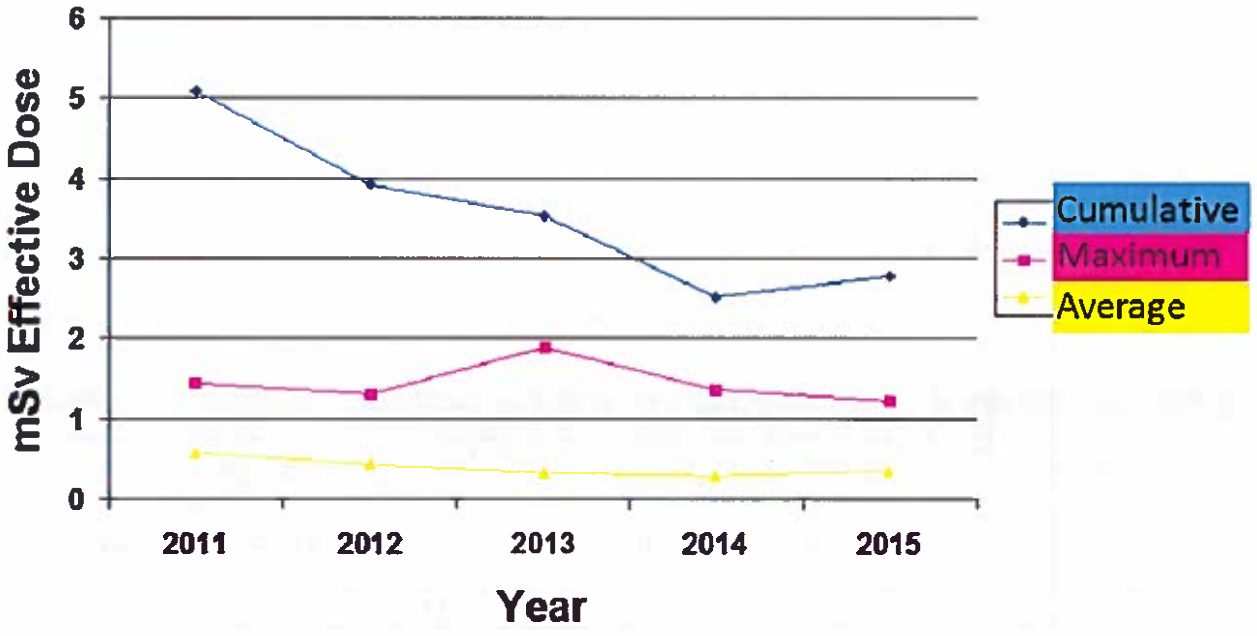



**Figure 12: Nuclear Medicine QC**

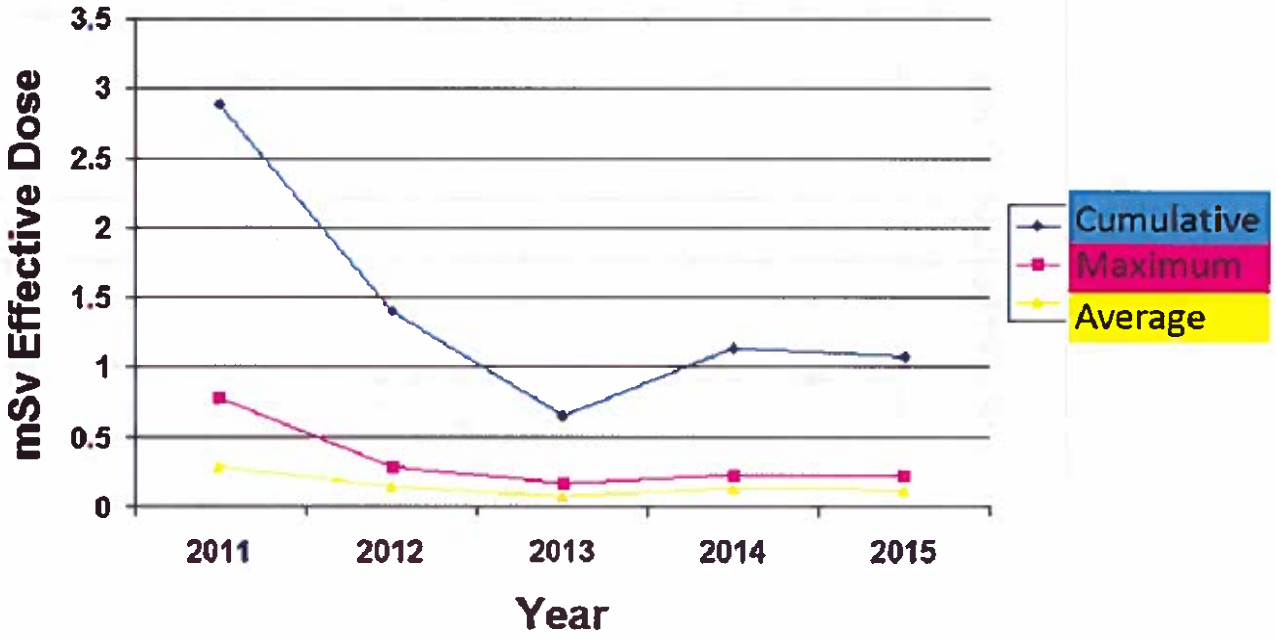


**Figure 13: Surveyors**

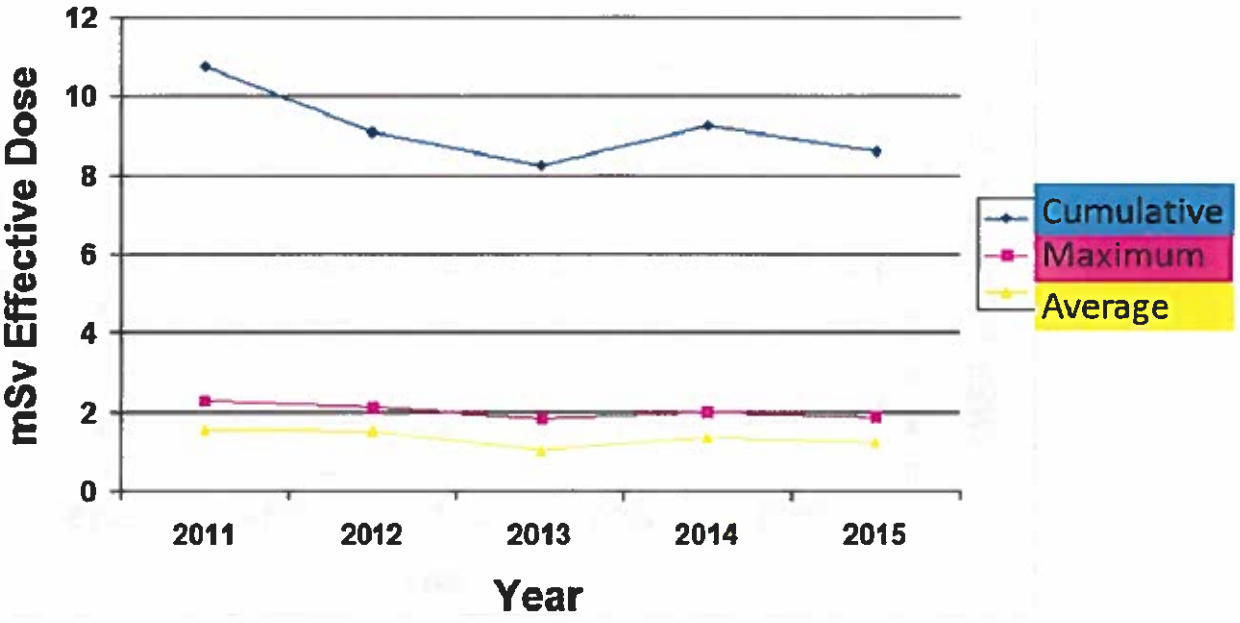



**Figure 14: Nuclear Medicine Operators, Helpers**

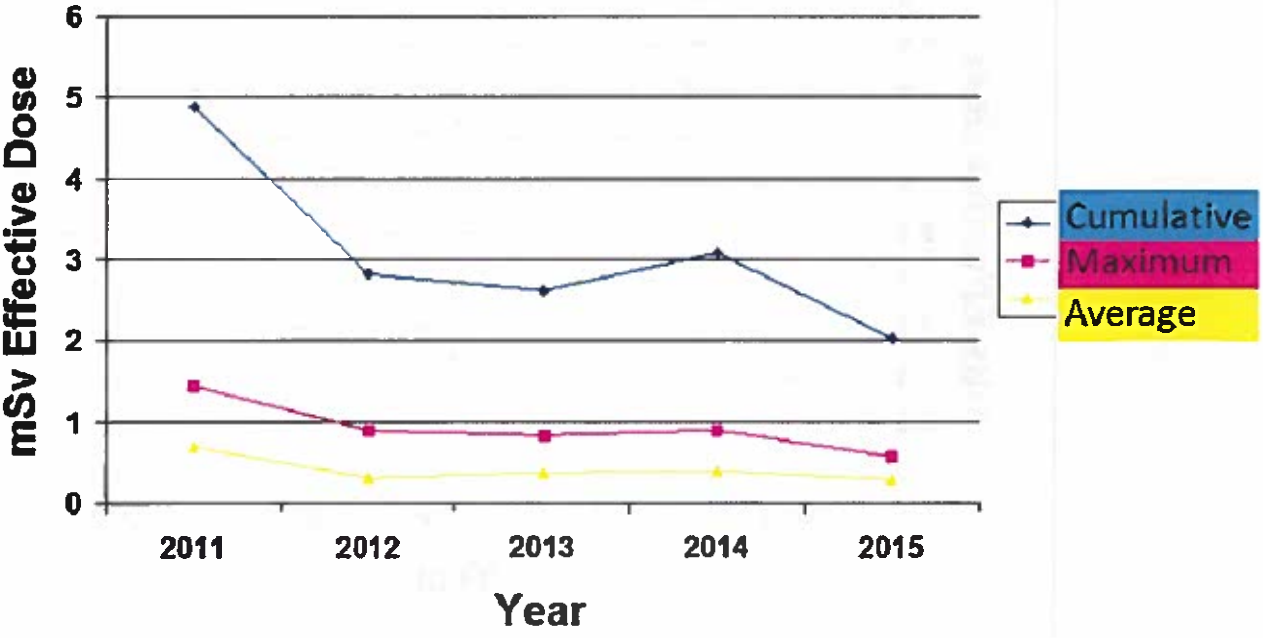


**Figure 15: Nuclear Medicine Radiation and Contamination Monitors**

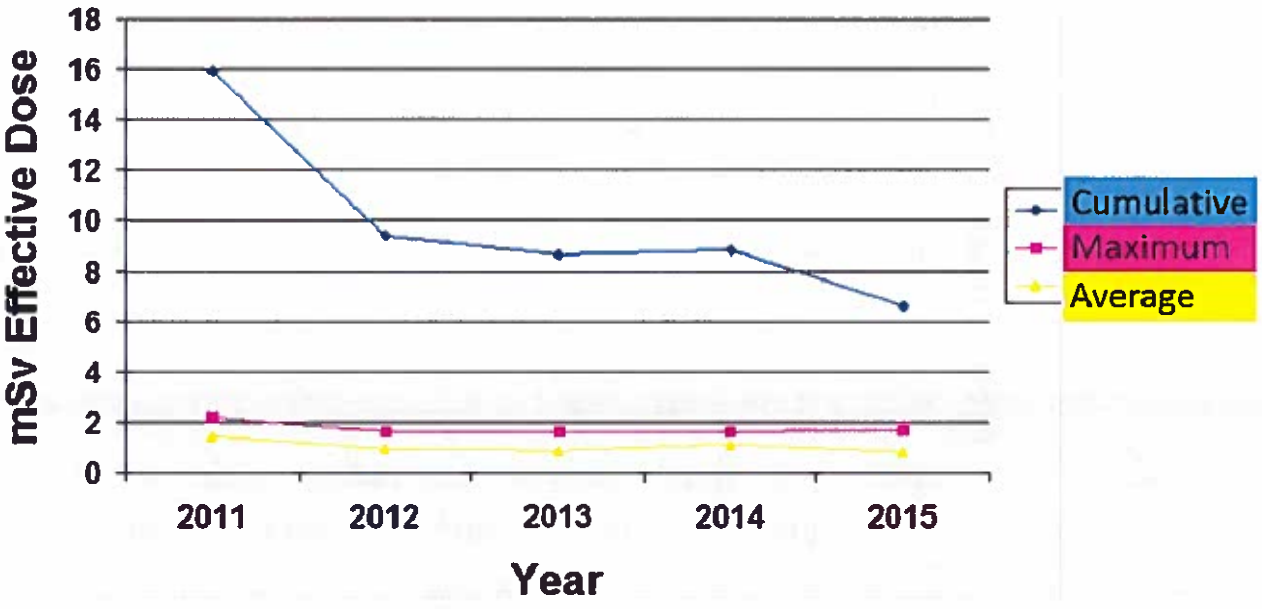



**Figure 16: Facilities, Motor Pool**

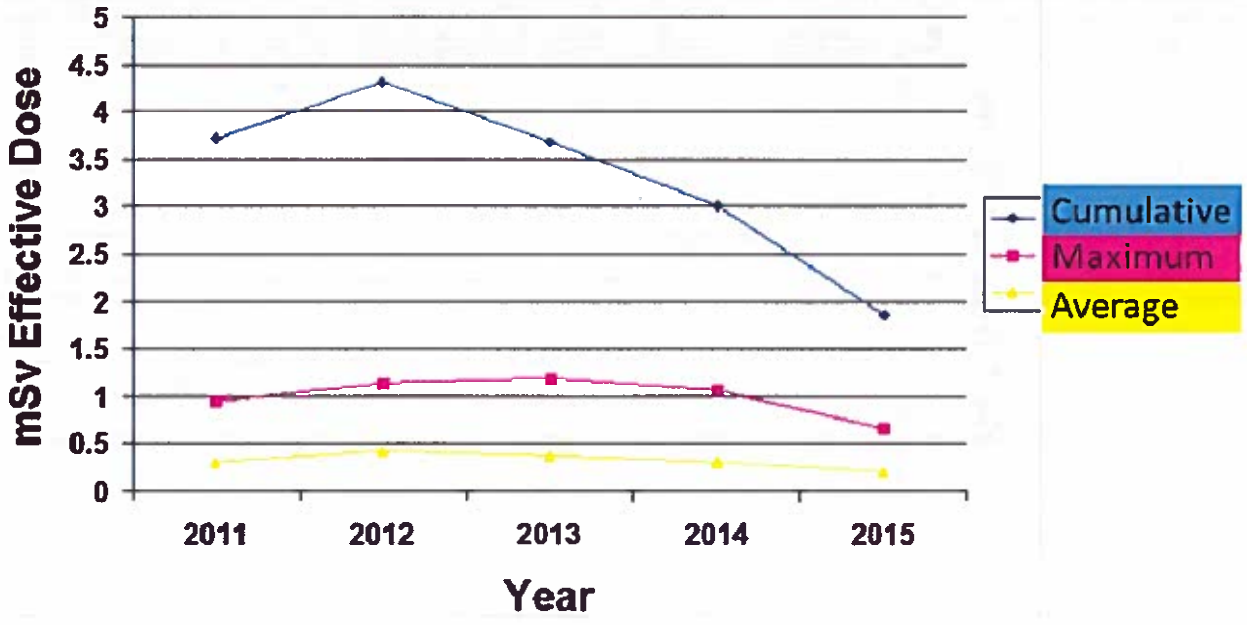


**Figure 17: Facilities, Mechanical**

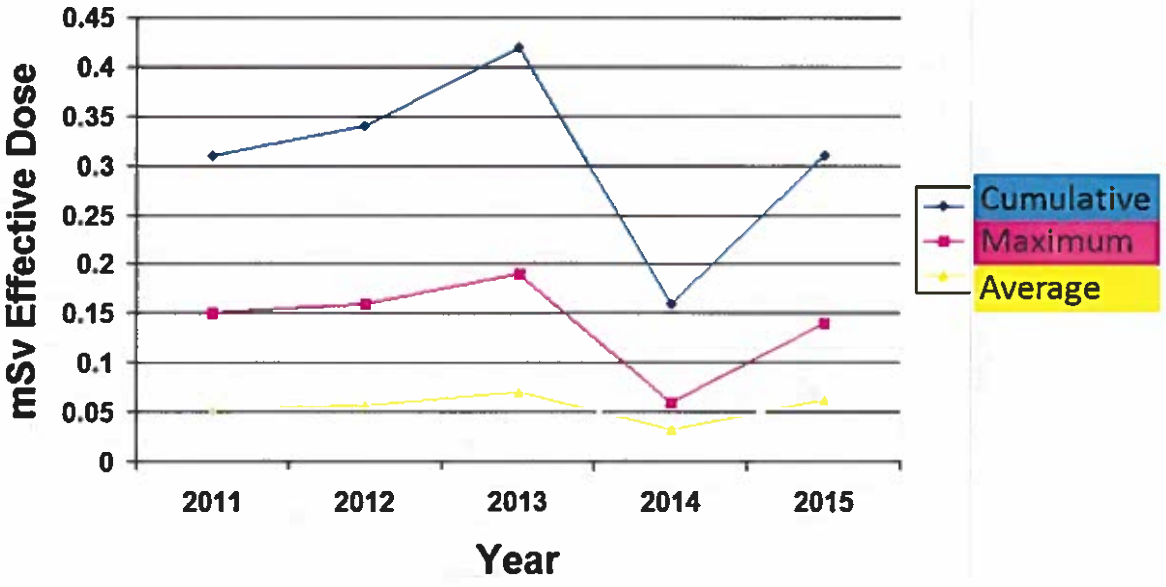



**Figure 18: Radiopharm QC**

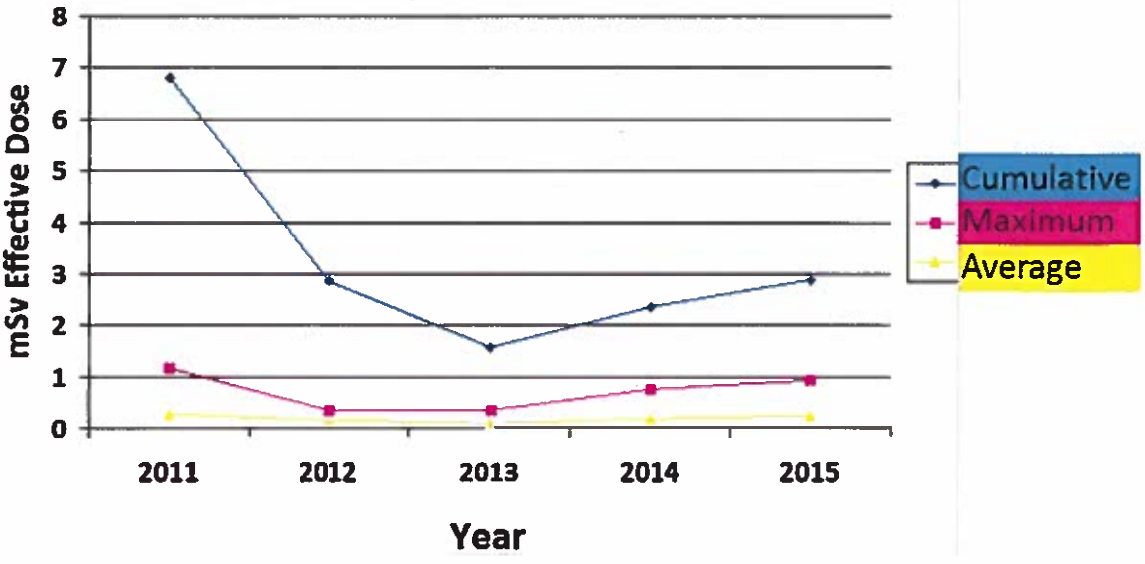
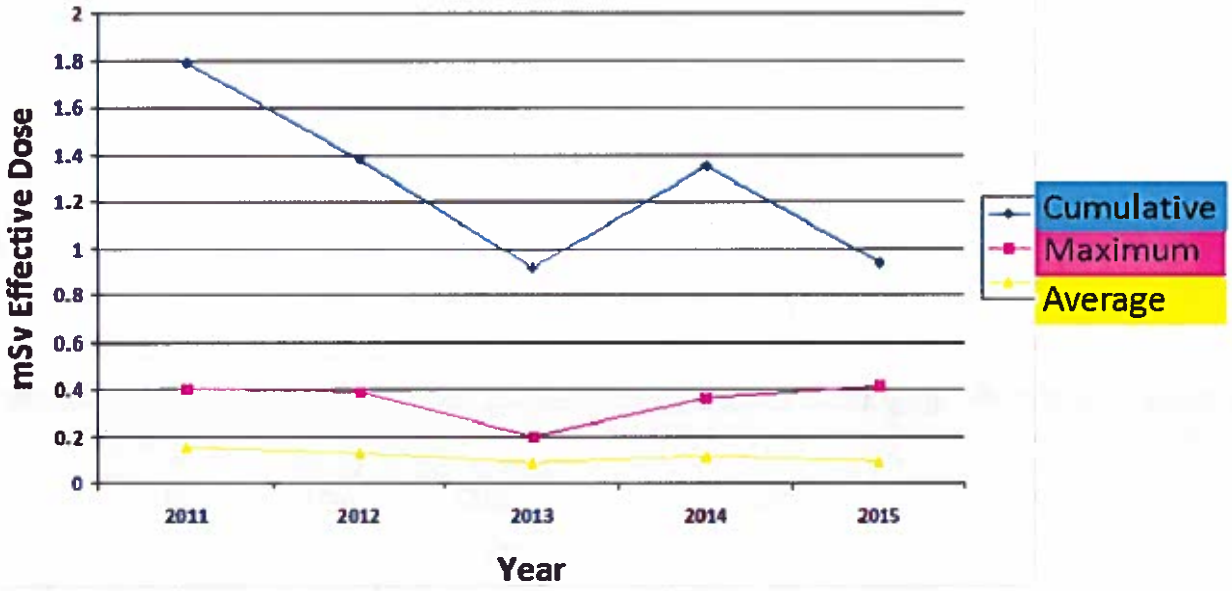


**Figure 19: Facilities, Electricians & Electronic Calibration Lab**



## Figure 20 - Location of "Off Site" TLDs

## Figure 21 - Location of "On Site" TLDs

## Figure 22: Groundwater Well Locations

# Appendix A
# Table of Incidents

| Date of Occurrence | Incident No. | Description | Reporting | Causes | Corrective Actions |
|---|---|---|---|---|---|
| 07-Jan-15 | 15-01 | A transport package from a supplier was shipped with unauthorized contents. | Authorized contents are specified in the transport certificate and is a condition of use. Reportable under Section 27(b)(ii) of the Nuclear Safety and Control Act (NSC) | An error during source manufacturing was determined as the likely root cause. | Enhanced manufacturing controls have been put in place at the supplier |
| Historic Issue | 15-02 | Nordion did not submit reports to the CNSC within the prescribed 21 day timeline. | Noncompliance with licence condition 6.1 (g). Reportable under Section 6.1 (g) of Class 1B site license NSPFOL-11A.05/2015 | Management System: standards, polices and administrative controls need improvement. Had there been in place a process for monitoring of the 21 day report due dates the timelines would have been respected. | Nordion implemented a monitoring process for the 21 day reports that includes alerts and escalation. |
| 15-Jan-15 | 15-03 | A transport package was found to have a damaged tie-down ring when received at the consignee's site | Noncompliance with Section 19 (1)(b) of Packaging and Transport of Nuclear Substances Regulations (PTNSR)<br>Reportable with Section 19(1)(b) of PTNSR | Incomplete installation of the screw into the F339 body and failure to detect the condition of the hoist ring. | Container has been returned to Nordion for repair. Nordion has expanded inspections to include review of the tie-down ring. |

| | | | | | |
|---|---|---|---|---|---|
| 15-Feb-09 | 15-04 | The Post Shipment Verification (PSV) for two Ir-192 shipments were not submitted to all of the required recipients at the CNSC. | Noncompliance with export licence<br>Reportable under Section 27(b)(ii) of NSC Act | Training required. Notification of PSV should have included a check to verify the email addresses. | Nordion has implemented a process for verification of PSVs and updated procedures accordingly. |
| 16-Mar-15 | 15-06 | External Security Breach | Section 29 of General Nuclear Safety and Control Regulations | An external security fence was cut but no damage or loss to the facility occurred. | *Considered confidential |
