Canada's Nuclear Regulator

National Sealed Source Registry and Sealed Source Tracking System

Annual Report 2010

Canadian Nuclear Safety Commission
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National Sealed Source Registry and Sealed Source Tracking System Annual Report 2010

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National Sealed Source Registry and Sealed Source Tracking System Annual Report 2010

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Executive Summary

This fifth 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, 2010. The report also describes developments made in the NSSR and SSTS during the same period.

The CNSC was the first nuclear regulator among G8 countries to develop a national registry and to implement a Web-based 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. Currently, the system contains detailed information on high-risk (Categories 1 and 2) and some information on moderate (Category 3) to low-risk (Categories 4 and 5) radioactive sealed sources in Canada. 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. In 2010, the CNSC introduced Access Key as the new secure online system for the SSTS.

In late 2007, the CNSC started compiling data from licensees' inventories of sealed sources for moderate-risk Category 3 and low-risk Categories 4 and 5. This compilation continues through licensees' provision of detailed inventory information required in their annual compliance reports (ACRs) to the CNSC. The CNSC has always required licensees to maintain accurate inventories of their sealed sources in all categories and to provide details of these inventories upon request.

In 2010, the CNSC continued to refine the development of a Web-based reporting module. Once complete, this module will allow licensees to submit ACRs electronically and update their sealed source inventories securely via the Internet. The process will facilitate submission and verification of information on sealed sources in Categories 3, 4 and 5, and permit the CNSC to pursue the validation of inventories of all nuclear substances. Development of this system is expected to continue through 2011 and 2012 and will eventually result in the registration and tracking of all categories of sealed sources in Canada.

By the end of 2010, the NSSR contained information on 39,263 radioactive sealed sources in all categories in Canada, representing an increase of 40% over the previous year. The SSTS was tracking 2,608 Category 1 sources and 22,541 Category 2 sources. The remaining 14,114 sources in the NSSR were in Categories 3, 4 and 5, which are not subject to mandatory tracking using the SSTS. The SSTS registered more than 52,000 individual transactions of all types throughout the year, representing a 19% increase over 2009.

Since its inception in 2006, the SSTS was only tracking the movement of Category 1 and 2 sealed sources in active use in Canada. In 2010, the CNSC started recording sealed sources that were not in active use, but rather in secure storage awaiting disposal. These sources had originally been excluded from the NSSR unless there was a clear intent to reuse or recycle them in some manner. Category 1 and 2 sealed sources, both those in use and in storage, are now tracked using the SSTS.

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 2010, there was only one event associated with the loss of a high-risk Category 2 source, which was found the following day. All other events involved low-risk Category 4 or 5 sources. Two of these events involved the discovery of Category 4 and 5 orphan sources that originated from the United States and did not represent radioactive material that was originally lost in Canada.

Introduction

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 a Web-based Sealed Source Tracking System (SSTS). In addition, enhanced controls were established for the import and export of high-risk sealed sources.

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 to December 31, 2010. The report also describes developments made to the systems during the same period.

This is the fifth annual report for the NSSR and SSTS. Additional information on the SSTS can be found on the CNSC Web site at nuclearsafety.gc.ca.

1. Past to present

From 1998 to 2004, the CNSC participated in international meetings to draft key documents concerning the safety and security of radioactive sources. In 2004, the International Atomic Energy Agency (IAEA) published the *Code of Conduct on the Safety and Security of Radioactive Sources* (the Code), which was followed in 2005 by the *Guidance on the Import and Export of Radioactive Sources* (the Guidance). These documents formed the basis for the development and implementation of the NSSR and SSTS, which included more stringent control and enhanced security measures on the possession, use and transport of high-risk sealed sources.

The NSSR and SSTS were implemented in January 2006; export licensing provisions to conform to the Code and the Guidance were implemented in April 2007.

The CNSC maintains specific regulatory requirements for the licensing of all sealed sources and radiation devices containing sealed sources. The CNSC's licences and certificates limit the specific radioactive nuclear substance and the maximum quantity of that nuclear substance allowable for each type of radiation device. For each licensee, the NSSR contains detailed information on each high-risk radioactive sealed source, including serial numbers, type, quantity and location in Canada.

