



Regulatory Oversight Report on the Use of Nuclear Substances in Canada: 2014



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Executive summary

The *Regulatory Oversight Report on the Use of Nuclear Substances in Canada: 2014* summarizes the safety performance of approximately 1,700 licensees, holding a total of 2,415 licences, authorized by the Canadian Nuclear Safety Commission (CNSC) for the use of nuclear substances and prescribed equipment in four nuclear industry sectors: medical, industrial, academic and research, and commercial, as well as two high-energy research particle accelerator facilities.

The CNSC regulates the nuclear industry in Canada through a comprehensive program of licensing, certification, compliance verification and enforcement. For each nuclear industry sector described in this report, CNSC staff conduct inspections, assessments, reviews and evaluations of licensee programs, processes and safety performance.

CNSC staff use a well-established safety and control area (SCA) framework in evaluating each licensee's safety performance. The framework includes 14 SCAs covering all technical areas of regulatory oversight. Each SCA is subdivided into specific areas that define its key components. For the purpose of this report, safety performance is measured by examining:

- licensees' regulatory compliance in select SCAs
- occupational doses to workers
- reported events

In 2014, as part of their ongoing regulatory oversight of licensees, CNSC staff conducted compliance verification activities consisting of field inspections, desktop reviews and technical assessments of licensee activities. The evaluations of findings for the SCAs covered in this report show that, overall, licensees made adequate provisions for the protection of the health, safety and security of persons and the environment from the use of nuclear substances, and took the measures required to implement Canada's international obligations. Based on this, CNSC staff conclude that the use of nuclear substances in Canada is safe.

Occupational doses to workers

Persons engaged in CNSC-licensed activities may be occupationally exposed to radiation. Regulatory compliance with radiation protection programs established under the CNSC licences ensures that licensees keep radiation doses to persons below CNSC regulatory limits and as low as reasonably achievable (ALARA). This ensures that there are no adverse impacts as a result of occupational doses. In 2014, doses were monitored for 60,407 workers in the four nuclear industry sectors and two high-energy research particle accelerator facilities covered in this report. Of these workers, 23,688 were designated as nuclear energy workers (NEWs).

In 2014, workers' occupational exposures to radiation continued to be very low. More than 99.9% of the 60,407 workers received doses below their applicable regulatory dose limits. This followed a trend consistent with previous reporting years. No NEWs exceeded the one- or five-year dose limits of 50 millisieverts (mSv) or 100 mSv, respectively.

There were two separate situations where, based on dosimetry results, workers (who were not NEWs) exceeded the annual regulatory dose limit of 1 mSv. In both situations, licensees responded in accordance with the *Radiation Protection Regulations*. Neither situation resulted in any immediate adverse health consequences to the workers.

Inspections

In 2014, the CNSC conducted 1,453 inspections across the four nuclear industry sectors (medical, industrial, academic and research, and commercial) and the two high-energy research particle accelerator facilities. Licensees showed satisfactory compliance ratings in the operating performance, radiation protection and security SCAs. Non-compliances identified during inspections are systematically tracked until licensees have addressed them to the satisfaction of the CNSC.

- **Operating performance:** Licensees continued to make adequate provisions for the health, safety and security of persons, and protection of the environment. Licensees continued to demonstrate good performance within this SCA, with improvements since 2010 in the medical and industrial sectors. CNSC staff found that 88.4% of inspected licensees have satisfactory regulatory compliance.
- **Radiation protection:** Licensees continued to ensure that exposure of workers and the public to ionizing radiation remains ALARA. In general, licensees continued to demonstrate good performance within this SCA, with steady improvements since 2010 among all four sectors. CNSC staff found that 89.1% of inspected licensees have satisfactory regulatory compliance.
- **Security:** Licensees demonstrated that they have adequate provisions in place to prevent the loss, sabotage, illegal use, illegal possession or illegal removal of sealed sources in their care and control. Overall, 94.8% of inspected licensees were found to be in regulatory compliance with this SCA.

Enforcement actions

In 2014, the CNSC took escalated compliance enforcement actions in 19 instances, including the issuance of 12 orders and seven administrative monetary penalties, to ensure that the health and safety of workers, the Canadian public and the environment were being adequately protected. Most of the enforcement actions were taken against licensees in the industrial sector, consistent with trends from previous years. All licensees to whom orders were issued have implemented corrective measures, which were reviewed by CNSC staff and found to be satisfactory. All seven administrative monetary penalties issued for the four nuclear industry sectors covered in this report have been paid. Further details on the enforcement actions taken in 2014 are presented in section [4.2.5](#).

Reported events

Reported events have been ranked using the International Nuclear and Radiological Event Scale (INES). INES is a tool originally introduced by the International Atomic Energy Agency to classify events at nuclear power plants. Since 2006, the use of the scale has been extended to include other radiological events. Further details on the use of the scale are presented in section [3.1](#).

There were 147 events reported to the CNSC related to nuclear substances involving the licensees covered in this report – all of which were assessed by CNSC staff. Of these, 141 were ranked as INES Level 0 (no safety significance) and five were ranked as Level 1 (anomaly) due to the amount of nuclear substances involved and the type of event reported (loss of nuclear substances). The remaining event – ranked as Level 2 (incident) – resulted in 10 persons receiving radiation doses above the public dose limit of 1 mSv. The event occurred in an industrial setting and was a result of the workers being inadvertently present in the proximity of two fixed nuclear gauges mistakenly left in the open position with the source exposed. None of the individuals was a NEW. The highest dose received by any individual in this event was 10.5 mSv (which amounts to approximately 20% of the annual dose limit for NEWs). There were no releases of nuclear substances into the environment above regulatory limits. No other members of the public were exposed to radiation in this incident.

For all of the events reported, licensees implemented appropriate response measures to mitigate the impacts of the events and to limit radiation exposure to workers and the public. These measures were reviewed by CNSC staff and found to be satisfactory.

1 Background

CNSC mission

The mission of the Canadian Nuclear Safety Commission (CNSC) is to regulate the use of nuclear energy and materials to protect health, safety, security and the environment, and to implement Canada's international commitments on the peaceful use of nuclear energy; and to disseminate objective scientific, technical and regulatory information to the public.

For a comprehensive overview of the CNSC and its activities, readers are invited to consult the CNSC's [annual report](#).

Regulatory oversight

The CNSC regulates the nuclear industry in Canada through a comprehensive program of licensing, certification, compliance verification and enforcement. For each nuclear industry sector described in this report (medical, industrial, academic and research, and commercial), CNSC staff conduct inspections, assessments and reviews to evaluate each licensee's programs, processes and safety performance. The safe use of nuclear substances in Canada is a reflection of licensees' compliance with the [Nuclear Safety and Control Act](#) (NSCA) as well as its associated regulations and specific conditions set out in CNSC licences. The NSCA, its regulations and the licences, require that licensees implement and maintain appropriate programs to ensure the safety of nuclear activities, minimize doses to workers and the public, and minimize consequences of events.

Regulatory process

The CNSC uses a risk-informed regulatory approach, applying resources and regulatory oversight commensurate with the risk associated with the regulated activity. The CNSC's regulatory effort, from a licensing and compliance perspective, is derived from this risk-informed approach.

For the activities covered in this report, the CNSC's risk-informed regulatory program is applied in the following way:

- Each licensed activity is assigned a weighting factor – a coefficient assigned to represent the activity's relative significance with respect to risk.
 - Factors considered in weighting include the form of the nuclear substances (sealed source, unsealed source or radiation device), where the material is being used (work site or controlled facility), and the compliance history of licensees conducting their licensed activities.
- Generally, all licensees are then inspected at a predetermined frequency of five years or less, based on their risk ranking.

The risk-informed regulatory program provides:

- a risk ranking that recognizes the potential safety impact of the licensed activity
- effective and informed allocation of regulatory oversight effort according to the risk ranking by licensed activity and the licensee performance history
- effective, transparent, consistent and comprehensive regulatory oversight

Licensing process

The possession, use, transfer, import, export, abandonment and storage of nuclear substances must be licensed by the CNSC when the amount of nuclear substance involved is greater than its exemption quantity (under subsection 30(3) of the [Nuclear Substances and Radiation Devices Regulations](#)). In addition, facilities containing certain types of [Class II prescribed equipment](#), such as particle accelerators, must also be licensed prior to the construction, operation or decommissioning of such a facility. A licence is also required to service radiation devices that contain nuclear substances, as well as Class II prescribed equipment.

To obtain a licence, an applicant must submit an application to the CNSC. The CNSC will issue a licence only when the applicant:

- is deemed qualified to carry on the activity that the licence will authorize
- has demonstrated that it will protect the health and safety of persons and the environment
- has demonstrated that it will maintain national security
- has confirmed that it will adhere to international obligations to which Canada has agreed

The licensing process includes a thorough technical assessment by CNSC staff of applications submitted to the CNSC. All licence applications are assessed based on the risk ranking of proposed licensed activities.

To ensure that the CNSC's expectations for licence applications are clear and to facilitate proponents' interactions with the regulator, the CNSC has produced a series of licence application guides that outline application expectations. Available from the [CNSC website](#), these guides are reviewed regularly to ensure that they provide useful guidance to the regulated community, thus facilitating CNSC licensing reviews and minimizing regulatory burden.

Existing licensees follow the same process as new applicants when applying for licence renewals. The CNSC decision to renew a licence is based on the application information submitted as well as a satisfactory compliance performance history. This includes a review of compliance information such as inspection results, reported incidents and events, and annual compliance reports.

If the application satisfies the above requirements, the Commission, or a designated officer authorized by the Commission, may issue a licence authorizing the licensee to conduct the activities requested in the application. The licence includes provisions that define and limit the scope of the authorized activities, as well as specific conditions that must be fulfilled by the licensee when conducting those activities.

Certification of prescribed equipment

All radiation devices and prescribed equipment, including certain types of transport packages, must be certified by the CNSC before they can be used in Canada.

An application for certification must be submitted to the CNSC in order for a certificate to be issued. Upon receipt, CNSC staff conduct a thorough technical review of the information contained in the submission to determine if:

- the radiation device or prescribed equipment meets all CNSC regulatory requirements and is safe to use
- adequate measures are in place in respect of their use in order to protect the environment, national security, and the health and safety and security of persons

If satisfied that the design meets the above requirements, the Commission, or a designated officer authorized by the Commission, may issue a certificate for the prescribed equipment or radiation device.

CNSC regulatory documents [RD/GD-352, Design, Testing and Performance of Exposure Devices](#) and [RD/GD-254, Licence Application Guide: Certification of Radiation Devices or Class II Prescribed Equipment](#) outline CNSC expectations for the certification of prescribed equipment.

Certification of Class II radiation safety officers

All licensees that operate Class II nuclear facilities or that service Class II prescribed equipment must have a certified radiation safety officer (RSO) and also designate a qualified temporary replacement. The person occupying the position of RSO has the responsibility to ensure that licensed activities are conducted safely and all regulatory expectations are met.

There are two components to the certification process:

- assessment of the candidate’s qualifications to perform the duties of the position, based on the submitted application
- assessment of the candidate’s knowledge, based on an examination

If the candidate is able to clearly demonstrate to the CNSC their knowledge, as it relates to the RSO position within their organization, the Commission or a designated officer authorized by the Commission will certify the candidate in the position of RSO.

The process for certification of Class II RSOs, along with guidance for applicants, is outlined in [REGDOC-2.2.3, Personnel Certification: Radiation Safety Officers for Class II Nuclear Facilities and Prescribed Equipment](#).

Licensing and certification decisions

In 2014, designated officers in the CNSC Directorate of Nuclear Substance Regulation made a total of 2,273 licensing and certification decisions. As shown in Table 1, the majority of these were licensing decisions.

Table 1: Licensing and certification decisions in 2014

Type of decision	
Licensing (issuance of new licences, licence renewals, licence amendments, licence revocations and licence transfers)	2,162
Certification of prescribed equipment	98
Certification of Class II RSOs	13

Compliance verification and enforcement

A critical part of the CNSC's regulatory oversight is its compliance and verification program, which measures licensee compliance with CNSC regulatory requirements. Regular inspections and desktop evaluations verify that licensees comply with the NSCA and regulations, as well as the conditions of their licences.

The CNSC verifies compliance by conducting site inspections and by reviewing licensee documentation and operational activities. Licensees are required to report routine performance data, through annual compliance reports, and unusual occurrences. In addition, the CNSC conducts investigations of unplanned events or accidents involving nuclear substances.

The CNSC uses a graded approach to enforcement to encourage compliance and deter future non-compliances. When a non-compliance (or a continued non-compliance) has been identified, CNSC staff assess its risk and safety significance in order to determine the appropriate enforcement action. The chosen enforcement action is commensurate with the risk that the non-compliance presents to the environment, the health and safety of workers and members of the public, and to national security. Enforcement actions may include a variety of actions with different levels of severity, including orders and administrative monetary penalties. Each enforcement action is a discrete and independent response to a non-compliance.

Safety and control area framework

To ensure comprehensive regulatory oversight and reporting, CNSC staff have developed a set of safety and control areas (SCAs). SCAs have been in use for a number of years, and represent a well-established set of technical areas that have proven effective in evaluating licensee safety performance of regulated facilities and activities under the CNSC's purview. Each SCA is subdivided into specific areas that define its key components. The CNSC has defined 14 SCAs:

- management system
- human performance management
- operating performance
- safety analysis
- physical design
- fitness for service
- radiation protection
- conventional health and safety
- environmental protection
- emergency management and fire protection
- waste management
- security
- safeguards and non-proliferation
- packaging and transport

For the purpose of this report, safety performance in the four nuclear sectors is measured by examining the licensees' regulatory compliance in three selected SCAs: operating performance, radiation protection and security. This report also considers doses to

workers and reported events. Because of their greater complexity, the two high-energy research particle accelerator facilities are subject to more frequent and more detailed CNSC compliance verification activities than other licensees covered in this report. Consequently, the safety performance for these two facilities is measured against all of the 14 SCAs using an approach consistent with reporting for other major CNSC-regulated facilities in Canada.

2 Introduction

The *Regulatory Oversight Report on the Use of Nuclear Substances in Canada: 2014* focuses on the results of compliance verification and enforcement activities for licensees that use nuclear substances and prescribed equipment in four nuclear sectors:

- medical
- industrial
- academic and research
- commercial

It also includes Canada's two high-energy research particle accelerator facilities: TRIUMF Accelerators Inc., located in Vancouver, BC, and Canadian Light Source Inc., located in Saskatoon, SK. It does not cover uranium mines and mills, waste facilities, dosimetry services or other Class I nuclear facilities such as nuclear power plants and nuclear research reactors. This annual regulatory oversight report provides regulatory information for the 2014 calendar year.

2.1 Compliance programs

CNSC staff establish compliance verification plans for each nuclear sector, based on risk-informed regulatory oversight of the activities of the sectors, to determine appropriate levels of regulatory monitoring and control. Modifications to the compliance plans are made on an ongoing basis in response to events and changes in licensee performance.

In 2014, CNSC staff conducted 1,453 inspections across the four nuclear sectors (medical, industrial, academic and research, and commercial) and two high-energy research particle accelerator facilities. Each inspection resulted in one inspection report per licensed activity inspected during the visit. Each inspection report provided an overall rating for each applicable safety and control area; these are included in this report. The CNSC utilized a risk-informed decision process for planning and conducting compliance activities, commensurate with the risk associated with the various uses of nuclear substances within those sectors and facilities. CNSC staff also verified compliance through desktop reviews of licensee annual compliance reports, licence applications and licensee program documents.

3 Overview

3.1 What's new in this report

- Security inspection ratings
 - The results of the inspection rating for the security safety and control area (SCA) have been included in this report. These ratings can be found in section 4.2.4.
- Reported events
 - Details of events reported by licensees are presented at the overall level rather than by sector, with the exception of those related to high-energy research particle accelerator facilities. Reported events are found in section 4.2.6 of this report.
 - Reported events have been ranked using the International Nuclear and Radiological Event Scale (INES), a tool for communicating the safety significance of nuclear and radiological events to the public. This tool allows the establishment of a proper perspective of an event's safety significance. [Additional information on the INES tool](#) can be found on the International Atomic Energy Agency (IAEA) website.

The scale has been used to classify events at nuclear power plants since 1990 and has been extended over the years to apply to all nuclear industry installations. By 2006, it had been adapted to all events associated with the transport, storage and use of radioactive sources and nuclear substances. Note that the scale is not a tool to compare safety performances among facilities or organizations, but to effectively communicate the safety significance of events.

- For the purposes of this report, the scale was applied to all events associated with the transport, storage and use of radioactive sources and nuclear substances reported by licensees within the four nuclear sectors covered under this report. The scale was also used to rate events that resulted in exposures to workers and members of the public as a result of events. Section 4.2.6 provides details on the events reported by licensees in 2014.

To validate the CNSC's use of the scale for nuclear substance-related events, CNSC staff reviewed historical data in the IAEA INES database. This data is included in Appendix A for reference. The review confirmed that the CNSC's ranking and number of nuclear substance-related events is on par with other countries.

Figure 1 provides an overview of the various INES levels.

Figure 1: International Nuclear and Radiological Event Scale (source: IAEA)

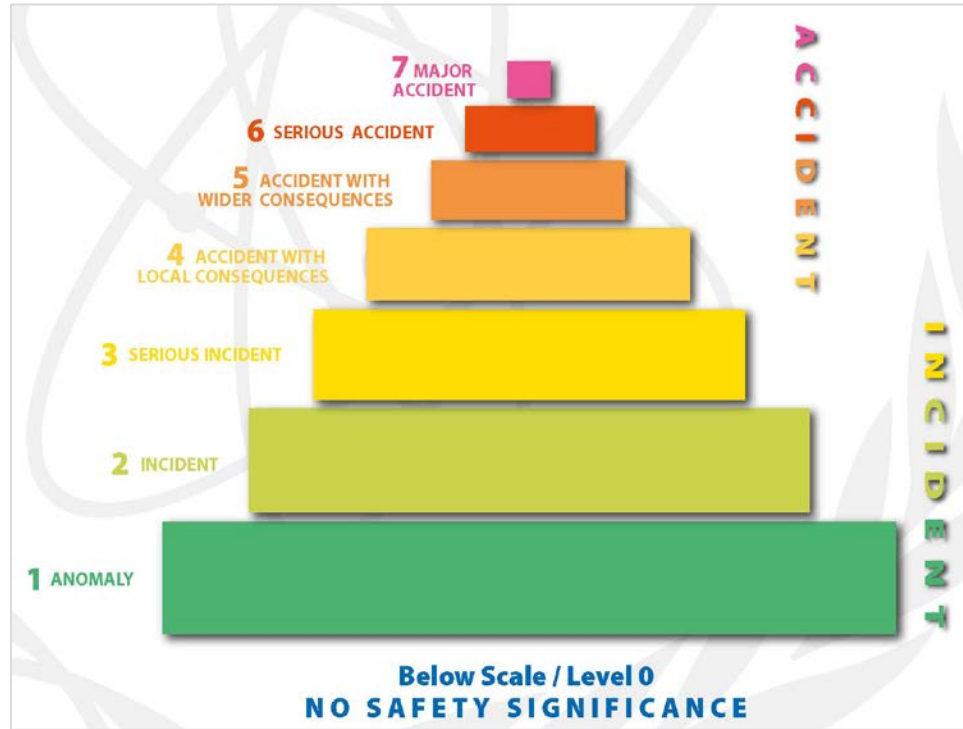


Figure 2 provides a description of nuclear and radiological events along with their respective levels, while Figure 3 provides examples of events involving radioactive sources in use, storage or transport along with their associated levels.

Figure 2: Description nuclear and radiological events along with their respective levels (source: IAEA)

INES Level	People and Environment	Radiological Barriers and Control	Defence-in-Depth
Major Accident Level 7	<ul style="list-style-type: none"> Major release of radioactive material with widespread health and environmental effects requiring implementation of planned and extended countermeasures. 		
Serious Accident Level 6	<ul style="list-style-type: none"> Significant release of radioactive material likely to require implementation of planned countermeasures. 		
Accident with Wider Consequences Level 5	<ul style="list-style-type: none"> Limited release of radioactive material likely to require implementation of some planned countermeasures. Several deaths from radiation. 	<ul style="list-style-type: none"> Severe damage to reactor core. Release of large quantities of radioactive material within an installation with a high probability of significant public exposure. This could arise from a major criticality accident or fire. 	
Accident with Local Consequences Level 4	<ul style="list-style-type: none"> Minor release of radioactive material unlikely to result in implementation of planned countermeasures other than local food controls. At least one death from radiation. 	<ul style="list-style-type: none"> Fuel melt or damage to fuel resulting in more than 0.1% release of core inventory. Release of significant quantities of radioactive material within an installation with a high probability of significant public exposure. 	
Serious Incident Level 3	<ul style="list-style-type: none"> Exposure in excess of ten times the statutory annual limit for workers. Non-lethal deterministic health effect (e.g., burns) from radiation. 	<ul style="list-style-type: none"> Exposure rates of more than 1 Sv/h in an operating area. Severe contamination in an area not expected by design, with a low probability of significant public exposure. 	<ul style="list-style-type: none"> Near accident at a nuclear power plant with no safety provisions remaining. Lost or stolen highly radioactive sealed source. Misdelivered highly radioactive sealed source without adequate procedures in place to handle it.
Incident Level 2	<ul style="list-style-type: none"> Exposure of a member of the public in excess of 10 mSv. Exposure of a worker in excess of the statutory annual limits. 	<ul style="list-style-type: none"> Radiation levels in an operating area of more than 50 mSv/h. Significant contamination within the facility into an area not expected by design. 	<ul style="list-style-type: none"> Significant failures in safety provisions but with no actual consequences. Found highly radioactive sealed orphan source, device or transport package with safety provisions intact. Inadequate packaging of a highly radioactive sealed source.
Anomaly Level 1			<ul style="list-style-type: none"> Overexposure of a member of the public in excess of statutory annual limits. Minor problems with safety components with significant defence-in-depth remaining. Low activity lost or stolen radioactive source, device or transport package.
NO SAFETY SIGNIFICANCE (Below Scale/Level 0)			

Figure 3: Examples of events involving radiation sources and transport (source: IAEA)

	People and Environment	Defence-in-Depth
7		
6		
5	<i>Goiânia, Brazil, 1987</i> — Four people died and six received doses of a few Gy from an abandoned and ruptured highly radioactive Cs-137 source.	
4	<i>Fleurus, Belgium, 2006</i> — Severe health effects for a worker at a commercial irradiation facility as a result of high doses of radiation.	
3	<i>Yanango, Peru, 1999</i> — Incident with radiography source resulting in severe radiation burns.	<i>İkitelli, Turkey, 1999</i> — Loss of a highly radioactive Co-60 source.
2	<i>USA, 2005</i> — Overexposure of a radiographer exceeding the annual limit for radiation workers.	<i>France, 1995</i> — Failure of access control systems at accelerator facility.
1		Theft of a moisture-density gauge.

- Management of disused, spent and orphaned sources
 - Disused, spent and orphaned sources are a growing concern for nuclear regulators worldwide. In Canada, there were some events reported to the CNSC in 2014 that underlined the importance of implementing a national strategy for addressing this issue. The events and details of the steps taken to address this issue are presented in section 4.2.6 of this report.
- Section on high-energy research particle accelerator facilities
 - Past editions of this report provided a section on high-energy research particle accelerator facilities as an appendix. For the 2014 edition, information related to high-energy research particle accelerator facilities is incorporated directly into the body of the report in section 9.

3.2 Sectors

3.2.1 Medical

Licensees in the medical sector use nuclear substances and operate accelerators and other equipment for diagnostic and therapeutic purposes in hospitals and medical clinics. Medical applications using radiopharmaceuticals are designed to target specific tissues and organs, allowing for the delivery of nuclear substances to specific areas of the body for diagnostic testing or treatment.

Diagnostic nuclear medicine studies assist in the diagnosis of medical conditions based on the physiological functions of organs, tissues or bones. Radiopharmaceuticals containing nuclear substances such as technetium-99m, gallium-67 and fluorine-18 are administered to patients for imaging purposes. Examples of common nuclear medicine diagnostic procedures include myocardial perfusion scans (to visualize heart function and blood flow), bone scans (to evaluate bone metabolism, infection or tumours) and renal scans (to evaluate kidney function).

Radioisotopes are also used in many therapeutic procedures. For example, iodine-131 is used to treat diseases of the thyroid gland, while other isotopes such as yttrium-90 may be used in conjunction with antibodies for site-specific treatment of certain cancers.

Medical linear accelerators (as shown in Figure 4) and teletherapy and brachytherapy equipment are also used for therapeutic procedures. These devices are used to treat cancer by delivering carefully controlled doses of radiation to cancerous tissue.

Veterinary nuclear medicine uses techniques similar to those employed in human nuclear medicine. Veterinary clinics across the country offer a wide range of diagnostic and therapeutic nuclear medicine procedures and, in some cases, radiation therapy treatment using medical accelerators or teletherapy.

The results of CNSC staff evaluation of the regulatory performance of all medical sector licensees inspected in 2014 are included in the overall results. The following three subsectors are highlighted in further detail: diagnostic and therapeutic nuclear medicine, radiation therapy and veterinary nuclear medicine.

Figure 4: Linear accelerator used in cancer treatment



3.2.2 Industrial

Licensees in the industrial sector use nuclear substances either in industrial facilities or as part of fieldwork or construction. Typical applications include the measurement of physical parameters such as density, moisture content and geological composition in civil engineering. They are also used for material examination in civil engineering, and level

and flow rate in industrial facilities (such as oil and gas exploration, mining and manufacturing). These nuclear substances are found in radiation devices such as fixed nuclear gauges, as shown in Figure 5, which monitor production processes in many industries, and portable nuclear gauges, as shown in Figure 6.

Portable gauges are often used to measure moisture and density in soil, and the compaction of asphalt in road construction. In industrial radiography, nuclear substances are used in exposure devices for the non-destructive examination of materials. Persons operating an exposure device, or supervising a trainee in the operation of such device, must be certified by the CNSC. Exposure devices used for industrial radiography are engineered and operated using multiple safety barriers to reduce the potential for accidental occupational exposure. One example is dense material, such as depleted uranium, which shields people against the intense radioactivity of the source contained inside the device.