| 19-May-15 | 15-08 | A transport package was reviewed from a supplier without valve plugs. | Packaging instructions referenced on Transport Certificate were not followed.<br>Reportable under Section 6.1 (g) of Class 1B site license NSPFOL-11A.05/2015 | There was an error during preparation for shipment from the supplier. | Nordion informed the supplier of the oversight. |
| 25-Jun-15 | 15-09 | Improper labeling of Type A Package | Noncompliance with Section 25 (1) of the PTNSR<br>Reportable as required by Section 6.1 (g) of Class 1B site license NSPFOL-11A.05/2015 | Operator Error | The circumstance of this event was reviewed with applicable Nordion personnel. |
| 01-Jul-15 | 15-10 | A container was received by a customer with evidence that the lid had been removed and replaced using duct tape. | Noncompliance with Section 19 (1)(b) of PTNSR.<br>Reportable as required by Section 6.1 (g) of Class 1B site license NSPFOL-11A.05/2015 | Unknown as this event occurred during transport. | The consignee followed up with their carrier. |

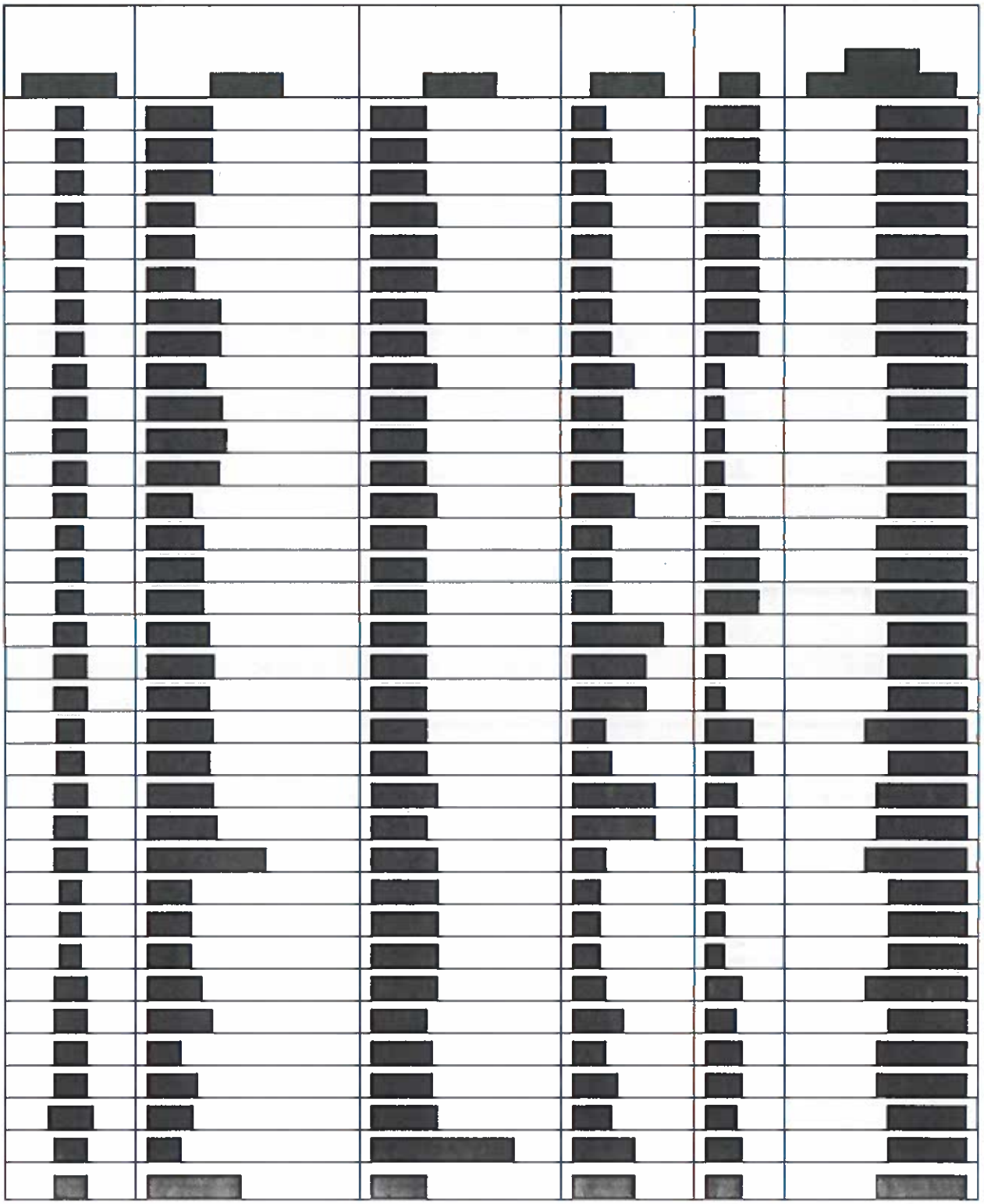
| | | | | | |
|---|---|---|---|---|---|
| 06-Aug-15 | 15-12 | Fire on the roof of the KOB. Repairs were being made by a contractor at the time of the incident. | Reportable under section 29 (1)(d) of the General Nuclear Safety and Control regulations | The use of a torch in an area to apply a membrane where there is wood construction underneath the flashing on the roof and the KOB Building ventilation system which has negative air pressure continuously drawing air into the building. | 1) All hot work was suspended until appropriate measures were put in place.<br>2) Developed an interim measure for reinstating hot work to ensure it is conducted in a safe and controlled manner.<br>3) The wood construction under the concealed space on the roof was replaced with a non-combustible material. |
| 11-Aug-15 | 15-13 | Customer received a vial in which the screw cap was not sealed properly. Product had escaped from the vial into the lead pot. | Noncompliance with Section 35(b) of PTNSR<br>Reportable under Section 37(1) of PTNSR. | Operator error. | The results of the investigation and associated customer complaint investigation was shared with the Production team. * |
| 19-Aug-15 | 15-14 | Carrier reported damage to a Type A package while in transit. | Noncompliance with Section 35(b) of PTNSR<br>Reportable under Section 37(1) of PTNSR | The Type A package was damaged during transport. | No actions required by Nordion. |
| 15-Jun-15 | 15-15 | Nordion did not include documentation relating to the CNSC export license with a shipment. | Non-compliance under Section 18 of the GNSCR.<br>Reportable as required by Section 6.1 (g) of Class 1B site license NSPFOL-11A.05/2015 | Persons involved were unaware that this was exported under Nordion's general export license and that declaration was required. | Nordion created modified procedures and concluded training. |
| 28-Aug-15 | 15-16 | Customer did not receive one of their packages | Noncompliance with Section 35(c) of PTNSR<br>Reportable under Section 37(1) of PTNSR | The package was misplaced by the carrier. | Incident occurred in transit. Carrier was notified. |

