Canada's Nuclear Regulator

# National Sealed Source Registry and Sealed Source Tracking System

## Annual Report 2012



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# National Sealed Source Registry and Sealed Source Tracking System Annual Report 2012

## 1. Executive Summary

This seventh annual report provides information on the registration and tracking of radioactive sealed sources in Canada through the Canadian Nuclear Safety Commission's (CNSC) National Sealed Source Registry (NSSR) and Sealed Source Tracking System (SSTS), from January 1 to December 31, 2012. A sealed source is a radioactive nuclear substance encased in a sealed capsule or in a cover to which the substance is bonded, and is used for a variety of activities, such as medical, industrial, commercial, as well as academic and research applications.

Among G8 countries, the CNSC was the first nuclear regulator to develop a national registry and to implement an online tracking system, along with enhanced export and import controls, for high-risk sealed sources. These systems have been efficient and effective since their establishment in 2006.

The NSSR is a CNSC-managed national database that maintains inventory information on all categories of sealed sources in Canada. It contains detailed information on high-risk sources (Categories 1 and 2) and some information on moderate (Category 3) to low-risk sources (Categories 4 and 5). This system, in conjunction with regulatory licensing and compliance operations, increases the security, safety and management of those sources. The NSSR's high-risk source tracking component, the SSTS, provides licensees and CNSC staff with an efficient, effective way to report and track the movement of high-risk sealed sources.

An important system redesign took place in 2012, to comply with the Government of Canada's new requirements for online services. The CNSC completed the development of an annual compliance reporting online system, to facilitate the submission and verification of licensees' sealed sources inventories. The CNSC also completed the development of a new system, the Event Information Tracking System, to improve the tracking and publishing of information related to unplanned events.

By the end of 2012, the NSSR contained information on 53,660 radioactive sealed sources from all categories in Canada. This represented an increase of 23.7% over the previous year, mostly due to the growth in the number of imported sealed sources in 2012. The SSTS was tracking 3,034 Category 1 sources and 28,585 Category 2 sources. The remaining 22,041 sources in the NSSR were in Categories 3, 4 and 5, which are not subject to mandatory tracking through the SSTS but are subject to reporting under CNSC regulatory oversight (licensing and compliance). The SSTS registered 57,779 individual transactions of all types throughout the year, representing an 8.8% increase over 2011; 86% were performed through the online interface.

The CNSC monitors and tracks unplanned events involving the loss, theft and discovery of sealed sources in Canada. Sealed sources that are found in the public domain are immediately investigated, to ensure that safety and security are maintained and that the original owners responsible for the material are identified. In 2012, there were 18 such reported events, all of them involving low-risk (Category 4 and 5) sealed sources. The sealed sources have been recovered in nine of these events. Throughout 2012, the CNSC performed 208 inspections among licensees using the SSTS, and found that 95% of them were compliant with their licence requirements related to the tracking of Category 1 and 2 sealed sources. The CNSC ensured that all non-compliances were adequately addressed by licensees. The information presented in this

report indicates an ongoing commitment by the CNSC and the licensees to the NSSR and SSTS and reflects the system's effectiveness, ensuring the safe and secure management of sealed sources in Canada.

## 2. Introduction

Sealed sources are radioactive nuclear substances encased in a sealed capsule or in a cover to which the substance is bonded, and are used for a variety of activities, such as medical, industrial, academic and research as well as commercial applications. The Canadian Nuclear Safety Commission (CNSC) was the first nuclear regulator among G8 countries to develop a National Sealed Source Registry (NSSR) and to implement an online Sealed Source Tracking System (SSTS). In addition, enhanced controls were established for the import and export of high-risk sealed sources.

The CNSC manages Canada's national inventory of high-risk radioactive sealed sources by means of the NSSR. The safety and security of these sources is increased through effective control and tracking. This report provides information on the registration and tracking of high-risk radioactive sealed sources in Canada through the NSSR and SSTS systems, for the period of January 1 to December 31, 2012. The report also describes developments made to the systems during the same period.

This is the seventh annual report for the NSSR and SSTS. Additional information on the SSTS, as well as previous annual reports, can be found on the CNSC Web site at nuclearsafety.gc.ca.

## 3. About the NSSR and SSTS Data

The SSTS is a secure information management computer program used to populate the NSSR, and allows licensees to report their source transfers online. The NSSR enables the CNSC to build an accurate and secure inventory of sealed sources in Canada, starting with those that are classified as high risk. The information is as current as the reporting timeframes required by the licence (e.g., reporting within two days of receipt and seven days in advance of any transfer).

Sealed sources are classified by the International Atomic Energy Agency (IAEA) into five different categories (see Appendix A), with Categories 1 and 2 designated as high risk (or risk-significant), Category 3 sources designated as moderate risk, and Categories 4 and 5 sources designated as low risk. The CNSC has focused its efforts to accurately capture data about these sources. Subsequently, the NSSR contains detailed information on Category 1 and 2 sealed sources in Canada, and limited information on sources in Categories 3, 4 and 5. Currently, as inventory information is received from licensees through their annual compliance reports (ACRs), the data is validated for accuracy and consistency, and compiled in tables. The ongoing rollout of an online ACR system, along with previously captured data, will facilitate the electronic registration of Category 3, 4 and 5 sealed sources in the NSSR.