Industrial applications of nuclear substances are as varied as the processes to which they are applied. Specific radioisotopes are chosen based on the type of radiation they emit, the intensity of their radiation and the intended application. For example, the nuclear substance chosen for industrial radiography depends on the size and density of the material to be imaged. Cobalt-60, with its high-energy gamma radiation, is used for large structures and dense materials such as structural concrete. When the material does not require the penetrating power of cobalt-60, other nuclear substances, such as iridium-192 or selenium-75, are used instead. Cesium-137, another gamma emitter, is most commonly used in portable and fixed gauges to measure density. In other industrial uses, such as measuring moisture content, portable gauges most commonly use neutron-emitting nuclear substances such as americium-241/beryllium.

The results of CNSC staff evaluation of the regulatory performance of all industrial sector licensees inspected in 2014 are included in the overall results. The following four subsectors are highlighted in further detail: industrial radiography, oil well logging, portable gauge and fixed gauge.

Figure 5: Mounted fixed nuclear gauge



Figure 6: Worker using portable gauge during construction



3.2.3 Academic and research

Licensed activities in the academic and research sector are conducted in universities, colleges and research laboratories, and focus mainly on biological and biomedical research that primarily uses open (unsealed) nuclear substances, as shown in Figure 7. This sector also uses sealed sources, radiation devices and accelerators for teaching, and for pure and applied research, as well as irradiators to irradiate cells or samples in laboratories.

The results of CNSC staff evaluation of the regulatory performance of all academic and research sector licensees inspected in 2014 are included in the overall results. The laboratory studies and consolidated uses of nuclear substances subsector is highlighted in further detail below.

CNSC laboratory

As part of its regulatory functions, the CNSC conducts certain activities regulated under the *Nuclear Safety and Control Act* (NSCA). To ensure oversight transparency, CNSC management has organizationally separated its role as a licensee (which resides within the Technical Support Branch) from its role as a regulator (under the responsibility of the Regulatory Operations Branch).

The laboratory provides calibration services and analytical services for both groups of CNSC staff, including CNSC inspectors. To provide these services, the CNSC holds two licences: one for its gamma calibration irradiator, located at its laboratory in Ottawa, and a second for consolidated uses of nuclear substances that covers all other activities conducted by the CNSC at its laboratory or elsewhere in Canada. Both licences were issued in accordance with the NSCA and are regulated using the same licensing and compliance verification processes that would apply to other, similar licensees.

Under analytical services, the laboratory analyzes samples that are taken for the Independent Environmental Monitoring Program, as well as those taken during CNSC inspections. The CNSC laboratory also participates in the Nuclear Forensic Capability Development Project under the Canadian Safety and Security Program. The CNSC laboratory provides the calibration services for all radiation instrumentation used by CNSC staff, including inspectors at nuclear power plants and those in CNSC regional offices.

Both the sample analysis and the radiation instrumentation calibration services require the use of radioactive substances and devices. The laboratory has an inventory of sealed sources that are used at the lab and are loaned out to internal permit holders. The inventory of sealed sources is quite large; over 500 sealed sources are stored at the laboratory.

Figure 7: Use of open sources in a laboratory



There are two internal permit holders under the consolidated uses licence: the laboratory itself, and the CNSC's Emergency Management Programs Division, which borrows sources for training for radiological emergencies for first responders within Canada.

The CNSC laboratory is responsible for the safe conduct of activities under both licences. In this report, the CNSC laboratory is included in the laboratory studies and consolidated use of nuclear substances subsector. Its specific performance results are provided to ensure that the CNSC, as both regulator and licensee, is reporting on its licensed activities in a transparent manner.

3.2.4 Commercial

The commercial sector encompasses a number of licensed activities related to the production, processing, storage and distribution of nuclear substances, the calibration of radiation detection instruments, as well as the servicing of radiation devices and Class II prescribed equipment for commercial purposes. Figure 8 shows the internal components of a partially assembled cyclotron used for the production of radioisotopes.

Nuclear substances are also found in devices that are commonly used by Canadians, such as smoke detectors. Such devices may not require a licence for their possession by the end user; however, their manufacture and initial distribution in Canada are licensed by the CNSC.

The results of CNSC staff evaluation of the regulatory performance of all commercial sector licensees inspected in 2014 are included in the overall results. The following five subsectors are highlighted in further detail: operation of isotope production accelerators, processing of nuclear substances, distribution of nuclear substances, servicing of radiation devices and prescribed equipment, and calibration of radiation devices and prescribed equipment.

Figure 8: Isotope production accelerator (cyclotron) (source: University of Alberta)



3.2.5 High-energy research particle accelerator facilities

There are two major high-energy research particle accelerator facilities operating under CNSC licences in Canada: TRIUMF Accelerators Inc. (TRIUMF) and Canadian Light Source Inc. (CLS).

TRIUMF, located on the University of British Columbia campus, is Canada's national laboratory for nuclear and particle physics research and related sciences. TRIUMF is also a major producer of radioisotopes used for medical diagnostic procedures. It is owned and operated as a joint venture by a consortium of 18 Canadian universities. TRIUMF operates one 520 mega-electron volt (MeV) cyclotron accelerator facility, shown in

Figure 9, four smaller cyclotrons facilities, and three linear accelerator facilities. The main cyclotron has been in operation for more than 40 years.

CLS operates a synchrotron facility, shown in Figure 10, on the University of Saskatchewan campus in Saskatoon. The facility consists of three major accelerator systems: a 300 MeV linear accelerator, a booster ring that accelerates electrons up to 2.9 giga-electron volts (GeV) and a storage ring that keeps electrons circulating at 2.9 GeV for several hours. The facility produces synchrotron radiation that is used as a light source for experiments in diverse fields such as biology, materials research, atomic and molecular science, earth sciences, pharmaceuticals, biomedical research and electronics. Synchrotron radiation is electromagnetic radiation produced by magnetic bending of high-energy electrons in a storage ring by different devices (magnets, wigglers and undulators). The light ranges from infrared through the visible spectrum to ultraviolet and X-rays. The experiments take place in optical beam lines tangential to the storage ring. The facility has been in operation since 2005.

In accordance with the CNSC risk-informed regulatory approach described previously in section 1, TRIUMF and CLS fall under the major facilities category. Both facilities have licence conditions handbooks and are subject to more frequent and more detailed compliance verification activities than other licensees covered in this report. Consequently, the compliance performance for these two facilities is addressed in a separate section. This approach is consistent with reporting for other major CNSC-regulated facilities in Canada, such as those on [uranium and nuclear processing facilities](#).

3.2.6 Number of licences by sector

There was an overall reduction in the number of licences in all sectors. Compared to the year 2010, there has been a 7.9% decrease in the total number of licences in 2014. This decrease is largely attributable to the considerable effort that CNSC staff have expended on consolidating licences, i.e., wherever feasible, replacing multiple licences held by a

Figure 9: Inside the 520 MeV cyclotron
(source: TRIUMF)

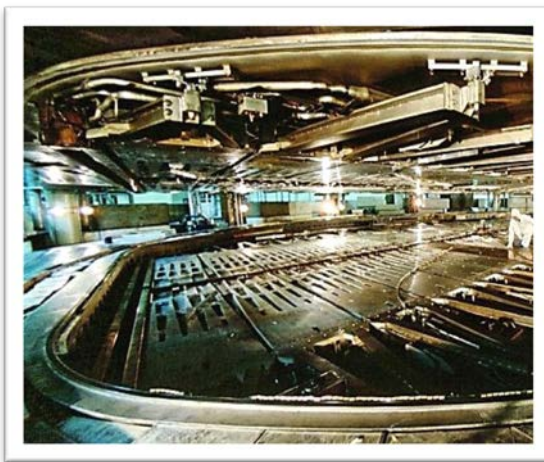


Figure 10: CLS research facility



single licensee by a single site licence. Other contributing factors are the amalgamation of regional healthcare authorities and the acquisition of small companies by larger ones.

Licence consolidation efforts undertaken by the CNSC staff have resulted in a reduction in red tape for licensees. An overall reduction in the administrative burden of maintaining multiple licences has allowed the CNSC to reallocate resources to oversee the regulation of activities that it previously did not regulate, such as mobile and low-energy accelerators. Regulatory performance results for these low-energy accelerators are included in the industrial and medical sectors of this report.

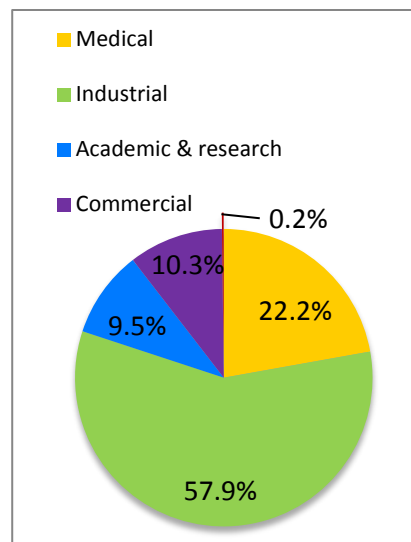
The distribution of licences among the four sectors has remained essentially unchanged since 2010. Figure 11 shows the distribution of licences by sector in 2014. Table 2 shows the number of licences by sector from 2010 to 2014.

Table 2: Number of licences by sector from 2010 to 2014

Sector	2010	2011	2012	2013	2014
Medical	593	568	561	552	536
Industrial	1,482	1,456	1,451	1,440	1,398
Academic and research	290	276	253	232	229
Commercial	257	250	248	256	248
Total	2,622	2,550	2,513	2,480	2,415*

*This total includes the licences at high-energy research particle accelerator facilities discussed in section 9.

Figure 11: Distribution of licences in 2014



Note: The sum of percentages does not add up to 100% due to rounding.

3.3 Workers

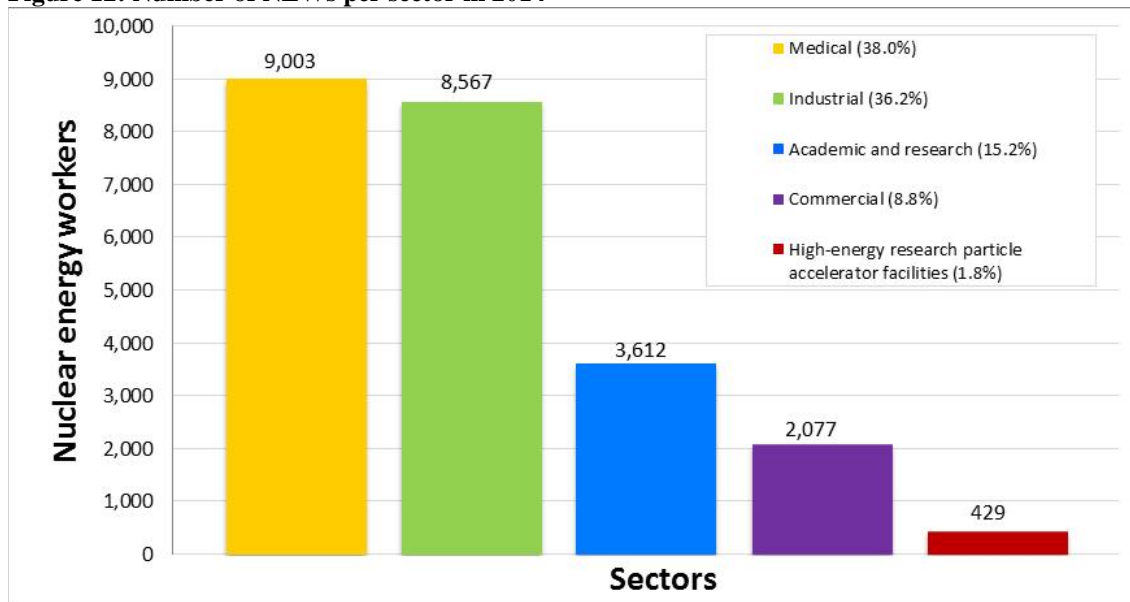
This report references two groups of workers that perform the types of work referenced in a CNSC licence: “nuclear energy workers” and “other workers” who are not nuclear energy workers. The term nuclear energy worker (NEW) means a person who is required, in the course of his or her business or occupation in connection with a nuclear substance or nuclear facility, to perform duties in circumstances that may result in receiving a dose of radiation greater than 1 millisievert (mSv) per year, which is the limit for members of the public. “Other worker” means a person who is unlikely to receive an annual dose greater than 1 mSv per year while performing duties in connection with a nuclear substance or nuclear facility. This report provides dose information for both types of workers, while primarily focusing on NEWs.

3.3.1 Nuclear energy workers by the numbers

A total of 60,407 workers in the four nuclear sectors and the two major facilities covered in this report were monitored in 2014. Of these, 23,688 were designated as NEWs. The number of workers was extracted from mandatory annual compliance reports submitted by licensees for 2014.

Of the 23,688 NEWs, 38.0% were employed in the medical sector, 36.2% were employed in the industrial sector, 15.2% were employed in the academic and research sector and 8.8% were employed in the commercial sector. The remaining 1.8% of NEWs were employed at the high-energy research particle accelerator facilities. Figure 12 shows the NEWs per sector.

Figure 12: Number of NEWs per sector in 2014



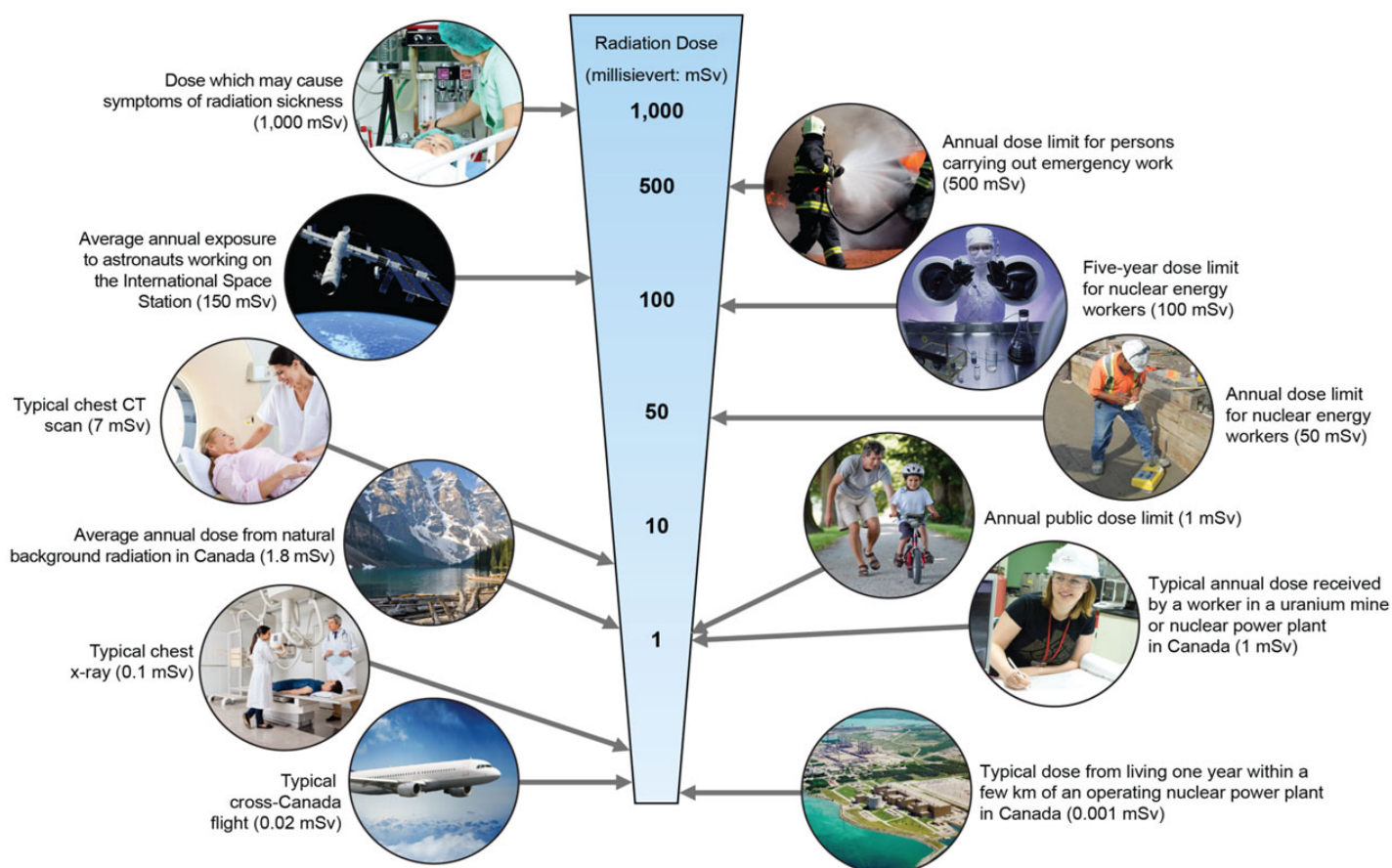
3.4 Occupational doses

3.4.1 Doses in perspective

Non-occupational exposure to radiation can occur in many situations. For example, a person may be exposed to radiation during an airplane flight or by undergoing a medical procedure such as a chest X-ray. Natural background radiation contributes to radiation exposure received by all persons living on earth. The average annual dose from natural background radiation is approximately 1.8 mSv in Canada and 2.4 mSv worldwide. Among major Canadian cities, Winnipeg has the highest annual average dose from [background radiation](#) at 4.1 mSv.

Figure 13 provides some perspective on these situations as they relate to occupational radiation exposures received by workers and the public as a result of nuclear activities licensed by the CNSC.

Figure 13: Doses in perspective



3.4.2 Dose limits

The CNSC's regulatory [effective dose limits](#) for NEWs are set at 50 mSv in any one-year dosimetry period and a total of 100 mSv over a five-year dosimetry period. The one-year dosimetry period covers January 1 to December 31 of every year. The current five-year dosimetry period started on January 1, 2011 and will end on December 31, 2015. For a person who is not a NEW, the effective dose limit is 1 mSv per calendar year. In this report, effective dose refers to the dose received by the whole body. For activities where there is a need for direct handling of nuclear substances, doses to the hands are also monitored. These are known as extremity doses, and they are subject to a regulatory dose limit of 500 mSv in any one-year dosimetry period for NEWs and 50 mSv per calendar year for other workers. The concept of a five-year dosimetry period is not applied to extremity doses or to the effective doses incurred by persons who are not NEWs.

For this report, workers who are not NEWs are referred to as "other workers" and are subject to the regulatory dose limit of 1 mSv per year – the same as for members of the public.

3.4.3 Ascertaining effective dose

Each licensee is required to ascertain the effective dose received by each worker engaged in activities authorized under their CNSC licence. Doses may be ascertained by direct

measurement (through monitoring) or by estimation, in accordance with the [Radiation Protection Regulations](#). The *Radiation Protection Regulations* also stipulate that the licensee must use a licensed dosimetry service for monitoring every NEW who has a reasonable probability of receiving an effective dose of greater than 5 mSv per year. However, regardless of the potential for occupational exposure, licensees conducting licensed activities in certain industries, such as industrial radiography, are always required to use a licensed dosimetry service provider to ascertain doses for the NEWs they employ (under subsection 30(3) of the [Nuclear Substances and Radiation Devices Regulations](#)).

3.4.4 When a dose limit is exceeded

In a situation where a worker may have exceeded a regulatory dose limit, licensees are required to remove the worker from any activities that may add to his or her dose, investigate the cause of the exposure, take action to prevent a recurrence, and report to the CNSC. CNSC staff review the information provided by the licensee following each investigation. Depending on the circumstances, the Commission, or in most cases a designated officer authorized by the Commission, may authorize the worker to return to work according to the process defined in the *Radiation Protection Regulations*. The return-to-work authorization may specify conditions and prorated dose limits for the remainder of the dosimetry period.

3.5 Safety performance measures

This report provides information on doses to workers, inspection compliance ratings, enforcement actions and reported events as safety performance measures. CNSC staff review licensee documents and conduct field inspections to verify that licensees have implemented effective safety programs and practices. Results of these inspections provide information on key aspects of safety performance, within each safety and control area (SCA) relevant to the licensed activity. For the purpose of this report, the following three SCAs are the most relevant indicators of safety performance for licensees in the four nuclear sectors covered in this report: operating performance, radiation protection and security. The report provides the compliance ratings (also referred to as inspection ratings), which reflect overall licensee performance at a program level for each of these SCAs. The nature, type and safety significance of events reported by licensees, and the nature and type of enforcement actions taken by the CNSC in 2014 are provided as supplementary indicators of safety performance. Each performance measure is described below.

Note that licensee performance for the two high-energy research particle accelerators are reported against each of the 14 SCAs, similar to other major CNSC-regulated facilities in Canada, and can be found in section 9 of this report.

3.5.1 Operating performance

Operating performance refers to the licensee's ability to perform licensed activities in accordance with pertinent operational and safety requirements defined in the *Nuclear Safety and Control Act* (NSCA), its associated regulations and licence conditions. Licensees are expected to demonstrate that they comply with operational and safety

requirements by providing workers with appropriate procedures for the safe use of nuclear substances and prescribed equipment, by ensuring that workers follow procedures, and by maintaining records that demonstrate compliance. Operating performance is also referred to as “Operational Procedures” in the inspection reports provided to licensees. Appendix B shows the links between the naming convention in the inspection reports and those presented in this report for safety and control areas.

3.5.2 Radiation protection

Radiation protection programs are required for every licensee to ensure that contamination levels and radiation doses received by individuals are monitored, controlled and maintained below regulatory dose limits, and kept at levels that are [as low as reasonably achievable](#) (ALARA), social and economic factors being taken into account. Licensees can meet these objectives by monitoring worker doses; posting radiation warning signs; planning appropriately for radiological emergencies; managing oversight of operational activities; instituting effective workplace practices that emphasize the use of time, distance and shielding to minimize exposure to radiation; and using appropriate protective equipment.

3.5.3 Doses to workers

All licensees are required to implement a radiation protection program that ensures that the radiation doses to workers are well below regulatory limit and kept ALARA, social and economic factors being taken into account. Thus, ascertainment of the magnitude of doses received by its personnel is an integral part of a licensee’s radiation protection program. The dose data discussed in this report was extracted from licensees’ mandatory annual compliance reports. Since 2013, data from all such reports has been included in this report. In previous years’ reports (2008 to 2012), the doses reported were based on only a representative sample of annual compliance reports within each sector.

3.5.4 Security

The security SCA covers the physical security measures, practices and programs that licensees are required to have in place to prevent the loss or illegal use, possession or removal of nuclear substances during their entire lifecycle, including while they are in storage or during transport. The extent of the security measures required depends upon the types of nuclear substances used and activities performed by each licensee.

3.5.5 Enforcement actions

The CNSC may take a variety of compliance enforcement actions to ensure that licensees correct non-compliances in an effective and timely manner. The type of enforcement action taken is commensurate with the risk the non-compliance presents to the environment, the health and safety of workers and the public, and to national security. This report provides information on the following types of enforcement actions taken by the CNSC: orders, administrative monetary penalties, decertification of certified exposure device operators, and decertification of radiation safety officers at Class II nuclear facilities.

3.5.6 Reported events

Licensees are required, under the NSCA and its associated regulations, to immediately report to the CNSC specific types of events related to their licensed activities. Within 21 days of the initial report, licensees are required to submit a final report to the CNSC on the event. The final report must include an analysis of the cause and circumstances of the event, as well as the measures taken, or proposed to be taken by the licensee to prevent recurrence. Together, the initial and final reports allow the CNSC to verify whether the licensee has taken appropriate measures to mitigate the event, and implemented adequate corrective actions to prevent recurrence.

3.6 Data collection

Dose data discussed in this report was extracted from annual compliance reports submitted by licensees in calendar year 2014. Such data is an indicator of the occupational doses incurred by all persons engaged in licensed activities in the four sectors and two major facilities covered in this report. Compliance ratings and non-compliance data, including CNSC enforcement actions, was obtained from the CNSC's compliance verification and enforcement program. Safety performance data from 2010 to 2013 is also included to identify five-year trends.

4 Use of nuclear substances: safety performance

4.1 Overall safety performance (all sectors)

In 2014, CNSC staff exercised ongoing regulatory oversight of approximately 1,700 licensees, holding a total of 2,415 licences in respect of the four nuclear sectors (medical, industrial, academic and research, and commercial) covered in this report. As part of this work, CNSC staff conducted compliance verification activities consisting of field inspections, desktop reviews of licensee annual compliance reports and other documentation, and technical assessments of licensee activities. Staff concluded that the use of nuclear substances in Canada is safe. The evaluations of findings for the safety and control areas (SCAs) covered in this report show that, overall, licensees made adequate provisions for the protection of the health, safety and security of persons and the protection of the environment from the use of nuclear substances, and took the measures required to implement Canada's international obligations.

Doses to workers remained very low in 2014 and followed a constant trend when compared with previous years. Overall, more than 99.9% of all workers – including both nuclear energy workers (NEWs) and other workers – received doses below their applicable regulatory dose limits. No NEWs exceeded the one- or five-year¹ dose limits of 50 millisieverts (mSv) and 100 mSv, respectively.

There were two separate situations where, based on dosimetry results, workers (who were not NEWs) exceeded the annual regulatory dose limit of 1 mSv. In both situations, licensees responded in accordance with the *Radiation Protection Regulations*. Workers did not experience immediate health consequences, nor are they expected to suffer long-term health consequences in either situation. More details are provided in section 4.2.1.

CNSC staff conducted 1,453 inspections in 2014 to verify compliance with CNSC regulatory requirements.

- All four nuclear sectors continued to demonstrate good performance within the operating performance SCA, with 88.4% of inspected licensees found to be in compliance. For licensees that failed to meet regulatory requirements, 11.5% were given “below expectations” ratings and 0.1% (or one inspection) received “unacceptable” ratings. The inspection with the “unacceptable” rating resulted in the inspector issuing an order to the licensee to ensure corrective actions were taken immediately. Inspectors may also issue orders to licensees to take immediate corrective action in cases of “below expectations” ratings or following CNSC investigations of reported events, in order to protect the workers, the public and the environment.
- Similarly, all four nuclear sectors continued to demonstrate good performance within the radiation protection SCA, with 89.1% of inspected licensees found to be in compliance. For licensees that failed to meet regulatory requirements, 10.7% were given “below expectations” ratings and 0.2% (or 3 inspections) were given

¹ The current five-year dosimetry period ends on December 31, 2015.