2. 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 IAEA into five different categories (see Appendix 1), 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. Currently, 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. More information about the tracking of Category 3, 4 and 5 sources is planned to be in place by 2012. Currently, as inventory information is received from licensees in their annual compliance reports (ACRs), it is validated for accuracy and consistency and compiled in data tables. The upcoming rollout of an online ACR system, along with utilizing data previously captured, will facilitate the electronic registration of Category 3, 4 and 5 sealed sources in the NSSR.

3. Major developments in 2010

3.1 Implementation of Access Key

The Government of Canada has transitioned from the epass system to Access Key, a new secure system for all online services. An access key is a unique electronic credential that allows the users to communicate securely with online government programs and services. It offers a cost-effective, efficient and flexible authentication solution. In December 2010, the CNSC implemented Access Key for the SSTS, replacing the previous epass system.

3.2 Confirmation of source exports

In 2009, the CNSC implemented an additional verification process to confirm source exports. Prior to issuing an export licence, the exporter's information is verified against the licence number and address provided by the licensee. Any discrepancies are resolved with the licensee prior to entering the information in SSTS. Electronic export transactions are verified by comparing the export report generated by the SSTS against the export licences issued by the CNSC. In 2010, following an internal audit's recommendation (Audit of Sealed Source Controls), the CNSC started to request that licensees confirm source exports by email. According to notification requirements, licensees must report exports seven days prior to shipment. The email sent by the licensee serves as confirmation that the export has really occurred. This confirms that a shipment has left Canada and is now the responsibility of the importing country.

3.3 Registration of Category 3, 4 and 5 sources

The CNSC currently maintains data on all categories of sealed sources used, stored or transported in Canada. In 2008, the CNSC started compiling data on sealed sources in Categories 3, 4 and 5. In 2009, the CNSC began the design of a Web-based module, whereby licensees will be able to submit and update their yearly source inventories through a secure online ACR system. Licensees will be able to enter and do yearly updates to their inventory data directly into structured data tables included in the online version of the ACR. Due to technical issues, the initial roll-out of the ACR online system has been delayed to March 2012 and will continue on throughout the year.

3.4 Review of sealed sources in storage

Since its inception, the SSTS has tracked the movement of Category 1 and 2 sealed sources in active use in Canada. As shown in Figure 2, there were more than 13,000 sealed source entries created in the NSSR in 2010, of which more than 9,000 were not in active use, but in secure storage awaiting disposal. These sources were originally excluded from the registry, unless there was a clear intent to reuse or recycle them in some manner; they have now been added to the NSSR in order to have a complete listing of all high-risk sealed sources in Canada.

3.5 Bulk transactions

In 2009, the CNSC finalized the development of the bulk upload tool. Using this tool, manufacturers can perform multiple transactions at once by listing them all in a specific file format. The tool was

specifically developed for licensees having to upload significant numbers of transactions such as sealed source manufacturers. The purpose of the tool was to facilitate reporting and alleviate the manual burden associated with large numbers of transactions. In 2010, the tool was released for licensee usage.

3.6 Outreach program

The CNSC notified licensees in advance of the Government of Canada Access Key change, through letters and Web site notices. Licensees who required more information contacted the CNSC directly. Overall, the outreach allowed for a smooth transition to Access Key.

3.7 International presentations

In October 2010, the Director of the Operations Inspection Division delivered a presentation entitled "Canadian Nuclear Safety Commission Orphaned Source Program" at the International Workshop on Sustainable Management of Disused Sealed Radioactive Sources held in Lisbon, Portugal. The presentation featured an overview of the CNSC's proposed enhanced orphan source program, including prevention measures such as the establishment of the NSSR and the use of the SSTS for tracking high-risk sources.

3.8 Orphan source program

An orphan source is a radioactive source that is not under proper regulatory control. Experience with these sources has shown that most of the accidents resulting in severe radiological consequences occur when high-risk sealed sources are outside of a regulatory control system. Orphan sources are sometimes discovered in industrial locations such as scrap metal facilities. The CNSC is currently enhancing its orphan source program to provide better regulatory control over these sources when they are discovered.

Elements of the orphan source program and a corresponding action plan are based on the IAEA *Code of Conduct on the Safety and Security of Radioactive Sources* and associated *Guidance on the Import and Export of Radioactive Sources* document. The orphan source program includes initiatives for promotion, communication, prevention and response in order to help those who come across orphan sources to manage them safely.