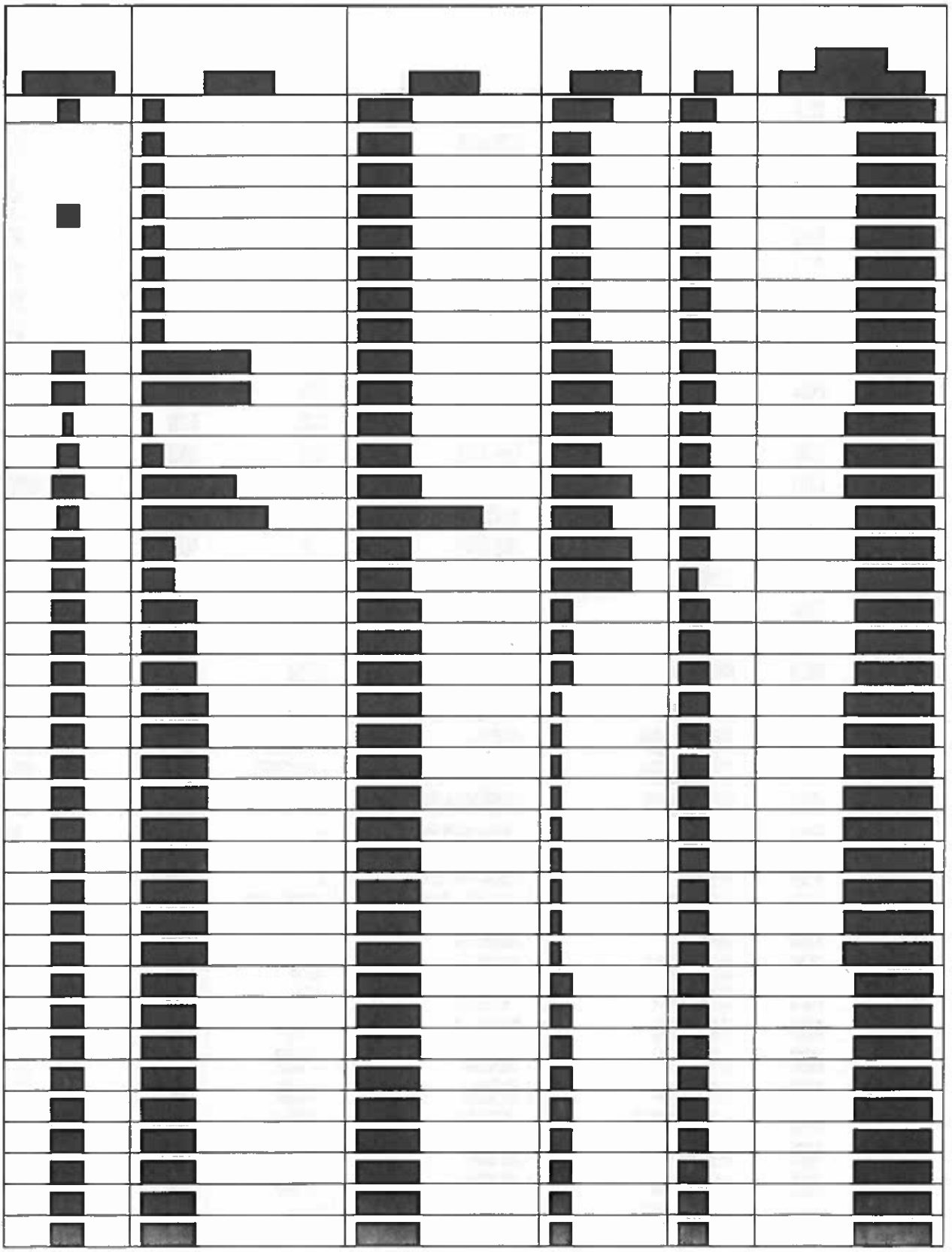
| | | | | | |
|---|---|---|---|---|---|
| 14-Sep-15 | 15-19 | Customer reported damaged Transport package. | Non-compliance with Section 35(b) of PTNSR Reportable under Section 37(1) of PTNSR. | Damage occurred in transport. | Incident occurred in transit. Carrier was notified. |
| 15-Sep-15 | 15-23 | Product dose did not match package labelling and documentation. | Non-compliance with Section 25(1) PTNSR<br>Reportable under Section 37(1) of the | There was a procedure error during Y-90 packaging that resulted in an incorrect dose being packaged related. | All remaining product from this batch was rejected and disposed of. CAPA 150902 was issued to investigate the root cause and is currently in progress. |
| 02-Oct-15 | 15-24 | Two product vials were incorrectly dispensed resulting in incorrect amount of activity in each vial. This further resulted in incorrect package labeling and shipping documentation. | Non-compliance with section 25(1) of the PTNSR<br>Reportable under Section 37(1) of PTNSR. | There was a design error during the I-131 dispensing process that resulted in two incorrectly filled product vials. | CAPA 150102 was issued to investigate the root cause and is currently still in progress. |
| Historic issue | 15-25 | The checklist used when inspecting a package revealed that a required quantitative dimensional inspection of both the top and bottom was not being performed. | Reportable as required by Section 6.1 (g) of Class 1B site license NSPFOL-11A.05/2015 | Required quantitative inspection of a package to include top and bottom was not being performed properly. | A CAPA 151006 was issued to investigate the root cause and is currently still in progress. |
| 22-Oct-15 | 15-26 | Two returned packages from a 3rd party site contained a sealed source even though the package was labeled as empty. | Non-compliance with Section 35(g) of the PTNSR<br>Reportable as required by Section 37(1) of the PTNSR. | Lack of process control at the 3rd party site. | 3rd party has implemented a visual check prior to return shipment. Nordion will be provided with a photograph of the empty packages prior to shipment. |
| 02-Nov-15 | 15-27 | A shipment was received that included an unwelded capsule. Package certification requires that capsules are sealed. | Authorized contents are specified in the transport certificate and is a condition of use. Reportable under Section 27(b)(ii) of NSC Act. | An error occurred during source manufacturing. | The supplier implemented enhanced manufacturing controls. |

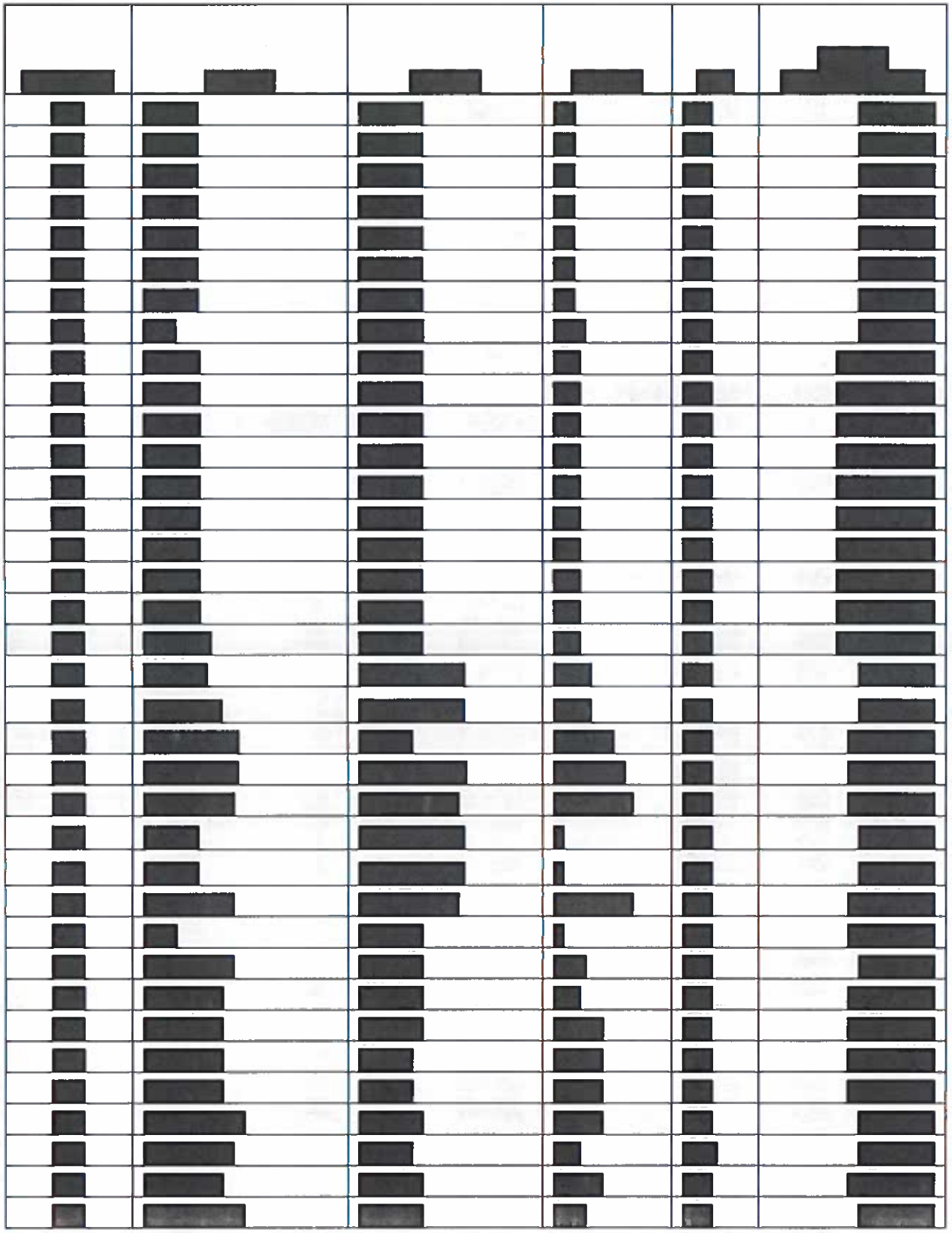
| | | | | | |
|---|---|---|---|---|---|
| 16-Nov-15 | 15-28 | A shipment was received with contents that exceed allowable allowable activity limit of Type B certification. | Non-compliance with CDN/2050/B(U) and reportable under Section 37(1) of PTNSR | The supplier did not match Nordion's measurements | Supplier to assess measurement of source process |
| 26-Nov-15 | 15-30 | F461 Type A package was received damaged. | Noncompliance with Section 35(b) of PTNSR and reportable under Section 37(1) of PTNSR | Damaged Type A package that occurred in transport | Carrier repackaged this shipment. |