“unacceptable” ratings. Those inspections with “unacceptable” ratings resulted in the inspectors issuing orders to licensees to ensure corrective actions were taken immediately.

- Results of compliance verification related to security (SCA-Security) are included in this report. Adequate security provisions were in place for 94.8% of inspected licensees. The remaining 5.2% of licensees obtained “below expectations” ratings.

CNSC staff required licensees that failed to meet regulatory requirements to take corrective measures to address non-compliances found during inspections. All non-compliances are systematically tracked by CNSC staff until licensees take appropriate corrective measures to address them to the satisfaction of the CNSC. Corrective measures put in place by licensees in 2014 were reviewed by CNSC staff and found to be satisfactory.

Compliance with the mandatory tracking of high-risk sealed sources was fully satisfactory in 2014. All of the 148 inspected licensees were found to be compliant with this requirement. Further information on this topic is available in the [National Sealed Source Registry and Sealed Source Tracking System Annual Report](#).

In 2014, the CNSC escalated compliance enforcement actions against 19 licensees in the four sectors covered in this report. A total of 12 orders were issued, of which 11 were issued by inspectors and one by a designated officer. All licensees complied with the terms and conditions of the orders and implemented corrective measures that were satisfactory to CNSC staff. Seven administrative monetary penalties (AMPs) were also issued by designated officers. Three of these AMPs were reviewed by the Commission following a request for such review by the person named in the administrative penalty. All seven AMPs were paid. Section 4.2.5 provides additional information on the CNSC’s enforcement actions.

For a second consecutive year, no exposure device operators or radiation safety officers at Class II nuclear facilities were decertified.

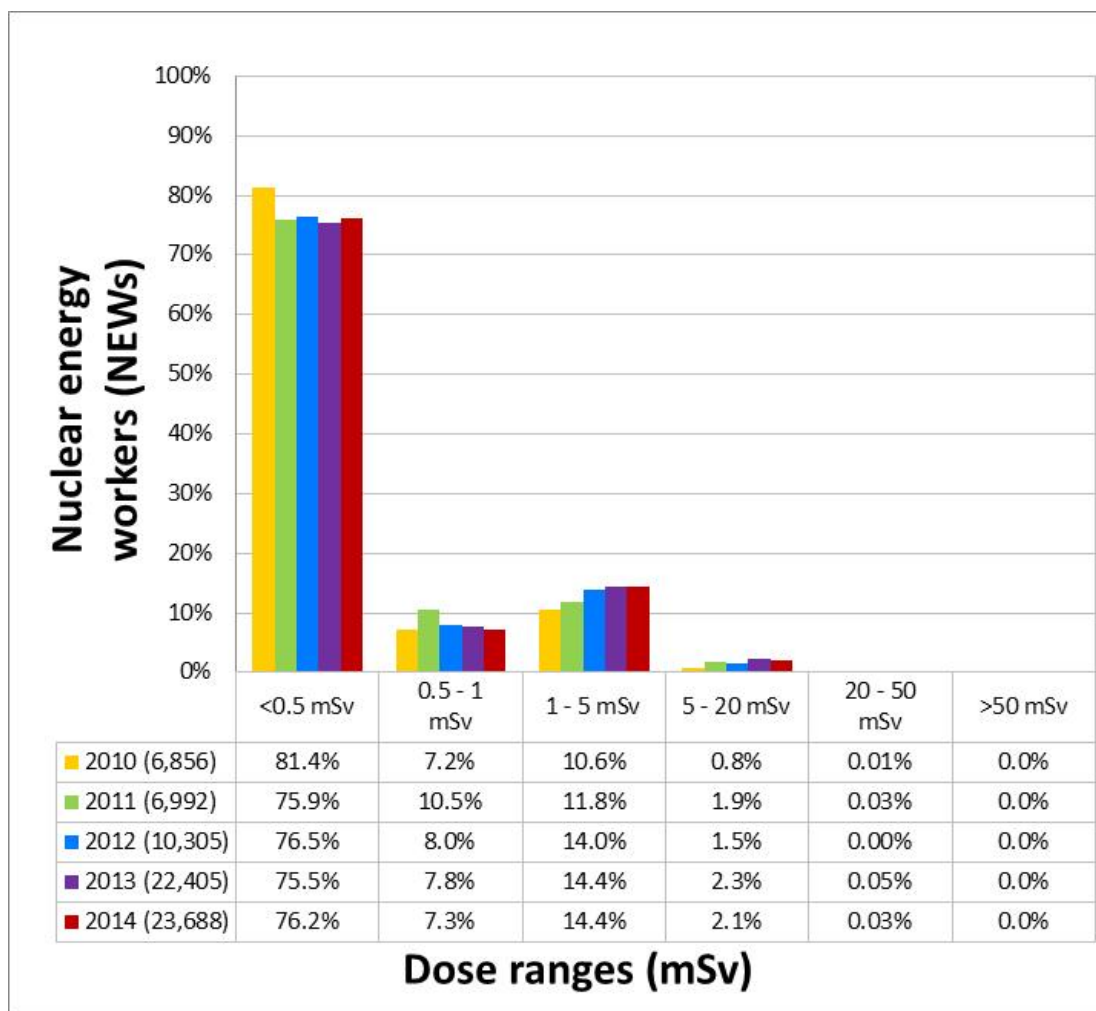
In 2014, licensees reported a total of 147 events to the CNSC involving nuclear substances. Of these, 141 were categorized by CNSC staff as Level 0 (no safety significance) according to the International Nuclear and Radiological Event Scale (INES), used for rating events involving nuclear substances. Five events were ranked as Level 1 (anomaly) due to the amount of nuclear substances involved and the type of event reported (loss of nuclear substances). One event, ranked as Level 2 (incident), is explained in further detail in section 4.2.1.

4.2 Safety performance results and trends

4.2.1 Doses to workers

Overall, doses received by NEWs remained low in 2014. The majority of workers received doses below 1 mSv, as shown in Figure 14.

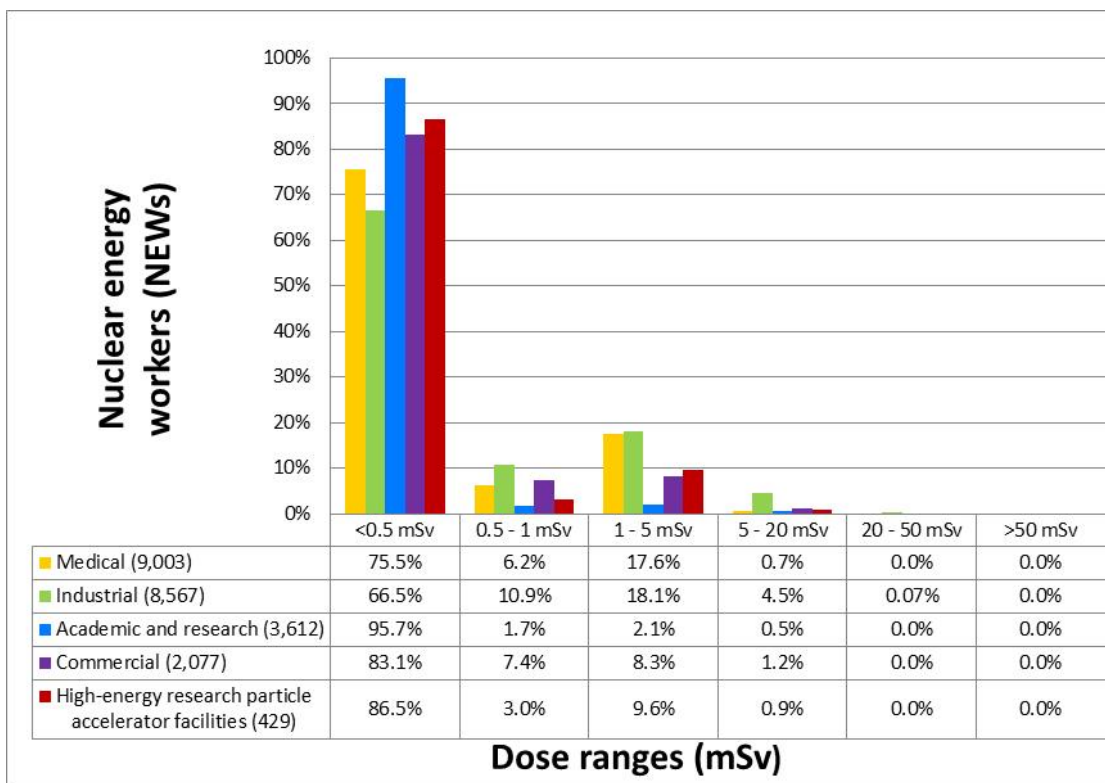
Figure 14: Annual effective doses to NEWs from 2010 to 2014 for all nuclear sectors combined



Note: The sum of the percentages listed in this figure may not add up to 100% due to rounding.

Figure 15 shows the dose distribution for NEWs across the nuclear sectors covered in this report. The differences in doses to workers among sectors continued to reflect the nature of the various activities within those sectors.

Figure 15: Annual effective doses to NEWs in 2014, sector-to-sector comparison



Note: The sum of the percentages listed in this figure may not add up to 100% due to rounding.

In 2014, there were two separate instances during which workers exceeded the applicable regulatory dose limits.

Fixed gauge workers – In March 2014, workers at a mine site operated by Cliffs Quebec Mine Iron Mining Limited, located in Fermont, QC, were exposed to levels of radiation above the annual effective dose limit of 1 mSv for members of the public. Cliffs holds a CNSC licence authorizing it to use fixed nuclear gauges as part of the mine production process control. The workers were in an area at the Cliffs facility where two nuclear gauges were located. The gauges should have been locked with the source in the shielded position for the duration of the work. However, in this instance the two gauges had their sources in the open or unshielded position. The 24 workers, who were not NEWs, received effective doses of radiation ranging from 0 mSv to 10.5 mSv. Ten workers exceeded the annual effective dose limit of 1 mSv. Using the INES tool presented in section 3.1, this event ranked as Level 2 (incident) since the exposure of one of the workers was above 10 mSv. Such doses are well below the regulatory dose limits for NEWs and would not be expected to result in adverse health effects to the exposed persons.

CNSC staff reported this event at the August 21, 2014 Commission public meeting (refer to the [August 20 and 21, 2014 meeting minutes](#)). Cliffs took appropriate corrective

measures to prevent recurrence of this event, which were reviewed by CNSC staff and found to be satisfactory. The CNSC review and investigation of this event were closed at the Commission public meeting.

Diagnostic and therapeutic nuclear medicine worker – A worker at a university hospital had a dosimeter showing an effective dose of 1.5 mSv over a three-month period. Since the worker was not a NEW, this exceeded the annual effective dose limit for members of the public of 1 mSv. The licensee determined that the worker's routine activities should not have resulted in an exposure of that magnitude, but could not explain why the incident occurred.

As the information submitted by the licensee was not sufficient to confirm that the dose was non-personal, no change was made to the individual's dose record in the [National Dose Registry](#).

Events of this nature are not reported to the Commission in its public meetings because of the uncertainty in the dose determination and since there is no safety significance associated with such events.

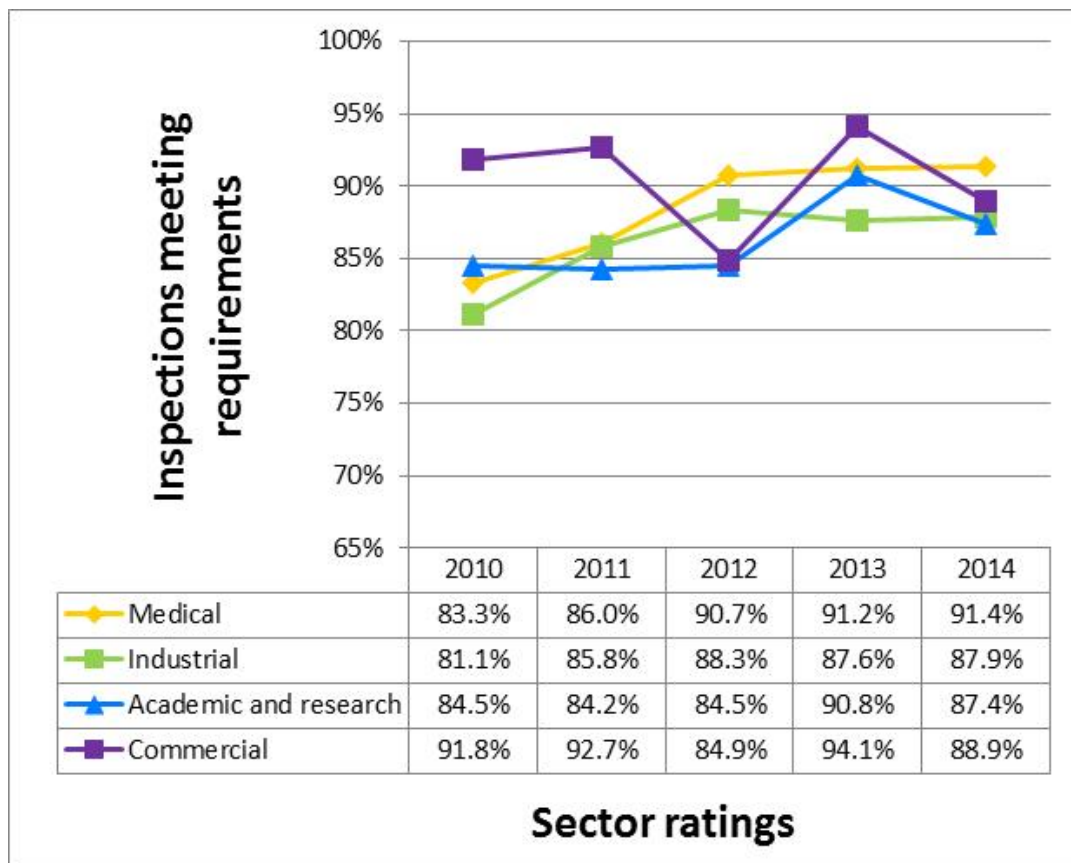
This event ranked as INES Level 0 (no safety significance).

4.2.2 Operating performance

In 2014, CNSC staff conducted inspections to verify licensee compliance with regulatory requirements related to the operating performance SCA. In general, all sectors continued to demonstrate good performance within this SCA, with 88.4% of inspected licensees found to be in compliance with regulatory requirements. The majority of non-compliances in this SCA included failure to comply with regulatory requirements related to worker obligations, retention of records, and sealed source leak testing. CNSC staff tracked the non-compliances to ensure that all were addressed and corrected by licensees to the satisfaction of the CNSC. The safety significance of individual non-compliances determined the urgency and the nature of corrective or enforcement actions in each case.

As shown in Figure 16, most sector ratings remained nearly constant in 2014 compared to the previous year, with the exception of the commercial sector which saw a moderate decrease in compliance ratings. More details on the decrease in the compliance rating in operating performance for the commercial sector are provided in section 8.2.2.

Figure 16: Sector-to-sector comparison for inspection ratings of operating performances from 2010 to 2014

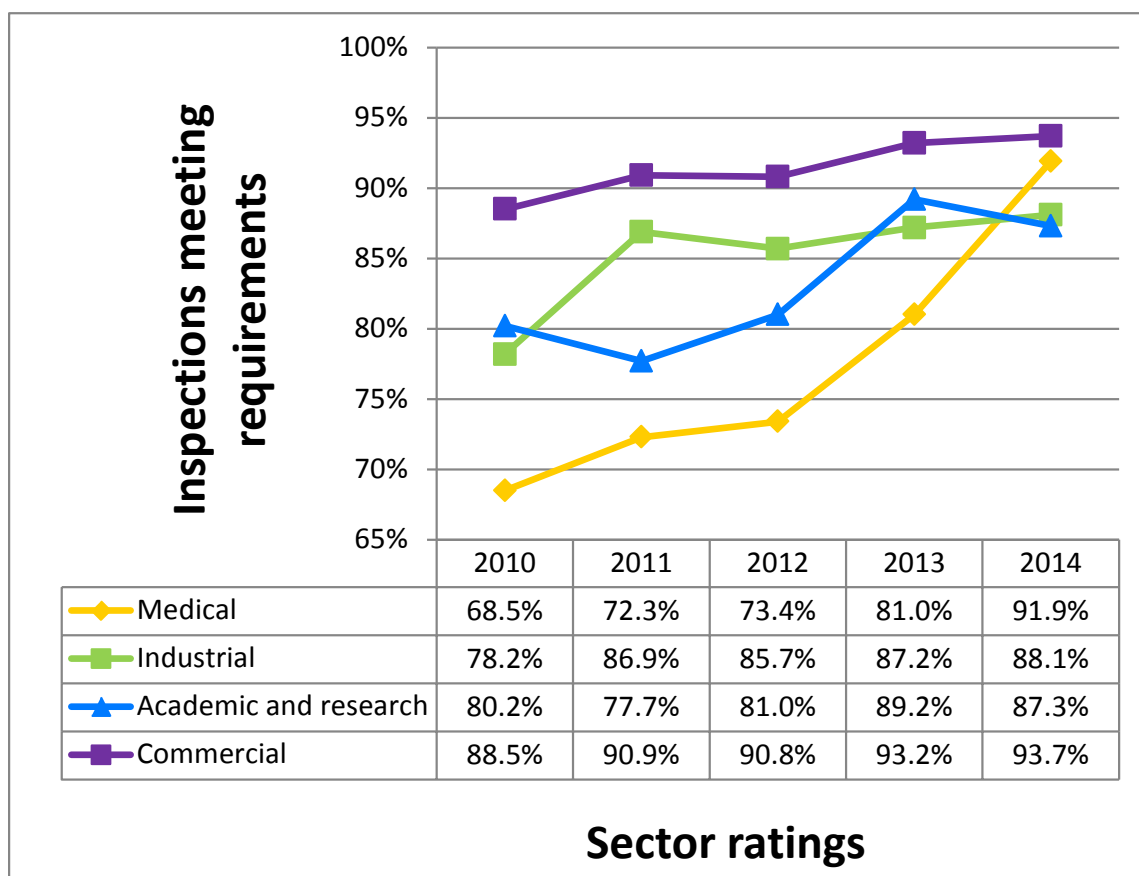


4.2.3 Radiation protection

In 2014, CNSC staff conducted inspections to verify licensee compliance with regulatory requirements related to the radiation protection SCA. In general, all sectors continued to demonstrate good performance within this SCA, with 89.1% of inspected licensees found to be compliant with regulatory requirements. The majority of non-compliances included inadequate implementation of measures to ensure that doses are kept as low as reasonably achievable, survey meters either not being available or not calibrated, and containers or radiation devices not being labelled properly. CNSC staff tracked the non-compliances to ensure that all were addressed and corrected by licensees to the satisfaction of the CNSC. The safety significance of individual non-compliances determined the urgency and the nature of corrective or enforcement actions in each case.

The ratings for all sectors are shown in Figure 17. With the exception of the medical sector, which showed significant improvement, all other sectors remained constant in 2014. Improvements in compliance ratings in the diagnostic and therapeutic nuclear medicine and radiation therapy subsectors are attributed to a greater understanding of regulatory requirements amongst licensees in those sectors due to increased regulatory oversight in the form of outreach and compliance promotion efforts by CNSC staff.

Figure 17: Sector-to-sector comparison of inspection ratings for radiation protection from 2010 to 2014



4.2.4 Security

The annual regulatory oversight report now includes results of inspection ratings for the security SCA. This SCA was not reported on in previous reports. CNSC staff verified licensee compliance against requirements described in [REGDOC-2.12.3, Security of Nuclear Substances: Sealed Sources](#). Mandatory compliance with these requirements came into effect May 31, 2015 for licensees with Category 1 and 2 sealed sources, and will come into effect May 31, 2018 for licensees with Category 3, 4 or 5 sealed sources. More information about [categories of sealed sources](#) is available on the CNSC website.

Table 3 summarizes the performance of the four sectors with the requirements encompassed by this SCA. Overall, all sectors showed satisfactory ratings for this SCA. CNSC staff tracked the non-compliances to ensure that all of them were addressed and corrected by licensees to the satisfaction of the CNSC.

Table 3: Sector-to-sector comparison of inspection ratings for security for 2014

Medical	Industrial	Academic and research	Commercial
96.3%	94.0%	97.6%	96.7%

The details of the non-compliances related to the security SCA are not disclosed in this report due to the sensitive nature of the information.

4.2.5 Enforcement actions

To address non-compliances, CNSC staff use a variety of enforcement actions ranging from a notification of non-compliance to the requirement for remedial action to the revocation of a licence. The nature of the enforcement action is based on the seriousness of the impact or potential impact of the non-compliance on health, safety, security, the environment and international obligations, as well as the circumstances that led to it. Depending on the severity of the problem, more than one enforcement action may be required to deal with a non-compliance.

In 2014, the CNSC escalated compliance enforcement actions in 19 instances against licensees in the medical, industrial, academic and research, and commercial sectors. In 12 instances, CNSC staff issued orders to licensees and directed them to take immediate corrective measures. Eleven of the orders were issued by inspectors and one by a designated officer. In each case, the licensee immediately complied with the order; however, the order remained in effect until the licensee addressed all terms and conditions of the order. Once the CNSC was satisfied that the licensee had addressed the terms and conditions of the order, the order was closed. All orders issued in 2014 have been closed. Table 4 shows details of orders issued to licensees.

CNSC designated officers issued AMPs² in seven instances. Three of these were reviewed by the Commission following a request for such a review by the person named in the AMP. All seven AMPs issued in 2014 have been paid. Table 5 shows details of the AMPs issued to licensees and individuals.

² Five of the seven AMPs were issued following, or in conjunction with, orders. Two were issued to individuals.

Table 4: Orders issued to licensees in 2014

Issue date	Licensee	Location	Measures taken by the licensee	Closure date
Feb. 20, 2014	Breton N.D. Testing Incorporated (Industrial radiography)	Reserve Mines, NS	Removed the worker from duties related to the operation of industrial radiography exposure devices until the worker no longer posed a risk to the health and safety of persons.	Aug. 15, 2014
Mar. 17, 2014	Anode NDT Ltd. ³ (Industrial radiography)	Grande Prairie, AB	Prohibited one of its workers from supervising any exposure device operator trainee until the CNSC was satisfied that the corrective measures taken or proposed by Anode NDT Ltd. provided sufficient evidence that the worker could perform radiography trainee supervisory duties in a safe manner in accordance with the <i>Nuclear Substances and Radiation Devices Regulations</i> , and that all non-compliance items identified in the CNSC inspection report issued to the company had been adequately addressed.	Jun. 10, 2014
Mar. 21, 2014	Cliffs Quebec Iron Mining Limited (Fixed gauge)	Fermont, QC	Produced all documentation related to an event, ceased all activities involving entry into confined spaces in which fixed gauges are installed, ceased all mounting and dismounting of nuclear gauges, and ceased all maintenance activities involving such devices. Section 4.2.6 contains further details of the event	Jan. 20, 2015
May 1, 2014	Sunnybrook Health Sciences Centre and Sunnybrook Research Institute (Consolidated uses of nuclear substances)	Toronto, ON	Took numerous remedial measures to the satisfaction of the CNSC, including performing a complete inventory of all nuclear substances and prescribed equipment in its possession, developing procedures and training to increase management oversight of work practices, and transferring surplus nuclear substances and prescribed equipment to authorized recipients.	Jul. 10, 2014
May 29, 2014	AR Geotechnical Engineering Ltd. (Portable gauge)	Medicine Hat, AB	Ceased the use of portable gauges at its Medicine Hat location until corrective measures were satisfactorily implemented to address all non-compliance items identified by the CNSC inspection report.	Jun. 30, 2014

³ The CNSC provided Anode NDT Ltd. with an opportunity to be heard about the order issued.