In the initial stages of enhancing the CNSC's orphan source program, specific information was provided to scrap metal dealers to show them what radioactive sources and devices may typically look like. In 2010, the CNSC published a poster and an associated brochure to provide guidance on how to respond to portal monitor alarms following detection of this kind of material. These documents are available on the CNSC's Web site and are meant to provide information to workers in the recycling industry, at landfill sites and in other sectors about how to safely manage and handle nuclear substances if they are detected. When this is the case, facility operators can refer to these documents and may contact the CNSC for further assistance or information. If the owner of the radioactive material can be identified, they may be required to recover the material and pay all the costs associated with its disposal and cleanup. In situations where the owner cannot be identified, the CNSC will provide assistance and support to determine the nature, origin and disposal options for the radioactive material.

4. Performance management

4.1 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 now include requirements to verify SSTS 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 radiography sealed source assemblies.

In 2010, there were a total of 279 inspections performed for the SSTS program among licensees using the system. Inspected licensees demonstrated a 91% compliance rating with SSTS program requirements. Of the 9% of licensees found to be in non-compliance, 6% were found to have non-compliances that did not severely affect the program's integrity, while the remaining 3% had a significant impact. The CNSC asked licensees to correct the non-compliances using graduated enforcement actions, such as written notifications, requirements for remedial action and increased regulatory scrutiny.

4.2 Event mitigation

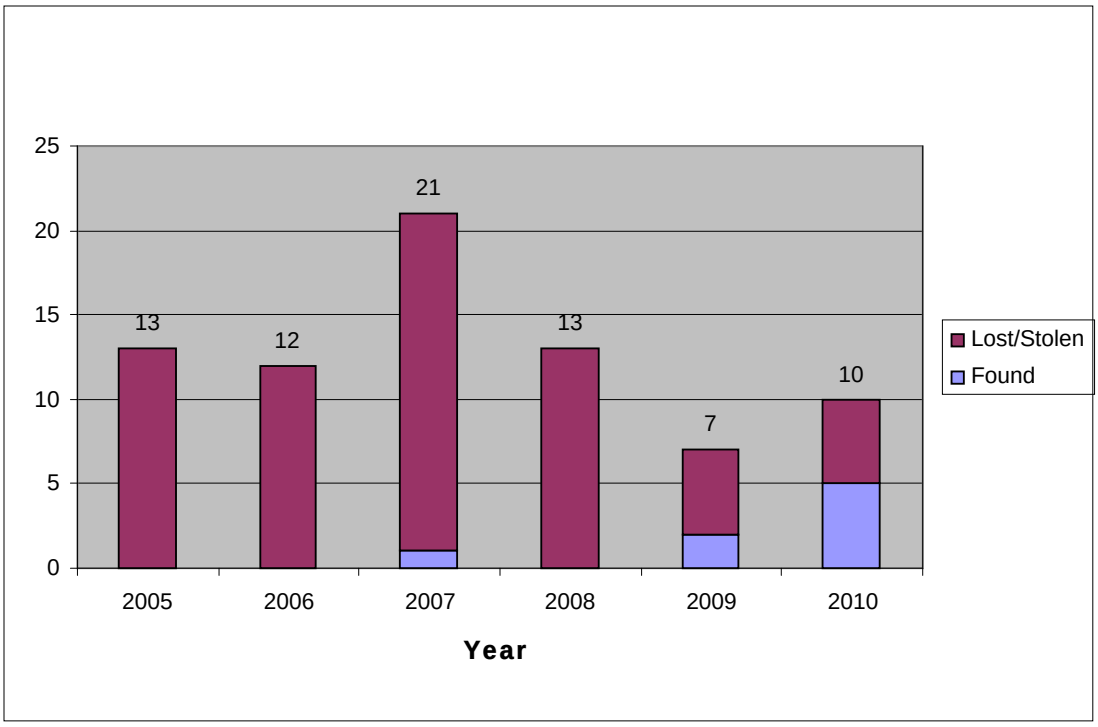
The NSSR and SSTS are essential to the maintenance of the safety and security programs for high-risk sealed sources. It is important for the CNSC to track and assist with the licensee's mitigation of all events involving sealed sources. Current CNSC regulations require all licensees to immediately report lost or stolen nuclear substances to the CNSC, with written descriptions of any actions taken or proposed to be taken in order 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 required additional resources to assist with the search and recovery. All events involving sealed sources are investigated and followed up by the CNSC, to ensure the licensee is taking all 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 of the event, in order for them to assist with the recovery.

