Canada's Nuclear Regulator

National Sealed Source Registry and Sealed Source Tracking System

Annual Report 2016



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National Sealed Source Registry and Sealed Source Tracking System Annual Report 2016

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Executive Summary

This report provides information on radioactive sealed sources in Canada that were registered and tracked through the National Sealed Source Registry (NSSR) and Sealed Source Tracking System (SSTS) in 2016. A sealed source is a radioactive nuclear substance encased in a sealed capsule or in a cover to which the substance is bonded. Sealed sources can be used for a variety of activities, including medical, industrial, commercial, and academic and research applications.

A national database managed by the Canadian Nuclear Safety Commission (CNSC), the NSSR maintains inventory information on all five categories of sealed sources in Canada. While the most detailed information is provided for high-risk sources (Category 1 or 2), the NSSR does contain some information on moderate-risk (Category 3) and low-risk sources (Categories 4 and 5). This system, in conjunction with regulatory licensing and compliance operations, increases the safety and security of those sources. The NSSR's tracking component for high-risk sources, the SSTS, provides licensees and CNSC staff with an efficient and effective way to report and track the movement of high-risk sealed sources.

By the end of 2016, the NSSR contained information on 100,996 radioactive sealed sources in Canada. This represented an increase of 9 percent over the previous year. Of those, the SSTS was tracking 6,273 Category 1 sources and 51,501 Category 2 sources. The remaining 43,222 sources in the NSSR were Category 3, 4 or 5, which are not subject to mandatory tracking for every movement. The SSTS registered 65,228 individual transactions of all types throughout the year — a decrease of 21.1 percent from 2015 — with 62,205 (95.3 percent) performed through the online interface.

The CNSC monitors and tracks unplanned events involving lost, stolen and found sealed sources in Canada. Sealed sources that are found are immediately investigated to ensure safety and security are maintained and that the original owners responsible for the material are identified. In 2016, there were 15 events involving a total of 28 sources reported as lost, stolen or found. One event involved a Category 2 source which was recovered the next day; the rest of the events involved low-risk (Category 4 or 5) sources that posed negligible to low risk to the environment or the public. The sealed sources involved were found or recovered in four cases. Thirteen sealed sources have not been recovered. Investigations into the theft of devices containing Category 4 sources remain open. In the case of Category 5 sources that have not been found following extensive searches, the events were closed due to the low risk the sources pose to health and safety.

Throughout 2016, the CNSC conducted 150 inspections of licensees using the SSTS and found that 94 percent were fully compliant with their licence condition for the tracking of Category 1 and Category 2 sealed sources. The CNSC tracked all identified instances (9) of non-compliance to ensure they were adequately addressed by the licensees in question. The non-compliances included licensees not providing notifications of a transaction within the required timeframe, and licensees with a discrepancy between the inventory onsite and the inventory registered in SSTS for a given location.

The information presented in this report indicates an ongoing commitment by the CNSC and its licensees to the NSSR and SSTS. It also reflects the system's effectiveness at ensuring the safe and secure management of sealed sources in Canada. As a result of the NSSR and SSTS, the CNSC has confidence in the overall safety and security of sealed sources in Canada.

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National Sealed Source Registry and Sealed Source Tracking System Annual Report 2016

1. Introduction

Sealed sources are radioactive nuclear substances encased in a sealed capsule or in a cover to which the substance is bonded. They can be used for a variety of activities, including medical, industrial, commercial, and academic and research applications. In 2006, the Canadian Nuclear Safety Commission (CNSC) became the first nuclear regulator among G7 countries to develop a National Sealed Source Registry (NSSR) and implement an online Sealed Source Tracking System (SSTS). These two systems were soon followed by the establishment of enhanced controls for the import and export of high-risk sealed sources.

The CNSC uses the NSSR to manage Canada's national inventory of high-risk radioactive sealed sources. 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 for the period of January 1 to December 31, 2016. It also describes developments and improvements made to these systems throughout the year.

This is the eleventh annual report for the NSSR and SSTS. Previous annual reports can be found on the CNSC website.

2. About the NSSR and SSTS data

In 2004, the International Atomic Energy Agency (IAEA) published the *Code of Conduct on the Safety and Security of Radioactive Sources* (the Code). CNSC staff who participated in the meetings to draft the Code realized there were three major issues – source tracking, registration and export licensing – that needed to be addressed for Canadian practices to conform to the Code's provisions. Consequently, CNSC staff began developing projects to address these gaps, beginning with the implementation of the NSSR and SSTS in January 2006 and an import/export licensing program for high-risk sealed sources in 2007.