# 4. Major Developments in 2012 and Future Improvements

## 4.1 System enhancements

On December 17, 2012 the CNSC launched a redesigned version of the Sealed Source Tracking System (SSTS), to adopt the GCKey, the new Government of Canada secure system for online services. The SSTS was also modified to comply in part with the Government of Canada's *Standard on Web Accessibility*. This was an important initiative to ensure compliance with government-wide requirements. The CNSC is planning a subsequent release of the SSTS, which will fully comply with the government standard for external-facing online applications. This release is planned for June 2013.

The CNSC also implements ongoing system improvements, to address issues and ensure proper system maintenance (for example, updates to the source activity decay calculator, category identification or licence number look-up table). As enabling tools are created and modified, the internal documentation associated with the NSSR and SSTS is also revised. In 2012, the CNSC fixed an issue related to the rounding of sealed source activity values in the system, and performed some other minor improvements.

## 4.2 Registration of Category 3, 4 and 5 sources

The CNSC is maintaining data based on inventories submitted annually by the licensees on all categories of sealed sources used in Canada, including those of Categories 3, 4 and 5. In late 2012, the CNSC completed the design of an online system, a secure Web-based interface whereby licensees can enter and revise their inventory data in their annual compliance reports. Three different licensed activities were implemented as part of this initial development.

The CNSC will continue to develop the system for other types of licences, and rollout will occur gradually as development is completed. This will facilitate the eventual inclusion of all sealed source categories in the NSSR. Meanwhile and until the online system is available, the manual entry of data on Category 3, 4 and 5 sources in the NSSR, will continue based on licensees' ACRs.

## 4.3 Implementation of new Event Information Tracking System

In order to enhance the control of radioactive sources in Canada, the CNSC has upgraded its existing events and incidents reporting database, to ensure a consistent approach throughout the organization. The development of the new system (referred to as the Event Information Tracking System) started in 2011, and the launch took place at the beginning of 2013. It amalgamates two previous databases into one, while facilitating the publication of the CNSC's *Report on Lost or Stolen Sealed Sources and Radiation Devices* and feeding the IAEA's Incident and Trafficking Database.

## 4.4 International presentations

In February 2012, the CNSC delivered a presentation titled "Update on the CNSC Orphan Source Strategy" at a meeting on the implementation of the *Code of Conduct on the Safety and Security of Radioactive Sources* at the IAEA headquarters in Vienna, Austria. The presentation provided an update on the strategic management of orphaned sources in Canada, with emphasis on key elements (such as the SSTS) and actions taken by the CNSC.

In March 2012, another presentation, titled "Updates on Canadian Regulatory Requirements and Strategies for the Safe Handling of Radioactive Sealed Sources" was delivered at the International Source Suppliers and Producers Association Workshop in Bethesda, Maryland, United States. It provided an overview of Canada's strategy for the safe handling of sealed sources, along with details about the NSSR and recent updates to the SSTS.

### 4.5 Outreach program

Prior to the launch of the redesigned version of the SSTS, in December 2012, the CNSC sent several notifications to the users community to provide them with details on the implemented changes, along with their new GCKey access codes.

### 4.6 International exchange of data

In late 2009, the CNSC and the United States Nuclear Regulatory Commission (USNRC) initiated discussions to determine the feasibility of an electronic exchange of sealed source information between the CNSC's SSTS and the USNRC's National Source Tracking System. This exchange of data would provide essential information on authorized sealed source import and export transactions between Canada and the United States, allowing for a continued tracking of sources in their respective systems. In 2012, the exchange of data between the two regulators was successfully tested; further analyses and potential developments are expected in upcoming years.

## 5. Performance Management

### 5.1 Performance measures and verification

In order to gauge the effectiveness of the SSTS program and verify the accuracy of data in the system, CNSC inspectors physically cross-reference data in the SSTS against the licensees' actual inventory of sealed sources. Routine CNSC compliance inspections include requirements to verify sealed source tracking information. Inconsistencies are immediately addressed to ensure accuracy in the data. These inconsistencies include errors in source serial numbers and reference dates, as well as the use of non-standard terminology when identifying sealed source assemblies.

In 2012, a total of 208 inspections were performed among those licensees for which mandatory tracking of high-risk sealed sources is required as a condition of their licence. These inspections covered the accuracy of the data related to sealed source transfers within Canada, as well as the accuracy of the licensees' inventory at their location, at the time of inspection. In 2012, 197 of the inspected licensees (or 95%) were found to be compliant, close to the 97% compliance level recorded in 2011. Examples of non-compliances include devices or sealed sources registered in the NSSR but not at the proper licensee location, errors in the transaction dates, or lack of proper notifications. The CNSC ensured that the licensees implemented appropriate corrective measures and regained compliance with regulatory requirements.

For more information on the performance results of Canadian licensees using nuclear substances, readers are invited to consult the annual safety performance reports posted on the CNSC Web site.