Issue date	Licensee	Location	Measures taken by the licensee	Closure date
Jun. 5, 2014	Paladin Inspection Services Ltd. (Industrial radiography)	Fort St. John, BC	Removed one of its workers from duties related to the use of nuclear substances (including the supervision of exposure device operator trainees), until the worker no longer posed a risk to the health and safety of persons.	Jul. 16, 2014
Jun. 6, 2014	Pump House Brewery Ltd. (Fixed gauge)	Moncton, NB	Placed the fixed gauge in secure storage, prevented its unauthorized access, and ceased all installation and removal of fixed gauges until all the safety requirements were satisfactorily addressed.	Jun. 24, 2014
Jul. 22, 2014	Mistras Canada Inc. (Industrial radiography)	Olds, AB	Removed one of its workers from duties related to the use of nuclear substances – including the supervision of exposure device operator trainees – until the worker no longer posed a risk to the health and safety of persons.	Sep. 12, 2014
Jul. 29, 2014	Parkland Geotechnical Consulting (Portable gauge)	Medicine Hat, AB	Ceased the use of portable gauges at its Medicine Hat location until corrective measures were satisfactorily implemented to address all non-compliance items identified in the CNSC inspection report.	Aug. 14, 2014
Sep. 11, 2014	Marsh Instrumentation Ltd. (Servicing)	Burlington, ON	Placed the radiation device in secure storage to prevent its unauthorized access, arranged for the transfer of the device to a person authorized by the CNSC to possess such a device, and provided the CNSC with documentary evidence of the transfer.	Sep. 29, 2014
Oct. 10, 2014	Fort McMurray Inspection and Testing Inc. (Portable gauge)	Fort McMurray, AB	Returned all its portable gauges to secure storage at its Fort McMurray location until an effective radiation protection program was implemented and all non-compliances observed during the inspection were satisfactorily addressed.	Oct. 17, 2014
Dec. 16, 2014	Nine Energy Canada Inc. (Oil well logging)	Calgary, AB	Placed all of its nuclear substances into secure storage until the company fully implemented its radiation safety program and corrected all items of non-compliance identified during the inspection.	Jan. 15, 2015

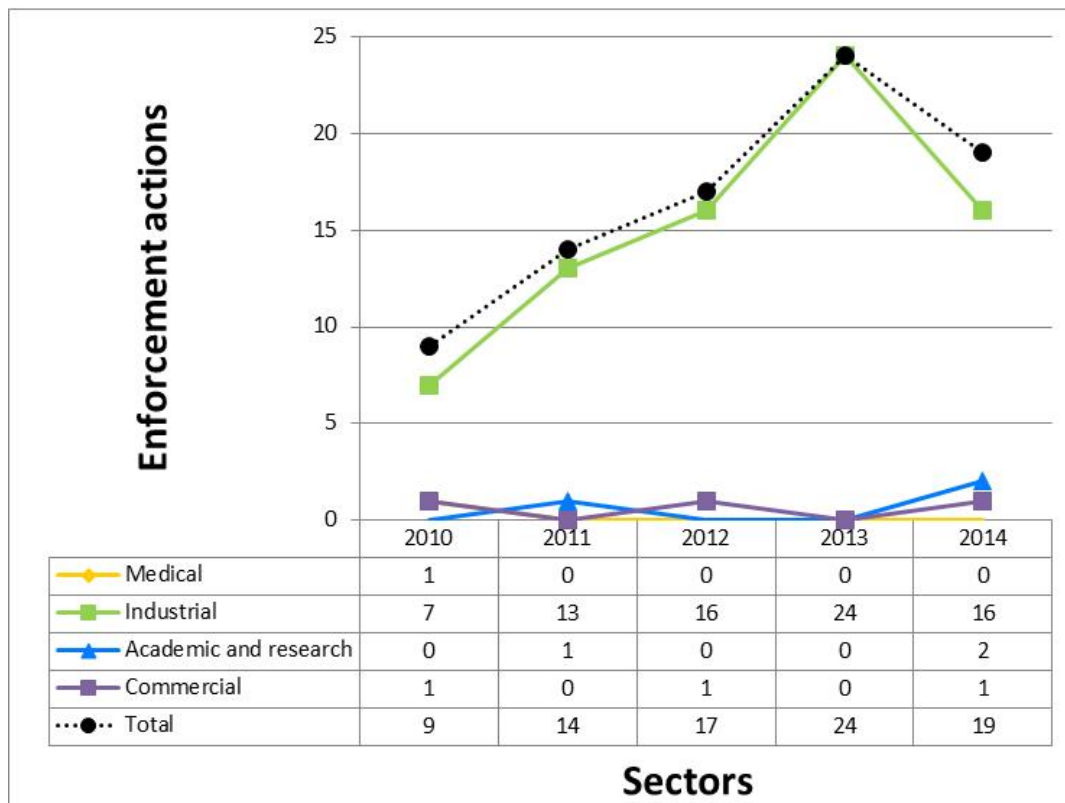
Table 5: Administrative monetary penalties issued in 2014

Issue date	Licensee or individual	Location	Reason for issuing AMP	Closure date
Jan. 20, 2014	Frédéric Dulude, employee of Labo S.M. Inc. (Portable gauge)	Lac-Mégantic, QC	Failure by a worker to correctly use equipment, devices, facilities and clothing.	Apr. 9, 2014
Apr. 8, 2014	Anode NDT Ltd.* (Industrial radiography)	Grande Prairie, AB	Improper appointment of an exposure device operator to supervise trainees.	Jun. 10, 2014
Apr. 2, 2014	Breton N.D. Testing Incorporated* (Industrial radiography)	Reserve Mines, NS	Failure to keep radiation exposure to persons as low as reasonably achievable through implementation control over work practices.	Oct. 29, 2014
Apr. 2, 2014	Corey Wells, employee of Breton N.D. Testing Incorporated (Industrial radiography)	Reserve Mines, NS	Failure to properly use equipment, devices, facilities and clothing.	Nov. 11, 2014
May 16, 2014	Sunnybrook Health Sciences Centre and Sunnybrook Research Institute (Consolidated uses of nuclear substances)	Toronto, ON	Failure to take all reasonable precautions to protect the environment and the health and safety of persons to maintain security of nuclear substances.	Jul. 10, 2014
Aug. 29, 2014	Canadian Air Transport Security Authority* (Electron capture detection)	Ottawa, ON	Carrying on a prescribed activity without or contrary to a licence.	Feb. 11, 2015
Oct. 29, 2014	Westcoast Energy Inc. (Fixed gauge)	Calgary, AB	Carrying on a prescribed activity without or contrary to a licence.	Nov. 4, 2014

*Note: the CNSC reviewed the AMP following a request for such review by the person named in the AMP.

As shown in Figure 18, the majority of these enforcement actions were taken against licensees in the industrial sector, following a trend from previous years. More details on these enforcement actions and an analysis of the compliance improvements in the industrial sector are provided in section 6.2.4.

Figure 18: Sector-to-sector comparison of CNSC enforcement actions from 2010 to 2014



Further information on [regulatory actions](#), including escalated enforcement actions, taken by the CNSC is available on the CNSC website.

4.2.6 Reported events

In Canada, more than 60,000 workers use nuclear substances in a variety of environments and settings every day. Licensees are required to have programs in place for the management of unplanned events and accidents. Mandatory reporting to the CNSC is required for certain types of events. The situations that warrant mandatory reporting and the content of the reports are set out in CNSC regulations.

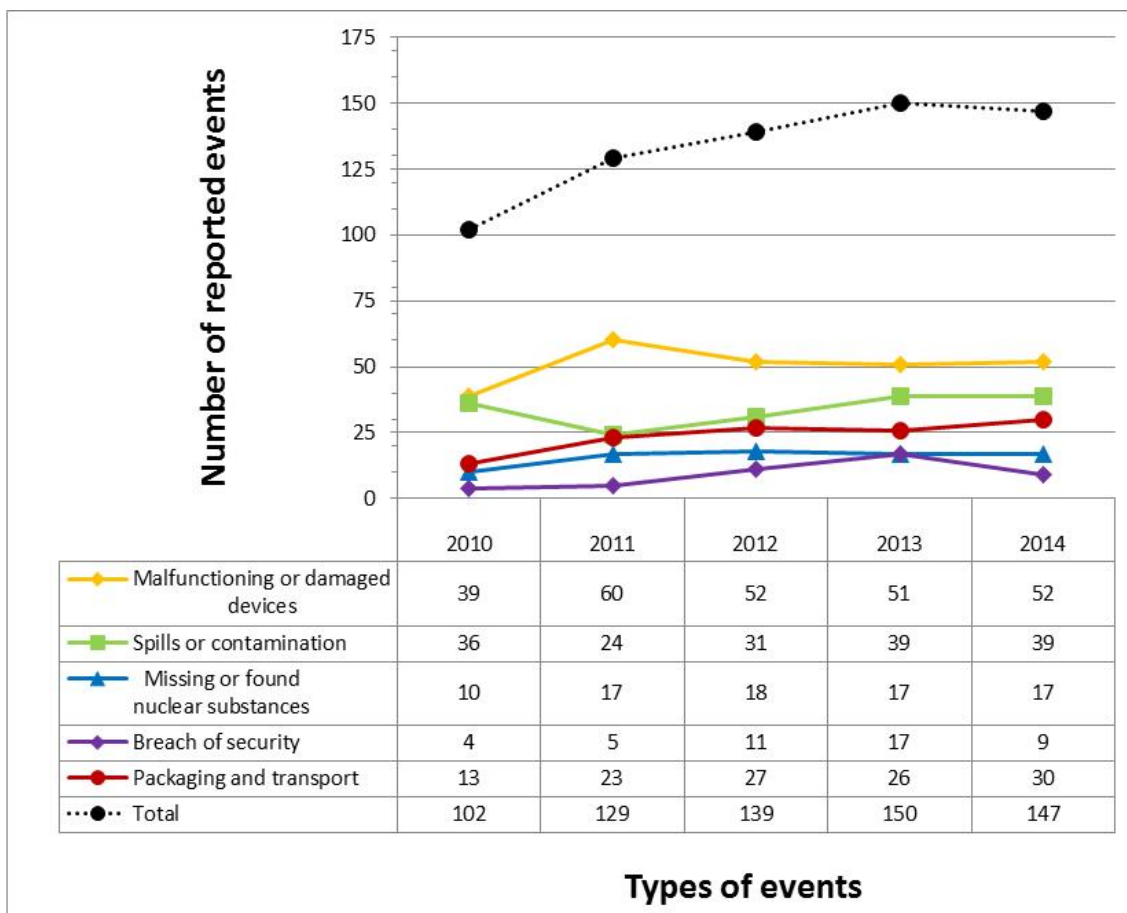
As shown in Figure 19, there were 147 events related to nuclear substances reported to the CNSC in 2014 by licensees in the four nuclear sectors covered in this report. As discussed in section 3.1, the INES tool has been used for the first time to categorize events in the sectors covered by this report. Of the 147 events, 141 were ranked as INES Level 0 (no safety significance), and five were ranked as Level 1 (anomaly) due to the amount of nuclear substances involved and the type of event reported (loss of nuclear substances). [Additional information on the INES tool](#) can be found on the International Atomic Energy Agency (IAEA) website.

The remaining event, ranked as Level 2 (incident), was the event at a fixed gauge facility, involving a group of workers (who were not NEWs) who received radiation doses above the public dose limit of 1 mSv. This event is described in detail in section 4.2.1,

Details of events reported by licensees are presented in this document at the overall level; those relating to high-energy research particle accelerator facilities are presented in detail in section 9.2.4.

For all reported events, the licensees implemented appropriate response measures to mitigate the impacts of the events and to limit radiation exposure to workers and the public. These measures were reviewed by CNSC staff and found to be satisfactory.

Figure 19: Reported events from 2010 to 2014, all sectors combined



Malfunctioning or damaged devices

There were 52 events related to damaged or malfunctioning devices or systems. Of these events, two involved malfunctioning systems that occurred at high-energy research particle accelerator facilities and are further described in section 9.2.4. The remaining 50 events fall into two categories: damaged devices and malfunctioning devices. Of these, 38 involved damaged devices where:

- 24 involved damage to portable gauges, which were hit or run over by vehicles at construction sites

- seven involved damage to fixed gauges, with most cases related to damage to the shutter handle
- seven involved damage to exposure devices from a drop or an impact

None of the above resulted in damage to the source or resulted in source leakage.

The remaining 12 events involved malfunctioning devices, where:

- eight involved malfunctioning fixed gauges where the shutter failed to close properly
- two involved malfunctioning exposure devices where each sealed source failed to retract into the shielded position
- one involved a malfunctioning portable gauge
- one involved a malfunctioning radiation detector calibrator

All malfunctioning devices were taken out of service as required by the regulations. None of the events resulted in radiation exposure to any person above the annual public regulatory dose limit of 1 mSv. All of these events are closed.

Spill or contamination

There were 39 events related to spills or contamination of personnel reported. Of these:

- 36 involved contamination resulting from mishandling of unsealed nuclear substances
- three involving spills during the production of fluorine-18

These events only include situations where spills or contamination occur outside of fume hoods, hot cells or other normal means of containment. In every case, the nuclear substances involved had half-lives ranging from a few hours to a few days. In all cases, the workers received a dose well below the annual public regulatory dose limit of 1 mSv. All of these events are closed.

Missing or found nuclear substances

In 2014, there were 17 reported events involving missing or found nuclear substances, of which 14 were reports of lost or stolen nuclear substances. The sealed sources or radiation devices were recovered in seven instances. At the time of writing, seven events remain open because the sources or radiation devices have not been recovered. The remaining three events were related to the discovery of radiation devices or sealed sources.

These events are reported in the [*Lost or Stolen Sealed Sources and Radiation Devices Report*](#), which is updated regularly.

The following events were presented by CNSC staff at Commission public meetings:

- During March and April 2014, the Sunnybrook Health Sciences Centre and Sunnybrook Research Institute reported two events involving the loss of one moderate-risk (Category 3) and 26 low-risk (Category 4 and 5) sealed sources. Most of the sealed sources involved in these two events pose negligible risk to the environment and to the health and safety of workers and the public. To date, only

the Category 3 source and one Category 5 source related to one event have been recovered. The remaining 25 low-risk sources are lost and unaccounted for. Sunnybrook has implemented corrective actions to prevent recurrence of this type of event. CNSC staff reviewed these actions and found them satisfactory. CNSC staff presented this event at the August 21, 2014 Commission public meeting, at which time the matter was closed (refer to the [August 20 and 21, 2014 meeting minutes](#)). Sunnybrook is based in Toronto, ON and holds CNSC licences for medical and research applications.

- In April 2014, the Alberta Health Services reported an event involving two low-risk (Category 4) disused brachytherapy sealed sources containing cesium-137, which were found in a machine shop at Alberta Health Services' Cross Cancer Institute in Edmonton, AB. Alberta Health Services safely moved the sources to a secure location to ensure that they posed no risk to workers, the public or the environment. This event was ranked as INES Level 1 (anomaly). Alberta Health Services implemented appropriate corrective measures to prevent recurrence of this event, which were reviewed by CNSC staff and found to be satisfactory. CNSC staff reported this event at the August 21, 2014 Commission public meeting, at which time the matter was closed (refer to the [August 20 and 21, 2014 meeting minutes](#)). Alberta Health Services holds various licences related to the possession, use, storage, transfer, import and export of nuclear substances and prescribed equipment.
- In November 2014, the CNSC laboratory reported an event involving the loss and subsequent recovery of a low-risk (Category 4) cesium-137 source that was used during a training session. Upon discovery of the lost source, the CNSC laboratory took immediate measures to mitigate the impacts of the event and to limit radiation exposure to workers and the public. The event, which ranked as INES Level 1 (anomaly), presented a low risk to workers, the public and the environment. CNSC staff presented this event orally at the November 5, 2014 Commission public meeting (refer to the [November 5, 2014 meeting minutes](#)) and provided a detailed update at the June 17, 2015 Commission public meeting (refer to the [June 17, 2015 meeting minutes](#)). The CNSC laboratory holds a licence for the possession and use of nuclear substances for training purposes. Complete information about the licensed activities conducted at the CNSC laboratory is presented in section 3.2.3.

The following events were not presented by CNSC staff at Commission public meetings:

- Four events involved portable gauges containing low-risk (Category 4) sealed sources. Three gauges were stolen from vehicles and one was lost during transport. One of the three stolen portable gauges and the portable gauge lost during transport were recovered. The INES tool was used to classify the loss or theft of these radiation devices and, as a result, the event was given an INES Level 1 (anomaly) rating. The events where portable gauges have not been recovered remain open and are being tracked by CNSC staff.
- Two events involved the loss of very low-risk sealed sources or devices (Category 5) following licensee inventory checks. In both cases, the sources

involved were sufficiently low activity that a licence would not be required for their possession and in both instances the licensee found the missing source or device subsequently. These events are closed.

- One event involved an industrial radiography exposure device containing a high-risk (Category 2) sealed source, which was stolen along with the vehicle in which it was stored. The licensee recovered both the device and vehicle the following day. This event is closed.
- One event involved the loss of a very low-risk europium-152 source (Category 5) used for instrument calibration. The licensee investigated the event and concluded that the sealed source likely fell to the floor and was inadvertently discarded in normal waste by cleaning staff. This source poses no risk to workers, the public or the environment. This event is closed.
- One event involved the theft of two packages containing a total of approximately 40 gigabecquerels (GBq) of technetium-99m (a radioisotope used for medical imaging diagnostics), which were stolen from a delivery vehicle. These packages present very low risk to workers, the public and the environment, as technetium-99m has a half-life of six hours and decays to background levels within three days. This event is closed and has been ranked as an INES Level 1 (anomaly).
- One event involved three very low-risk (Category 5) cesium-137 calibration sources that were discovered in an unlicensed location. CNSC inspectors retrieved the sources and safely disposed of them at a CNSC-licensed facility. This event is closed.
- One event involved a vehicle carrying scrap metal that triggered portal alarms at a metal recycling facility. The source of radiation was identified as a dew point detector containing a very low-risk (Category 5) sealed source. The owner retrieved the radiation device and subsequently transferred it to a person licensed to possess such a device. This event is closed.
- One event involved a liquid scintillation counter containing a very low-risk (Category 5) cesium-137 source that the licensee reported missing following an unauthorized transfer for disposal. The sealed source posed a negligible risk to workers, the public and the environment. This event is closed.
- One event involved an X-ray fluorescence analyzer containing a very low-risk (Category 5) sealed source that a licensee reported stolen from a vehicle while in transport. The event remains open and is being tracked by CNSC staff.

Disused, spent and orphaned sources are a growing concern for all nuclear regulators. The [IAEA Safety Glossary](#) defines a disused source as “a radioactive source that is no longer used, and is not intended to be used, for the practice for which an authorization has been granted.” A spent source is a source that is no longer suitable for its intended purpose as a result of radioactive decay, but which may nevertheless represent a radiological hazard.

Over time, licensees build up inventories of disused sources. Maintaining adequate control of these sources may become an ongoing problem if appropriate oversight is not exercised. There is an increased awareness of this issue in the nuclear sectors covered in this report, following the events described above, which CNSC staff presented at the August and November 2014 Commission public meetings.

The CNSC is using a combination of enhanced verification of licensee inventory by CNSC inspectors and licensee outreach by CNSC staff to communicate the importance of a robust inventory control program to licensees. CNSC staff strongly encourage licensees to safely dispose of the sources they no longer use.

In contrast, an orphan source is a radioactive source that is not under regulatory control, either because it has never been under regulatory control or because it has been abandoned, lost, misplaced, stolen or otherwise transferred without proper authorization. Orphaned sources are usually found in the public domain – outside a CNSC-regulated facility, where no responsible licensed owner can be established, or in the possession of a person who cannot be held responsible for safe storage or disposal. These sources present both security and safety risks. When such events are reported to the CNSC and all attempts to identify the rightful licensed owner are unsuccessful, the CNSC takes control of the source. In 2014, the CNSC took possession of five low-risk orphaned sources and took the necessary measures to safely dispose of the sources at a CNSC-licensed facility.

In 2015, the CNSC implemented a new requirement for licensees in the four sectors covered by this report to provide [financial guarantees](#) as tangible commitments that there will be sufficient resources to safely terminate licensed activities. A financial guarantee does not relieve licensees from complying with regulatory requirements for termination of licensed activities, but ensures that there are funds available to the CNSC when licensees are unable to carry out safe termination. Whereas financial guarantees are well established for Class I nuclear facility licences, this is the first time such a program has been implemented for licensees in the nuclear substance sectors. In addition to ensuring that licensees do not maintain unnecessarily large inventories of nuclear substances (the amount of the financial guarantee being proportional to the number of sources of nuclear substances), the program also provides a source of funds to the CNSC in the event that it must intervene to take control of orphan sources.

Breach of security

In 2014, there were nine events reported to the CNSC relating to security breaches. Some security breaches are actually safety barrier breaches, which typically involve people entering restricted work areas that licensees have established prior to the use of industrial radiography exposure devices. These types of events pose a risk of potential exposure to persons entering the area while industrial radiography work is being conducted. Although these events were categorized as security breaches, all of the safety barrier breaches were a result of licensee workers not following procedures to establish or control such a barrier.

There were nine reported events in 2014:

- Four involved safety barrier breaches where people entered restricted work areas that were established prior to the use of exposure devices for industrial

radiography work. In all cases, the people crossing the barriers received doses well below the public regulatory dose limit of 1 mSv. These events are closed.

- Three involved break-ins at licensee storage facilities or clinics that had nuclear substances or radiation devices. There was no access to, or theft of, the nuclear substances or radiation devices during these incidents. These events are closed.
- One involved a key lock box for a brachytherapy unit that was found to have been forced open. The licensee investigation concluded that the lock box was forced open by a physicist authorized to work in the area who had forgotten the access code. Appropriate corrective measures were taken by the licensee. These measures were reviewed by CNSC staff and found to be satisfactory. This event is closed.
- One was related to one of the high-energy research particle accelerator facilities and is further described in section [9.2.4](#).

Packaging and transport

Approximately 1 million packages containing nuclear substances are safely transported each year in Canada. In 2014, there were 30 events reported to the CNSC relating to packaging and transport.

The following event was presented by CNSC staff at a Commission public meeting:

- Over a three-day period in August 2014, Isologic Innovative Pharmaceuticals Ltd. delivered packages with external contamination to various hospitals in the Montréal, QC area. The packages had external contamination above regulatory limits. CNSC staff presented this event at the November 5, 2014 Commission public meeting (refer to the [November 5, 2014 meeting minutes](#)). Isologic implemented appropriate corrective measures to prevent recurrence of this event, which were reviewed by CNSC staff and found to be satisfactory. CNSC staff presented an update on this event at the December 18, 2014 Commission public meeting, at which time the matter was closed (refer to the [December 18, 2014 meeting minutes](#)).

Following the event involving contaminated packages from Isologic, CNSC staff issued a safety notice to all licensees that receive shipments of unsealed nuclear substances, in order to emphasize the need to check incoming packages for contamination as per industry best practices. In 2015, the CNSC will increase regulatory focus on licensees that process and distribute unsealed nuclear substances, with inspections focusing on the preparation, handling and receipt of packages that contain unsealed nuclear substances.

The following is a summary of other events of no safety significance that were not presented by CNSC staff at Commission public meetings, and which are all closed:

- Twelve events involved minor accidents involving vehicles transporting the packages, with no reported damage to the packages following the accidents.
- Eight events involved external damage to packages. The licensee investigations concluded that there was no external contamination and that the internal containers were not breached.
- Six events involved delays in delivery of the packages.
- Three events involved internal contamination of the package discovered following the opening of the packages. In all cases, the contamination was contained within the package. There was no spread of contamination.

Summary statements

For all of the events reported, the licensees implemented adequate response measures to mitigate the impacts of the events and to limit radiation exposure to workers or any radiological impact on the environment. CNSC staff reviewed these measures, along with licensee corrective actions to prevent recurrence of the events, and found them to be satisfactory.

4.3 Stakeholder engagement

CNSC staff believe that increased awareness and better understanding of regulatory requirements by licensees and other persons regulated by the CNSC lead to increased safety in the workplace. Increased safety is reflected by improved licensee compliance ratings for subsectors that have been targeted by CNSC staff for focused stakeholder engagement activities.

In 2014, the CNSC continued to create more opportunities for licensees and other persons to interact with the regulator outside the scope of inspection and licensing activities. The CNSC achieved this through stakeholder engagement activities across Canada in the form of outreach sessions.

4.3.1 Outreach sessions

Stakeholder engagement in the form of outreach is integral to the CNSC's objectives. Since 2009, the CNSC has offered an outreach program for licensees that use nuclear substances. The presentations made by CNSC staff and discussions associated with outreach are meant to inform licensees and other persons regulated by the CNSC on upcoming and recent regulatory changes, and provide education regarding the CNSC's expectations for licensing and compliance requirements.

The 2014 CNSC outreach program for licensees using nuclear substances reached 23 cities across Canada. Topics covered included:

- existing regulatory requirements, such as for reporting and transport of nuclear substances

- new regulatory requirements, such as [REGDOC-2.12.3, Security of Nuclear Substances: Sealed Sources](#), and the proposed CNSC [financial guarantees](#) program
- changes to the CNSC compliance program and inspection results from the previous year
- information on the forthcoming amendments to the *Radiation Protection Regulations* and the *Packaging and Transport of Nuclear Substances Regulations*⁴

In 2014, CNSC staff also delivered a special regulatory workshop at the request of the diagnostic and therapeutic nuclear medicine subsector in the Montréal, QC area.

4.3.2 Industrial radiography working group

In 2009, the CNSC and industry representatives established a joint CNSC/industrial radiography working group. The group's objective is to foster communications between the CNSC and the industry, discuss best practices and safety performance, and stay informed of new developments in the field from both the technical and regulatory perspectives.

The industrial radiography working group held two regular meetings in 2014 to discuss safety culture and new developments that may impact the radiography industry, and to review the mandate and membership of the working group. The working group also held its annual meetings with the radiography industry at large in Nisku, AB and Ottawa, ON. It adopted safety culture as its meeting theme for 2014. Representatives from France also participated in the Ottawa meeting, providing information on how the radiography industry is regulated in France.

CNSC staff, with input from the working group, developed a booklet titled, [Working Safely with Industrial Radiography](#). The document contains guidelines on the safe handling and use of industrial radiography exposure devices, and provides basic information about radiation exposure to people working with (or near) these devices.

The working group continued to support the development of the [new CSA certification guide for exposure device operators PCP-09](#). This new guide will replace the CNSC's current regulatory guide G-229, *Certification of Exposure Device Operators*, and address the most current safety, security and regulatory requirements for the industry. CNSC staff will implement this guide starting in 2015.

4.3.3 Canadian Radiation Protection Association

For almost three decades CNSC staff have delivered regulatory-focused presentations and participated in regulatory workshops at the Canadian Radiation Protection Association (CRPA) annual conferences. At the 2014 conference in Vancouver, BC, CNSC staff

⁴ The latter regulations were published in 2015 as the [Packaging and Transport of Nuclear Substances Regulations, 2015](#).

delivered 11 presentations and participated in an open discussion panel on regulatory topics.

In addition, in 2014, CNSC staff and representatives from the CRPA established a joint working group, the proposed mission of which is “to be a forum for implementing solutions and resolving issues in order to promote a strong radiation safety culture while respecting and understanding the interest and expectations of stakeholders.” This working group plans to meet twice a year or more frequently if required.

The group’s first meeting was held in September 2014 and focused on developing the terms of reference for the group and on the expectations of each participant.

4.3.4 Canadian Organization of Medical Physicists

The Canadian Organization of Medical Physicists (COMP) represents medical physicists working in radiotherapy facilities in the medical sector and in isotope production cyclotron facilities in the commercial sector. Many certified radiation safety officers at Class II nuclear facilities are members of COMP. In 2014, CNSC staff outreach activities included presenting talks and posters on regulatory issues at the COMP annual conference, attending the COMP winter school and submitting quarterly articles on regulatory topics of interest to radiotherapy licensees to the *COMP Interactions* bulletin.

CNSC staff also worked with COMP to develop quality assurance testing requirements for specific radiotherapy facility safety systems, which are required under the [Class II Nuclear Facilities and Prescribed Equipment Regulations](#). When completed, these testing requirements will be incorporated into technical quality control guidelines published through the [Canadian Partnership for Quality Radiotherapy](#).

4.3.5 Portable gauge workshops

In 2014, the CNSC developed a regulatory workshop for portable gauge licensees in an effort to promote compliance and safety culture within this industrial subsector. CNSC staff believe that improved industry engagement will be effective in addressing such issues. Positive results have already been observed in a marked improvement in compliance and by fewer CNSC enforcement actions taken against these licensees.

In June 2014, CNSC staff held a pilot workshop for portable gauge radiation safety officers in the Toronto, ON area. The workshop consisted of presentations delivered by CNSC staff followed by a question-and-answer session and general discussions. Participants responded positively. Based on this success, similar workshops will be repeated across Canada in 2015.