The SSTS is a secure information-management system used to populate the NSSR. It also allows licensees to report their source transfers online. The NSSR enables the CNSC to maintain an accurate and secure inventory of sealed sources in Canada, with a particular focus on those classified as high risk. The information is as current as the licence reporting allows (e.g., reporting within two days of receipt and seven days in advance of any transfer).

Sealed sources are classified by the IAEA into five different categories: Category 1 and Category 2 sources are considered to be high risk (or risk-significant), Category 3 sources are considered to be moderate risk, and Category 4 and Category 5 sources are considered to be low risk. (For more information on how sealed sources are categorized, see appendix a or consult the CNSC website). The CNSC has placed particular emphasis on capturing data on high-risk sources, with the NSSR housing detailed information – such as the serial number, isotope, activity and current location – for Category 1 and Category 2 sealed sources in Canada. Information on moderate- and low-risk sources is updated annually using the inventory data included in licensees' annual compliance reports (ACRs) and validated by the CNSC for accuracy and consistency.

3. Major developments in 2016 and future improvements

3.1 System enhancements

The CNSC makes ongoing system improvements to address any identified issues and ensure proper system maintenance. These include, for example, updates to the source activity decay calculator, category identification and licence number look-up tables. As enabling tools are created and modified, the internal documentation associated with the NSSR and SSTS is also revised. Currently a potential upgrade to the SSTS and NSSR is being studied. The proposed upgrade would add reprocessing as an activity manufacturing licensees can perform, and would also integrate the lower activity sealed sources, Categories 3–5, into the NSSR. The project is still in a feasibility study stage.

3.2 Registration of moderate- and low-risk sources

In addition to the information on high-risk sources gathered though SSTS reporting, the CNSC also maintains data on moderate- and low-risk sealed sources used in Canada. This data is based on the inventories submitted by licensees in their ACRs. The CNSC has moved towards ACR forms that can be completed and submitted electronically.

3.3 International engagement

At an international meeting held in Vienna in June 2016, the CNSC delivered a presentation on Canada's implementation of the IAEA *Code of Conduct on the Safety and Security of Radioactive Sources*, and its *Supplementary Guidance on the Import and Export of Radioactive Sources.* The purpose of the meeting was to promote an exchange of information between States on their respective implementation of the Code and its supplementary guidance.

4. Performance management

4.1 Performance measures and verification

To gauge the effectiveness of the SSTS and verify the accuracy of the data in the system, CNSC inspectors physically cross-reference SSTS data against 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. Typically administrative in nature, these inconsistencies may include errors in source serial numbers and reference dates, or the use of non-standard terminology when identifying sealed source assemblies.

In 2016, 150 inspections were conducted among licensees whose licence conditions require mandatory tracking of high-risk sealed sources. These inspections covered the accuracy of the data related to sealed source transfers within Canada, and the accuracy of licensees' on-premise inventory of sealed sources at the time of the inspection.

Of the licensees inspected, 141 (94 percent) were found to be compliant. The nine licensees that were initially found to be non-compliant have adequately addressed the issues identified during their inspections. The non-compliances included licensees not providing notifications of a transaction within the required timeframe, and licensees with a discrepancy between the inventory onsite and the inventory registered in SSTS for a given location.

For more information on the inspection results of Canadian licensees using nuclear substances relative to doses to workers, radiation protection, operating performance and sealed source security, refer to the annual *Regulatory Oversight Report on the Use of Nuclear Substances in Canada*, posted on the CNSC website.

4.2 Event mitigation

Both the NSSR and SSTS are essential to maintaining the safety and security of high-risk sealed sources. Current regulations require all licensees to immediately report lost or stolen nuclear substances (including sealed sources) to the CNSC. They must also submit written descriptions of any actions taken (or proposed to be taken) to recover the missing nuclear substances. To ensure licensees are taking all necessary actions to mitigate the impacts of lost or stolen nuclear substances, the CNSC investigates every such event. If an event involves the loss or theft of a sealed source or radiation device, the CNSC also informs local, national and international stakeholders who may assist with the recovery. A listing of all events reported to the CNSC related to lost, stolen and found nuclear substances in Canada can be found in the *Lost or Stolen Sealed Sources and Radiation Devices Report*, available on the CNSC website.

The International Nuclear and Radiation Events Scale (INES) is a tool for communicating the safety significance of nuclear and radiological events to technical communities and the public. Every event reported to the CNSC is classified in accordance with the INES, based on its safety significance rating.

As shown in Figure 1, there were 15 events involving 28 lost, stolen or found sealed sources in Canada during 2016.

One radiation device containing two Category 4 sources, reported stolen in 2015, was recovered in 2016. In addition, two Category 5 sources were found at scrap metal facilities.