### 5.2 Event mitigation

The NSSR and SSTS are essential to the maintenance of the safety and security programs for high-risk sealed sources. It is important for the CNSC to track and assist with its licensees' mitigation of all events involving sealed sources. Current CNSC regulations require all licensees to immediately report lost or stolen nuclear substances to the federal regulator, with written descriptions of any actions taken (or proposed to be taken) to recover the missing material. Any loss or theft of high-risk or moderate-risk sealed sources requires the licensee to work with local police and other authorities, to inform the public, and to obtain any additional resources required to assist with the search and recovery. All events involving sealed sources are investigated and followed up by the CNSC, to ensure that the licensees take all the necessary actions to mitigate the event. If an event involves the loss or theft of a sealed source or radiation device, the CNSC informs national and international stakeholders who may assist with the recovery.

Information on lost and stolen nuclear substances can be found in the CNSC's *Report on Lost or Stolen Sealed Sources and Radiation Devices*, available on the CNSC Web site. The report lists all the lost, stolen and found sealed sources and radiation devices in Canada, as reported to the CNSC since 2005. As shown in Figure 1, there were 18 events involving 26 lost, stolen or found sealed sources in Canada during 2012. Although the total number of events has increased from the previous year, it is worth noting that there were no events involving higher-risk (Category 1, 2 or 3) sealed sources in 2012. Four of these 18 events relate to the finding of sealed sources and devices (shown in blue on the figure). For the other 14 events, the material was recovered in five instances; the remaining nine events are under investigation.

- There were no events involving **Category 1, 2** or **3** sealed sources over the reporting period.

- Eight events involved **Category 4** sealed sources. Category 4 sources are considered low risk, and are unlikely to be dangerous to persons[1].

    - Lost: Two events of lost sealed sources. In one case, the sealed sources were recovered on the same day they were lost; the other event is under investigation.
    - Stolen: Four events of stolen sources. For three of these events, the sealed sources have been recovered; one event is under investigation.
    - Found: Two events where sealed sources were found. In one case, the sealed sources had been reported stolen in 2003, and were found in 2012 at a metal recycling facility. The other event involved a sealed source found at an industrial site. Following their discovery, the sealed sources were safely disposed of.

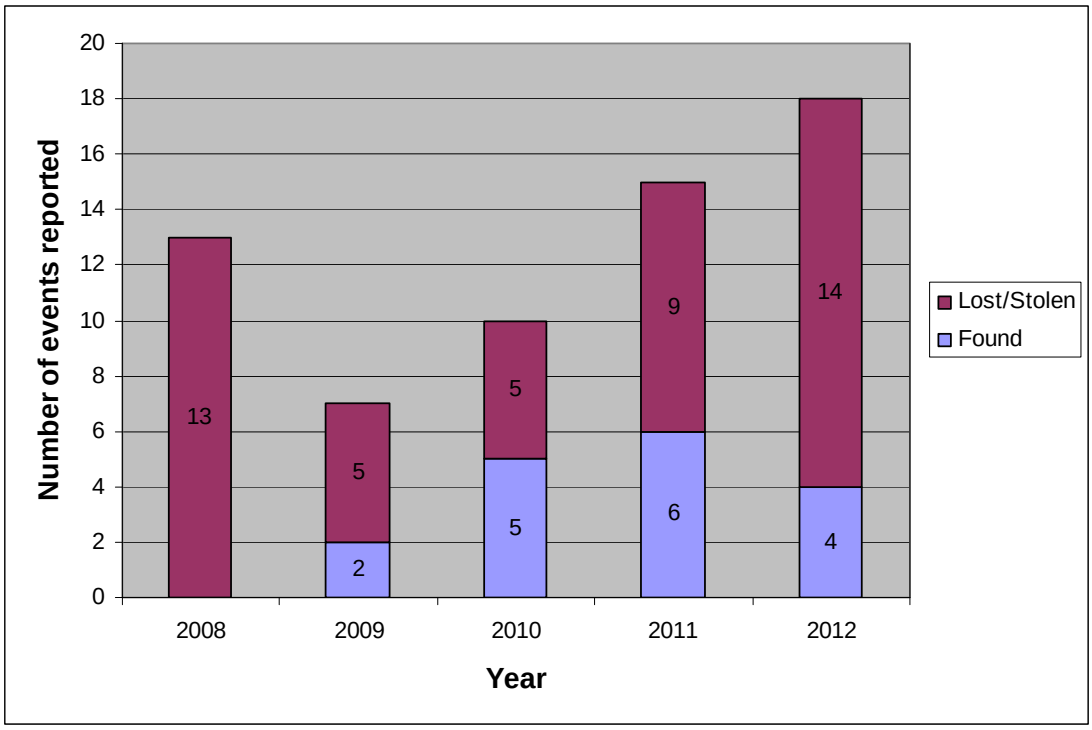
- Ten events involved **Category 5** sealed sources. Category 5 sources are considered very low risk, posing no personal danger to persons (due to their low activity, short half-life or their radiological nature).

    - Lost: Seven events of lost sealed sources. In two events, the sources were recovered following their loss; four events are under investigation, and one event has been closed and is no longer being investigated, after thorough but unsuccessful searches. In this case, the nuclear substance was exempted from licensing requirements because of its low activity.
    - Stolen: One event of a stolen sealed source, which is under investigation.

[1] IAEA, *Categorization of Radioactive Sources*, RS-G-1.9, (2005), Table 3.