Information on lost and stolen nuclear substances can be found in the CNSC's *Lost or Stolen Sealed Sources and Radiation Devices Report*, located on its *Reading Room/Reports* Web page at http://www.nuclearsafety.gc.ca/eng/readingroom/reports/index.cfm. 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 ten events involving lost, stolen or found sealed sources in Canada during 2010. Although the number of events has increased from the previous year, it is worth noting that five of these ten events relate to the finding of sealed sources and devices (shown in blue on the figure). This means that half of the events reported in 2010 were relating to finding previously lost or stolen material. Out of the other five events relating to lost or stolen sealed sources and devices, the material was recovered in two instances and the remaining three events are still under investigation. In some cases, a single event may involve more than one sealed source.

- There were no events involving **Category 1** or **3** sealed sources over the reporting period.
- One event involved **Category 2** high-risk sealed sources:
  - Lost: one event of a lost sealed source that was recovered the following day.
- Five events involved **Category 4** low-risk sealed sources:
  - Lost: one event of a lost sealed source that was recovered the following day.
  - Stolen: two events of stolen sources which are still under investigation. Category 4 sources are considered low-risk and are unlikely to be dangerous to persons[1].
  - Found: two events of found sealed sources: one source originating from the United States and returned to the manufacturer (therefore did not represent radioactive material that was originally lost in Canada); the other involving sources of Canadian-origin that had been stolen in 2006. After recovery, these sources were returned to the licensee and are now under proper regulatory control.
- Four events involved **Category 5** sealed sources:
  - Lost: one event of a lost sealed source is still under investigation. Category 5 sources are very low-risk sealed sources that pose no personal danger to persons due to their low activity, short half-life or by their radiological nature[1].
  - Found: three events of finding sealed sources: one where the sealed source originated from the United States, and two involving sources that originated from Canada (in all cases, the sources have been safely disposed of)

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

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



5. Planned improvements and objectives

5.1 Ongoing documentation

As enabling tools are created and modified, internal documentation associated with the NSSR and SSTS will be revised. This includes any additions to the source activity decay calculator, category identification and licence number look-up table.

5.2 Population of the NSSR with Category 3, 4 and 5 sources

In 2008, the CNSC started compiling data on sealed sources in Categories 3, 4 and 5. In 2009 and 2010, the CNSC began the design of a Web-based module, whereby licensees will be able to submit and update their yearly source inventories using a secure online ACR system. Licensees will be able to enter their inventory data directly into structured data tables included in the online version of the ACR. The CNSC will be pursuing its efforts in 2011 and 2012 in implementing this online system, which will facilitate eventual inclusion of all sealed source categories in the NSSR.

5.3 International exchange of data

In late 2009, the CNSC and the United States Nuclear Regulatory Commission (USNRC) initiated discussions to determine the feasibility of the electronic exchange of sealed source information between the CNSC's SSTS and the USNRC's National Source Tracking System. The exchange of data

will provide essential information on authorized sealed source import and export transactions between Canada and the United States. This initiative will be further reviewed for implementation in 2011.