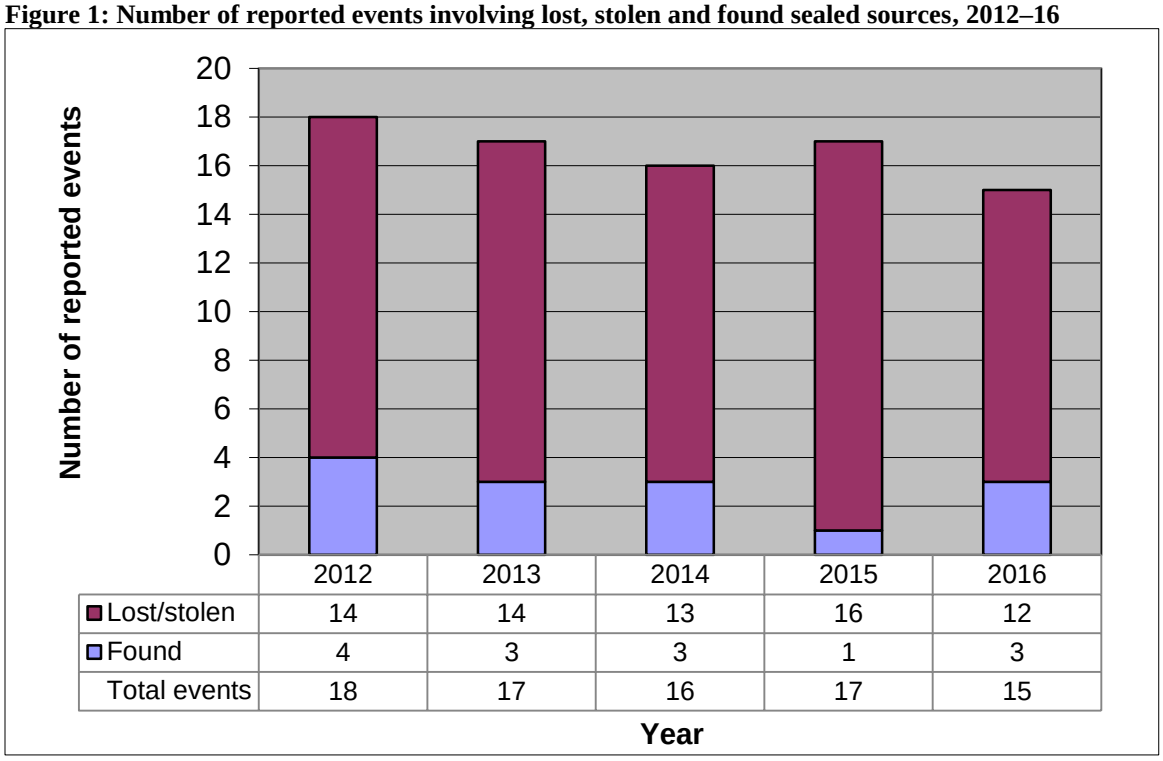
One event involved the loss of an exposure device containing a Category 2 source during transport to a job site. The device and sealed source were recovered the next day.

Six events involved 12 Category 4 sealed sources inside radiation devices (2 per device) that were lost or stolen. In four of the cases, the device and sources were recovered. The remaining two events during which the radiation device was stolen remain open and are still under investigation.

In one event, one Category 4 sealed source and six Category 5 sealed sources were lost. They are presumed to have been sent to a radioactive waste facility. The event is considered closed.

The remaining four events involved Category 5 sealed sources. In two cases the sealed sources were found, while in two others they were not. Given the very low risk these sealed sources pose to the public, the investigations were closed.

Figure 1: Number of reported events involving lost, stolen and found sealed sources, 2012–16



	2012	2013	2014	2015	2016
Lost/stolen	14	14	13	16	12
Found	4	3	3	1	3
Total events	18	17	16	17	15

Over the 2016 reporting period:

- No events involved **Category 1 or 3** sealed sources.
- One event involved a **Category 2** sealed source.
    - An exposure device containing an Ir-192 sealed source was lost during transport. The licensee found and recovered the device the day after it was reported lost.
- Seven events involved **Category 4** sealed sources. These are considered low-risk sources and are unlikely to be dangerous.[1]
    - **Lost:** There were two events involving the loss of Category 4 sealed sources. Both events involved portable gauges. These devices each contain two sealed sources.
        - A licensee reported that a portable gauge did not arrive at its destination. The portable gauge went missing during transport. The portable gauge was located in the carrier's warehouse and delivered to the consignor.
        - A licensee had left a portable gauge in a parked car. When the worker returned to the car it was gone. The car was located at an impound lot later in the day. It had been towed by the city. The gauge was still in the car and was recovered by the licensee.