- Found: There were two events where sealed sources were found. In one event, the sealed source was found in a waste management facility. The other event involved a low-activity check source found in a school. In both cases, the sealed sources were properly identified and safely disposed of.

**Figure 1: Number of reported events involving lost, stolen and found sealed sources**

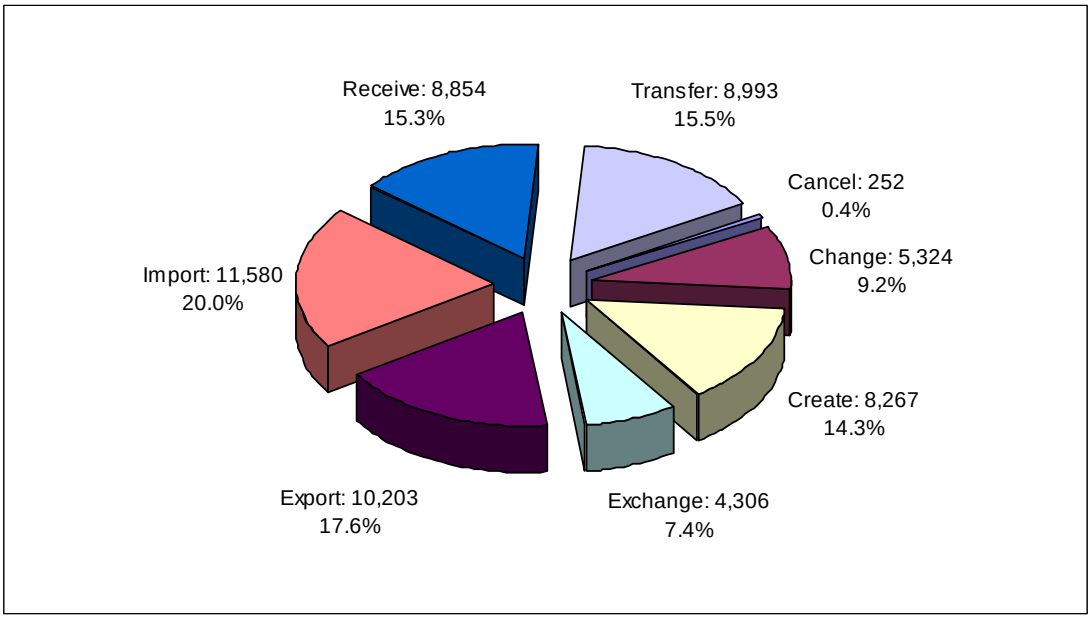



# 6. Operational Data

## 6.1 National Sealed Source Registry statistics

During 2012, the NSSR continued to be populated with sealed source information for all categories, as licensees reported their transactions via the online interface or by other means (such as phone, fax, email and written submissions by regular mail). The following operational data encompasses the entire NSSR and SSTS. Figure 2 shows all the transactions reported in 2012, which include transfers, receipts, imports, exports, cancellations, changes, creations and exchanges.

**Figure 2: National Sealed Source Registry transactions by type for 2012**




## Types of transactions

**Receive**: Sources received by licensees at licensed locations

**Transfer**: Sources transferred within Canada between licensees and licensed locations

**Cancel**: Transaction cancelled due to unforeseen circumstances (export and shipment cancellations and delayed transfers)

**Change**: Data change or correction (e.g., to reference date of source activity)

**Create**: Creation of a new source manufactured in Canada, or recording of sealed sources in secure storage awaiting disposal