5.4 System enhancements

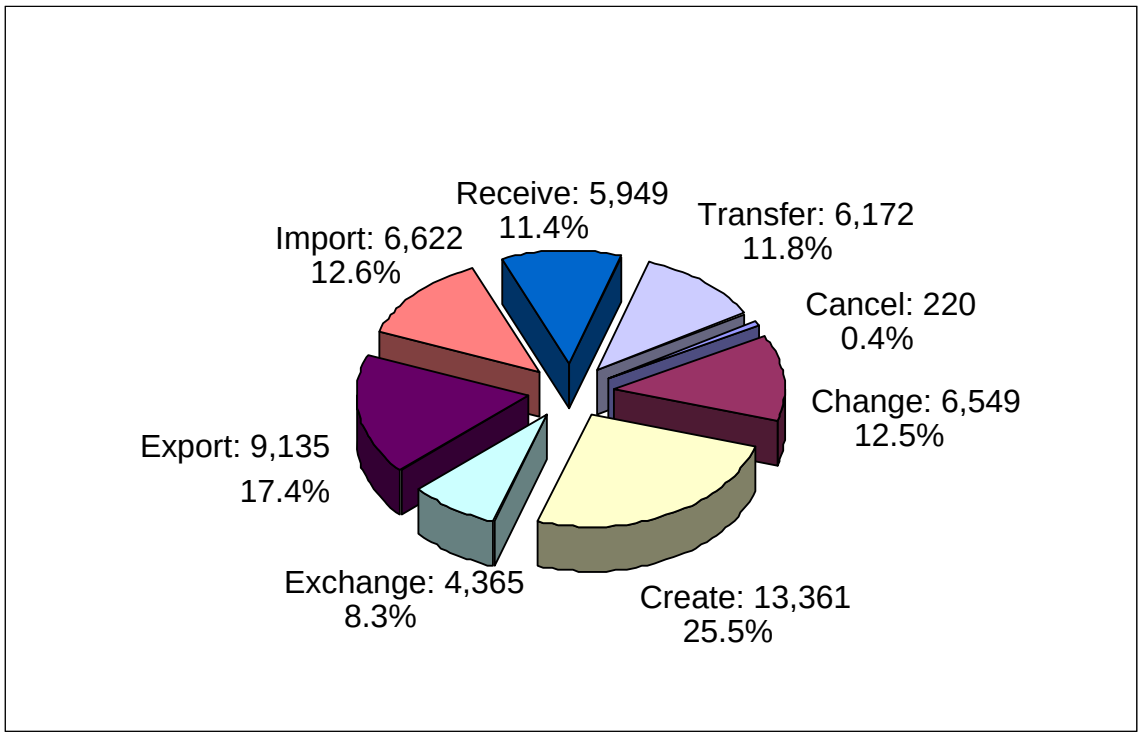
In 2010, the CNSC began the business case analysis for version 3 of SSTS. Results of the analysis could bring modifications to the system in 2012.

6. Operational data

6.1 NSSR statistics

During 2010, the NSSR continued to be populated with high-risk source information, as licensees reported their transactions. The following operational data encompass the entire NSSR and SSTS. Figure 2 includes all sources reported by mail, fax and email, as well as Web transactions (transfers, receipts, imports, exports, cancellations, changes, and creations).

Figure 2: NSSR transactions by type for 2010



Types of transactions

Receive: sources received by licensees at licensed locations

Transfer: sources transferred within Canada between licensees and licensed locations

Cancel: cancel a transaction 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

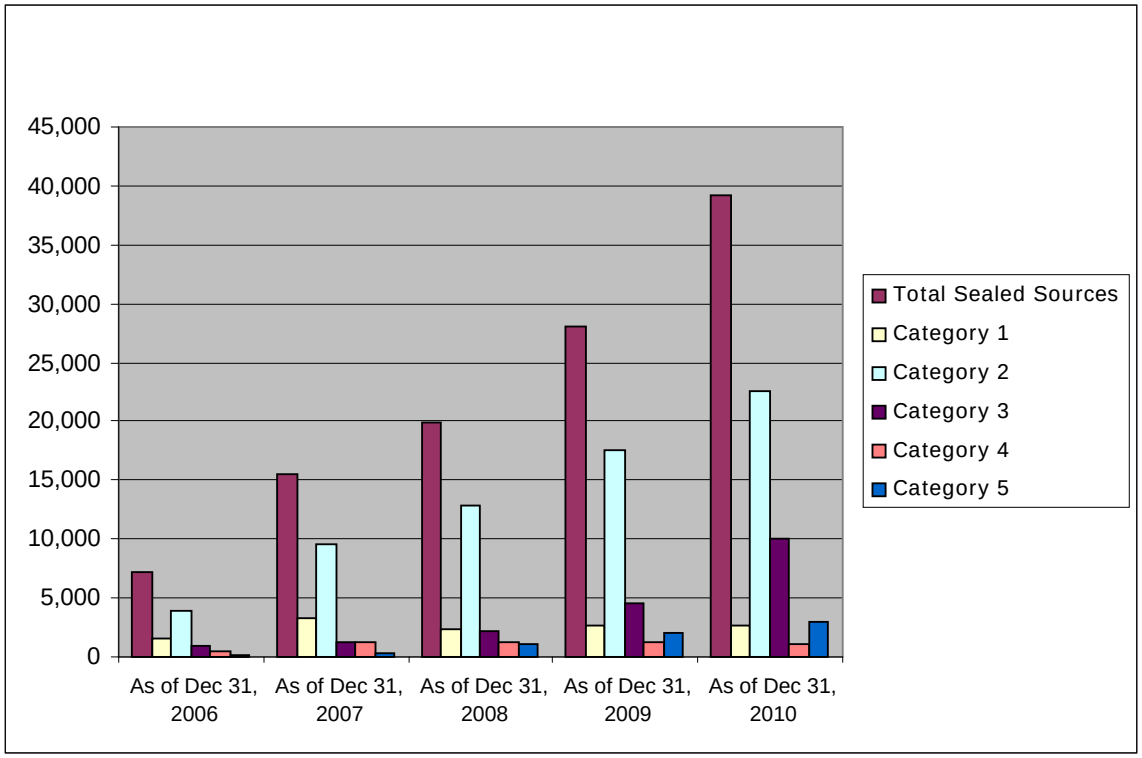
Table 1 and Figure 3 show the total number of sources in the NSSR, as well as the breakdown by Category[2]. The number of sources continued to increase in 2010, as higher risk sources naturally decayed to lower categories and as more licensees added Category 3, 4 and 5 sources as an integral part of their overall inventory. The number of Category 1 and 2 high-risk sources, subject to mandatory source tracking, varied with the number of sources created, disposed, and imported or exported by manufacturers and licensees.