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

- **Stolen:** There were four events involving stolen portable gauges containing two Category 4 sealed sources each. The two events involving stolen Category 4 sources that were not recovered were given an INES Level 1 (anomaly) rating. Events where the sealed sources have not been recovered pose a low potential risk to the public and the environment.
    - In two cases, a portable gauge that was locked in its carrying case was stolen from a locked vehicle. Local authorities were notified. The portable gauges have not been recovered; both events remain under investigation.
    - In one case, the vehicle in which the portable gauge was stored was stolen. Local authorities were notified; the vehicle and the portable gauge were recovered two days later.
    - A portable gauge was stolen from a work site while the worker was not paying attention. The gauge was recovered later the same day.
- **Found:** A portable gauge stolen in 2015 containing two category 4 sources was recovered.

- Seven events involved **Category 5** sealed sources, which are considered very low risk and pose no danger because of their low activity, short half-life or radiological nature.
    - **Lost:** There were 5 events involving a combined total of 9 lost sealed sources. All five events presented negligible risk to the public or the environment.
        - In one case a sealed source was reported missing when a licensee noticed that a sealed source was missing from a gas chromatograph. The licensee found the sealed source in a different gas chromatograph about three weeks later.
        - The package containing one sealed source went missing during transport. The carrier found the package four days later and delivered it to the consignee.
        - Seven sealed sources were reported lost when the licensee was unable to locate them following a verification of their sealed source inventory. Six sealed sources were Category 5 and one was Category 4. The sealed sources have not been recovered. The licensee believes they were transferred to a secure waste facility without updating the inventory logs.
        - One sealed source was reported missing when a licensee conducted an internal audit and was unable to locate the package containing the source. The package was prepared for shipment to a customer but the shipment was deferred and the package put in storage. The licensee has not located the sealed source. Given the low risk of the sources that were lost, the event is considered closed.
        - The final event involved a radioactive seed used in nuclear medicine. The seed was not implanted into the patient, but could not be found after the clean-up. The source was not located following a search by the licensee. The licensee believes the seed was disposed of in the normal waste streams. Even though the sealed source is still missing, the event has been closed.

- **Found:** There were two events reported during which a device containing one Category 5 sealed source was found. Both events posed a low risk to the public or the environment.
  - A scrap metal facility discovered an old gauge containing one sealed source inside a bail of metal. Ultimately, a CNSC inspector took possession of the gauge for disposal.
  - A scrap metal facility operator notified the CNSC that it found a piece of metal with radiation warning markings. CNSC staff investigated and determined there was a source, likely Sr-90, inside the device, but were unable to identify the device or an owner. A CNSC inspector took possession of the device for disposal.