**Exchange**: Replacement of one source for another in a device or prescribed equipment, at a licensed location

**Export**: Sources shipped out of Canada

**Import**: Sources shipped into Canada

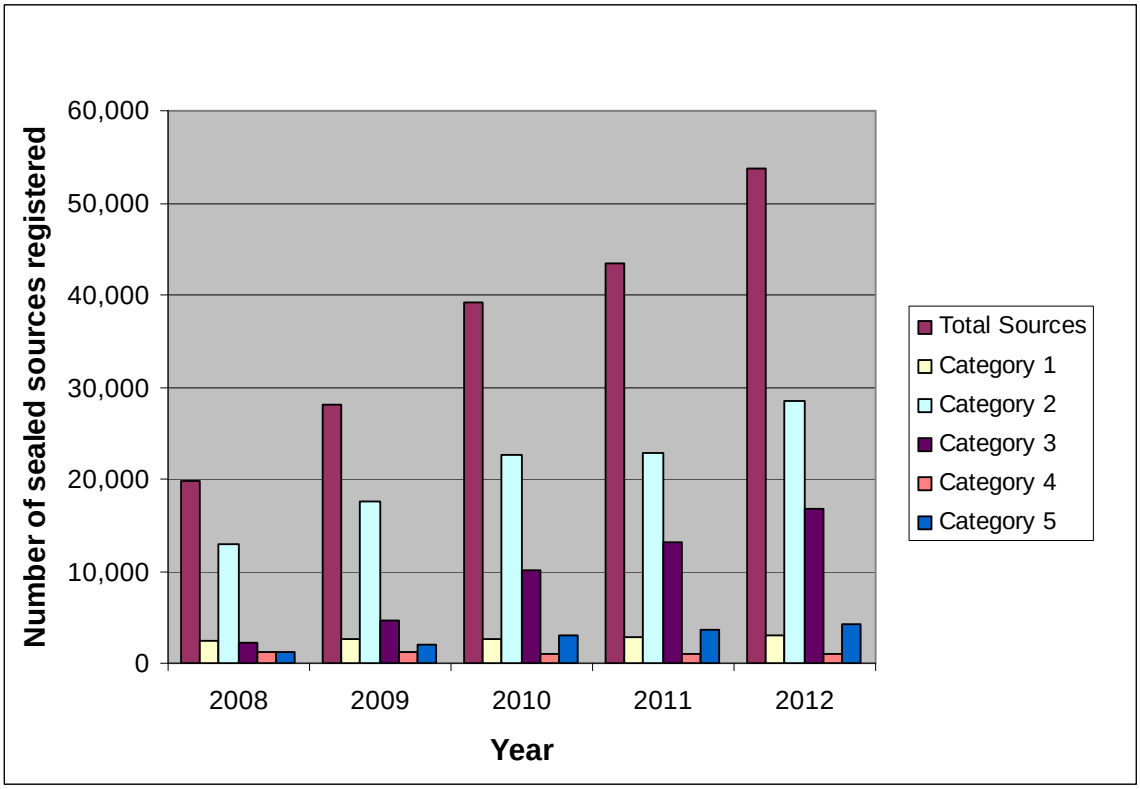
Table 1 and Figure 3 show the total number of sources in the NSSR as of December 31 of each year, as well as the breakdown by IAEA category[2]. The number of Category 1 and 2 high-risk sources (subject to mandatory source tracking) varies with the number of sources created, imported and exported by licensees. However, this number has continuously increased over the years, as the activity of higher-risk sources naturally decayed to lower categories and as more licensees added Category 3, 4 and 5 sources as an integral part of their overall inventory. In 2012, there was an increase of 23.7% in the total number of sealed sources registered in the NSSR (when compared to 2011), mostly due to the increase in the number of imported sealed sources throughout 2012. Details are provided in section 6.3, on page 11.

**Table 1: National Sealed Source Registry statistics**

| | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|
| Number of sources in NSSR (all Categories) in Canada | 19,847 | 28,132 | 39,263 | 43,371 | 53,660 |
| Number of Category 1 sources tracked in Canada | 2,410 | 2,702 | 2,608 | 2,777 | 3,034 |
| Number of Category 2 sources tracked in Canada | 12,881 | 17,530 | 22,541 | 22,778 | 28,585 |
| Number of Category 3 sources recorded in the registry | 2,137 | 4,578 | 10,051 | 13,092 | 16,814 |
| Number of Category 4 sources recorded in the registry | 1,273 | 1,263 | 1,094 | 1,006 | 917 |
| Number of Category 5 sources recorded in the registry | 1,146 | 2,059 | 2,969 | 3,718 | 4,310 |

[2] IAEA, *Categorization of Radioactive Sources*, RS-G-1.9 (2005).

**Figure 3: Number of sealed sources registered by category**




## 6.2 Number of transactions and online usage

Following the system design enhancements implemented in 2008, online usage initially increased, but seems to have stabilized in the past four years. In 2012, there were a total of 57,779 transactions (representing all transactions for the NSSR and SSTS systems), which amounted to an increase of 8.8% from the 53,083 transactions recorded in 2011. With respect to online usage, Figure 4 shows that 86% of these transactions were done via the online interface in 2012. In fact, the number of online transactions has remained relatively stable in the past four years, following the changes implemented in 2008. There were 8,266 transactions conducted by phone, fax, mail and email in 2012, representing an 8.3% decrease from the 9,016 such transactions in 2011. Figure 5 shows the comparison of manual transactions (conducted by phone, fax, mail and email) versus those conducted online.