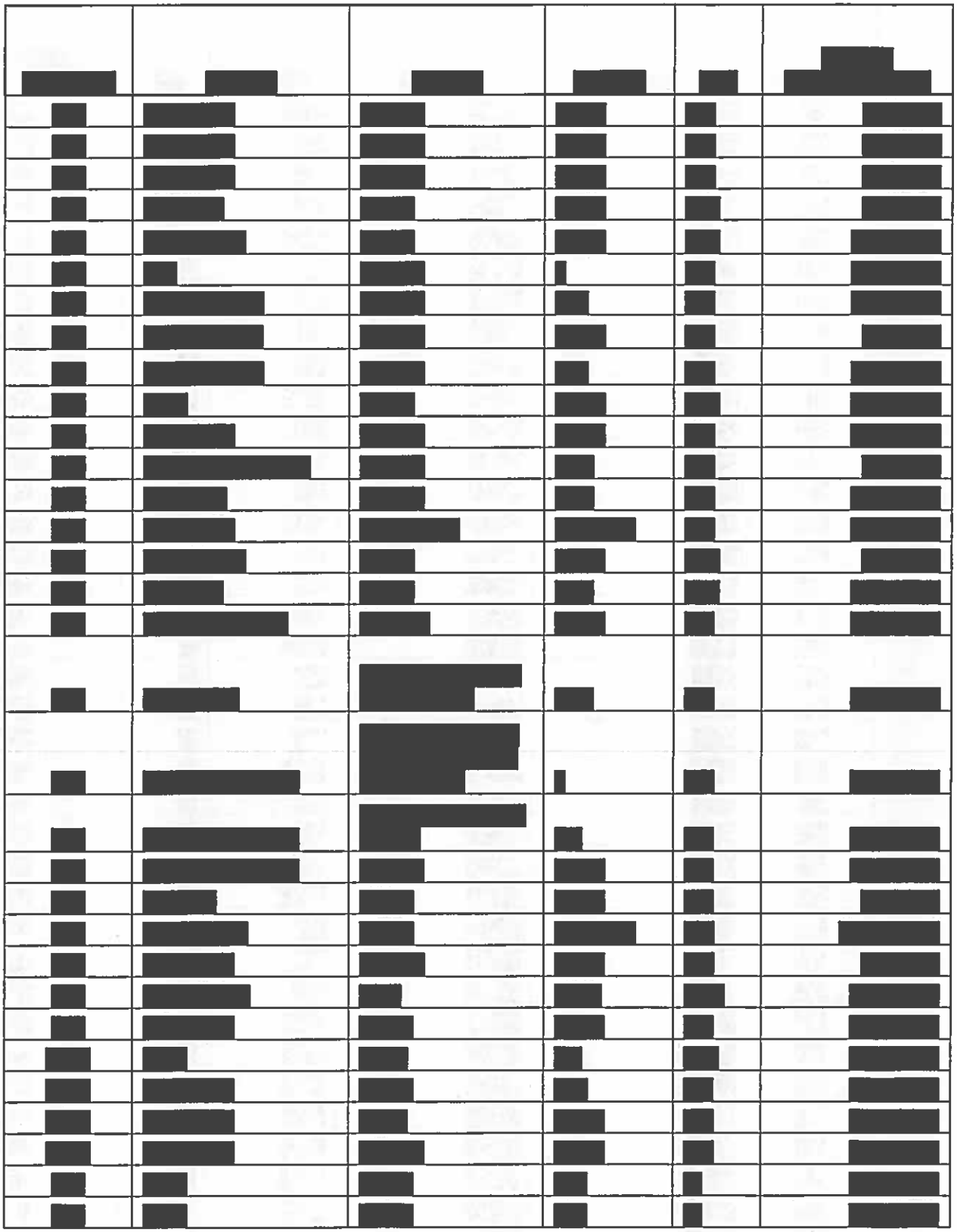
# Appendix B

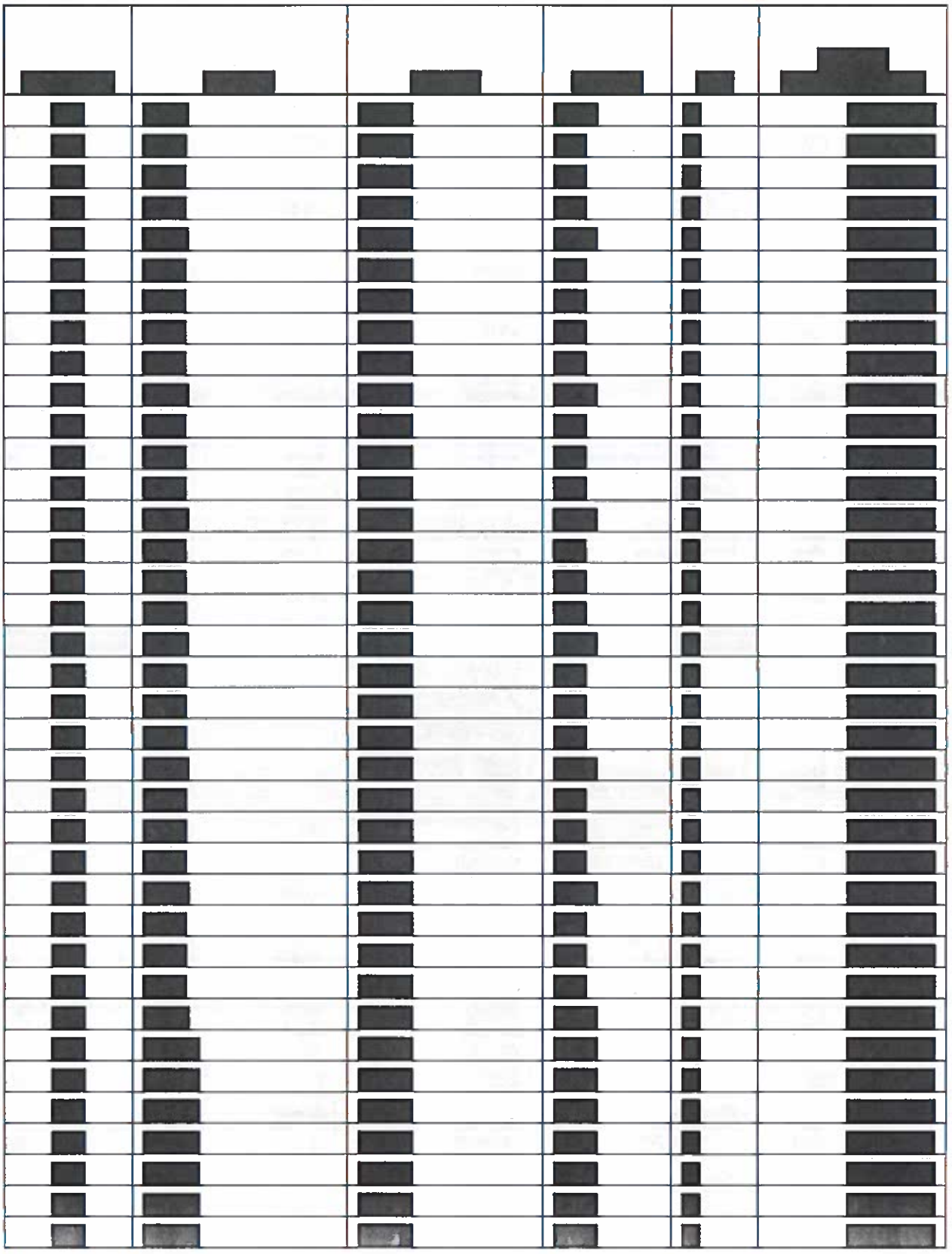
[redacted]