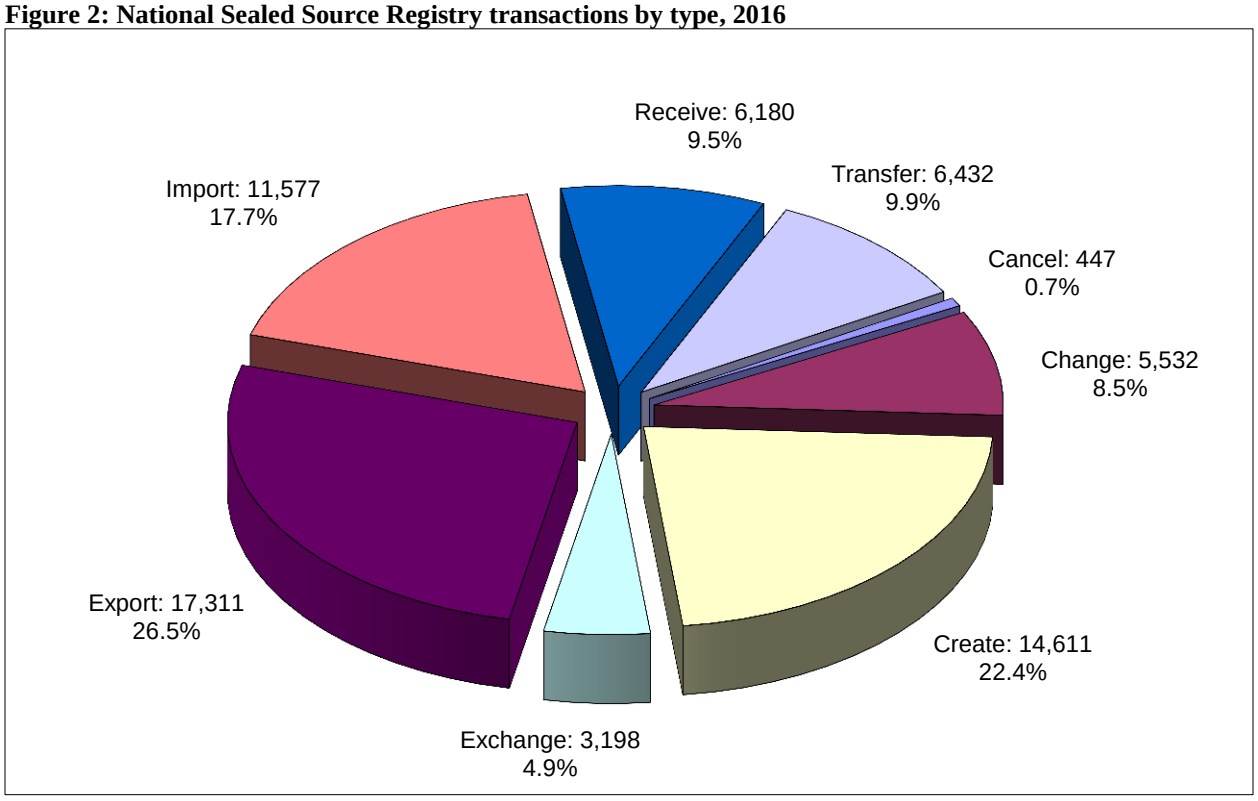
5. Operational data

5.1 National Sealed Source Registry statistics

The NSSR continued to be populated with sealed source information for all categories in 2016, with licensees reporting their transactions via the online interface or by other means (such as fax, email or written submissions by regular mail). The following operational data encompasses sources contained in the NSSR that have been entered through the SSTS. Additionally, the CNSC continues to enhance the NSSR to include information for Category 3, 4, and 5 sources that are not required by licence conditions to be entered into the SSTS. Licensees report their annual inventory of sealed sources through the required ACRs.

Figure 2 shows all the transactions in SSTS reported in 2016, which include transfers, receipts, imports, exports, cancellations, changes, creations and exchanges. (See the following page for definitions of these transaction types.)

Figure 2: National Sealed Source Registry transactions by type, 2016



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 (e.g., export and shipment cancellations, 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

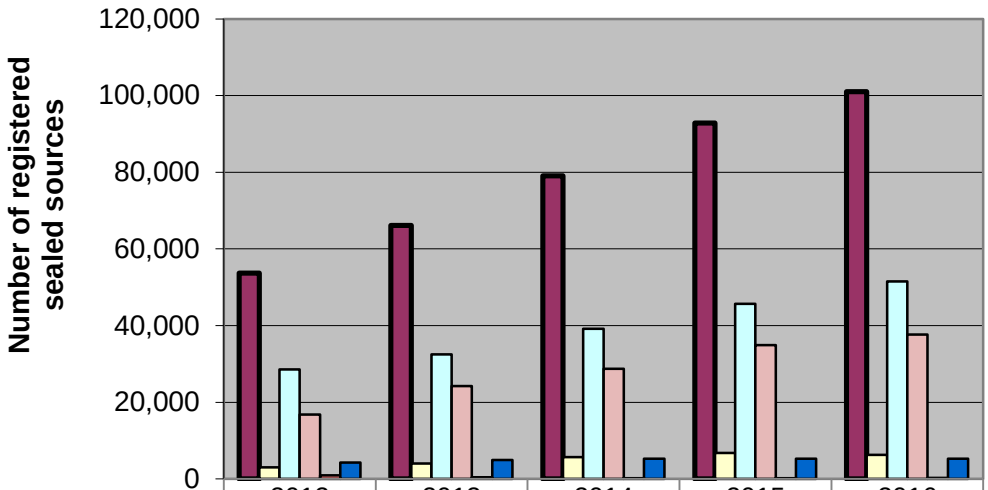
Exchange: Replacement of one source for another in a radiation device or prescribed equipment at a licensed location.

Export: The transfer of a sealed source from Canada to a foreign destination

Import: The transfer of a sealed source into Canada from a foreign destination

Figure 3 shows the total number of sources in the NSSR as well as their 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. In 2016, there was a 10 percent increase in the number of these high-risk sources compared to 2015, most notably an increase in Category 2 sources. The increase in Category 3 sealed sources is primarily due to the return of sealed sources no longer suitable for use in prescribed equipment, similar to previous years, and to the decay of Category 2 sources held by licensees. The number of Category 5 sources dropped slightly due to the export of Ir-192 sources at the Category 5 level. More often, these types of sources are Category 3 or 4 when they are exported.