**Figure 4: Sealed Source Tracking System online transactions relative to total number of transactions**

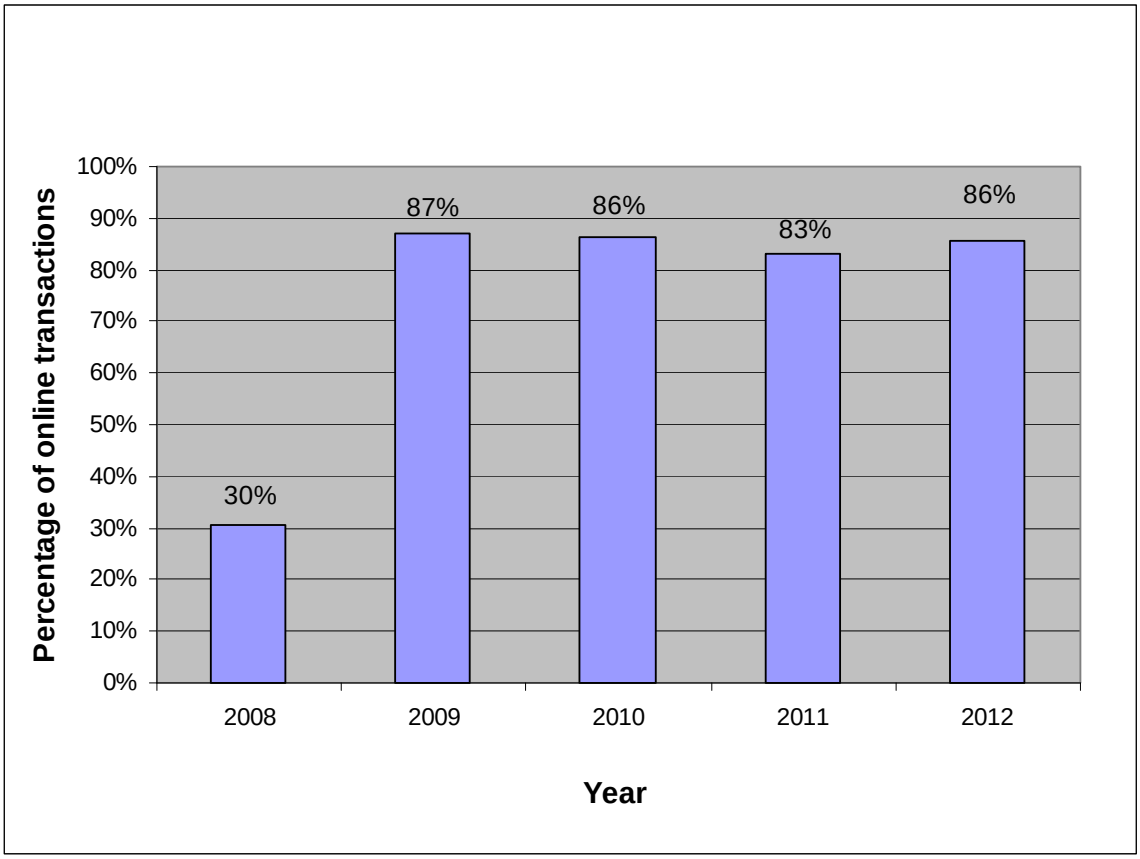
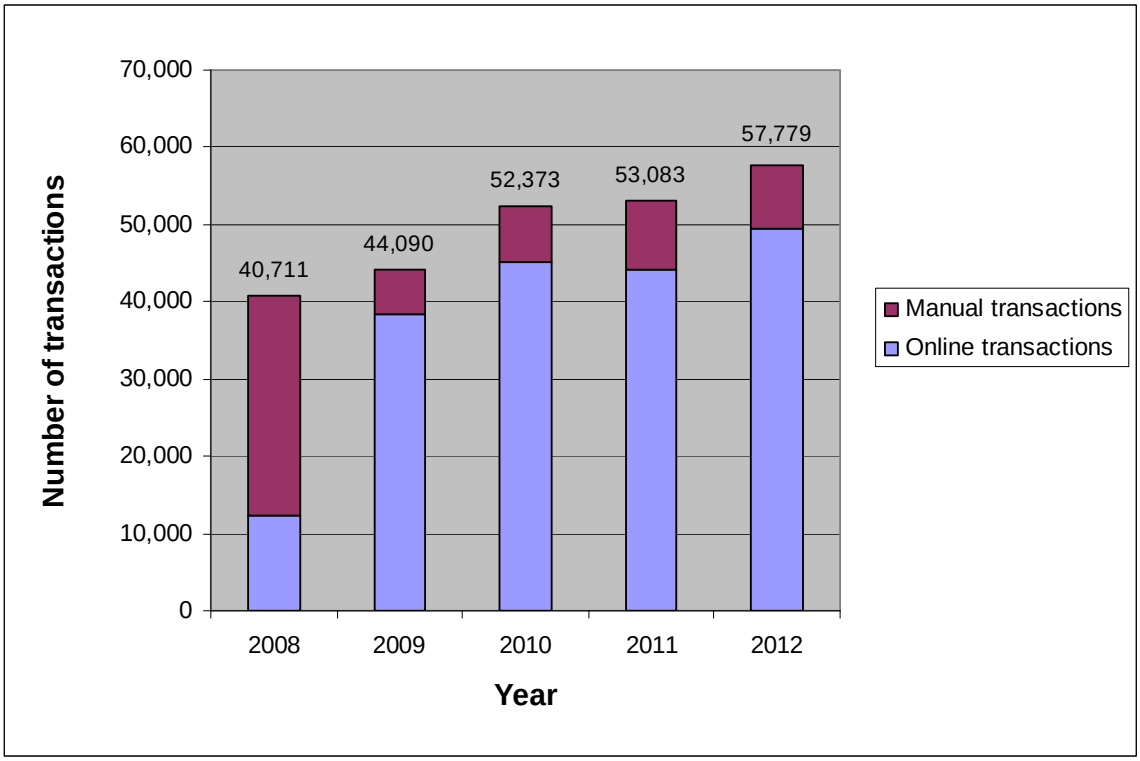