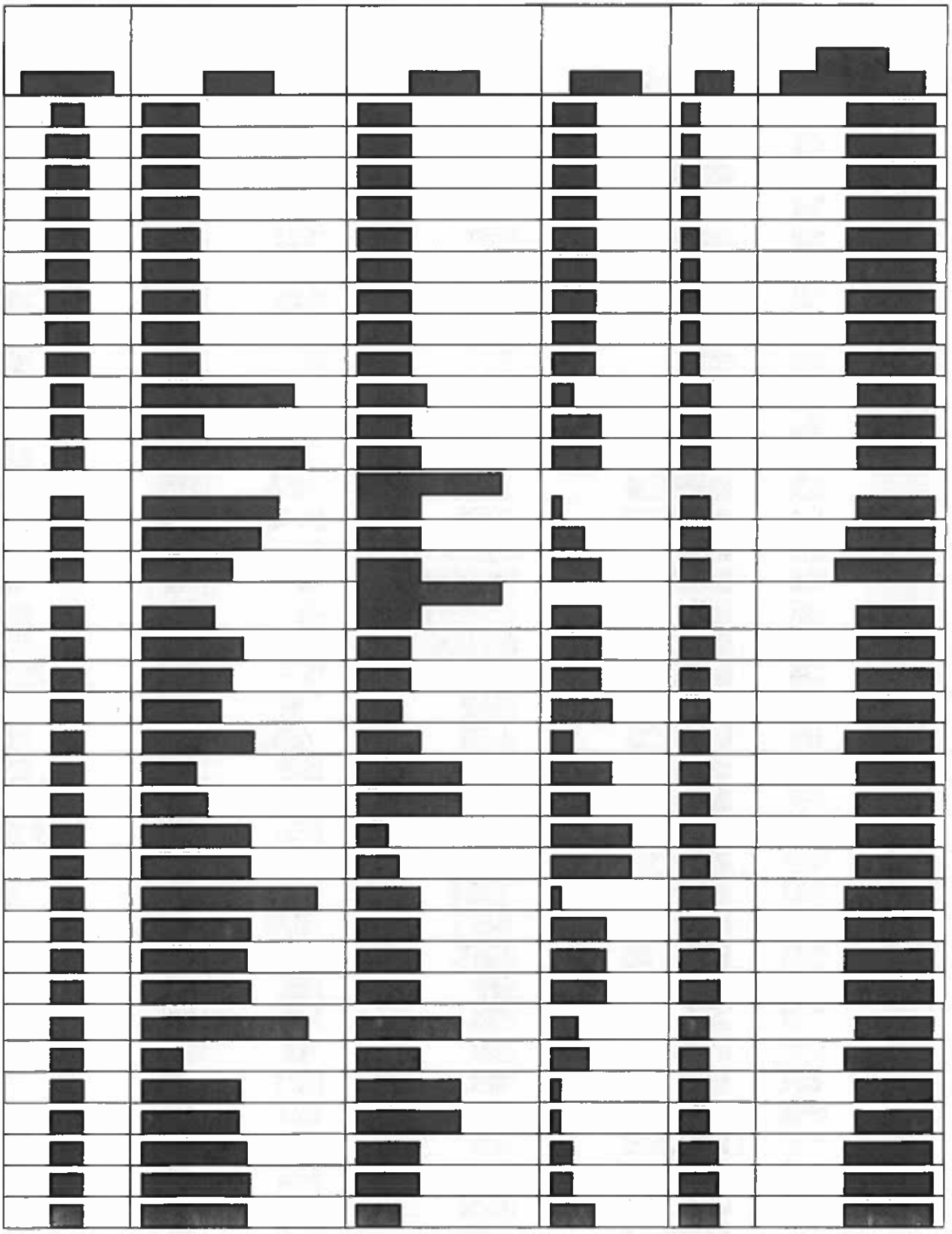


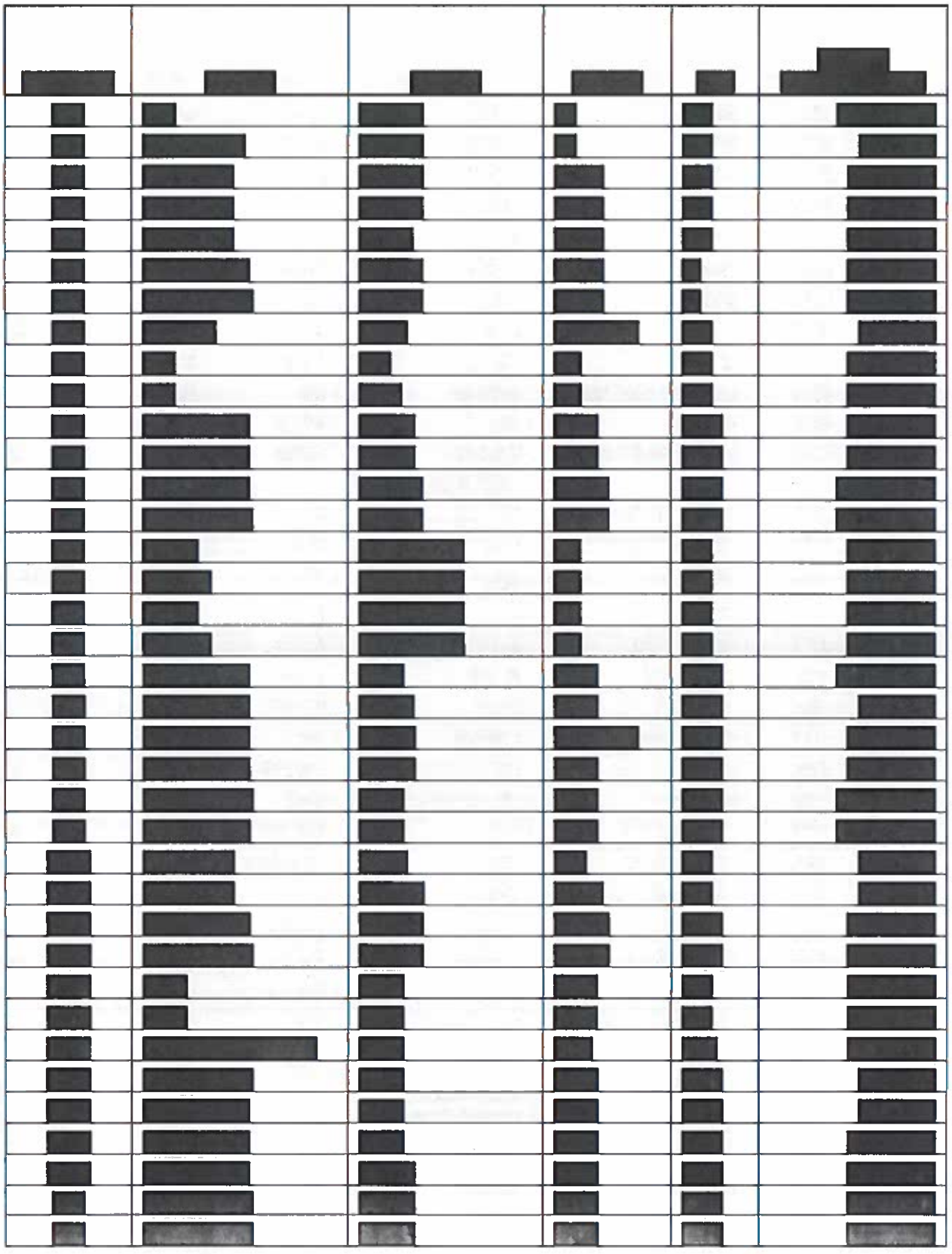


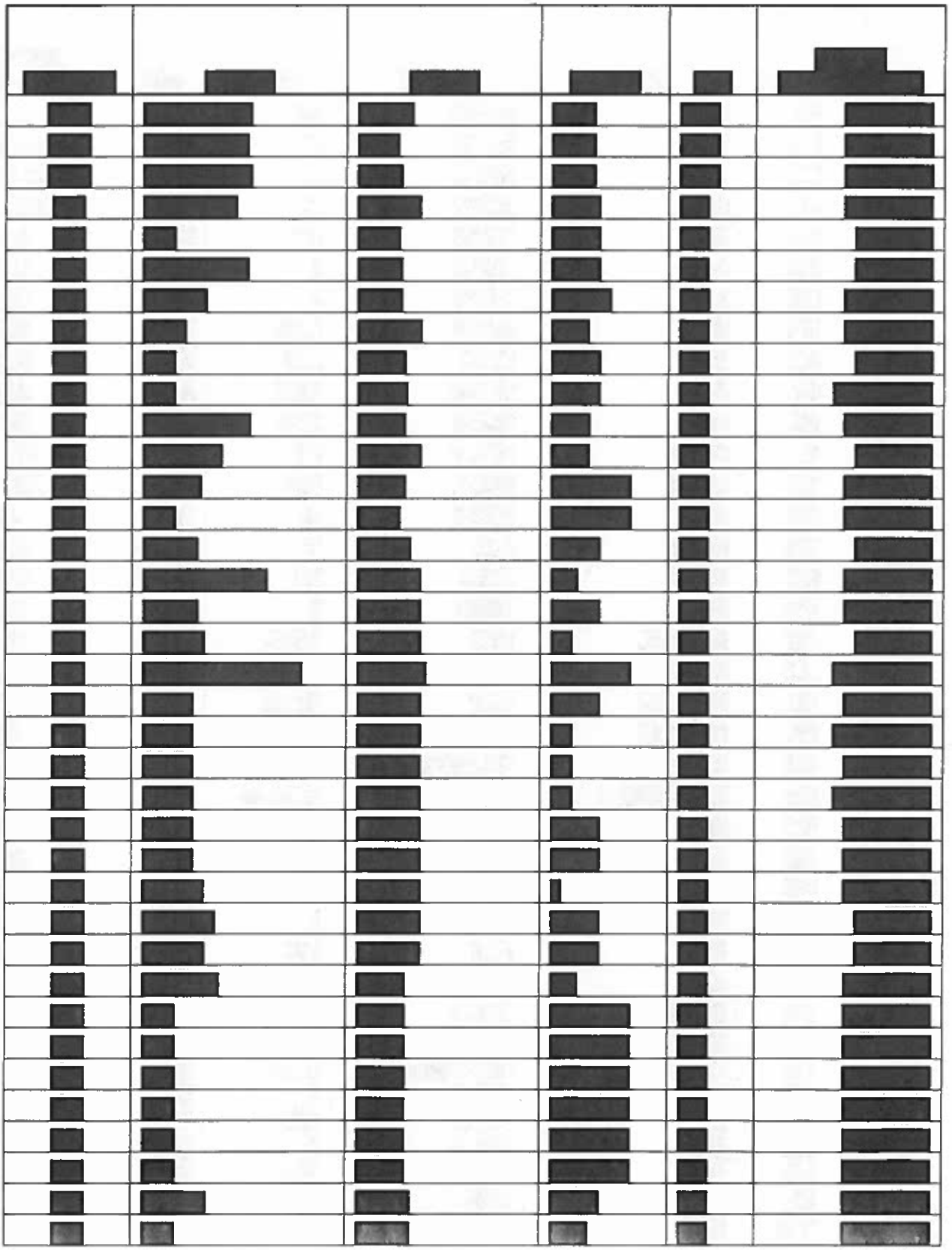


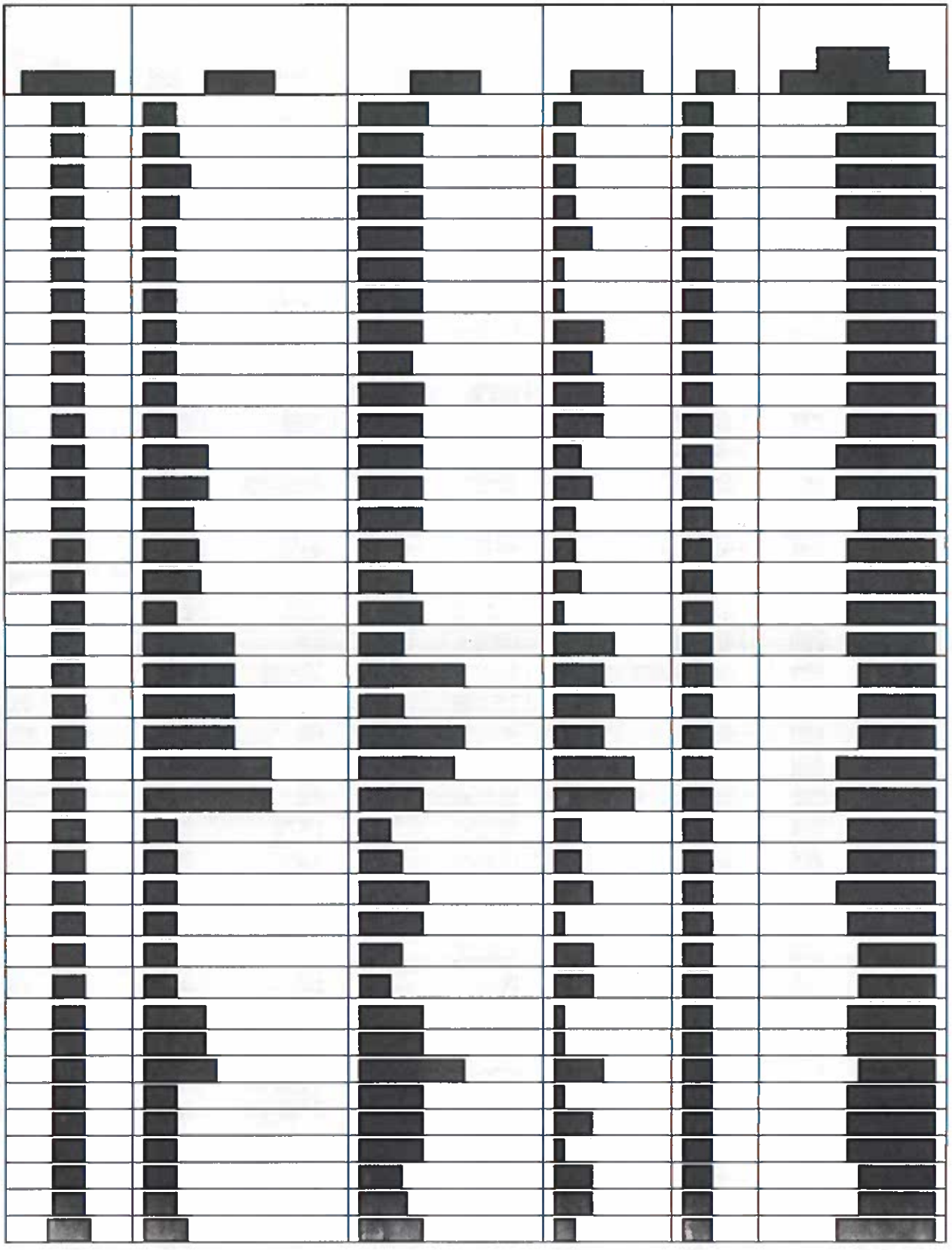


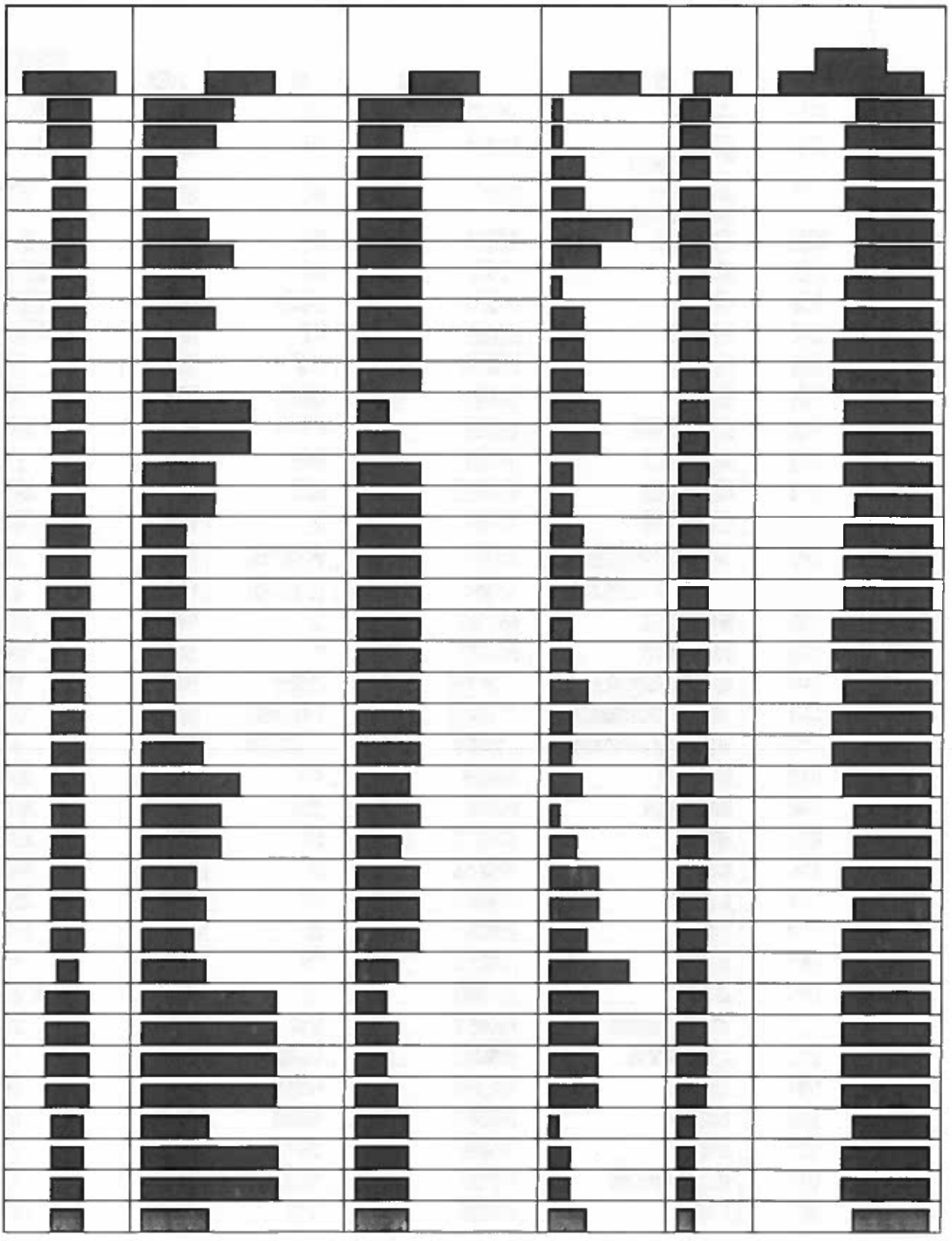


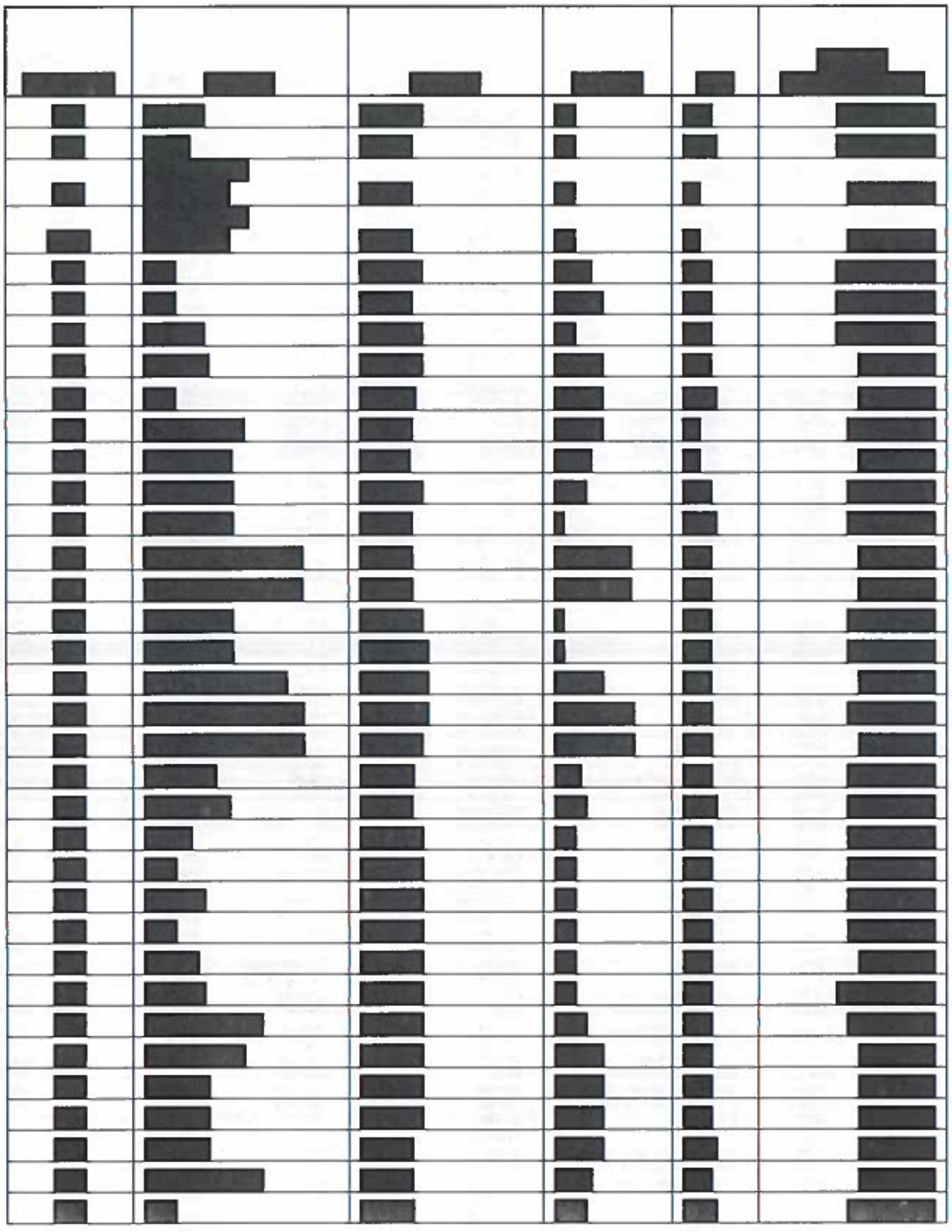


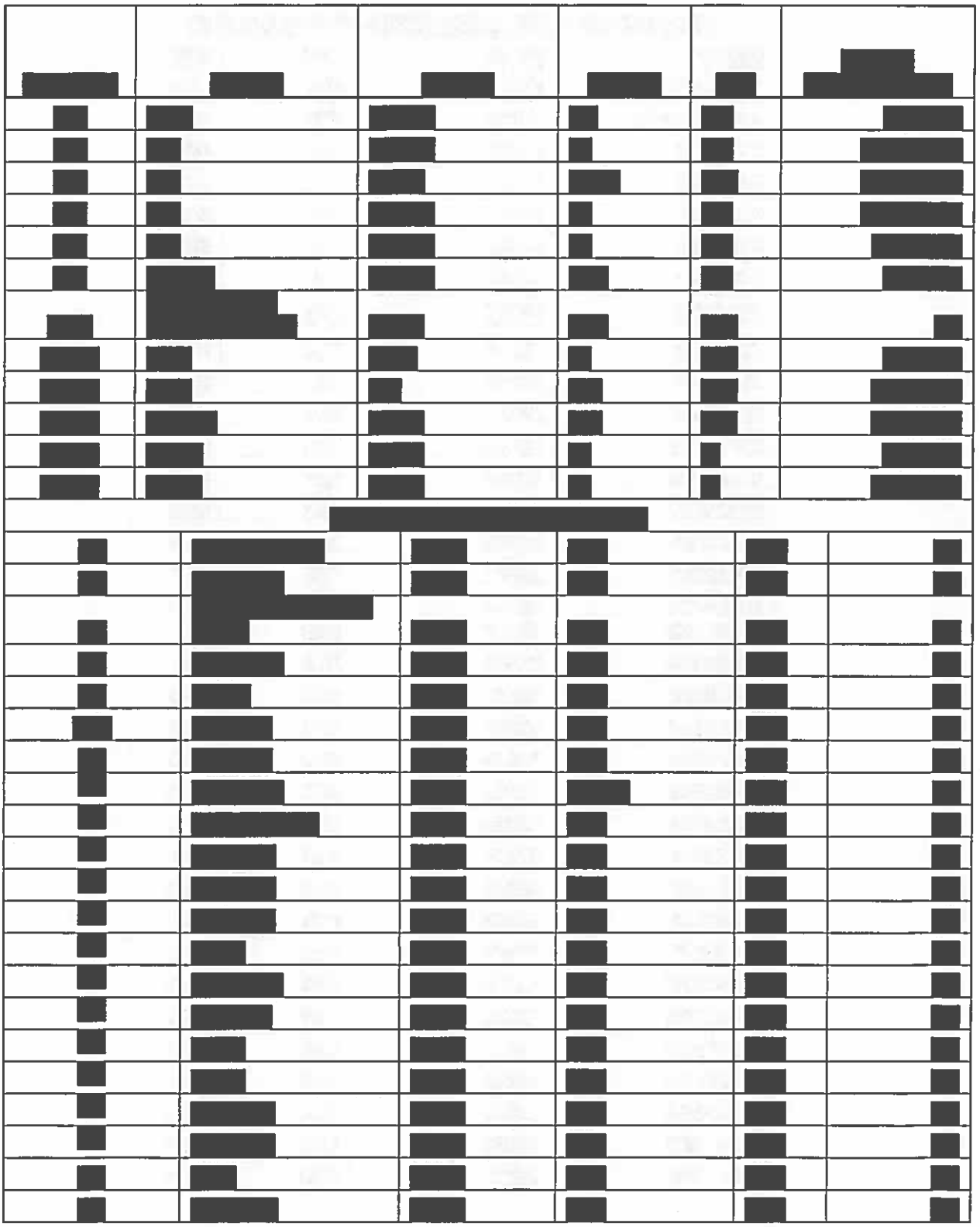


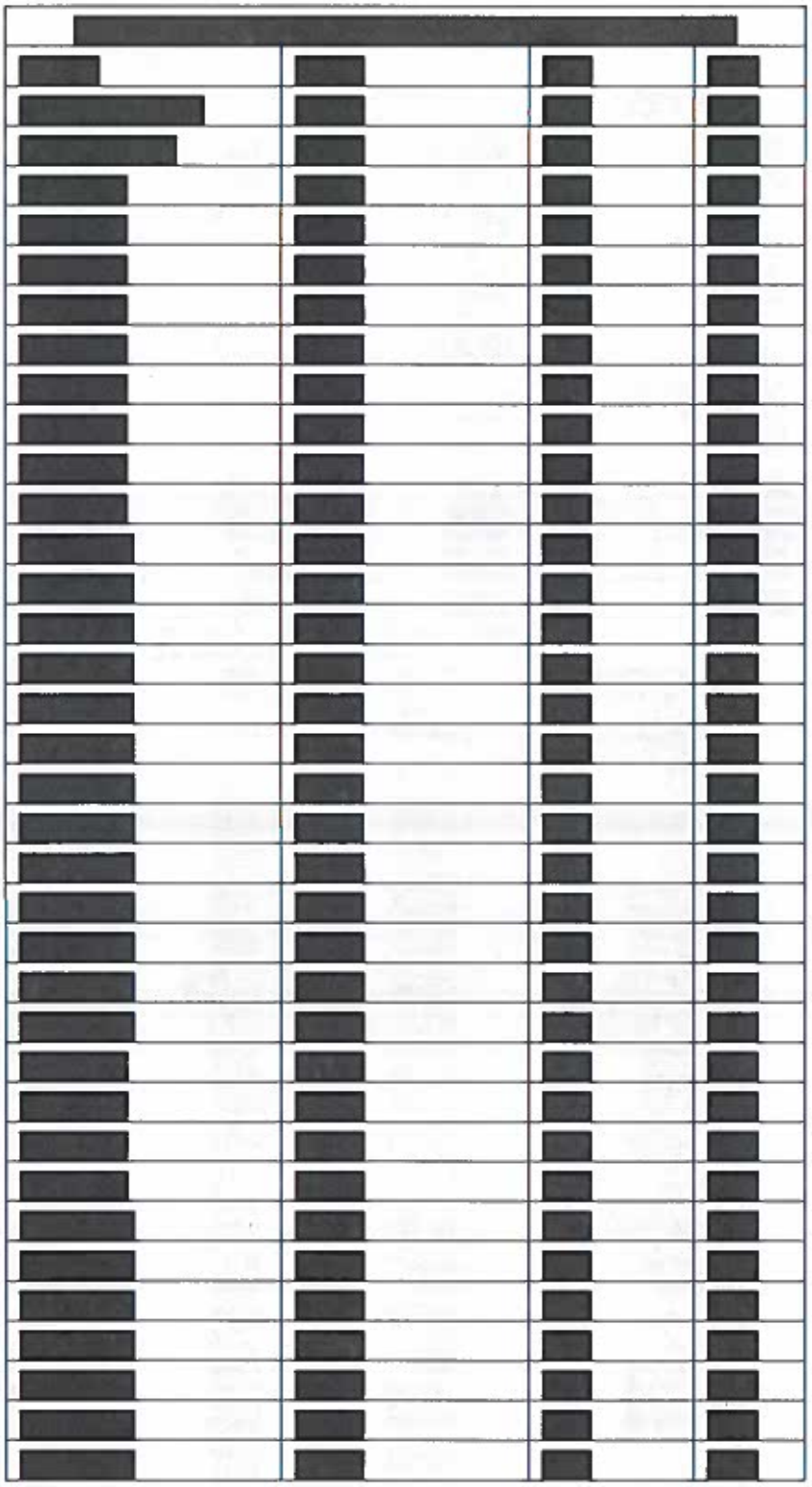


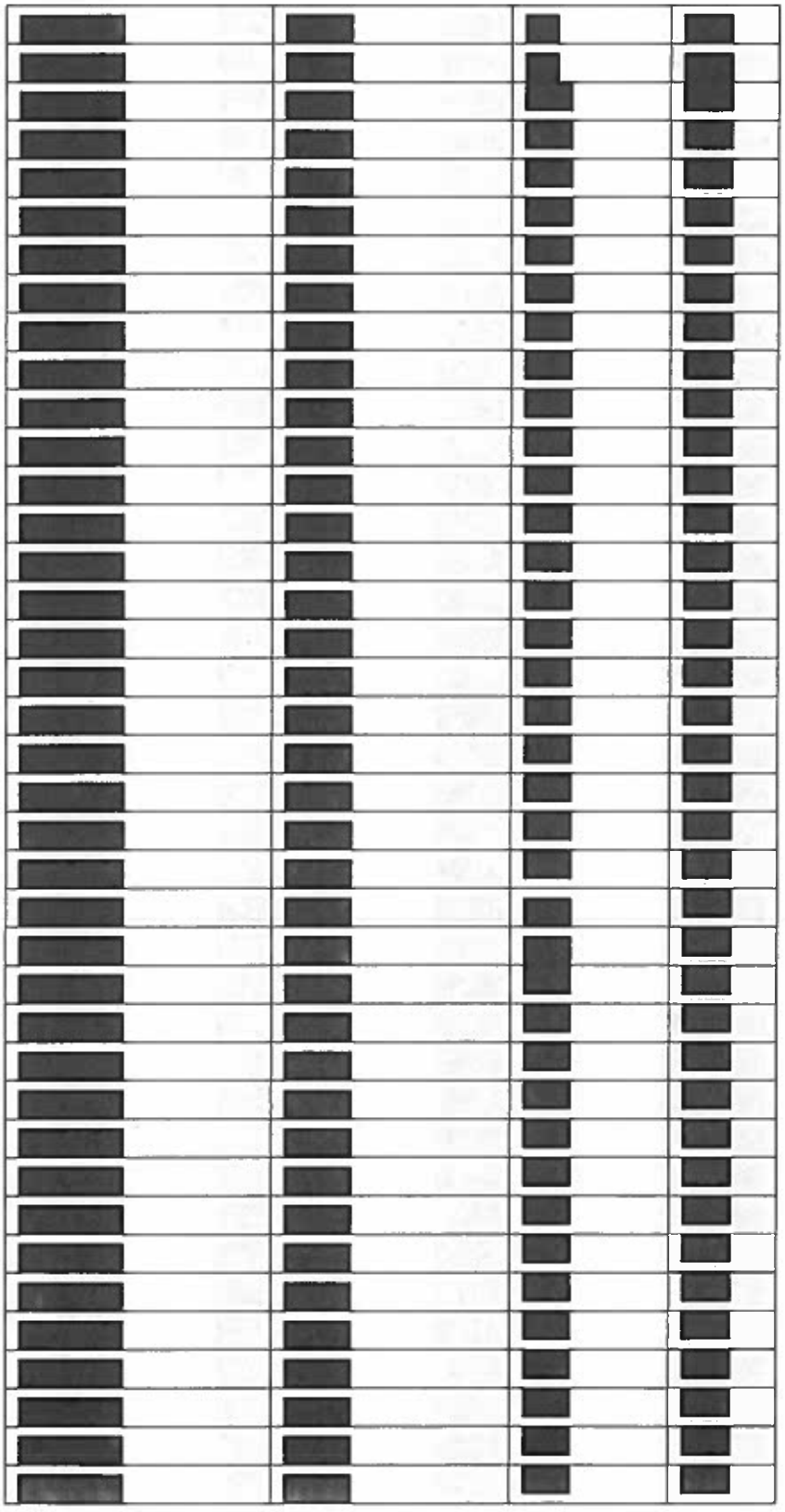


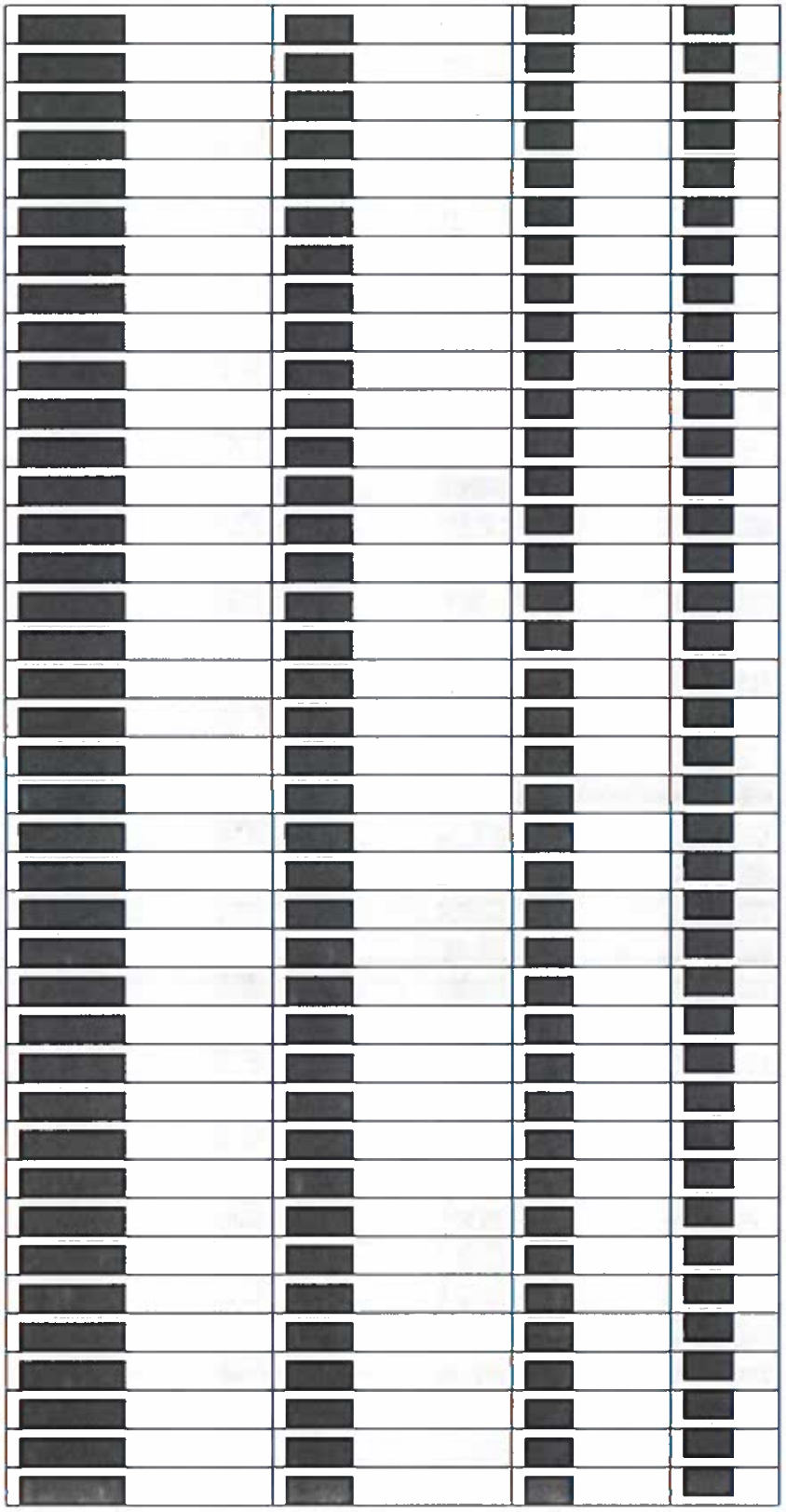


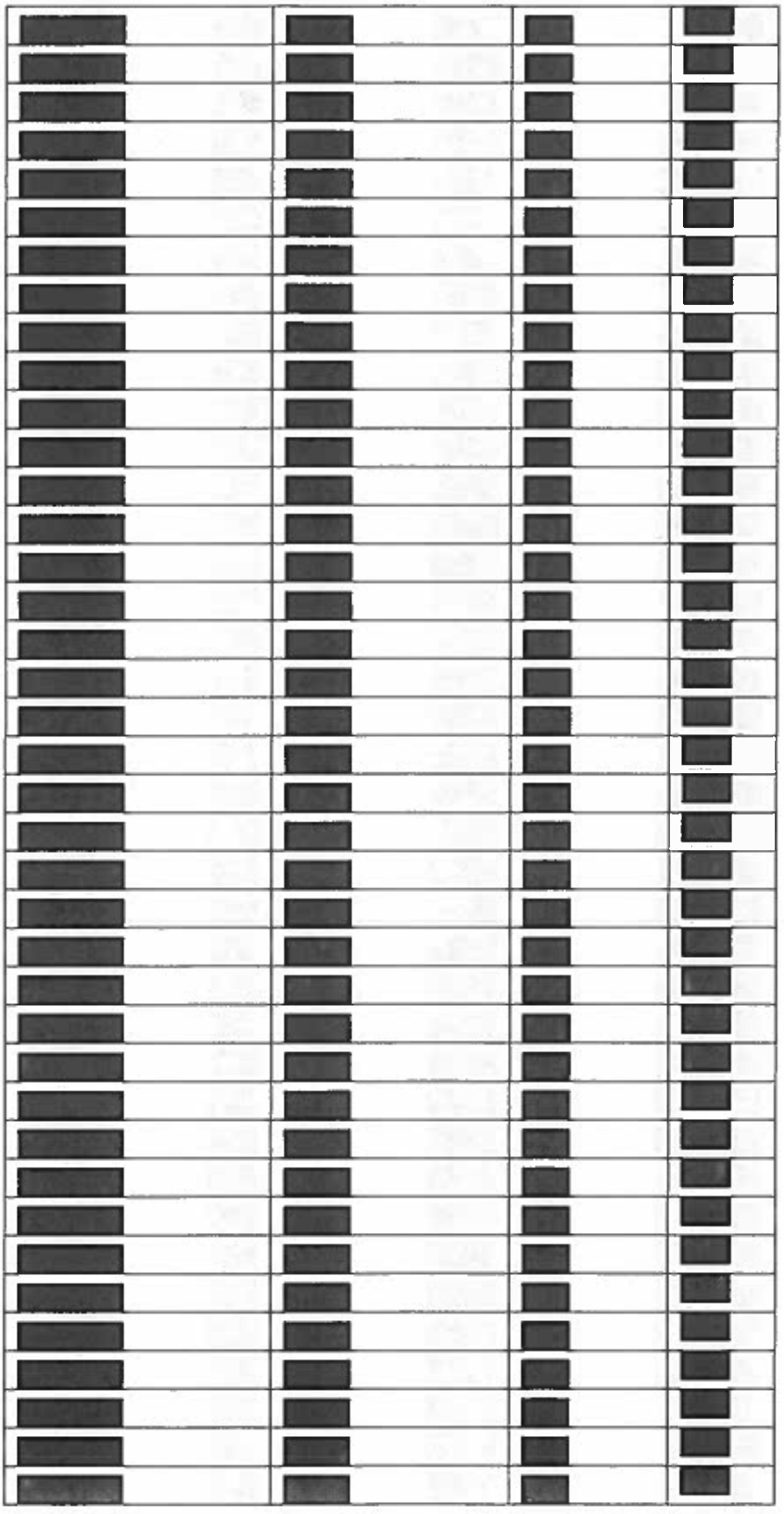


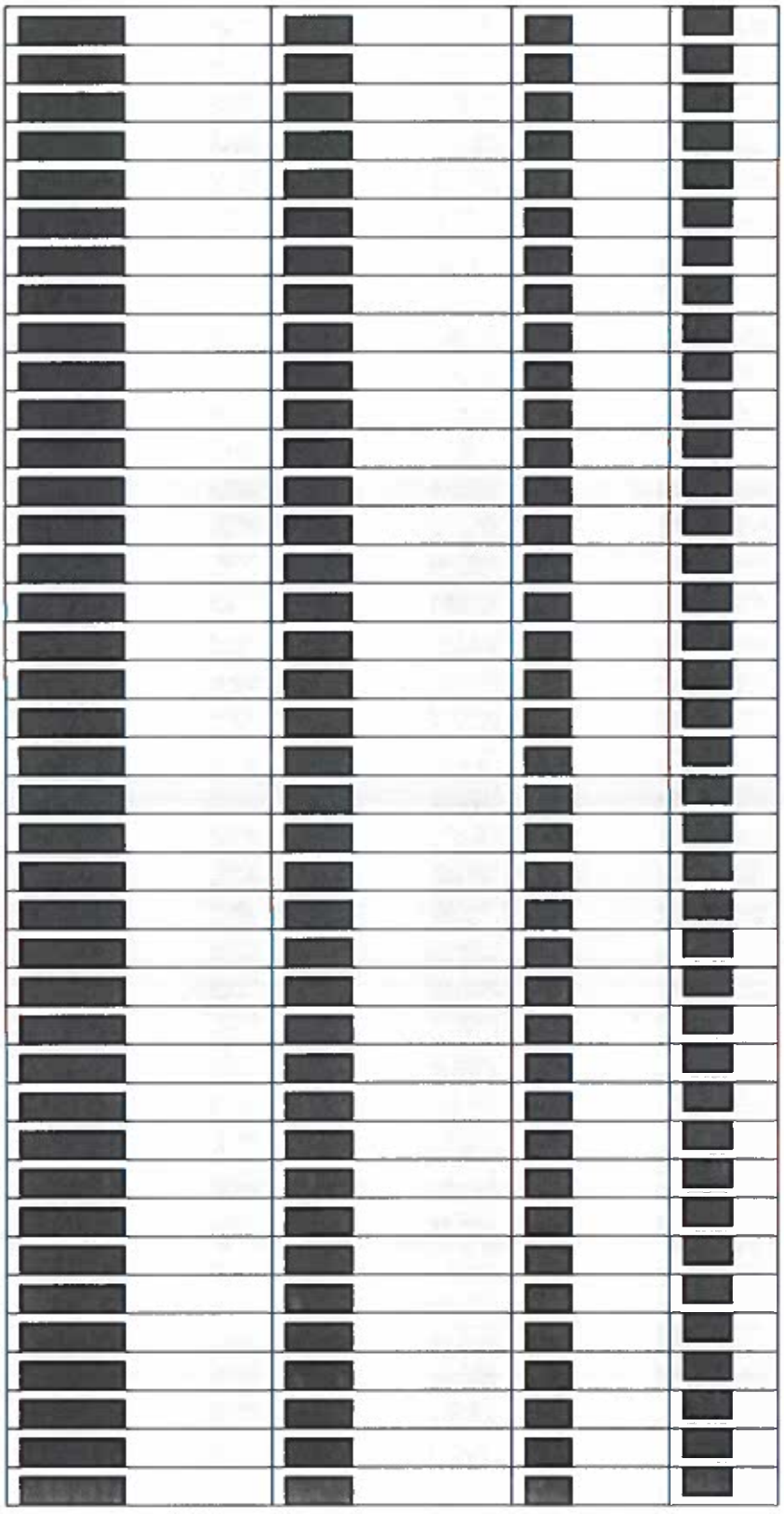


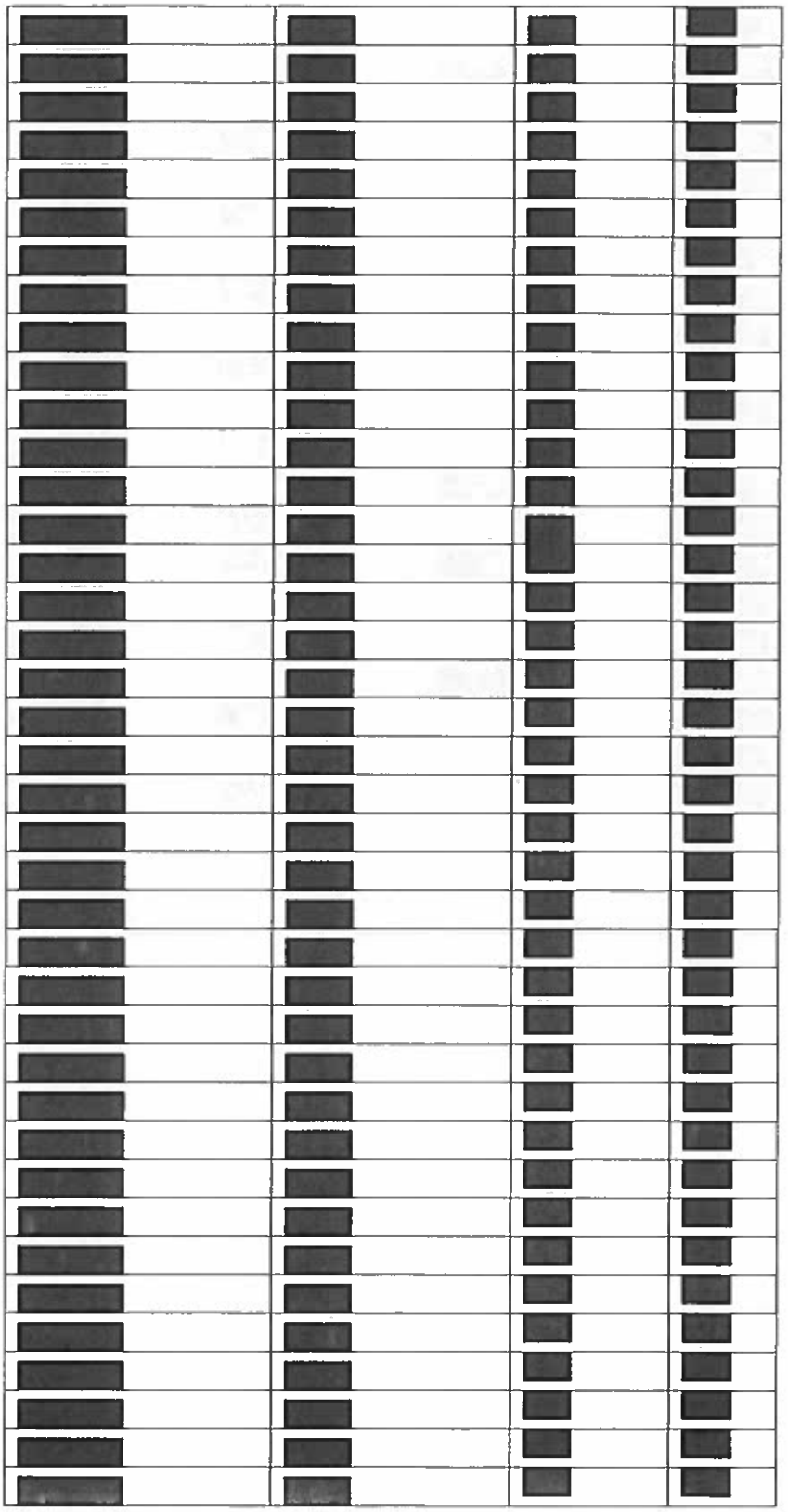


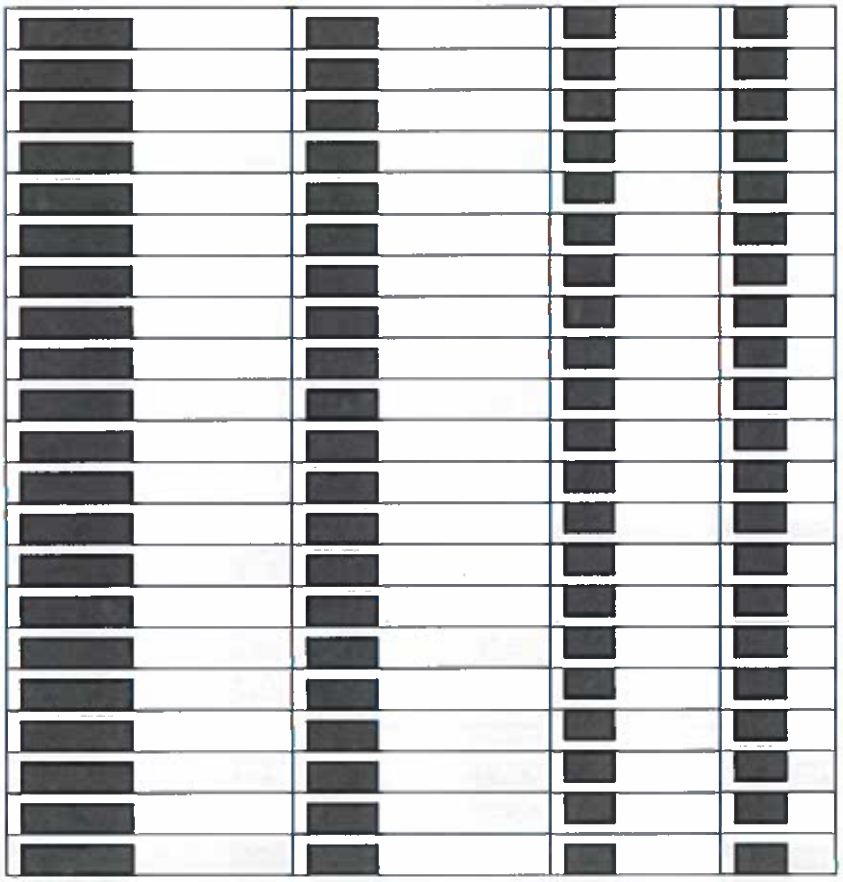












# Appendix C
## Groundwater Sampling (Non-radiological)
## Borehole #1 (2005-BH1)

| Sample Date: | | | 2015-10-05 | 2014-10-29 | 2013-09-18 | 2012-11-16 | 2011-11-01 | 2010-10-18 |
|---|---|---|---|---|---|---|---|---|
| Sample ID: | | | 2005-BH1 | 2005-BH1 | 2005-BH1 | 2005-BH1 | 2005-BH1 | 2005-BH1 |
| Parameter | UNITS | MDL | | | | | | |
| Alkalinity as CaCO3 | mg/L | 5 | 517 | 507 | 493 | 536 | 505 | 496 |
| Biochemical Oxygen Demand | mg/L | 1 | 1 | <1 | 2 | 12 | 1 | <1 |
| Chemical Oxygen Demand | mg/L | 5 | 13 | 13 | 5 | 25 | 15 | 15 |
| Chloride (Cl) | mg/L | 1 | 96 | 77 | 46 | 97 | 78 | 53 |
| Conductivity | µS/cm | 5 | 1260 | 1200 | 1110 | 1320 | 1190 | 1170 |
| Dissolved Organic Carbon | mg/L | 0.5 | 7.0 | 4.0 | 3.0 | 6.5 | 3.8 | 3 |
| N-NH3 (Ammonia) | mg/L | 0.02 | 819 | 0.18 | 0.12 | 0.12 | 0.1 | 0.07 |
| N-NO3 (Nitrate) | mg/L | 0.1 | 819 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| pH | n/a | n/a | 819 | 7.89 | 7.76 | 7.69 | 7.72 | 7.77 |
| Sulphate (SO4) | mg/L | 1 | 819 | 51 | 60 | 59 | 62 | 77 |
| TDS (COND - CALC) | mg/L | 5 | 819 | 780 | 722 | 858 | 774 | 761 |
| Total Suspended Solids | mg/L | 2 | 86 | 62 | 36 | 51 | 36 | 52 |
| Calcium (Ca) | mg/L | 1 | 125 | 120 | 90 | 115 | 108 | 86 |
| Magnesium (Mg) | mg/L | 1 | 66 | 52 | 39 | 61 | 52 | 38 |
| Sodium (Na) | mg/L | 2 | 59 | 70 | 102 | 68 | 66 | 101 |
| Barium (Ba) | mg/L | 0.01 | 0.14 | 0.12 | 0.07 | 0.08 | 0.07 | <0.1 |