Figure 3: Number of sealed sources registered in the NSSR by category, 2012–16



	2012	2013	2014	2015	2016
Total sources	53,660	66,139	79,077	92,831	100,996
Category 1	3,034	3,993	5,734	6,748	6,273
Category 2	28,585	32,466	39,167	45,673	51,501
Category 3	16,814	24,242	28,701	34,899	37,675
Category 4	917	484	224	200	293
Category 5	4,310	4,954	5,251	5,311	5,254

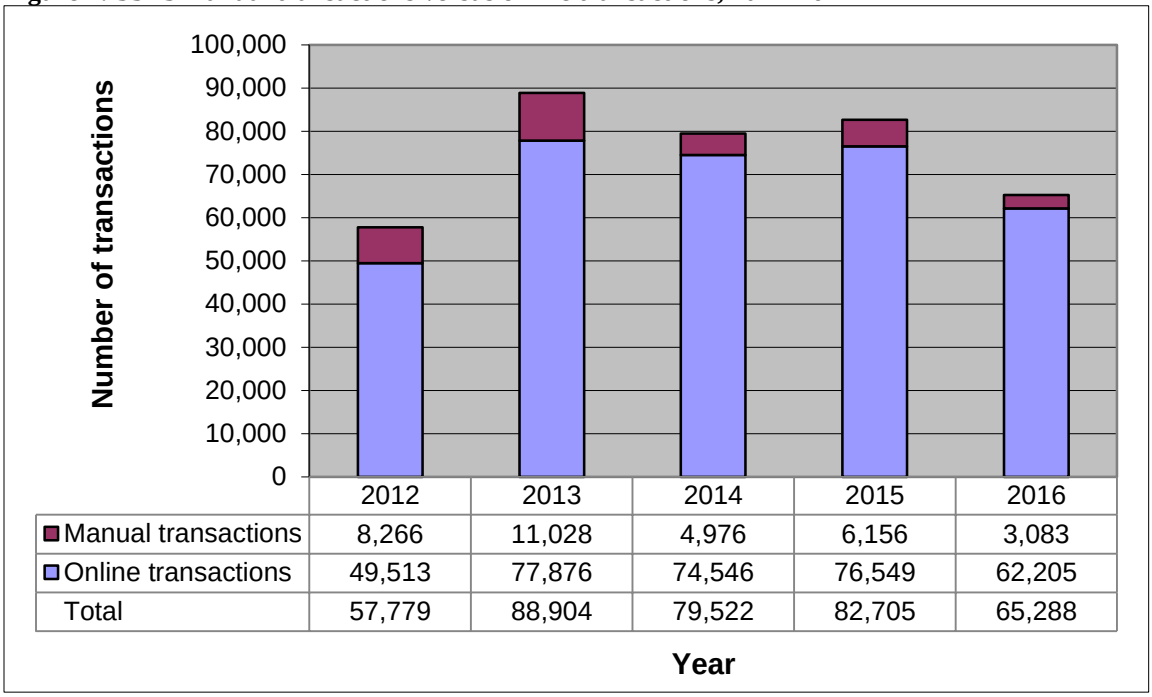
Year

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

5.2 Number of transactions and online usage

Figure 4 shows the total number of transactions made through the SSTS, broken down into manual transactions (i.e., those conducted by fax, mail or email) and those conducted online. A total of 65,288 transactions were recorded in 2016, which represents a 21-percent decrease from the number of transactions recorded in 2015.