Table 1: NSSR statistics

NSSR Statistics	As of Dec 31, 2006	As of Dec 31, 2007	As of Dec 31, 2008	As of Dec 31, 2009	As of Dec 31, 2010
Number of sources in NSSR (all categories) in Canada	**7,150**	**15,538**	**19,847**	**28,132**	**39,263**
Number of Category 1 sources tracked in Canada	**1,638**	**3,224**	**2,410**	**2,702**	**2,608**
Number of Category 2 sources tracked in Canada	**3,920**	**9,523**	**12,881**	**17,530**	**22,541**
Number of Category 3 sources recorded in the registry	**995**	**1,186**	**2,137**	**4,578**	**10,051**
Number of Category 4 sources recorded in the registry	**500**	**1,312**	**1,273**	**1,263**	**1,094**
Number of Category 5 sources recorded in the registry	**97**	**293**	**1,146**	**2,059**	**2,969**

[2] *"Categorization of radioactive sources", IAEA TECDOC-1344, 2003.*

Figure 3: Number of sealed sources registered by category



6.2 Online usage

With the system design enhancements implemented in 2008, online usage has drastically increased. In 2010, there were a total of 52,373 transactions, representing all transactions for the NSSR and SSTS systems, including new sources added by manufacturers, as well as imports and exports. This represents an increase of 19% from the previous year and of 74% from the system's inception in 2006. Figure 4 shows that 86% of these transactions were done via the online interface in 2010. Figure 5 shows the comparison of manual transactions conducted by phone, fax, mail and email versus those conducted online.