**Figure 5: Comparison of manual versus online transactions**



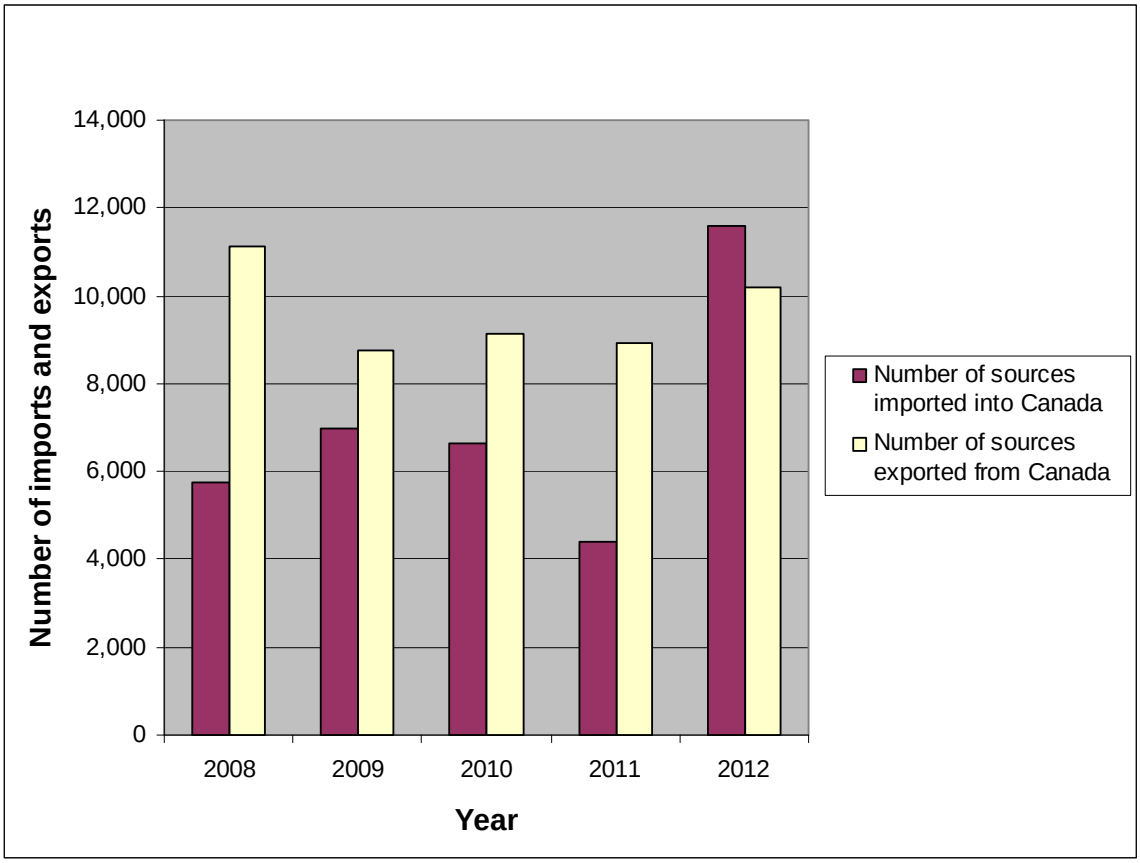

## 6.3 Import and export details

Table 2 and Figure 6 show the number of import and export transactions in the SSTS, as of December 31 of each year. Canadian licensees routinely import sealed sources and export them in accordance with their licences. In 2012, there was a significant increase in the number of sources imported into Canada, compared to previous years. This increase is due to multiple sealed sources (used in cancer therapy centres) being returned to the manufacturer, as well as to the decommissioning of irradiator units.

**Table 2: Import and export statistics per year**

| | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|
| Number of sources imported into Canada | 5,763 | 6,995 | 6,622 | 4,378 | 11,580 |
| Number of sources exported from Canada | 11,127 | 8,746 | 9,135 | 8,932 | 10,203 |

**Figure 6: Number of imports and exports per year**




## 7. Conclusion

The NSSR and SSTS contain information on the movement and location of high-risk radioactive sources in Canada, from their manufacture to their final disposition. Among the G8 countries, the CNSC was the first nuclear regulator to implement a national registry of high-risk sealed sources and monitor their movement using an online tracking system.

An important redesign of the SSTS was implemented in December 2012, in order to comply with the Government of Canada's requirements for online services. Statistics show a 23.7% increase in the number of sealed sources tracked in the SSTS when compared to 2011, mostly due to an increase in the number of imported sealed sources. Compliance inspection results in 2012 show a high level of compliance with the requirements for the tracking of high-risk sealed sources movements: 95% of all inspected licensees were compliant. This indicates an ongoing licensee commitment to the NSSR and SSTS, and reflects the system's effectiveness, which contributes to ensuring the safe and secure management of sealed sources in Canada.

# Appendix A: Categorization of Sources

Radioactive sealed sources are used throughout the world in medicine, industry, agriculture, research and education, and vary widely in radiological risk. In 2005, the IAEA published a risk-based ranking of radioactive sources and practices, which uses five categories[3]. The category assigned to each practice or radioactive nuclear substance (enclosed in the sealed source) takes into account factors such as the following:

1. The radiological risk associated with the source
2. The nature of the work (or application for which the source is used)
3. The mobility of the source, experience from reported accidents
4. Typical versus unique activities within an application

These factors were used to assign sources and practices to one of five categories. If not managed safely and securely, Category 1 sources are considered to pose the greatest risk to human health, while Category 5 sources pose the lowest risk[4].

## A.1 Category 1 (very high risk)

**Category 1 sources are classified as "personally extremely dangerous".**

This radioactive material, if not safely managed or securely protected, would be likely to cause permanent injury (in some cases fatal) to a person handling or coming in contact with the material for a period of a few minutes. Exposure would be fatal if a person were close to it in an unshielded manner for a few minutes to an hour. Category 1 sources are associated with licensed activities to which the CNSC's *Class II Nuclear Facilities and Prescribed Equipment Regulations* apply.