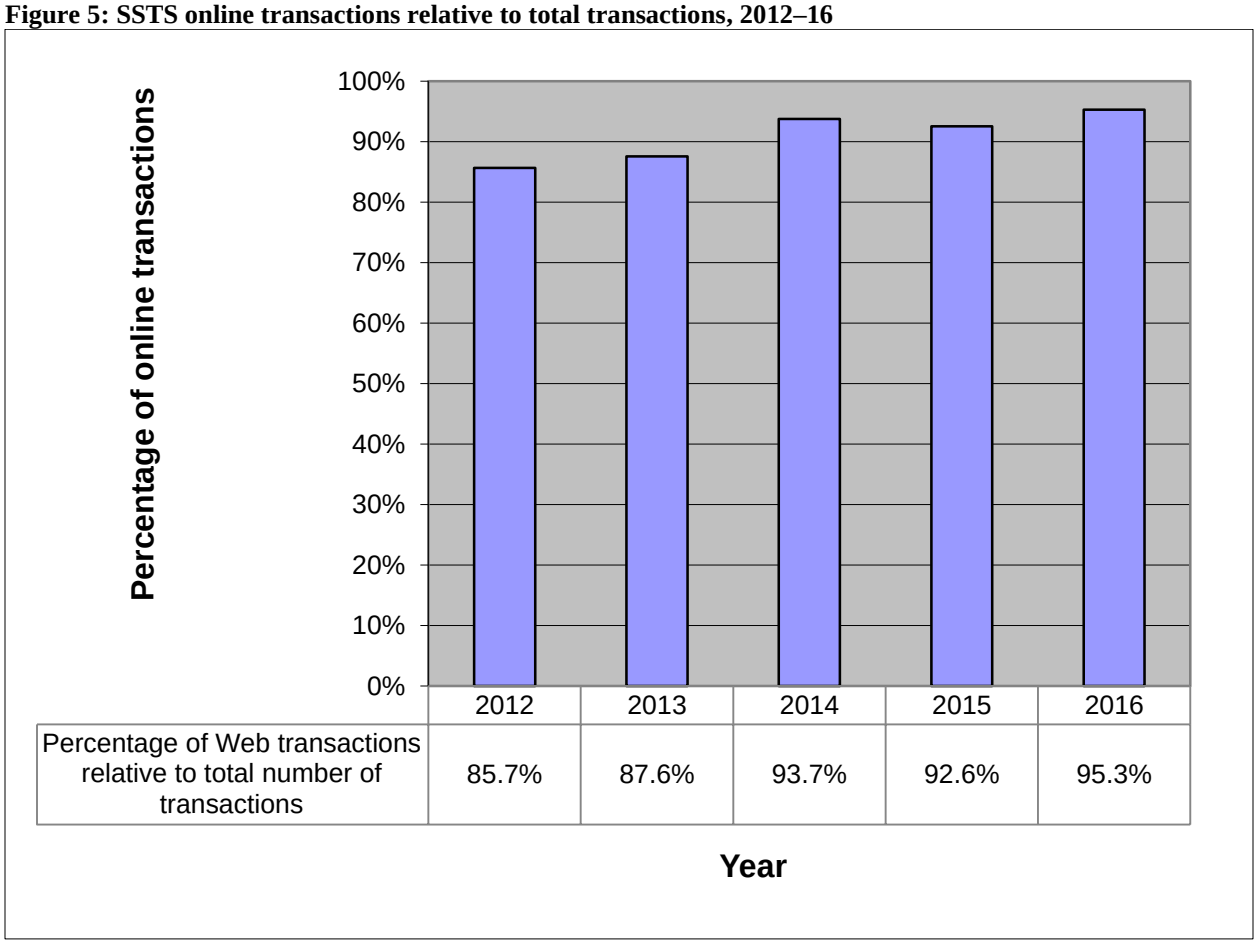
Figure 4: SSTS manual transactions versus online transactions, 2012–16



	2012	2013	2014	2015	2016
Manual transactions	8,266	11,028	4,976	6,156	3,083
Online transactions	49,513	77,876	74,546	76,549	62,205
Total	57,779	88,904	79,522	82,705	65,288

Figure 5 shows that 62,205 (95.3 percent) of the transactions made through the SSTS were performed via the online interface in 2016; a proportion that has remained steady since 2014.

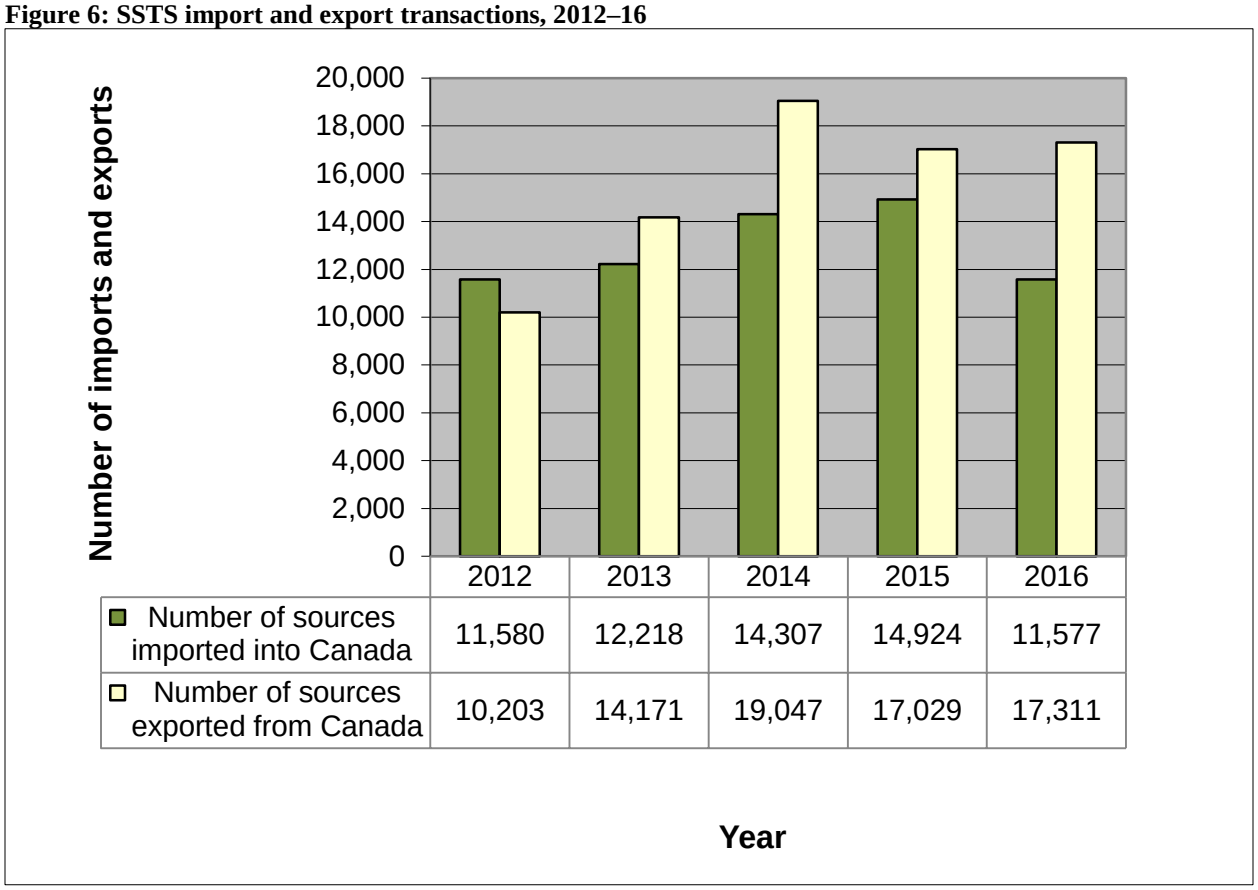
Figure 5: SSTS online transactions relative to total transactions, 2012–16