Figure 4: SSTS Web transactions relative to total number of transactions

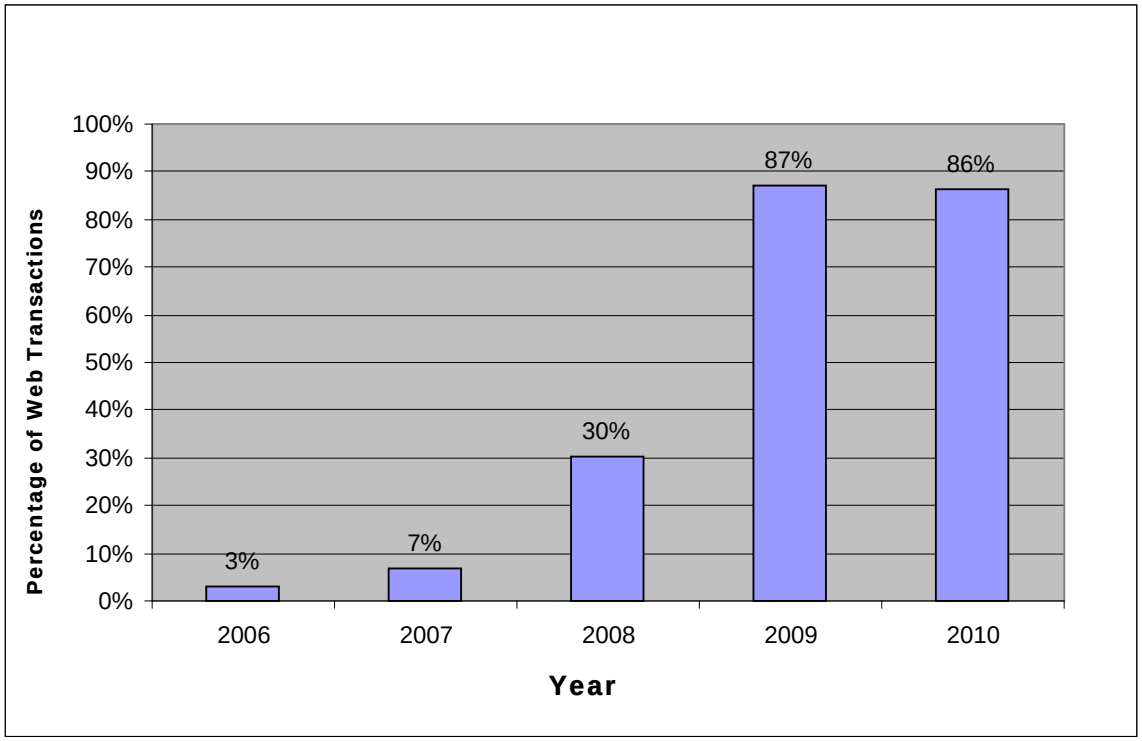
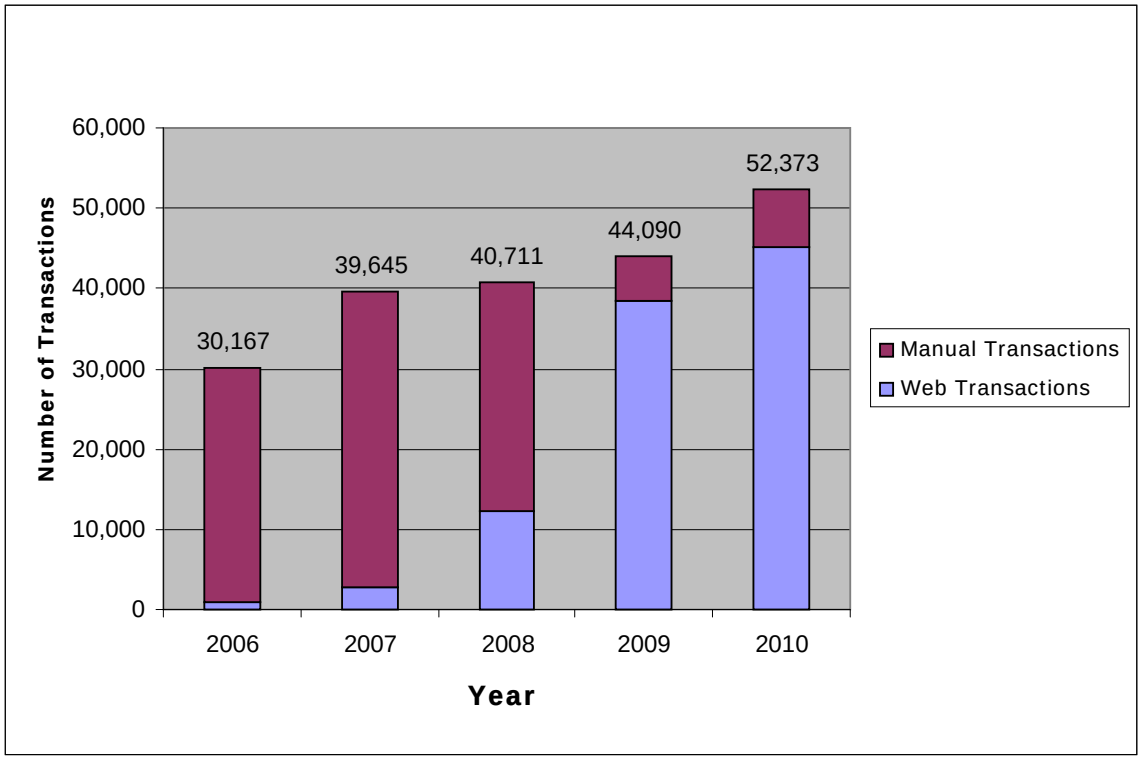