4.3.6 Newsletters

In 2009, the CNSC introduced the *DNSR Newsletter* – typically published twice a year by the Directorate of Nuclear Substance Regulation, with special editions as needed – as a forum for disseminating regulatory and safety information to licensees that use nuclear substances and prescribed equipment in Canada. The newsletter includes articles addressing various regulatory compliance issues and is an integral part of the regulator’s commitment to keep both licensees and the public informed. While regular editions

provide valuable information to licensees in all sectors, special editions tend to focus on a specific subsector as the main audience.

Two *DNSR Newsletter* editions were published in 2014. The regular edition provided timely information such as updates to the CNSC compliance program and on the consultation period for the then-draft new *Packaging and Transport of Nuclear Substances Regulations*, while the special edition focused on exposure device operators. All [published newsletters](#) can be found on the CNSC website.

5 Medical sector

This sector accounted for 536 CNSC licences and 9,003 nuclear energy workers (NEWs) as of December 31, 2014.

Safety performance results are provided for all licensees in the medical sector, with the following three subsectors highlighted in further detail: diagnostic and therapeutic nuclear medicine, radiation therapy and veterinary nuclear medicine.

5.1 Safety performance summary

Based on their evaluation and verification of licensee performance, CNSC staff concluded that the safety performance of the medical sector was satisfactory in 2014.

Doses received by NEWs in this sector remained low, with the majority of workers receiving doses below 1 millisievert (mSv). No NEW received a dose in excess of the annual regulatory limits.

Of the inspected licensees in this sector, 91.4% and 91.9% were found to be compliant in the operating performance and radiation protection safety and control areas (SCAs), respectively. Licensees took appropriate corrective actions, satisfactory to CNSC staff, to address the non-compliances noted during the inspections.

The CNSC took no escalated compliance enforcement actions against licensees in the medical sector in 2014.

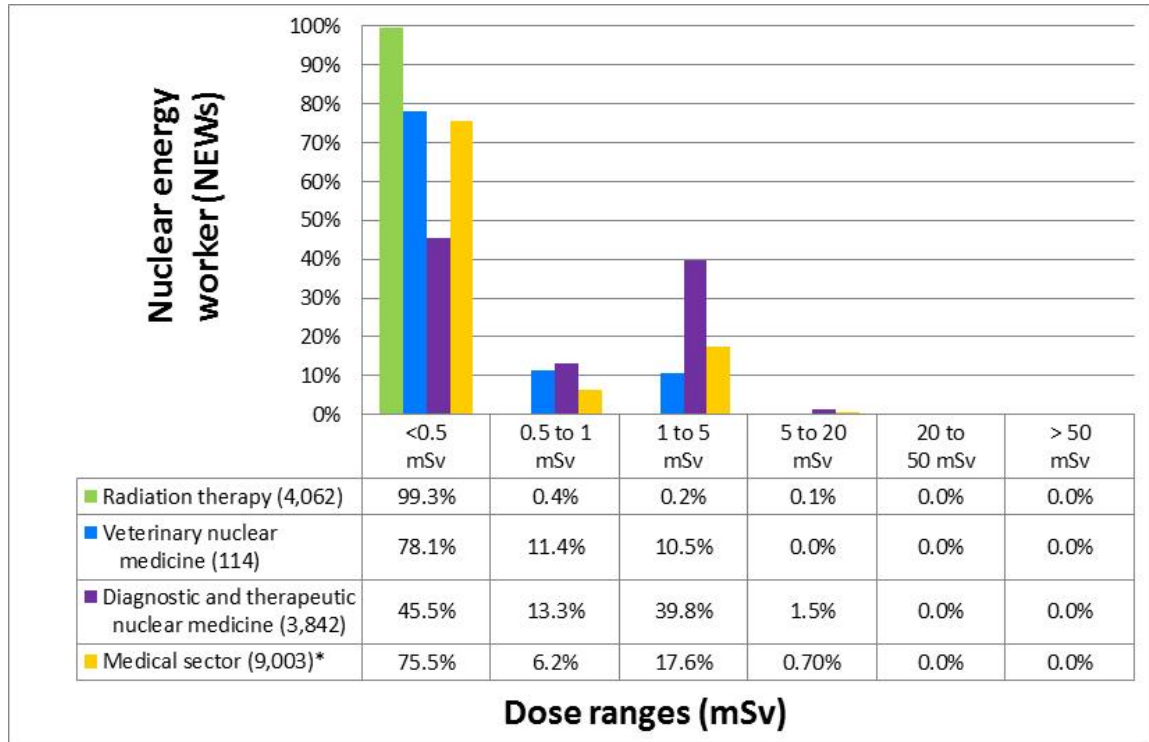
5.2 Safety performance results and trends

5.2.1 Doses to workers

As indicated in Figure 20, NEWs in the diagnostic and therapeutic nuclear medicine subsector continued to receive higher doses than workers in other medical subsectors. This is a result of directly administering nuclear substances to patients and constantly working in environments where patients are in close proximity to health professionals. Note that the vast majority of these workers received doses below 5 mSv. Doses received by NEWs in the diagnostic and therapeutic nuclear medicine subsector from 2010 to 2014 are shown in Figure 21.

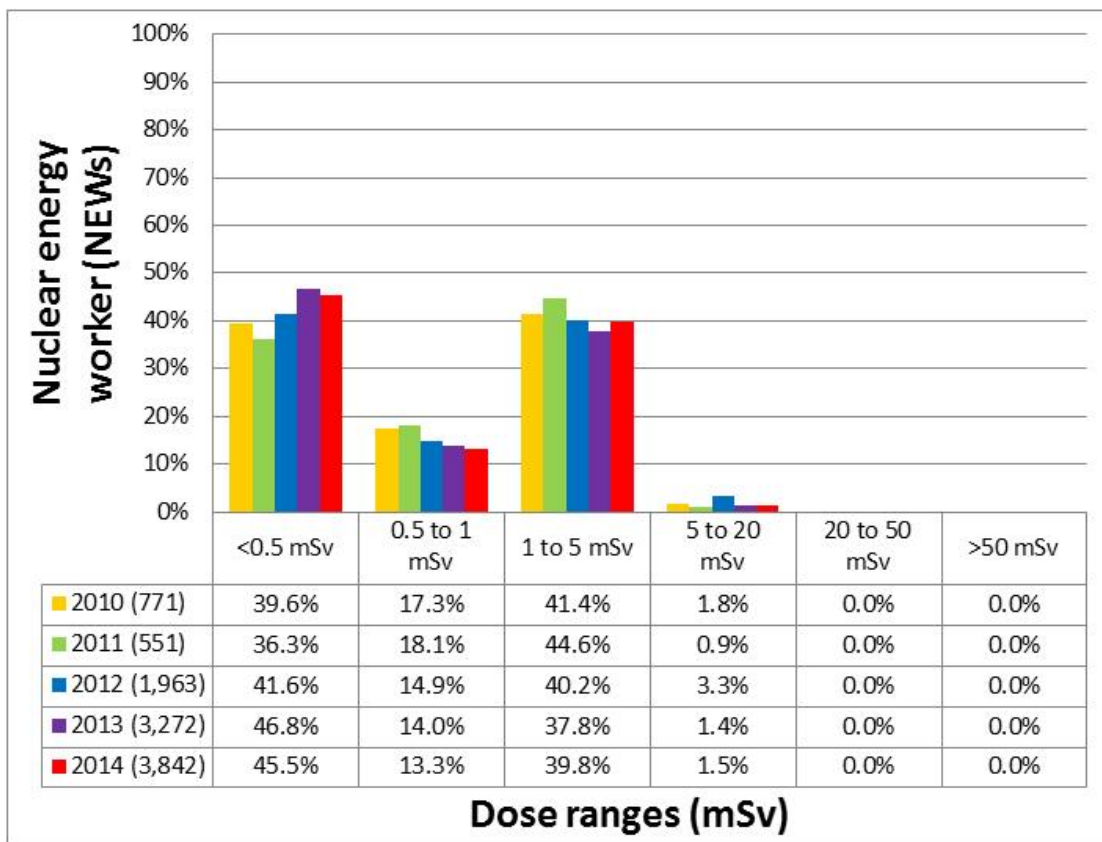
NEWs in the veterinary nuclear medicine and radiation therapy subsectors continued to receive low doses, with the majority of workers receiving doses below 1 mSv.

Figure 20: Medical sector performance comparison with select subsectors, effective doses to NEWs in 2014



* The total number of NEWs shown in this row is the aggregate for the entire medical sector, including subsectors not highlighted in this report.

Note: The sum of percentages may not add up to 100% due to rounding.

Figure 21: Diagnostic and therapeutic nuclear medicine subsector performance, annual effective doses to NEWs from 2010 to 2014

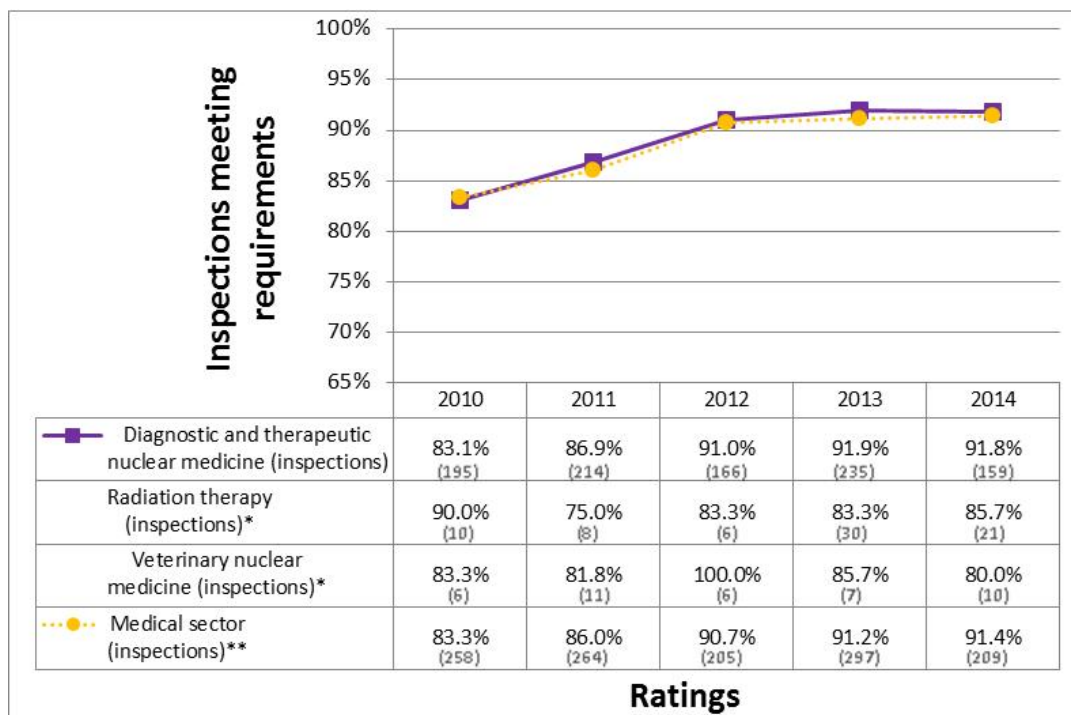
Note: The sum of percentages may not add up to 100% due to rounding.

5.2.2 Operating performance

The overall compliance rating for operating performance in the medical sector was 91.4% in 2014, as shown in Figure 22. Performance in this SCA has remained constant since 2012, when 90.7% of licensees inspected by the CNSC were found to be compliant. Since diagnostic and therapeutic nuclear medicine subsector inspections account for the vast majority of all medical operating performance inspections, any change in the compliance rating in this subsector has a large impact on the overall compliance rating of the medical sector.

Non-compliances observed by CNSC staff in the medical sector were mainly related to failure to comply with some of the regulatory requirements related to worker obligations, retention of records, sealed source leak testing, adherence to approved operating procedures and use of required equipment. Using the graded approach to compliance enforcement, CNSC staff used a range of compliance measures commensurate with the severity of the non-compliance to address non-compliances. None of the observed non-compliances had serious safety significance or required any escalation of enforcement actions.

In all cases, licensees addressed these non-compliances to the satisfaction of the CNSC.

Figure 22: Medical sector performance comparison with select subsectors – Inspection ratings of operating performance from 2010 to 2014

*Since there were relatively few inspections in the radiation therapy and veterinary nuclear medicine subsectors, their trend lines are not provided.

** The total number of inspections shown in this row is the aggregate for the entire medical sector, including subsectors not highlighted in this report.

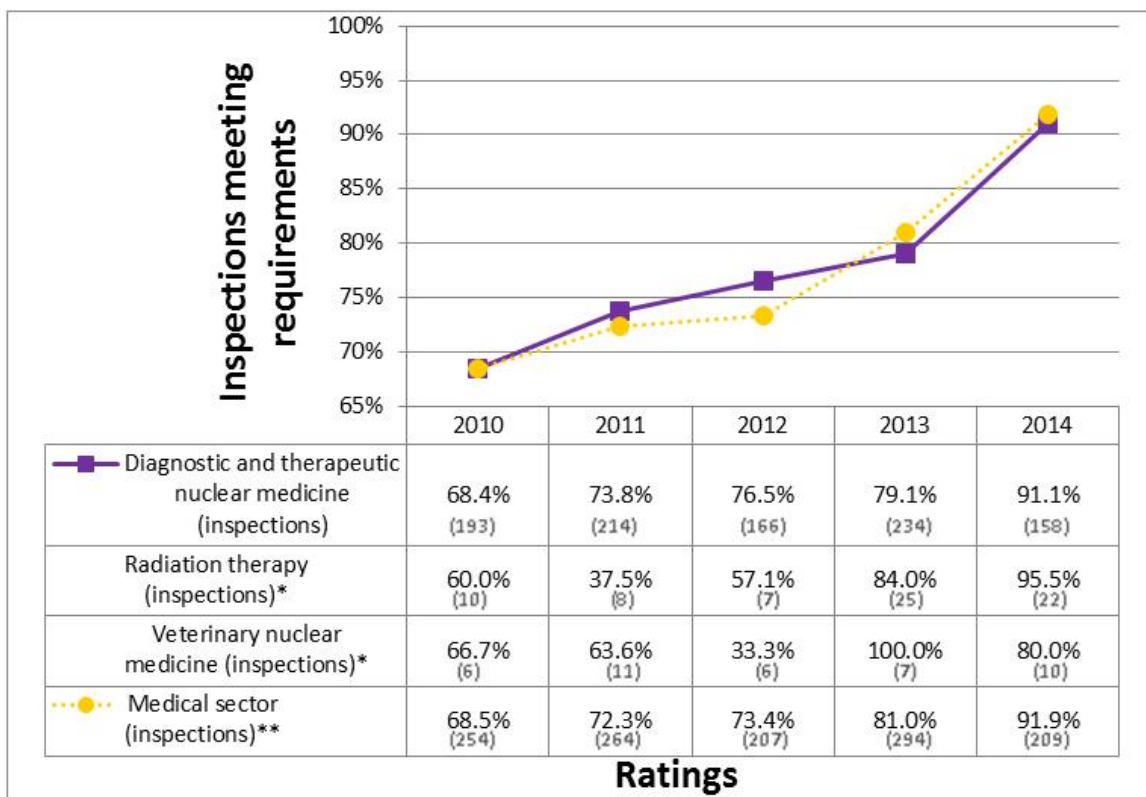
5.2.3 Radiation protection

The overall compliance rating for radiation protection in the medical sector was 91.9% in 2014, as shown in Figure 23. Performance in this SCA has continued to show steady and marked improvement. In 2010, 68.5% of licensees inspected by the CNSC were found to be compliant with the regulatory requirements of this SCA. Since diagnostic and therapeutic nuclear medicine subsector inspections account for the vast majority of all medical radioprotection performance inspections, the increase in the compliance rating in this subsector had a large impact on the overall compliance rating of the medical sector. The compliance rating for the radiation therapy subsector also continued to show improvement in 2014.

Non-compliances observed by CNSC staff in the medical sector were mainly related to improper storage of nuclear substances, containers not being properly labelled, inadequate implementation of measures to ensure that doses are kept as low as reasonably achievable and survey meters not being available or properly calibrated. Using the graded approach to compliance enforcement, CNSC staff used a range of compliance measures commensurate with the severity of the non-compliance to address non-compliances. None of the observed non-compliances had serious safety significance or required any escalation of enforcement actions.

In all cases, licensees addressed these non-compliances to the satisfaction of the CNSC.

Figure 23: Medical sector performance comparison with select subsectors – Inspection ratings of radiation protection from 2010 to 2014



*Since there were relatively few inspections in the radiation therapy and veterinary nuclear medicine subsectors, their trend lines are not provided.

**The total number of inspections shown in this row is the aggregate for the entire medical sector, including subsectors not highlighted in this report.

5.2.4 Enforcement actions

No escalated enforcement actions were taken by the CNSC against medical sector licensees in 2014.

6 Industrial sector

This sector accounted for 1,398 CNSC licences and 8,567 nuclear energy workers (NEWs) as of December 31, 2014.

Safety performance results are provided for all licensees included in the industrial sector, with the following four subsectors highlighted in further detail: industrial radiography, oil well logging, portable gauge and fixed gauge.

The CNSC inspection program for the fixed gauge subsector was revised in 2014. The inspection frequency was changed from every five years to every three years (effective 2014) to provide enhanced regulatory oversight. (Under the revised inspection regime, CNSC inspectors conduct more field performance-based inspections, in addition to conducting records and desktop inspections). As a result, the number of CNSC inspections in this subsector increased by 12.9%.

6.1 Safety performance summary

Based on their evaluation and verification of licensee performance, CNSC staff concluded that the safety performance of the industrial sector was satisfactory in 2014.

Doses received by NEWs in this sector remained low, with the majority of workers receiving doses below 1 millisievert (mSv). No NEW received a dose in excess of the annual regulatory limits.

Of all the inspected licensees in this sector, 87.9% and 88.1% were found to be compliant in the operating performance and radiation protection safety and control areas (SCAs), respectively. Licensees took appropriate corrective actions, satisfactory to CNSC staff, to address the non-compliances noted during the inspections.

The CNSC took 16 escalated enforcement actions against licensees in the industrial sector in 2014: 10 orders and six administrative monetary penalties. Further details are provided in section [6.2.4](#).

6.2 Safety performance results and trends

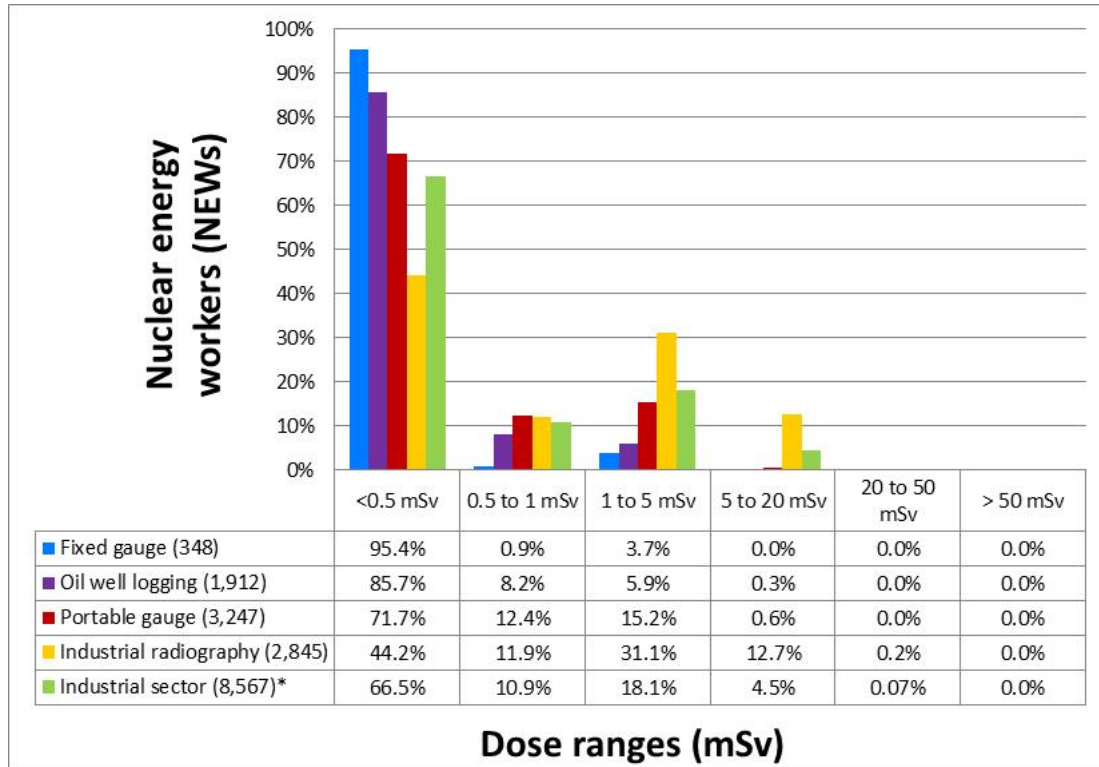
6.2.1 Doses to workers

Figure 24 summarizes the doses received by workers in this sector in 2014. The vast majority of these NEWs received doses below 5 mSv. NEWs in the industrial radiography subsector continued to receive higher doses than workers in other industrial subsectors. This is a result of working in close proximity to exposure devices containing high activity sealed sources. Doses received by NEWs in the industrial radiography subsector from 2010 to 2014 are shown in Figure 25.

NEWs in the portable gauge and oil well logging subsectors continued to receive low doses, with the majority of workers receiving less than 1 mSv.

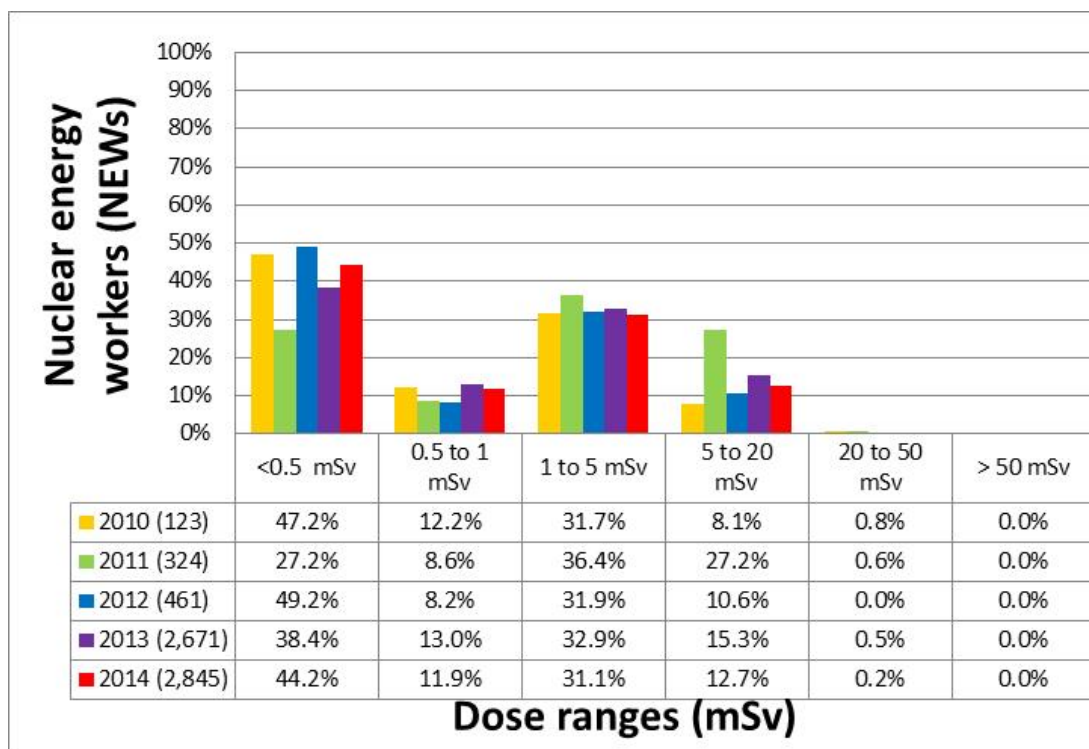
NEWs in the fixed gauge subsector continued to receive extremely low doses, due primarily to the limited direct handling of radiation devices required in this subsector.

Figure 24: Industrial sector performance comparison with select subsectors – Effective doses of NEWs in 2014



* The total number of NEWs shown in this row is the aggregate for the entire industrial sector, including subsectors not highlighted in this report.

Note: The sum of percentages may not add up to 100% due to rounding.

Figure 25: Industrial radiography subsector performance – Annual effective doses to NEWs from 2010 to 2014

Note: The sum of percentages may not add up to 100% due to rounding.

6.2.2 Operating performance

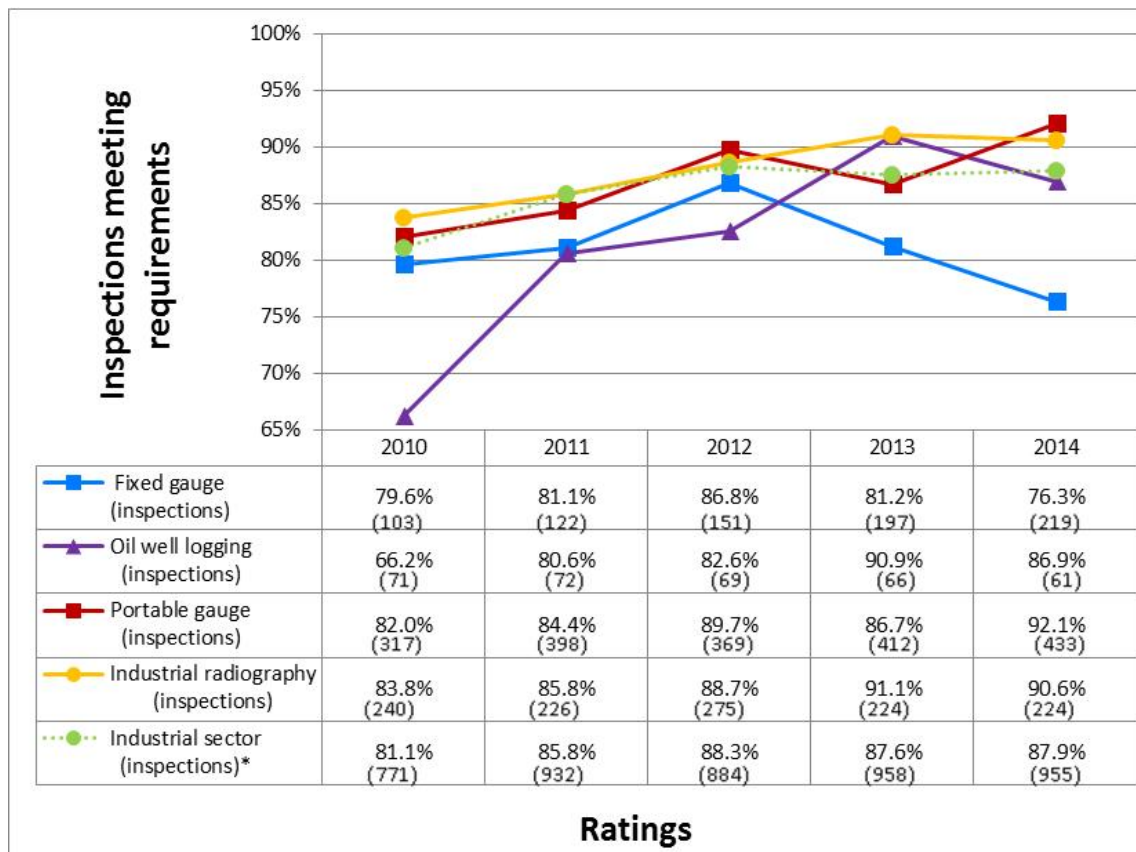
The compliance rating for operating performance in the industrial sector is summarized in Figure 26. Whereas overall licensee performance in this SCA has remained largely unchanged since 2012, a downward trend is observed in the fixed gauge subsector. Note that the radiation doses received by workers in the fixed gauge subsector are the lowest in the industrial sector.