5.3 Import and export transactions

Figure 6 shows the number of import and export transactions in the SSTS for the past five years. Users of nuclear substances in Canada routinely import and export sealed sources (in accordance with their licences). The number of sealed sources exported from Canada in 2016 remained similar compared to 2015. Conversely, the number of sources imported into Canada decreased by 22 percent compared to 2015.

Figure 6: SSTS import and export transactions, 2012–16



	2012	2013	2014	2015	2016
Number of sources imported into Canada	11,580	12,218	14,307	14,924	11,577
Number of sources exported from Canada	10,203	14,171	19,047	17,029	17,311

6. Conclusion

The National Sealed Source Registry (NSSR) and Sealed Source Tracking System (SSTS) contain information on the movement and location of high-risk radioactive sealed sources in Canada, from their manufacture to their final disposition. Among the G7 countries, the Canadian Nuclear Safety Commission (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.

In addition to the information on high-risk sealed sources included in the NSSR, the CNSC maintains data on all categories of sealed sources used in Canada. The data is based on inventories submitted by licensees in their annual compliance reports. The implementation of electronically fillable forms in 2014 made it easier for licensees to complete these reports, which in turn helps the CNSC by improving the quality of the data submitted by licensees and facilitating the compilation of inventory data for Category 3, 4 and 5 sealed sources.

Data from the NSSR and SSTS show that the number of sealed sources in Canada has grown modestly in 2016, compared to the steady growth of the previous four years.

To confirm the accuracy of the data in the NSSR and SSTS, the routine compliance inspections conducted by the CNSC include requirements to verify licensees' sealed source tracking information. Inspection results for 2016 show a continued high level of compliance with the requirements for tracking high-risk sealed sources movements, with 141 of the 150 inspected licensees (94 percent) found to be compliant. CNSC staff ensured that the six instances of non-compliance were adequately addressed by the licensees in question. This high level of compliance indicates an ongoing commitment from the licensees to the NSSR and SSTS. It also reflects the system's effectiveness, which contributes to ensuring the safe and secure management of sealed sources in Canada. As a result of the NSSR and SSTS, the CNSC has confidence in the overall safety and security 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:

- the radiological risk associated with the source
- the nature of the work (or application for which the source is used)
- the mobility of the source
- experience from reported accidents
- 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".

These sealed sources, 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 them 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".

These sealed sources, if not safely managed or securely protected, could cause permanent injury to a person handling it, or coming in contact with them, 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 the radioactive sealed source

Image 6: NDT Pipeline inspection, using industrial radiography equipment

A.3 Category 3 (moderate risk)

Category 3 sources are classified as "personally dangerous".

These sealed sources, if not safely managed or securely protected, could cause permanent injury to a person either handling it, or otherwise coming in contact with them, for some hours. Although unlikely, it could be fatal to be close to this amount of unshielded radioactive nuclear substances 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 these sealed sources. However, if this unshielded radioactive nuclear substance 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 nuclear substance. 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: Low dose rate brachytherapy