| Boron (B) | mg/L | 0.01 | 0.10 | 0.09 | 0.05 | 0.1 | 0.09 | 0.1 |
| Iron (Fe) | mg/L | 0.03 | 1.01 | 0.76 | 0.35 | 0.69 | 0.19 | <0.3 |
| PHC F1 (C6-C10) | mg/L | 0.2 | <0.2 | <0.2 | <0.1 | <0.1 | <0.1 | <0.1 |
| PHC F2 (C10-C16) | mg/L | 0.2 | <0.2 | <0.2 | <0.1 | <0.1 | <0.1 | <0.1 |
| PHC F3 (C16-C34) | mg/L | 0.5 | <0.5 | <0.5 | 0.5<br><0.2* | <0.2 | <0.2 | <0.2 |
| PHC F4 (C34-C50) | mg/L | 0.5 | <0.5 | <0.5 | <0.2 | <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: | | | 2015-10-05 | 2014-10-29 | 2013-09-18 | 2012-11-16 | 2011-11-01 | 2010-10-18 |
|---|---|---|---|---|---|---|---|---|
| Sample ID: | | | 2005-BH2 | 2005-BH2 | 2005-BH2 | 2005-BH2 | 2005-BH2 | 2005-BH2 |
| **Parameter** | **UNITS** | **MDL** | | | | | | |
| Alkalinity as CaCO3 | mg/L | 5 | 337 | 329 | 314 | 308 | 309 | 296 |
| Biochemical Oxygen Demand | mg/L | 1 | <1 | <1 | 1 | 8 | 1 | <1 |
| Chemical Oxygen Demand | mg/L | 5 | 9 | 8 | <5 | 29 | 5 | 5 |
| Chloride (Cl) | mg/L | 1 | 141 | 139 | 89 | 76 | 84 | 76 |
| Conductivity | µS/cm | 5 | 1100 | 1080 | 888 | 834 | 828 | 822 |
| Dissolved Organic Carbon | mg/L | 0.5 | 2.8 | 2.2 | 1.6 | 5.7 | 1.6 | 1.4 |
| N-NH3 (Ammonia) | mg/L | 0.02 | <0.025 | 0.13 | 0.08 | <0.02 | <0.02 | <0.02 |
| N-NO3 (Nitrate) | mg/L | 0.1 | 0 | 0 | 0 | 0 | 0.24 | 0.52 |
| pH | | | 7.77 | 7.96 | 7.82 | 7.80 | 7.65 | 7.80 |
| Sulphate (SO4) | mg/L | 1 | 24 | 24 | 23 | 23 | 21 | 22 |
| TDS (COND - CALC) | mg/L | 5 | 715 | 702 | 577 | 542 | 538 | 534 |
| Total Suspended Solids | mg/L | 2 | 81 | 58 | 24 | 18 | 56 | 6 |
| Calcium (Ca) | mg/L | 1 | 124 | 125 | 97 | 92 | 94 | 97 |
| Magnesium (Mg) | mg/L | 1 | 48 | 44 | 37 | 33 | 32 | 34 |
| Sodium (Na) | mg/L | 2 | 36 | 38 | 30 | 29 | 25 | 26 |
| Barium (Ba) | mg/L | 0.01 | 0.03 | 0.02 | 0.02 | <0.01 | 0.02 | <0.1 |
| Boron (B) | mg/L | 0.01 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | <0.1 |
| Iron (Fe) | mg/L | 0.03 | 0.62 | 0.27 | 0.24 | 0.19 | <0.03 | <0.3 |
| PHC F1 (C6-C10) | mg/L | 0.2 | <0.2 | <0.2 | <0.1 | <0.1 | <0.1 | <0.1 |