Fixed gauges have a high degree of reliability and their use involves little interaction with the worker after the gauge is installed and in use. During field observations, CNSC inspectors noted deficiencies in licensee oversight of fixed gauges during normal operation; these deficiencies resulted in the failure to follow approved procedures. The CNSC has recognized that the lower performance of this subsector remains an issue. Accordingly, it increased its regulatory oversight of the fixed gauge subsector in 2014.

Non-compliances observed by CNSC staff in the industrial sector were related to failure to comply with regulatory requirements applicable to worker obligations, retention of records, sealed source leak testing, use of required equipment and following procedures specified in their CNSC licences. Using the graded approach to compliance enforcement, CNSC staff used a range of compliance enforcement measures commensurate with the severity of the non-compliance to address non-compliances with regulatory requirements. In some instances, based on safety significance, there was an escalation of enforcement actions. See section 6.2.4 for further details.

In all cases, licensees addressed these non-compliances to the satisfaction of the CNSC.

Figure 26: Industrial sector performance comparison with select subsectors – Inspection ratings of operating performance from 2010 to 2014



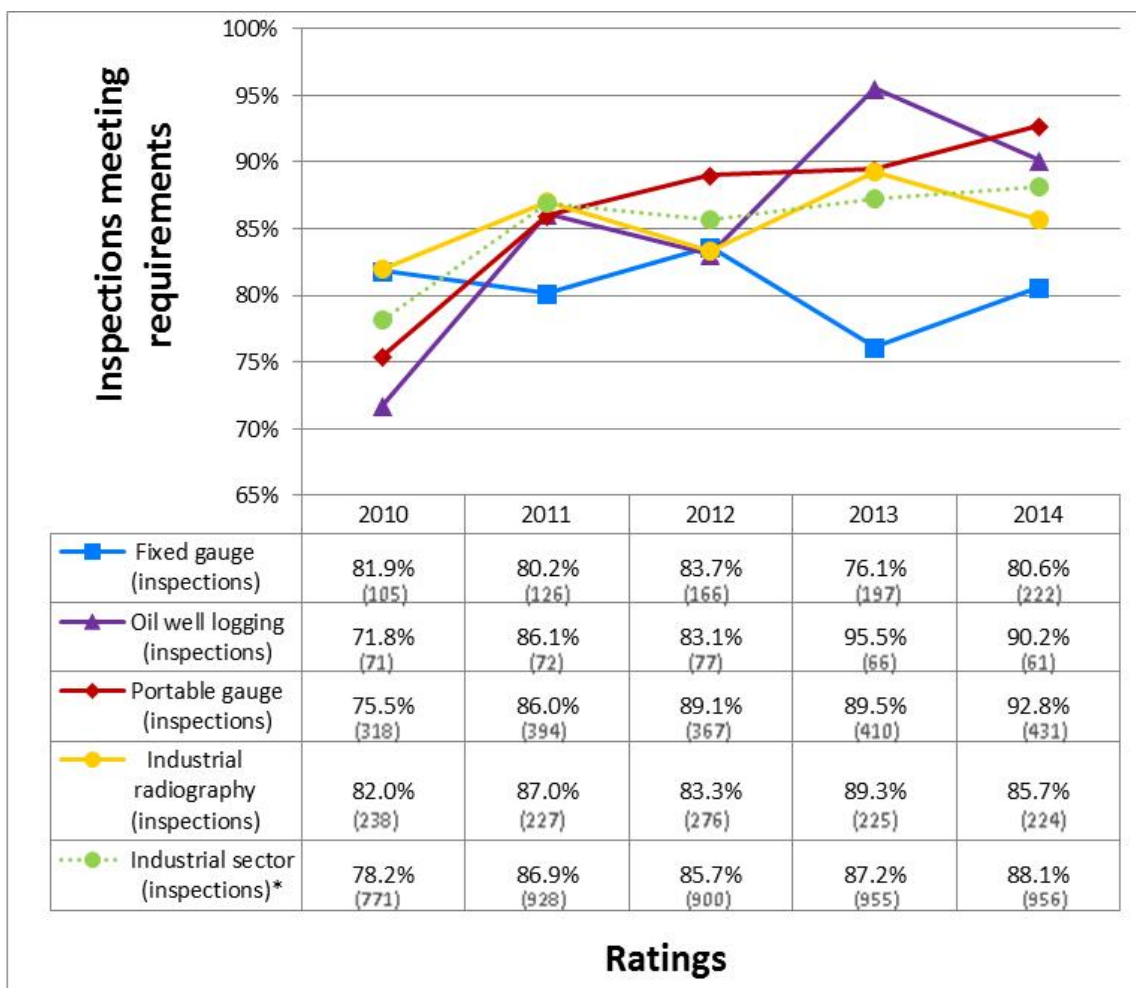
* The total number of inspections shown in this row is the aggregate for the entire industrial sector, including subsectors not highlighted in this report.

6.2.3 Radiation protection

The compliance rating for radiation protection SCA for licensees in the industrial sector was 88.1% in 2014, as shown in Figure 27. The overall licensee performance in this SCA has remained largely unchanged since 2011.

Non-compliances observed by CNSC staff in the industrial sector were related to survey meters not being available or properly calibrated, failure to post signs at boundaries and points of access, inadequate implementation of measures to ensure doses are kept as low as reasonably achievable, containers or radiation devices not labelled properly, and failure to comply with regulatory obligations. Using the graded approach to compliance enforcement, CNSC staff used a range of compliance enforcement measures commensurate with the severity of the non-compliance to address non-compliances with regulatory requirements. In some instances, based on safety significance, there was an escalation of enforcement actions. See section 6.2.4 for further details.

In all cases, licensees addressed these non-compliances to the satisfaction of the CNSC.

Figure 27: Industrial sector performance comparison with select subsectors – Inspection ratings of radiation protection from 2010 to 2014

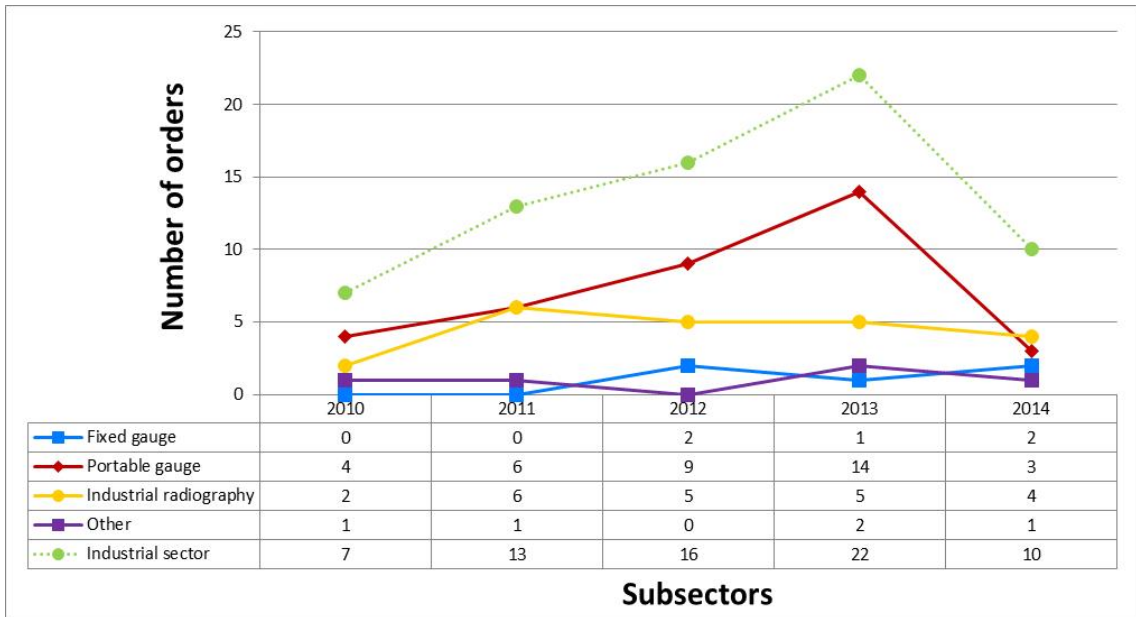
* The total number of inspections shown in this row is the aggregate for the entire industrial sector, including subsectors not highlighted in this report.

6.2.4 Enforcement actions

As shown in Figure 28, the CNSC took 16 escalated enforcement actions against licensees in the industrial sector in 2014, consisting of 10 orders and six administrative monetary penalties (AMPs). Most of the enforcement actions were taken against licensees in the industrial radiography and portable gauge subsectors. The industrial sector saw a significant drop in the number of orders issued in 2014 compared to 2013, primarily due to significantly fewer orders being issued to licensees in the portable gauge subsector. The performance of the portable gauge subsector improved in all SCAs in 2014, demonstrating the effectiveness of the outreach and compliance promotion efforts by CNSC staff.

All licensees to whom orders were issued complied with the terms and conditions of the orders and implemented corrective measures to the satisfaction of CNSC staff. All six licensees who were issued AMPs have paid their penalty amounts. Details on the orders and AMPs issued can be found in section 4.2.5.

Figure 28: Summary of orders by type of licensed activity in the industrial sector from 2010 to 2014



For more information on enforcement actions, consult the [regulatory actions](#) page on the CNSC website.

7 Academic and research

This sector accounted for 229 CNSC licences and 3,612 nuclear energy workers (NEWs) as of December 31, 2014.

Safety performance results are provided for all licensees included in the academic and research sector, with one subsector – laboratory studies and consolidated uses of nuclear substances – highlighted in further detail.

There has been a steady decrease in the number of laboratory studies and consolidated uses of nuclear substances licences over the years, with a recent drop of 22.2% – from 198 licences in 2010 to 154 licences in 2014. This change is in response to institutions finding alternative methods of performing research that do not require the use of nuclear substances.

In 2013, the CNSC inspection program for the laboratory studies and consolidated uses of nuclear substances subsector was revised, based on the positive safety performance ratings and the low-risk level associated with these licensed activities. The frequency of CNSC inspections was changed from annually to every two years, which is reflected in the 30.8% decrease in the number of inspections conducted in 2014 for this subsector.

7.1 Safety performance summary

The academic and research sector continued to show good safety performance in 2014.

Doses received by NEWs in this sector remained very low, with the majority of workers receiving doses below 0.5 millisievert (mSv).

Of the inspected licensees in this sector, 87.4% and 87.3% were found to be in compliance in the operating performance and radiation protection safety and control areas (SCAs), respectively. Licensees took appropriate corrective actions, satisfactory to CNSC staff, to address the non-compliances noted during the inspections.

The CNSC took two escalated enforcement actions against a licensee in the academic and research sector, consisting of one order and one administrative monetary penalty. Further details are provided in section 4.2.5.

7.1.1 CNSC laboratory

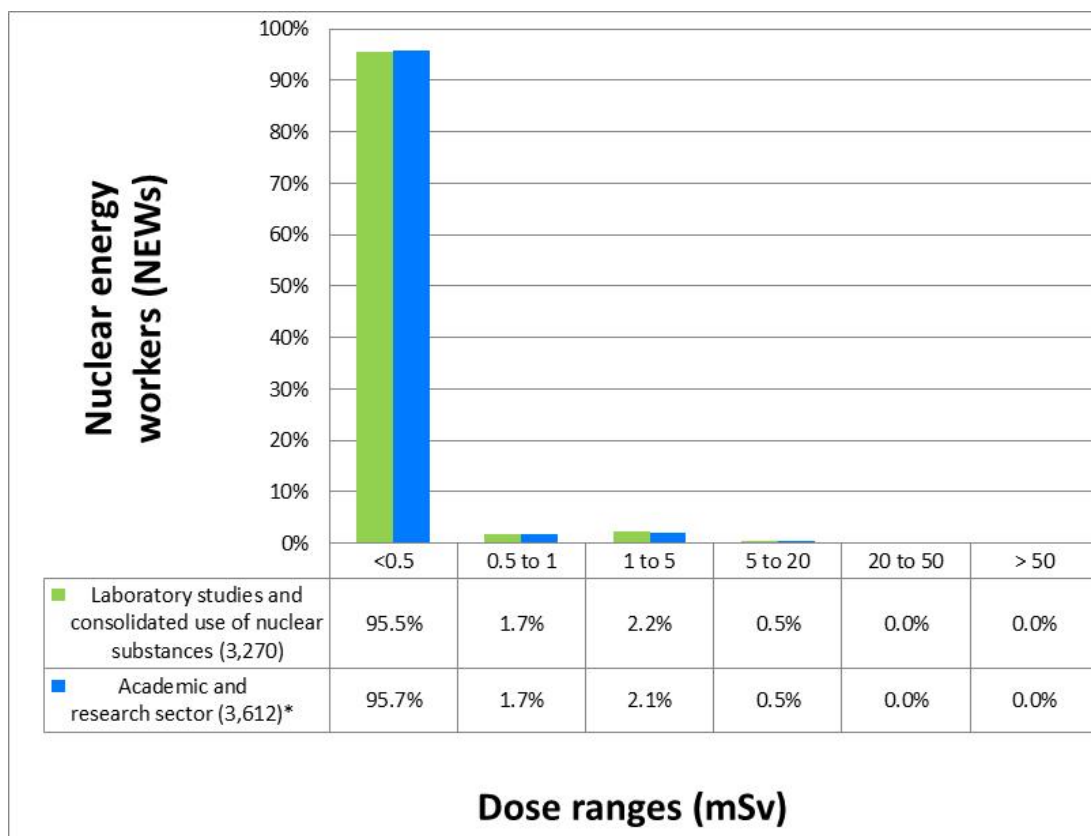
Doses received by NEWs working at the CNSC laboratory remained very low, with most workers receiving doses below 0.5 mSv. There was one reported event at the CNSC laboratory involving a missing low-risk (Category 4) cesium-137 source. This event is discussed in detail in section 4.2.6. As a follow-up to this event, CNSC staff conducted a compliance inspection at the CNSC laboratory in December 2014 and concluded that the use of nuclear substances and prescribed equipment at the laboratory is safe.

7.2 Safety performance results and trends

7.2.1 Doses to workers

As Figure 29 indicates, NEWs in the laboratory studies and consolidated uses of nuclear substances subsector constitute over 90% of the total number of workers in this sector.

Figure 29: Academic and research sector performance comparison with the laboratory studies and consolidated use of nuclear substances subsector – effective doses of NEWs in 2014



* The total number of NEWs shown in this row is the aggregate for the entire academic and research sector, including subsectors not highlighted in this report.

Note: The sum of percentages may not add up to 100% due to rounding.

Among the workers included in Figure 29 are seven CNSC employees designated as NEWs who worked at the CNSC laboratory. Six of these workers received doses below 0.5 mSv; one received a dose between 1 and 5 mSv.

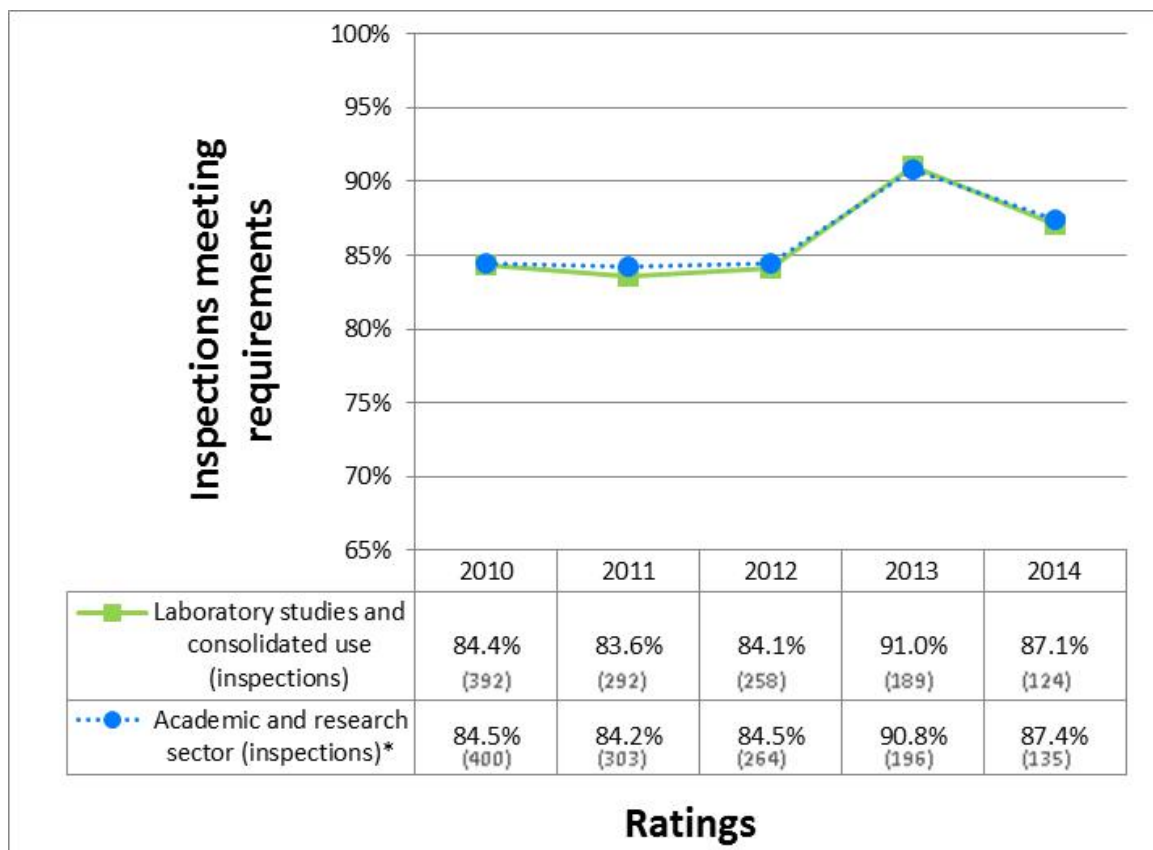
7.2.2 Operating performance

The overall compliance rating for operating performance in the academic and research sector was 87.4% in 2014, as shown in Figure 30. Despite fluctuations over the past two years, performance in this SCA has remained generally constant since 2010, when 84.5% of inspected licensees were found to be compliant.

Non-compliances observed by CNSC staff in the academic and research sector were related to failures to comply with regulatory requirements having to do with retaining inventory records, worker obligations, inappropriate posting of radiation warning signs, procedures not being followed and failure to post licences. Using the graded approach to compliance enforcement, CNSC staff used a range of compliance measures commensurate with the severity of the non-compliance to address non-compliances. None of the observed non-compliances had serious safety significance or required any escalation of enforcement actions.

In all cases, licensees addressed these non-compliances to the satisfaction of the CNSC.

Figure 30: Academic and research sector performance comparison with the laboratory studies and consolidated use of nuclear substances subsector – Inspection ratings of operating performance from 2010 to 2014



* The total number of inspections shown in this row is the aggregate for the entire academic and research sector, including subsectors not highlighted in this report.

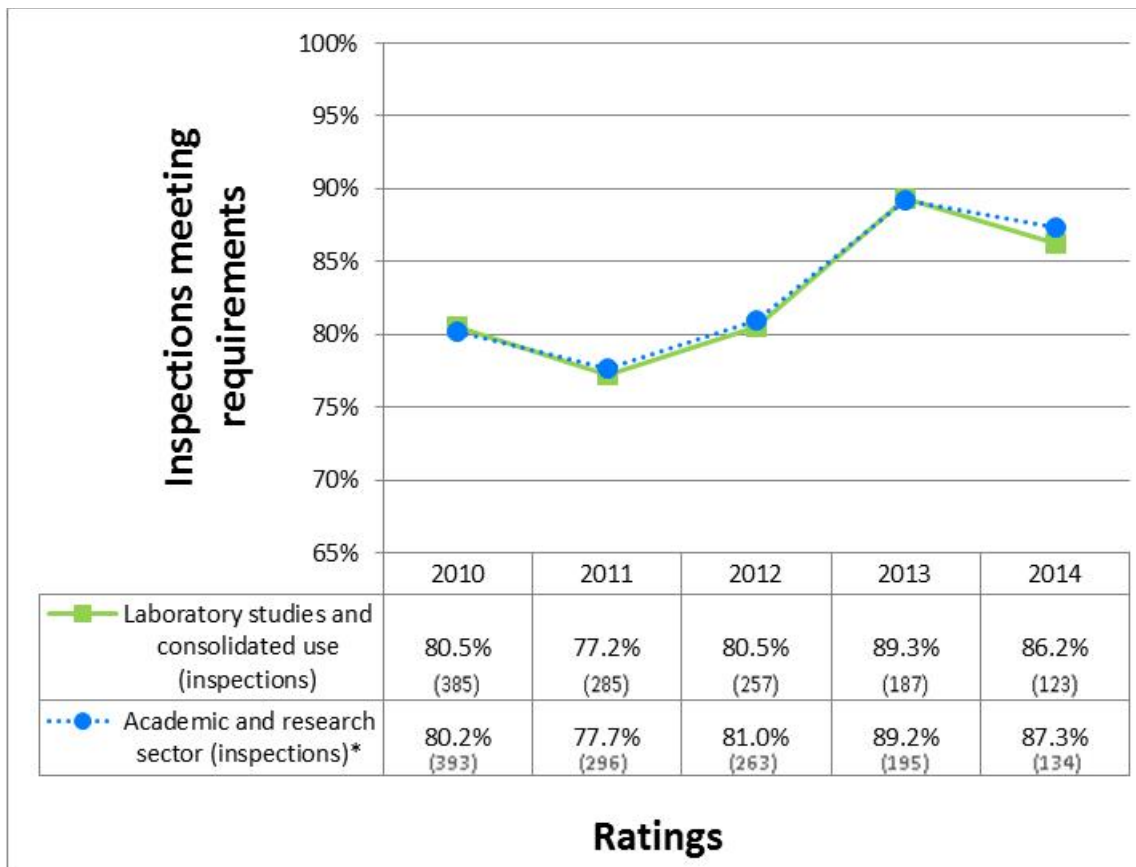
7.2.3 Radiation protection

The overall compliance rating for radiation protection in the academic and research sector was 87.3% in 2014, as shown in Figure 31. Performance in this SCA has made gains since 2010, when 80.2% of inspected licensees were found to be compliant.

Non-compliances observed by CNSC staff in the academic and research sector related to inadequate implementation of measures to ensure that doses are kept as low as reasonably achievable, containers or radiation devices not being labelled properly, improper storage of nuclear substances and failure to post signs at boundaries and points of access. Using the graded approach to compliance enforcement, CNSC staff used a range of compliance enforcement measures commensurate with the severity of the non-compliance to address non-compliances with regulatory requirements. In some instances, based on safety significance, there was an escalation of enforcement actions. See section 7.2.4 for further details.

In all cases, licensees addressed these non-compliances to the satisfaction of the CNSC.

Figure 31: Academic and research sector performance comparison with the laboratory studies and consolidated use of nuclear substances subsector – Inspection ratings of radiation protection from 2010 to 2014



* The total number of inspections shown in this row is the aggregate for the entire academic and research sector, including subsectors not highlighted in this report.

7.2.4 Enforcement actions

The CNSC took two escalated enforcement actions against a licensee in the academic and research sector: one order and one administrative monetary penalty. Both were issued in conjunction with an event relating to the licensee's sealed source inventory control, as illustrated in section 4.2.6. The licensee complied with the terms and conditions of the order and implemented corrective measures in response to the order, including corrective measures to prevent recurrence of the event, all of which have been reviewed by CNSC staff and found to be satisfactory. The licensee also paid the administrative monetary penalty. Details on the order and the penalty issued can be found in section 4.2.5.

8 Commercial sector

This sector accounted for 248 CNSC licences and 2,077 nuclear energy workers (NEWs) as of December 31, 2014.

Safety performance results are provided for all licensees included in the commercial sector, with the following five subsectors highlighted in further detail: operation of isotope production accelerators, processing of nuclear substances, distribution of nuclear substances, servicing of radiation devices and prescribed equipment, and calibration of radiation devices and prescribed equipment.

8.1 Safety performance summary

The commercial sector continued to show good safety performance in 2014.

Doses received by NEWs in this sector remained low, with the majority of workers receiving doses below 1 millisievert (mSv).

Of the inspected licensees, 88.9% and 93.7% were found to be compliant in the operating performance and radiation protection safety and control areas (SCAs), respectively. Licensees took appropriate corrective actions, satisfactory to CNSC staff, to address the non-compliances noted during the inspections.

The CNSC took one escalated enforcement action against a licensee in the commercial sector. Further details are provided in section [8.2.4](#).