**Examples of Category 1 source usage:**

- Self-shielded irradiators: Gamma sources are used in these irradiators for experimental purposes or as a means of sterilization. Gamma irradiation kills bacteria by breaking down bacterial DNA and inhibiting cell division. Blood products, for example, are sterilized in self-shielded irradiators.

**Image 1: Cobalt 60 gammacell**


[3] IAEA, *Categorization of Radioactive Sources*, RS-G-1.9 (2005).
[4] IAEA, *Categorization of Radioactive Sources*, RS-G-1.9 (2005), Table 3.

Gamma knife radiosurgery: An advanced form of surgery, performed with highly focused beams of radiation. As many as 201 radioactive sealed sources create intersecting beams of gamma radiation, which deliver a concentrated dose of radiation to a precise area of the brain. These radiation beams form the “knife”.

**Image 2: Elekta gamma knife**

**Image 3: Gamma knife in use**

- Radioactive source teletherapy: External beam radiotherapy (otherwise known as “teletherapy”) is the most frequently used form of radiotherapy. Radiotherapy is the medical use of radiation (produced by a radioactive sealed source mounted inside the machine) as part of cancer treatment or to control malignant cells.

**Image 4: Cobalt 60 teletherapy**


## A.2 Category 2 (high risk)

**Category 2 sources are classified as “personally very dangerous”.**

This radioactive material, if not safely managed or securely protected, could cause permanent injury to a person handling it, or coming in contact with it, for a short period of time (minutes to hours), or be fatal if close to it in an unshielded manner for a few days. Category 2 sources are associated with licensed activities to which the CNSC’s *Nuclear Substances and Radiation Devices Regulations* generally apply.

**Example of Category 2 source usage:**

- Industrial radiography is a non-destructive testing (NDT) application that uses gamma radiation from a highly radioactive source, and photographic film, for the detection of internal physical imperfections (such as voids, cracks, flaws, segregations, pores and inclusions) in pressure vessels, pipelines, ships and reactor components. Radiography produces images on photographic film, similar to X-ray images, which show varying densities according to the amount of radiation absorbed in the material.

**Image 5: Industrial radiography camera, which contains a radioactive sealed source**

**Image 6: Pipeline inspection using industrial radiography equipment**

## A.3 Category 3 (moderate risk)

**Category 3 sources are classified as "personally dangerous".**

This radioactive material, if not safely managed or securely protected, could cause permanent injury to a person either handling it, or otherwise coming in contact with it, for some hours. Although unlikely, it could be fatal to be close to this amount of unshielded radioactive material for a period of days to weeks. Category 3 sources are associated with licensed activities to which the CNSC's *Nuclear Substances and Radiation Devices Regulations* apply.

**Examples of Category 3 source usage:**

- Industrial gauges: These gauges are usually installed in fixed positions for measuring and process control purposes. These include density gauges, level gauges, belt mass meters, and thickness gauges. The radioactive sealed source is mounted inside the gauge and projects a radiation beam, through the material, and is picked up by a detector to provide a measurement.

**Image 7: Industrial fixed gauge**

- Brachytherapy delivers a concentrated dose of radiation to cancerous tissue from within. High dose rate (HDR) brachytherapy is the placement of a small, highly radioactive sealed source, for a short period of time, directly into cancerous tissues. The procedure is sometimes guided by ultrasound or 3D computerized mapping techniques.

**Image 8: HDR brachytherapy**

## A.4 Category 4 (low risk)

**Category 4 sources are classified as "unlikely to be personally dangerous".**

It is very unlikely that anyone would be permanently injured by this radioactive material. However, if this unshielded radioactive material is not safely managed or securely protected, although unlikely, it could temporarily injure someone handling it, in contact with it, or who is close to it for several weeks. Category 4 sources are associated with licensed activities to which the CNSC's *Nuclear Substances and Radiation Devices Regulations* apply.

**Example of Category 4 source usage:**

Low dose rate industrial gauges, such as moisture and density gauges, are used to measure the density of asphalt, soil, aggregate or concrete, as well as the moisture content of soil or aggregate.

**Image 9: Portable gauge**

**Image 10:** Portable gauge in use

## A.5 Category 5 (very low risk)

**Category 5 sources are classified as "most unlikely to be personally dangerous".**

No one could be permanently injured by this radioactive material. Category 5 sources are associated with licensed activities to which the CNSC's *Nuclear Substances and Radiation Devices Regulations* apply.

**Examples of Category 5 source usage:**

- Nickel-63 sources, in electron capture detectors, are used in gas chromatography instruments. They detect minute amounts of chemical compounds, such as halogenated organic chemicals in environmental samples. Pesticide levels in foodstuffs, for example, are measured with these detectors.

**Image 11: Nickel-63 sealed source used in electron capture detectors**

- Low dose rate (LDR) brachytherapy involves exposure to small radioactive sealed sources for a few hours or days. Ocular melanoma is one example of a tumour that can be treated with LDR brachytherapy. In another example, radioactive seeds of iodine-125 are surgically implanted to treat prostate cancer.

**Image 12: LDR brachytherapy**