| PHC F2 (C10-C16) | mg/L | 0.2 | <0.2 | <0.2 | <0.1 | <0.1 | <0.1 | <0.1 |
| PHC F3 (C16-C34) | mg/L | 0.5 | <0.5 | <0.5 | <0.2 | <0.2 | <0.2 | <0.2 |
| PHC F4 (C34-C50) | mg/L | 0.5 | <0.5 | <0.5 | <0.2 | <0.2 | <0.2 | <0.2 |

# Borehole #3 (2005-BH3)

| Sample Date: | | | 2015-10-05 | 2014-10-29 | 2013-09-18 | 2012-11-16 | 2011-11-01 | 2010-10-18 |
|---|---|---|---|---|---|---|---|---|
| Sample ID: | | | 2005-BH3 | 2005-BH3 | 2005-BH3 | 2005-BH3 | 2005-BH3 | 2005-BH3 |
| Parameter | UNITS | MDL | | | | | | |
| Alkalinity as CaCO3 | mg/L | 5 | 484 | 481 | 471 | 481 | 484 | 471 |
| Biochemical Oxygen Demand | mg/L | 1 | 2 | <1 | 2 | >21 | 1 | <1 |
| Chemical Oxygen Demand | mg/L | 5 | 12 | 11 | 8 | 61 | 10 | 13 |
| Chloride (Cl) | mg/L | 1 | 69 | 66 | 59 | 57 | 56 | 49 |
| Conductivity | µS/cm | 5 | 1150 | 1170 | 1140 | 1150 | 1120 | 1110 |
| Dissolved Organic Carbon | mg/L | 0.5 | 4.6 | 3.2 | 3.0 | 9.5 | 3.0 | 3.0 |
| N-NH3 (Ammonia) | mg/L | 0.02 | 0.07 | 0.26 | 0.06 | 0.06 | 0.03 | 0.13 |
| N-NO3 (Nitrate) | mg/L | 0.1 | 0.31 | 0.35 | <0.10 | 0.15 | 0.18 | 0.29 |
| pH | | | 7.81 | 8.00 | 7.81 | 7.88 | 7.81 | 7.79 |
| Sulphate (SO4) | mg/L | 1 | 63 | 70 | 77 | 78 | 74 | 83 |
| TDS (COND - CALC) | mg/L | 5 | 748 | 760 | 741 | 748 | 728 | 722 |
| Total Suspended Solids | mg/L | 2 | 22 | 18 | 8 | 8 | 6 | 9 |
| Calcium (Ca) | mg/L | 1 | 109 | 112 | 97 | 104 | 96 | 104 |
| Magnesium (Mg) | mg/L | 1 | 50 | 47 | 45 | 46 | 41 | 45 |
| Sodium (Na) | mg/L | 2 | 84 | 87 | 84 | 87 | 76 | 84 |
| Barium (Ba) | mg/L | 0.01 | 0.08 | 0.09 | 0.09 | 0.07 | 0.05 | <0.1 |
| Boron (B) | mg/L | 0.01 | 0.24 | 0.28 | 0.25 | 0.28 | 0.17 | 0.20 |
| Iron (Fe) | mg/L | 0.03 | 0.07 | 0.12 | 0.04 | <0.03 | <0.03 | <0.3 |
| PHC F1 (C6-C10) | mg/L | 0.2 | <0.2 | <0.2 | <0.1 | <0.1 | <0.1 | <0.1 |
| PHC F2 (C10-C16) | mg/L | 0.2 | <0.2 | <0.2 | <0.1 | <0.1 | <0.1 | <0.1 |
| PHC F3 (C16-C34) | mg/L | 0.5 | <0.5 | <0.5 | <0.2 | <0.2 | <0.2 | <0.2 |
| PHC F4 (C34-C50) | mg/L | 0.5 | <0.5 | <0.5 | <0.2 | <0.2 | <0.2 | <0.2 |