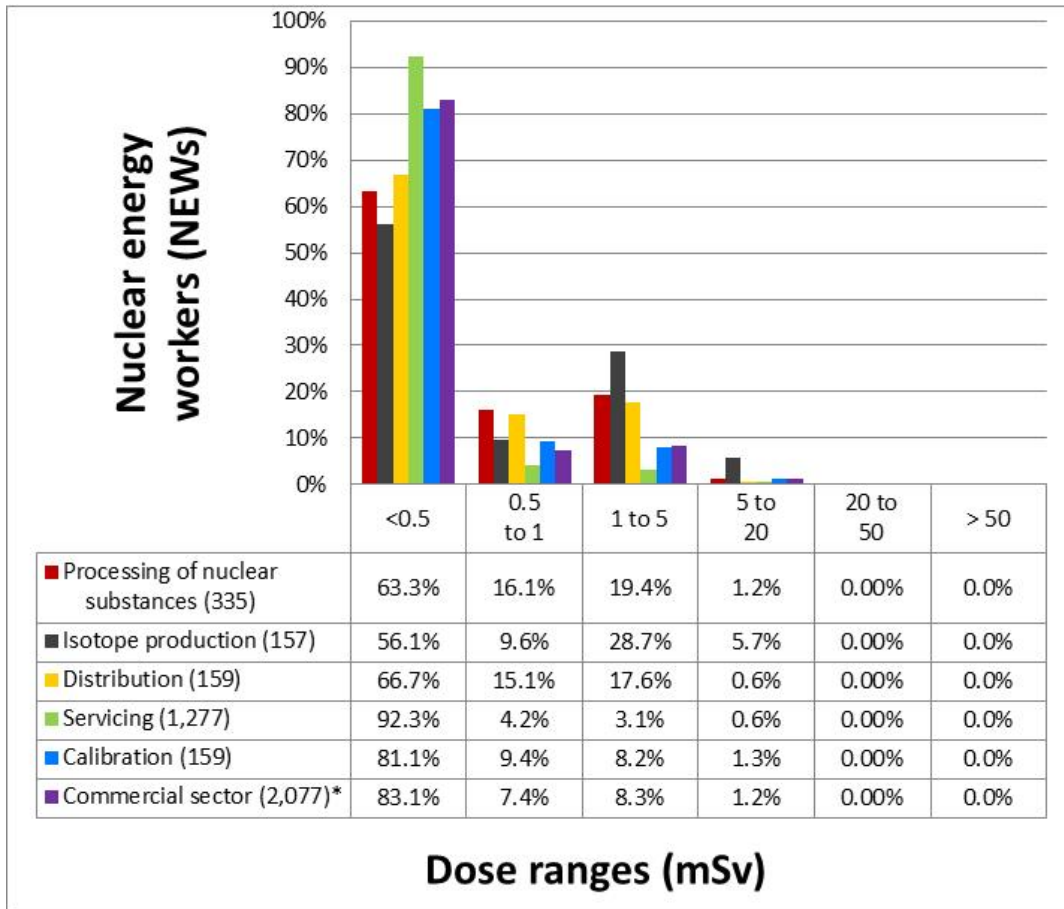
8.2 Safety performance results and trends

8.2.1 Doses to workers

As Figure 32 indicates, NEWs in the isotope production accelerators, processing of nuclear substances and distribution subsectors continued to receive higher doses than workers in other commercial subsectors. This is due to their manual handling of nuclear substances and activated cyclotron components. Despite this, the vast majority of NEWs in these subsectors received doses below 5 mSv. Doses received from 2010 to 2014 by NEWs in the processing of nuclear substances and isotope production accelerators subsectors are shown in Figure 33 and Figure 34, respectively.

NEWs in the servicing and calibration subsectors continued to receive low doses, with the majority of them receiving doses below 0.5 mSv.

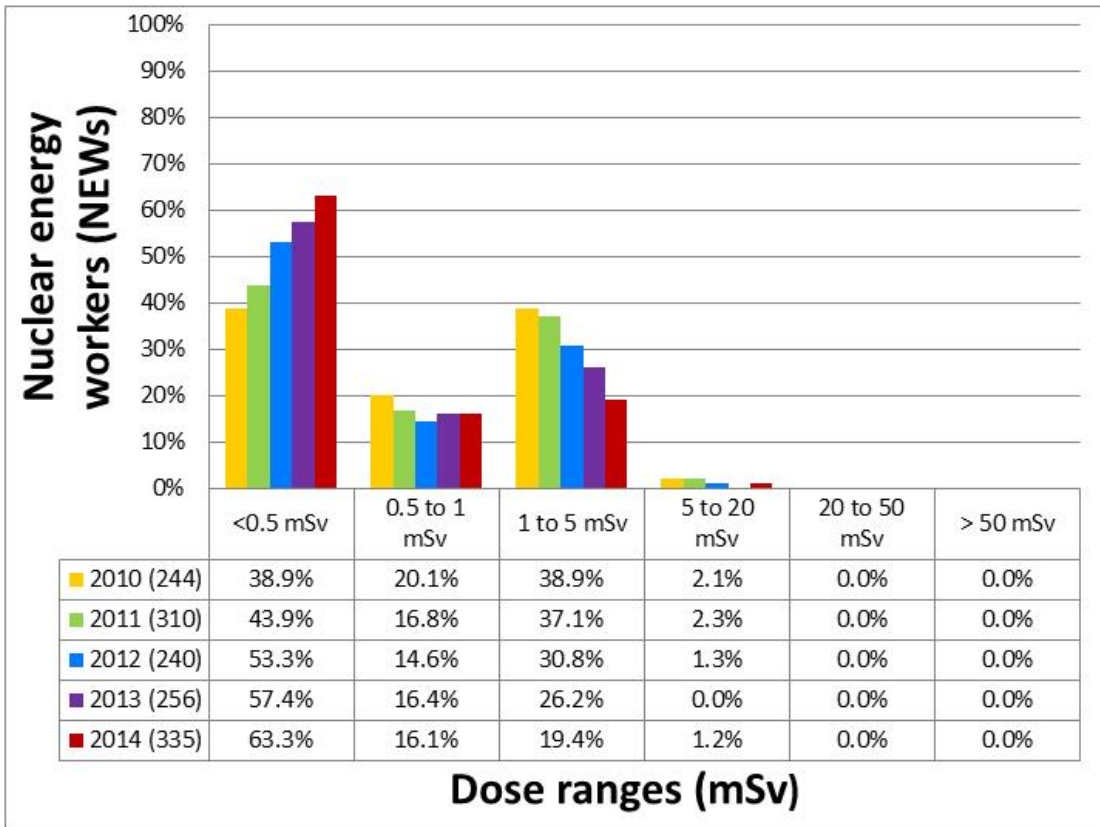
Figure 32: Commercial sector performance comparison with select subsectors – Effective doses to NEWs in 2014



* The total number of NEWs shown for the commercial sector is the aggregate for the entire commercial sector, including subsectors not highlighted in this report. Note that due to the fact that some licensees in this sector possess multiple licences covering different activities, it is not possible to distinguish the specific activity associated with a particular dose. Licensees therefore submit the same dose summary for each licence. For this report, the total number of NEWs excludes the duplicate dose data. As a result, the total number of NEWs is lower than the sum of the subsectors highlighted for this sector.

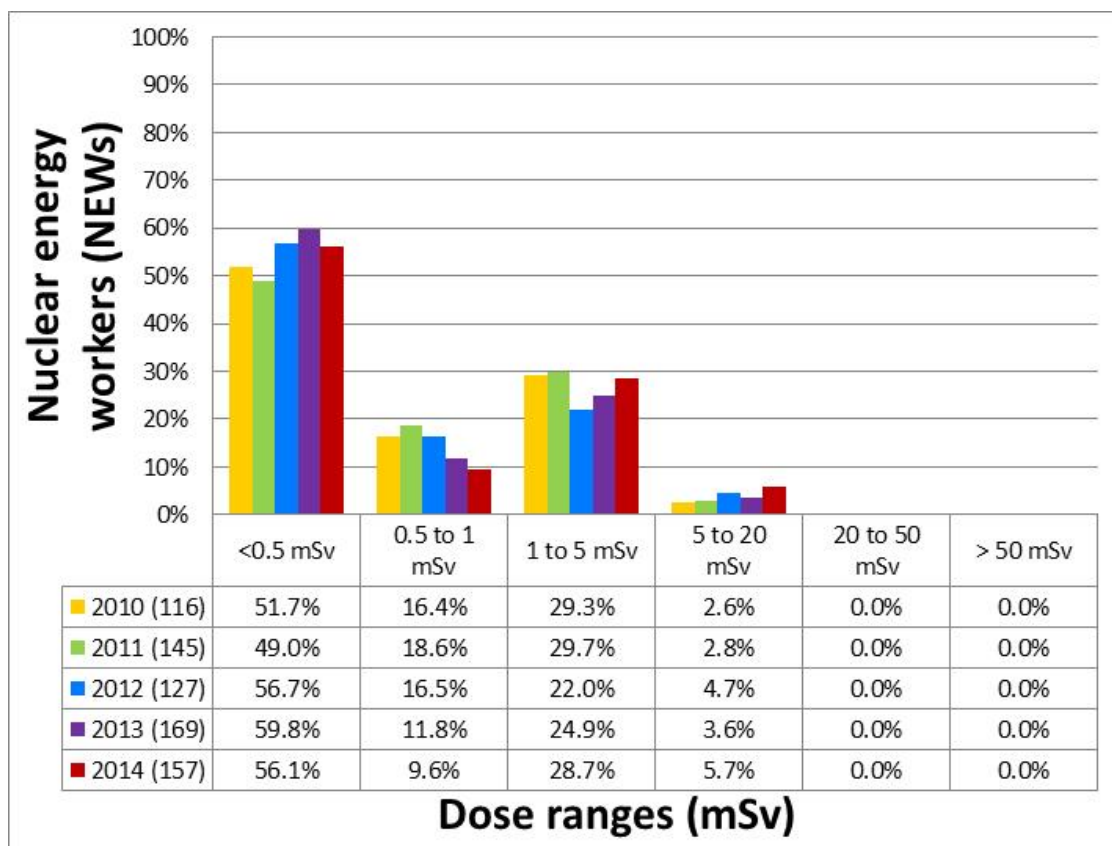
Note: The sum of percentages may not add up to 100% due to rounding.

Figure 33: Processing of nuclear substance subsector performance – Annual effective doses to NEWs from 2010 to 2014



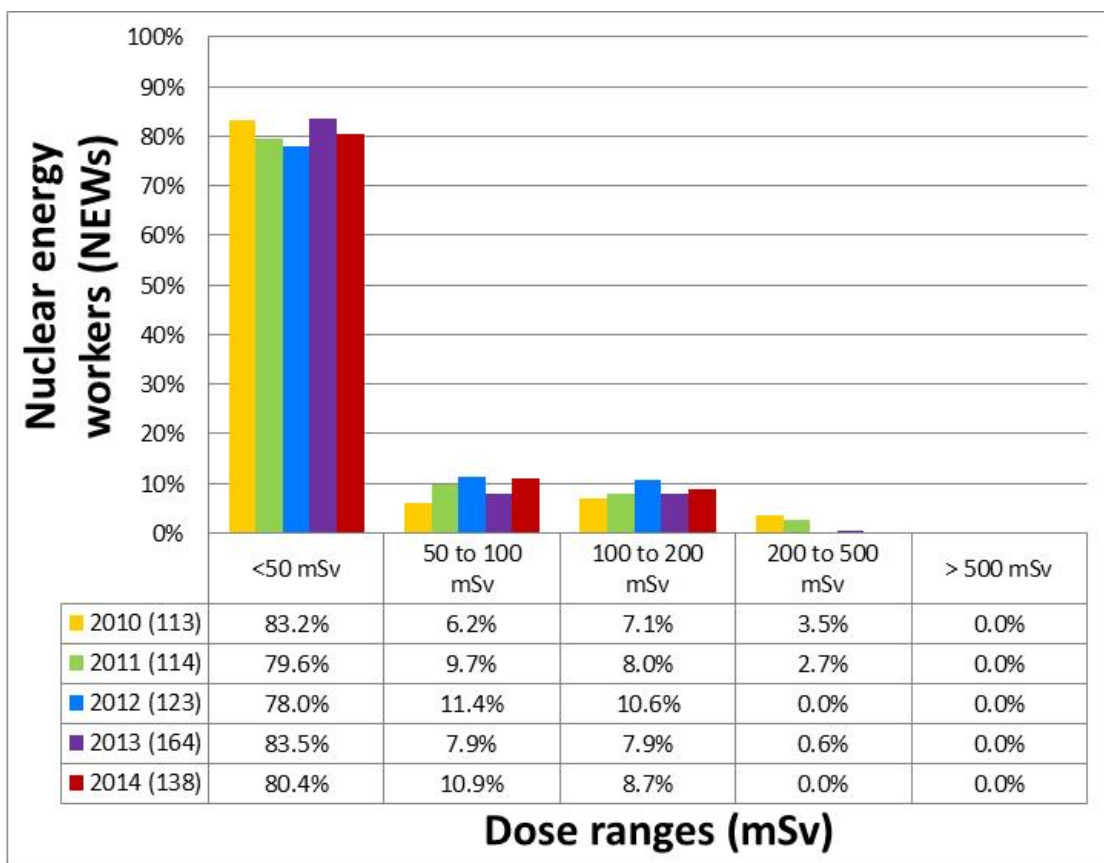
Note: The sum of percentages may not add up to 100% due to rounding.

Figure 34: Isotope production accelerators subsector performance – Annual effective doses to NEWs from 2010 to 2014



Note: The sum of percentages may not add up to 100% due to rounding.

Due to the need to manually handle nuclear substances (the handling is associated with dispensing and quality assurance testing during radioisotope production), doses to the hands (known as extremity doses) of NEWs in certain subsectors are monitored and subject to the regulatory dose limit of 500 mSv per year. The extremity doses received by NEWs in the isotope production accelerators subsector from 2010 to 2014 are shown in Figure 35. Overall, extremity doses received by NEWs in this subsector continued to be low, with the majority of workers receiving doses below 50 mSv.

Figure 35: Isotope production accelerators subsector performance – Annual extremity doses to NEWs from 2010 to 2014

Note: The sum of percentages may not add up to 100% due to rounding.

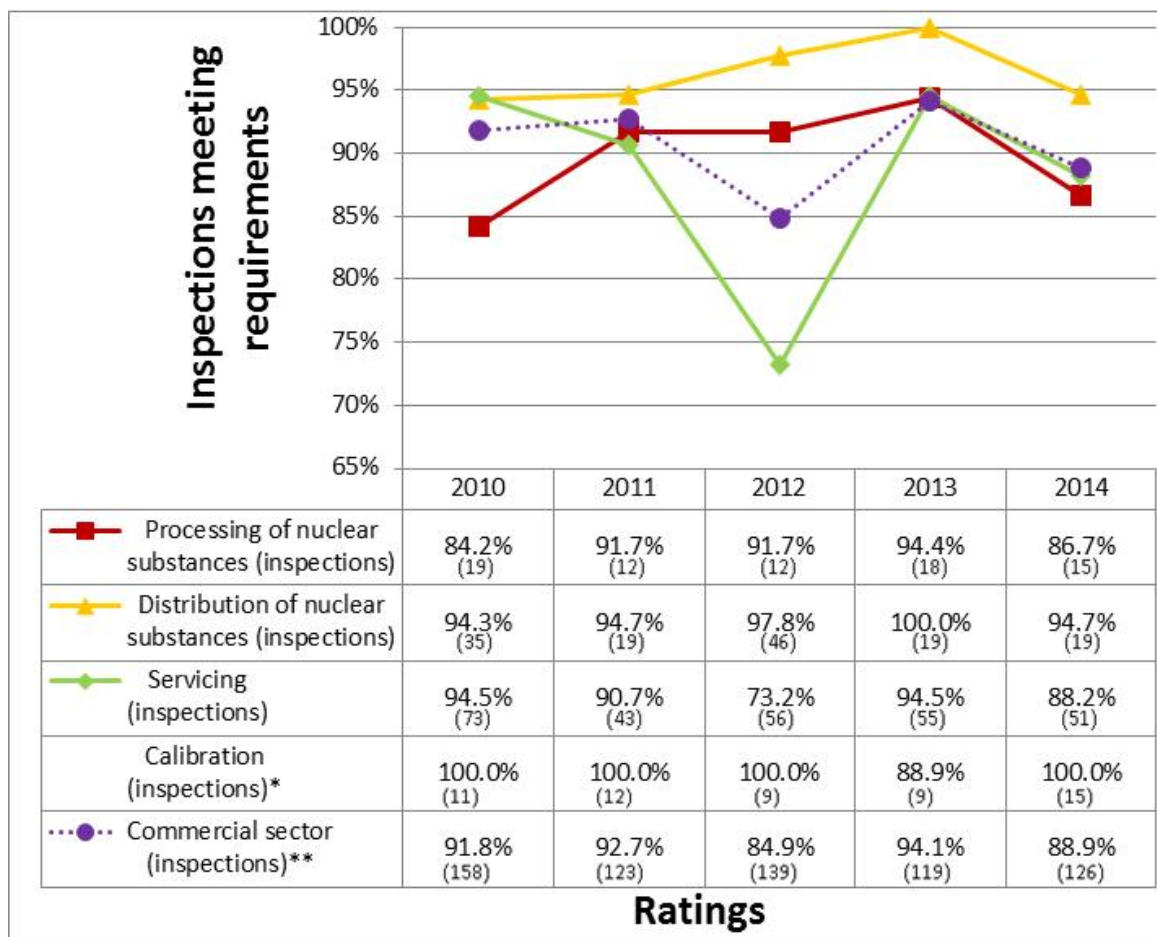
8.2.2 Operating performance

The overall compliance rating in 2014 for operating performance in the commercial sector was 88.9%, as shown in Figure 36. The performance of this sector in the operating performance SCA mostly declined in 2014 compared to 2013. Only the calibration services subsector showed improved performance. The overall sector drop was mainly due to lower compliance ratings in the servicing and processing of nuclear substances subsectors.

Non-compliances observed by CNSC staff in the commercial sector were related to failure to comply with regulatory requirements associated with worker obligations, sealed source leak testing, posting licences, following procedures specified in their CNSC licences and retaining records. Using the graded approach to compliance enforcement, CNSC staff used a range of compliance measures commensurate with the severity of the non-compliance to address non-compliances. None of the observed non-compliances had serious safety significance or required any escalation of enforcement actions.

In all cases, licensees addressed these non-compliances to the satisfaction of the CNSC.

Figure 36: Commercial sector performance comparison with select subsectors – Inspection ratings of operating performance from 2010 to 2014⁵



* Since there were relatively few inspections for the calibration subsector, its trend line is not provided.

** The total number of inspections shown in this row is the aggregate for the entire commercial sector, including subsectors not highlighted in this report.

8.2.3 Radiation protection

The overall compliance rating for radiation protection in the commercial sector was 93.7% in 2014, as shown in Figure 37. Performance in this SCA is essentially unchanged from 2013.

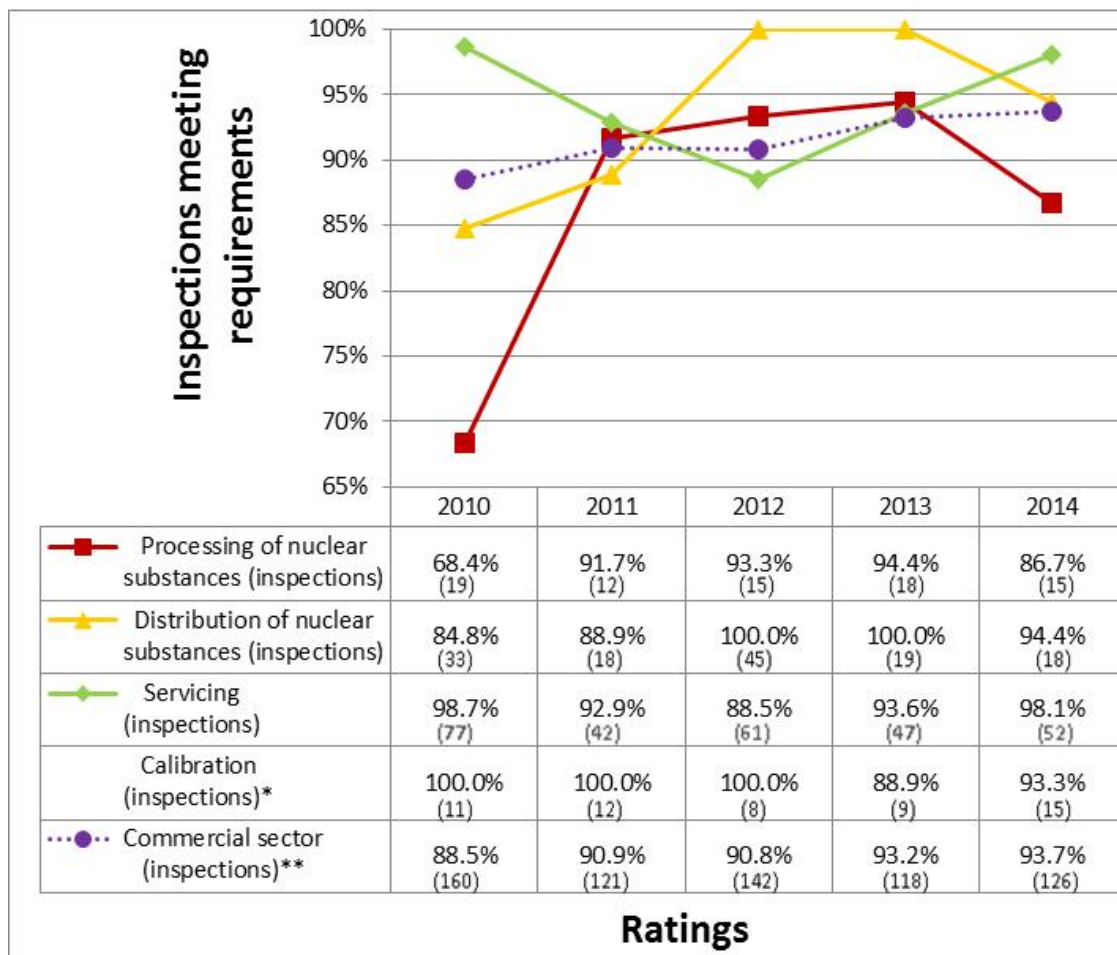
Non-compliances observed by CNSC staff in the commercial sector involved improper storage of nuclear substances, inadequate implementation of measures to ensure doses are kept as low as reasonably achievable, failure to follow contamination criteria, and failures to post signs at boundaries and points of access. Using the graded approach to compliance enforcement, CNSC staff used a range of compliance enforcement measures

⁵ Operating performance and radiation protection compliance ratings for the isotope production subsector are not provided since there were few inspections over the five-year period.

commensurate with the severity of the non-compliance to address non-compliances with regulatory requirements. In some instances, based on safety significance, there was an escalation of enforcement actions. See section 8.2.4 for further details.

In all cases, licensees addressed these non-compliances to the satisfaction of the CNSC.

Figure 37: Commercial sector performance comparison with select subsectors – Inspection ratings of radiation protection from 2010 to 2014



* Since there were relatively few total inspections for the calibration subsector, its trend line is not provided.

** The total number of inspections shown in this row is the aggregate for the entire commercial sector, including subsectors not highlighted in this report.

8.2.4 Enforcement actions

One escalated enforcement action was taken against a licensee in the commercial sector in 2014. The action consisted of an order to a servicing company in possession of a radiation device not listed on the licence. The licensee complied with the terms and conditions of the order and implemented corrective measures that have been reviewed by CNSC staff and found to be satisfactory. Details on the order issued can be found in section 4.2.5.

9 High-energy research particle accelerator facilities

In accordance with the CNSC risk-informed regulatory approach described in section 1 of this report, the two major high-energy research particle accelerator facilities operating under CNSC licences in Canada: TRIUMF Accelerators Inc. (TRIUMF), in British Columbia, and Canadian Light Source Inc. (CLS), in Saskatchewan, fall under the major facilities category. Both facilities have licence conditions handbooks and are subject to more frequent and more detailed compliance verification activities than other licensees covered in this report. Consequently, the compliance performance for these two facilities is addressed under this section, using an approach consistent with reporting for other major CNSC-regulated facilities in Canada.

This sector accounts for four CNSC licences and 429 nuclear energy workers (NEWs) as of December 31, 2014.

9.1 Safety performance summary and sector overview

Based on their evaluation and verification of licensee performance, CNSC staff concluded that high-energy research particle accelerator facility safety performance remained stable in 2014.

Doses received by NEWs in this sector remained low, with the majority of NEWs receiving doses below 1 mSv.

Performance ratings for high-energy research particle accelerator facilities are categorized into 14 safety and control areas (SCAs), as described in section 3.5. Compliance in most SCAs remained satisfactory in 2014.

The CNSC took no enforcement action against either high-energy research particle accelerator facility in 2014.

There were three events reported to the CNSC involving the two high-energy research particle accelerator facilities in 2014. All ranked as Level 0 (no safety significance) on the International Nuclear and Radiological Event Scale.

9.1.1 Observations, major projects and developments

Both high-energy research particle accelerator facilities continue to expand the scope of their operations. For example, the Advanced Rare Isotope Laboratory (ARIEL) project at TRIUMF Accelerators Inc. involves developing a high-power superconducting electron accelerator that will expand Canada's capabilities to produce and study isotopes for physics and medicine. Commissioning tests on the accelerator commenced in 2014 with the first accelerated beam achieved in July 2014.

TRIUMF is also leading a collaborative effort with several other Canadian facilities to deliver an alternative technology for producing technetium-99m, the world's most commonly used medical isotope. The goal of this project is to enable the use of existing medical cyclotrons to produce technetium-99m without the need for a nuclear reactor. More information on this project can be found on the [TRIUMF website](#).

The Medical Isotope Project at Canadian Light Source Inc. (CLS) consists of a 40 kW, 35 mega-electron volt linear electron accelerator facility to investigate an alternative technology for producing molybdenum-99, which is used to generate technetium-99m. More information on this project can be found on the [CLS website](#).

In 2014, the new accelerator was commissioned at incremental power levels up to 10 kW, which is the minimum power required for trial production of molybdenum-99. In August 2014, once commissioning at 10 kW had been completed, an operating licence was issued, which permitted CLS to begin production of molybdenum-99. The first delivery of molybdenum-99 for processing and testing by the Prairie Isotope Production Enterprise in Winnipeg, MB, which is CLS's partner in the Medical Isotope Project, was achieved in November 2014.

9.1.2 Compliance program

The inspection program for these facilities utilizes focused inspections that address one or more of the 14 applicable SCAs. The number of inspections performed in a single year may vary from one per facility to as many as three or four, depending upon factors such as the nature of the licensed activities taking place. On average, CNSC staff conduct two inspections per facility per year.

In addition to onsite inspections, compliance monitoring activities include a review of mandatory reports submitted by the licensee. These include reports on incidents or unusual events, follow-up on corrective actions identified during previous inspections, and an annual compliance report summarizing facility operations. Some of the parameters included in high-energy research particle accelerator annual compliance reports are:

- major safety and regulatory compliance-related activities undertaken by various key working groups and committees
- significant changes and improvements to the facility and related safety systems
- results of ongoing monitoring of radiation dose rates throughout the site
- testing and calibration of radiation monitors and access control systems
- radiation doses incurred by all staff and contractors
- accelerator operating statistics
- sealed source inventory
- site emissions and environmental monitoring results
- plans for any significant future changes to the site

9.2 Safety performance results and trends

9.2.1 Doses to workers

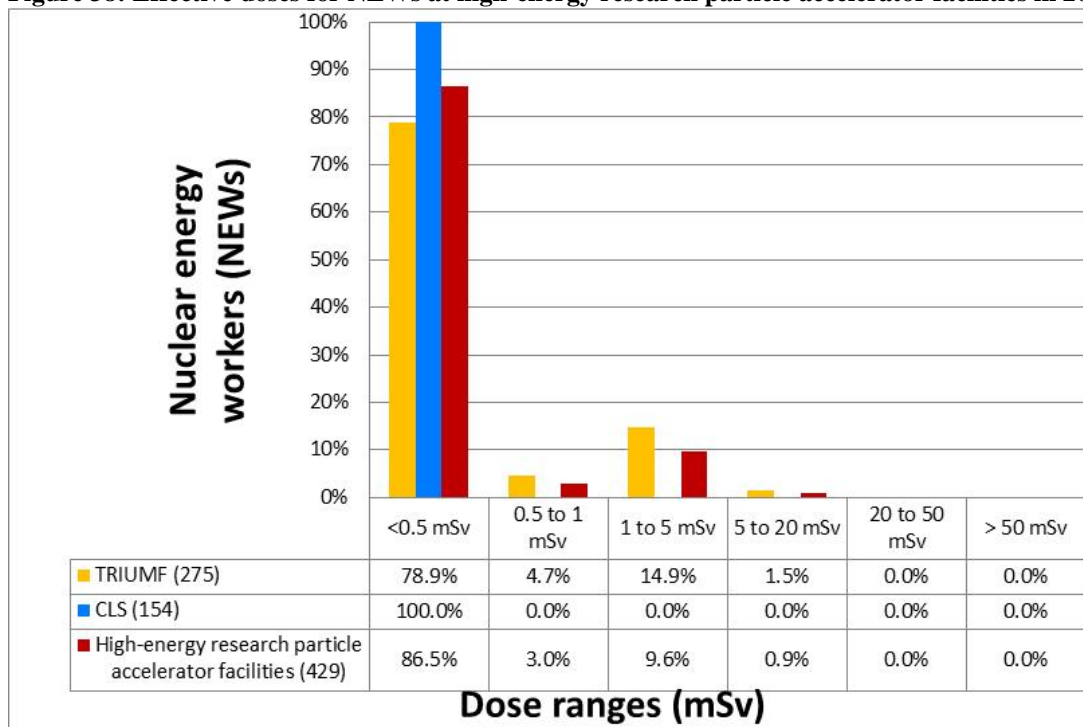
The doses received by high-energy research particle accelerator facility NEWs continued to be low, with the majority of NEWs receiving doses below 1 mSv per year.

Figure 38 shows the differences in worker doses between TRIUMF and CLS. As the figure indicates, NEW doses at CLS are generally much lower than those at TRIUMF. This is the result of the fundamentally different nature of the accelerators used and the licensed activities conducted at these two facilities.

The collective dose for all NEWs at TRIUMF was 143 mSv, continuing the trend of steady yearly decreases at TRIUMF over the past decade. The total dose to all workers was at its lowest level in the past 35 years of operation. The maximum individual dose was 6.3 mSv and the maximum cumulative dose to any NEW over the current five-year dosimetry period (2011 to 2015) was 24.3 mSv.

The collective dose for all NEWs at CLS was 1.1 mSv and was consistent with the results from previous years. The maximum individual dose was 0.14 mSv and the maximum cumulative dose to any NEW over the current five-year dosimetry period (2011 to 2015) is less than 1.0 mSv.

Figure 38: Effective doses for NEWs at high-energy research particle accelerator facilities in 2014



9.2.2 Compliance performance

CNSC staff conducted four inspections at TRIUMF in 2014. These inspections encompassed the following SCAs:

- human performance management
- waste management
- security
- safeguards

Other areas addressed during these inspections included conventional health and safety issues, the preliminary decommissioning plan and the associated financial guarantees. In addition, the major focus of one inspection was follow-up on corrective actions related to reported incidents that addressed aspects of several SCAs.

TRIUMF was required to implement corrective actions to address 11 non-compliances arising from these inspections and from desktop reviews of event reports. In addition, four recommendations were made relating to potential improvements to various procedures and one with regard to upgrading safety interlock systems.

The licensee fully addressed three corrective actions related to site security and one related to incident reporting before the end of 2014. The remaining seven corrective actions were all issued to TRIUMF in November and December of 2014. TRIUMF had already implemented immediate remedial measures to mitigate any risk to the safety of personnel, and all of the actions required were in the nature of longer-term actions to prevent recurrences of the observed non-compliances. They involve revisions to procedures and documents, retraining of staff, and internal auditing of TRIUMF operations. CNSC staff are monitoring progress on the remaining actions, and acceptable progress has been demonstrated to date. It is expected that all actions will be completed by the middle of 2015. TRIUMF has also indicated that all five recommendations will be implemented.

Combined airborne and liquid effluent releases of nuclear substances from the site remained stable at the normal, extremely low levels expected for TRIUMF. Total site releases were 1.6% of the derived release limits, which is equivalent to a maximum dose of 0.016 mSv or 1.6% of the general public dose limit.

CNSC staff conducted one inspection at CLS in 2014. The inspection focused on the following areas:

- human performance management
- radiation protection program
- the Medical Isotope Project

CLS was required to implement corrective actions to address seven specific non-compliances noted during the inspection. None of these non-compliances presented a significant risk to workers, the public, the environment or the maintenance of security. All of the required corrective actions have been satisfactorily addressed by CLS.

There are no airborne and liquid effluent releases of nuclear substances from CLS.

Performance ratings for TRIUMF and CLS are categorized into the 14 SCAs. The ratings are derived from the compliance activities, reported events and enforcement actions described in the preceding three sections. The 2014 performance ratings for both TRIUMF and CLS are summarized in Table 6.

Table 6: Performance ratings for high-energy research particle accelerator facilities

Safety and control area	TRIUMF			CLS		
	2012	2013	2014	2012	2013	2014
Management system	SA	SA	BE	SA	BE	SA
Human performance management	SA	SA	BE	SA	BE	SA
Operating performance	SA	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA	FS
Physical design	SA	SA	SA	SA	SA	FS
Fitness for service	SA	BE	SA	SA	SA	FS
Radiation protection	SA	SA	FS	SA	SA	FS
Conventional health and safety	SA	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA	FS
Emergency management and fire protection	SA	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA	FS
Security	SA	SA	SA	SA	SA	FS
Safeguards and non-proliferation	SA	SA	FS	Not applicable ⁶		
Packaging and transport	SA	SA	SA	SA	SA	FS

Note: Performance ratings range from unacceptable (UA) or below expectations (BE) to satisfactory (SA) or fully satisfactory (FS).

9.2.3 Enforcement actions

No enforcement actions were taken by the CNSC against either high-energy research particle accelerator facility in 2014.

⁶ As CLS does not conduct any licensed activities subject to safeguards obligations, there is no rating associated with this particular safety and control area.

9.2.4 Reported events and incidents

There were three events reported to the CNSC involving the two high-energy research particle accelerator facilities in 2014: two at TRIUMF and one at CLS. All three events were ranked as Level 0 (no safety significance) on the International Nuclear and Radiological Event Scale. The CLS event involved the non-approved bypass of one component of a safety system. The two reported events at TRIUMF dealt with:

- the failure of a target window, which resulted in the unintended release of a small quantity of nuclear substances via the nuclear exhaust system
- a breach of the site perimeter fence and the theft of non-radioactive recycled copper from the site

In February 2014, CLS reported that the oxygen deficiency monitoring system alarm horn located in the control room had been temporarily disconnected by operating room staff due to an ongoing problem with nuisance alarms. Operating staff implemented a periodic visual check of the oxygen monitor display as an interim measure while the alarm was disconnected. While disconnecting the alarm has no impact on the function of the local audible and visual alarms located in each of the seven zones monitored for potential oxygen deficiency hazards, it does weaken the overall defense in depth of the system. CLS subsequently retrained operating staff to emphasize that disconnecting the alarm is not an acceptable practice under any circumstances. CLS is in the process of replacing this system, which has had recurrent problems with generating false alarms. CNSC staff followed up on this incident during the 2014 inspection and concur that the corrective actions that CLS has implemented are sufficient to prevent recurrence of this type of incident in the future.

In April 2014, TRIUMF reported that a target window on a newly redesigned target used for the production of the medical isotope strontium-82/rubidium-82 had failed during two consecutive test irradiations, resulting in the unintended release of up to 44 gigabecquerel (GBq) of the gaseous krypton-79 by-product contained within the target. The estimated maximum dose to the general public resulting from these releases was 0.00043 mSv, or less than 0.1% of the general public dose limit. The maximum potential onsite dose to TRIUMF staff was estimated to be less than 0.015 mSv, which again is less than 0.1% of the applicable NEW dose limit. TRIUMF suspended all further testing of the target. Subsequent re-analysis indicated that the failure was due to an unanticipated thermal stress on the target window. The target is now being redesigned to address this problem. Use of the target has been suspended by TRIUMF pending completion of the redesign and submission of the associated design documents for review by CNSC staff.

In December 2014, TRIUMF reported that the perimeter fence near the onsite scrap metal recycling depot had been breached and that a quantity of recycled copper had been stolen from the site. There was no access to any of the radiological work areas on the site. Additional security precautions were subsequently implemented in that area.

In addition to these two events, in September 2014, TRIUMF reported a near-miss incident in which a worker in the new ARIEL electron accelerator facility was not accounted for during a pre-lockup search of the electron hall. These searches are conducted in a systematic manner prior to securing the accelerator vault to ensure no one

remains inside the room before initiating operation of the accelerator. Once the search and lockup is complete, there is a delay in which a pre-irradiation warning alarm is activated, after which power can be applied to begin conditioning and stabilizing the accelerator before actually injecting electrons to produce an accelerated beam. The worker responded appropriately to the pre-irradiation warning alarm and the warm-up sequence was terminated automatically by the door interlock system when the worker exited the area. The worker did not incur any radiation exposure as a result of this incident. TRIUMF's internal investigation of the incident identified multiple contributing factors, ranging from a failure to properly implement procedures and inadequate training to inadequacies in the siting of the search switches, which otherwise might have ensured that the worker was detected during the search of the electron hall. All operations of the electron linear accelerator were voluntarily suspended by TRIUMF for the remainder of 2014 pending completion of multiple corrective actions required to address these deficiencies.

Summary statement

None of the three reported events or the near-miss incident had any adverse radiological effects on the environment, or resulted in workers or the public receiving doses in excess of the regulatory limits. In all cases, the licensees implemented adequate response measures to mitigate the impacts of the events and to limit radiation exposure to workers or any radiological impact on the environment. All of these measures were reviewed by CNSC staff and found to be satisfactory.

9.2.5 Licensing

The CNSC operating licences issued to TRIUMF and CLS include licence conditions handbooks that define key documents and compliance criteria related to the facility. The Commission has delegated its authority to a designated officer to make changes to the licence conditions handbooks with the provision that such changes must not reduce the overall level of safety for the facility.

For TRIUMF, multiple changes were combined into a single revision of the handbook in 2014. Some of these changes were administrative in nature and included updates to TRIUMF documents related to:

- calibration of effluent air monitor calibration procedures
- procedures for the packaging and transport of nuclear substances

Three of the changes were related to facility operations and the production of medical and research isotopes. These were:

- the addition of a new safety analysis report for the use of thorium oxide targets in conjunction with the Isotope Separator and Accelerator actinide target system, including acceptance of the proposed plan for conducting a single, low-current test run using a thorium oxide target
- an increase in the production limit for the medical isotope technetium-99m, which allowed TRIUMF to perform production test runs on one of the two TR-30 medical isotope cyclotrons

- changes to the export limits for several by-product isotopes contained within the potassium chloride target used to produce the isotope silicon-32, which is used for oceanographic research and is shipped to the Los Alamos National Laboratory in the United States for processing

The CLS licence conditions handbook was modified for the first time in 2014. This involved updating various CLS document references to more recent revisions. All of the revisions were administrative in nature.

10 Conclusion

In 2014, CNSC staff continued their ongoing regulatory oversight of licensees in four nuclear sectors (medical, industrial, academic and research, and commercial) and two high-energy research particle accelerator facilities. CNSC staff conducted compliance verification activities consisting of field inspections, desktop reviews and technical assessments of licensee activities, and concluded that the use of nuclear substances in Canada is safe. The evaluations of findings for the safety and control areas (SCAs) covered in this report show that, overall, licensees made adequate provisions for the protection of the health, safety and security of persons and the environment from the use of nuclear substances, and took the measures required to implement Canada's international obligations.

Doses to workers remained very low in 2014 and followed a constant trend when compared with previous years. Overall, over 99.9% of all workers – including both nuclear energy workers (NEWs) and other workers – received doses below the applicable CNSC regulatory dose limits. There were no NEWs who exceeded the one- or five-year dose limits of 50 millisieverts (mSv) and 100 mSv, respectively.

There were two separate situations where, based on dosimetry results, workers (who were not NEWs) exceeded the annual regulatory dose limit of 1 mSv. In both situations, licensees responded in accordance with the *Radiation Protection Regulations*. Neither situation resulted in any immediate adverse health consequences to the workers.

CNSC staff conducted 1,453 inspections in 2014 to verify compliance with CNSC regulatory requirements. All four nuclear sectors continued to demonstrate good performance. CNSC staff found that 88.4% and 89.1% of inspected licensees found to be in compliance with the operating performance and radiation protection SCAs, respectively. The security SCA is reported on for the first time in this report. CNSC staff found that adequate security provisions were in place for 94.8% of inspected licensees.

Overall, licensees showed satisfactory compliance ratings in the operating performance, radiation protection and security SCAs. Those licensees failing to meet requirements took appropriate corrective measures to address non-compliances found during inspections. All non-compliances were being systematically tracked by CNSC staff until licensees take the appropriate corrective measures to address them to the satisfaction of the CNSC. Corrective measures put in place by licensees in 2014 were reviewed by CNSC staff and found to be satisfactory.

In 2014, safety performance for Canadian Light Source, a high-energy research particle accelerator facility, was rated either satisfactory or fully satisfactory in all of the 14 SCAs evaluated by CNSC staff. For the TRIUMF facility, two of the 14 SCAs evaluated were rated below expectations while the other 12 SCAs were rated as satisfactory or fully satisfactory.

In 2014, the CNSC took 19 escalated compliance enforcement actions against licensees in the four nuclear sectors covered in this report, consisting of 12 orders and seven administrative monetary penalties. All licensees to whom orders were issued complied with the terms and conditions of the orders and implemented corrective measures that

were reviewed by CNSC staff and found to be satisfactory. All of the administrative monetary penalties were paid.

No exposure device operators or radiation safety officers at Class II nuclear facilities were decertified in 2014.

In 2014, the CNSC adopted the International Nuclear and Radiological Event Scale tool to report events in the nuclear substance sector. Of the 147 events reported to the CNSC in 2014 in relation to nuclear substances, the overwhelming majority (141) were categorized as INES Level 0 (no safety significance). Five events were ranked as Level 1 (anomaly) due to the amount of nuclear substances involved and the type of event reported (loss of nuclear substances). One event – ranked as Level 2 (incident) – involved members of the public receiving radiation doses above the public dose limit of 1 mSv. No adverse health consequences are expected from this event.

There were no releases of a nuclear substance to the environment that had an adverse radiological impact or that resulted in a person receiving a dose in excess of the regulatory limit for members of the public.

For all reported events, the licensees implemented appropriate response measures to mitigate the impacts of the events and to limit radiation exposure to workers and the public. These measures were reviewed by CNSC staff and found to be satisfactory.

In 2015, the CNSC focus will continue to be on effective regulatory oversight with increased emphasis on inventory management, contamination control and event reporting.

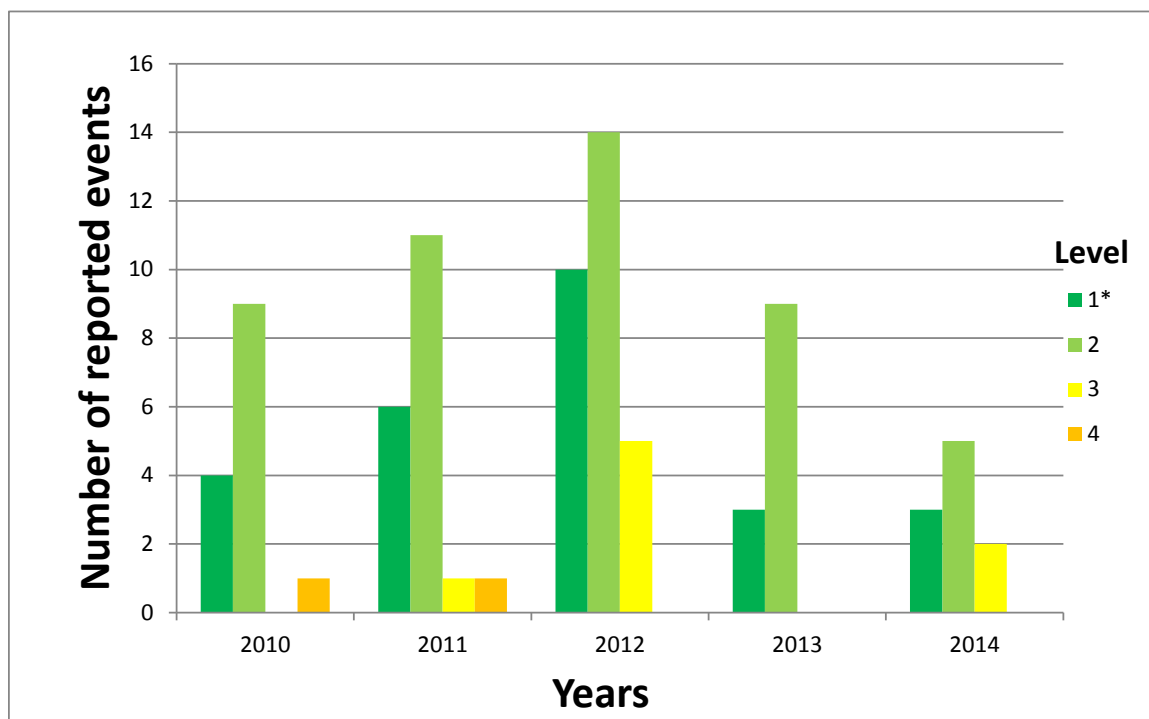
Appendix A: INES ranking of nuclear substance-related events

The International Nuclear and Radiological Event Scale (INES) was revised in 2006 to include nuclear substance-related events. Since the revision, a number of countries have been reporting these events to the International Atomic Energy Agency (IAEA).

Figure 39 and Table 7 show the number of nuclear substance-related events that have been reported to the IAEA between 2010 and 2014, along with their corresponding level.

A review of all events presented in the graph below indicates that the ranking established by CNSC staff for the events presented in this report is consistent with international practice.

Figure 39: Number of nuclear substance-related events report reported to the IAEA and ranked with the INES tool from 2010 to 2014.



*Note that in accordance with IAEA guidance, not all countries report events below Level 2.

Table 7: Number of nuclear substance-related events by year from 2010 to 2014

Year	Rating	Number of Member States* that posted event information	Total number of events posted
2010	Level 1	2	4
	Level 2	7	9
	Level 3	0	0
	Level 4	1	1
2011	Level 1	6	6
	Level 2	5	11
	Level 3	1	1
	Level 4	1	1
2012	Level 1	8	10
	Level 2	7	14
	Level 3	3	5
	Level 4	0	0
2013	Level 1	3	3
	Level 2	6	9
	Level 3	0	0
	Level 4	0	0
2014	Level 1	3	3
	Level 2	3	5
	Level 3	2	2
	Level 4	0	0

*Austria, Australia, Belgium, Bulgaria, Czech Republic, Finland, France, Greece, Hungary, India, Iran, Italy, Lebanon, Pakistan, Peru, Poland, Spain, South Korea, Sri Lanka, Sweden, Switzerland, USA.

Appendix B: Safety and control area naming conventions

Safety and control areas (SCAs) used in this report reflect the standardized set and naming convention approved for CNSC licensed activities, as shown in column 1 of table 8. For historical reasons, a modified naming convention of SCAs (see column 2 of table 8) is used for the inspections of nuclear substance activities (e.g.,: nuclear substance radiation devices) as covered in this report. In the near future, the CNSC intends to adopt the standardized naming convention of SCAs for all types of licensees that use nuclear substances. In all inspections, only applicable SCAs are considered.

Table 8: Differences in the naming conventions for safety and control areas (for CNSC licensed activities) and for the inspection of nuclear substances activities.

Safety and control area	Safety and control area: Inspection reports
Management system	- Organization and management - Quality management
Human performance management	- Training and qualification
Operating performance	- Operational procedures
Safety analysis	- Facility shielding design - Facility safety systems
Physical design	- Facility shielding design - Facility safety systems
Fitness for service	- Entrance monitors - Alarms and status machines - Fault indicators
Radiation protection	- Radiation protection
Conventional health and safety	- Non-radiological health and safety
Environmental protection	- Environmental protection
Emergency management and fire protection	- Emergencies and unplanned events - Fire protection
Waste management	- Environmental protection
Security	- Security
Safeguards	- International obligations and safeguards
Packaging and transport	- Packaging and transport

Appendix C: Abbreviations and glossary

Abbreviations

ALARA

as low as reasonably achievable

CLS

Canadian Light Source Inc.

CNSC

Canadian Nuclear Safety Commission

GBq

gigabecquerel

INES

International Nuclear and Radiological Event Scale

MBq

megabecquerel

MeV

mega-electron-volt

GeV

giga-electron volt

MIP

Medical Isotope Project

mSv

millisievert

NEW

nuclear energy worker

NSCA

Nuclear Safety and Control Act

TRIUMF

TRIUMF Accelerators Inc.

Glossary

cyclotron

A particle accelerator that speeds up particles in a circular motion until they hit a target at the perimeter of the cyclotron. Some cyclotrons are used to produce medical isotopes.

disused sources

Sources no longer in routine use but nevertheless kept in storage by licensees for various reasons.

effective dose

The sum of the products, in sievert, obtained by multiplying the equivalent dose of radiation received by, and committed to, each organ or tissue by a specific weighting factor established for each of these organs or tissues.

enforcement actions

The set of activities associated with re-establishing compliance with regulatory requirements.

exposure device

A radiation device designed for carrying out gamma radiography, including any accessory to the device such as a sealed source assembly, a drive mechanism, a sealed source assembly guide tube and an exposure head.

five-year dosimetry period

A period of five calendar years beginning on January 1 of the year following the year in which the *Radiation Protection Regulations* came into force, and every period of five calendar years after that period.

fixed nuclear gauge

A radiation device attached to a structure and that enables the nuclear substance contained in it to be used for its radiation properties to measure process-related parameters (e.g., liquid flow, liquid level).

medical linear accelerator

An accelerator that produces high-energy photons (X-rays) for therapeutic purposes by delivering controlled doses of radiation in a collimated beam.

natural background radiation

Radiation that is emitted from naturally occurring radioactive materials on the Earth and from cosmic rays.

nuclear energy worker

A person who is required, in the course of his or her business or occupation in connection with a nuclear substance or nuclear facility, to perform duties in circumstances where there is a reasonable probability that the person may receive a dose of radiation that is greater than the prescribed limit for members of the public of 1 millisievert per year.

nuclear medicine technologist

A medical radiation technologist certified by the Canadian Association of Medical Radiation Technologists. The nuclear medicine technologist works in the field of nuclear medicine and performs various duties such as preparing and administering radiopharmaceuticals, taking images of different organs and bodily structures, using computers to process data and enhance images, analyzing biological specimens and working closely with all members of the healthcare team.

one-year dosimetry period

A period of one calendar year beginning on January 1 of the year following the year in which the *Radiation Protection Regulation* came into force, and every period of one calendar year after that period.

orphaned sources

Orphaned sources are radiation sources found in the public domain, where no responsible owner can be established, or that are in the possession of a person who cannot be held responsible for the source's safe storage or disposal.

other worker

A worker who has not been designated as a nuclear energy worker and is subject to the prescribed dose limit for members of the public of 1 millisievert per year.

portable nuclear gauge

A portable radiation device that enables the nuclear substance contained in it to be used for its radiation properties to measure material property (e.g., material thickness, density, moisture content).

prescribed equipment

Equipment prescribed by section 20 of the *General Nuclear Safety and Control Regulations*.

radiation device

A device that contains more than the exemption quantity of a nuclear substance and that enables the nuclear substance to be used for its radiation properties for various purposes such as industrial radiography, oil exploration, road construction and industrial processes.

radiopharmaceutical

A drug containing a radioactive substance that is used in medical imaging and cancer treatment.

recommendations

A written suggestion to effect an improvement based on good industry practice. A recommendation is not an indication of non-compliance with regulatory requirements, and the recipient is not obliged to accept the recommendation.

sealed source

A radioactive nuclear substance in a sealed capsule or in a cover to which the substance is bonded, where the capsule or cover is strong enough to prevent contact with or the dispersion of the substance under the conditions for which the capsule or cover is designed.

unsealed source

A radioactive nuclear substance that is not contained in a sealed capsule or in a cover to which the substance is bonded.