# Borehole #4 (2005-BH4)

| Sample Date: | | | 2015-10-05 | 2014-10-29 | 2013-09-18 | 2012-11-16 | 2011-11-01 | 2010-10-18 |
|---|---|---|---|---|---|---|---|---|
| Sample ID: | | | 2005-BH4 | 2005-BH4 | 2005-BH4 | 2005-BH4 | 2005-BH4 | 2005-BH4 |
| Parameter | UNITS | MDL | | | | | | |
| Alkalinity as CaCO3 | mg/L | 5 | 271 | 272 | 264 | 245 | 275 | 278 |
| Biochemical Oxygen Demand | mg/L | 1 | 1 | 2 | 2 | 5 | 1 | <1 |
| Chemical Oxygen Demand | mg/L | 5 | 11 | 13 | <5 | 18 | 5 | 13 |
| Chloride (Cl) | mg/L | 1 | 28 | 22 | 18 | 15 | 32 | 27 |
| Conductivity | µS/cm | 5 | 701 | 665 | 657 | 611 | 684 | 679 |
| Dissolved Organic Carbon | mg/L | 0.5 | 3.2 | 3.4 | 2.5 | 4.7 | 2.9 | 3.4 |
| N-NH3 (Ammonia) | mg/L | 0.02 | 0.18 | 0.35 | 0.29 | 0.12 | 0.14 | 0.19 |
| N-NO3 (Nitrate) | mg/L | 0.1 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| pH | | | 7.85 | 8.10 | 7.97 | 7.92 | 7.53 | 7.90 |
| Sulphate (SO4) | mg/L | 1 | 56 | 58 | 55 | 56 | 52 | 45 |
| TDS (COND - CALC) | mg/L | 5 | 456 | 432 | 427 | 397 | 445 | 441 |
| Total Suspended Solids | mg/L | 2 | <2 | 4 | <2 | 10 | 4 | <2 |
| Calcium (Ca) | mg/L | 1 | 54 | 45 | 36 | 36 | 56 | 41 |
| Magnesium (Mg) | mg/L | 1 | 22 | 18 | 16 | 14 | 21 | 17 |
| Sodium (Na) | mg/L | 2 | 70 | 78 | 81 | 78 | 47 | 76 |
| Barium (Ba) | mg/L | 0.01 | 0.08 | 0.08 | 0.07 | 0.05 | 0.08 | <0.1 |
| Boron (B) | mg/L | 0.01 | 0.21 | 0.27 | 0.22 | 0.24 | 0.11 | <0.1 |
| Iron (Fe) | mg/L | 0.03 | 0.69 | 1.26 | 0.29 | 0.71 | 0.23 | <0.3 |
| PHC F1 (C6-C10) | mg/L | 0.2 | <0.2 | <0.2 | <0.1 | <0.1 | <0.1 | <0.1 |
| PHC F2 (C10-C16) | mg/L | 0.2 | <0.2 | <0.2 | <0.1 | <0.1 | <0.1 | <0.1 |
| PHC F3 (C16-C34) | mg/L | 0.5 | <0.5 | <0.5 | <0.2 | <0.2 | <0.2 | <0.2 |
| PHC F4 (C34-C50) | mg/L | 0.5 | <0.5 | <0.5 | <0.2 | <0.2 | <0.2 | <0.2 |

## Appendix D.1
## 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 D.2
# Ads Placed in Local Newspaper


Figure D.2a: Copy of ad placed in the May and June 2015 issues of the *Kanata Kourier*


Figure D.2b: Copy of ad placed in the December 2015 issue of the *Kanata Kourier*