Figure 5: Comparison of SSTS manual versus Web transactions



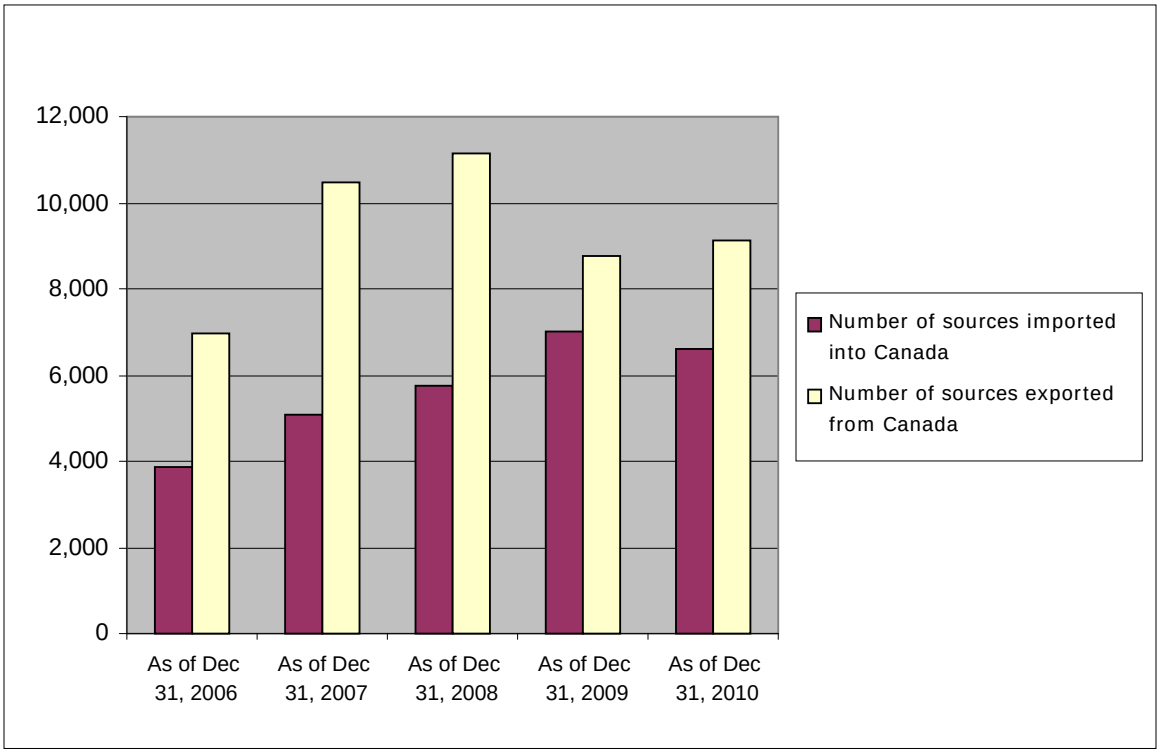
6.3 Import and export details

Table 2 and Figure 6 below show the number of import and export transactions in SSTS, on a yearly basis. Canadian licensees routinely import sealed sources and export them in accordance with their export licences.

Table 2: SSTS import and export statistics per year

SSTS Statistics	As of Dec. 31, 2006	As of Dec. 31, 2007	As of Dec. 31, 2008	As of Dec. 31, 2009	As of Dec. 31, 2010
Number of sources imported into Canada	**3,846**	**5,093**	**5,763**	**6,995**	**6,622**
Number of sources exported from Canada	**6,945**	**10,476**	**11,127**	**8,746**	**9,135**

Figure 6: Number of SSTS import 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. The CNSC was the first nuclear regulator among the G8 countries to implement a national registry of high-risk sealed sources and monitor their movement using a Web-based tracking system. Ongoing improvements and enhancements to the systems continue to demonstrate the CNSC's commitment to the safe and secure control of high-risk radioactive sealed sources.

In 2010, the CNSC successfully implemented Access Key, a new secure system for online services. Furthermore, the CNSC continues to enhance existing electronic information systems to allow data on Category 3, 4 and 5 sealed sources to be efficiently and effectively registered and tracked on an annual basis. Current performance measures and data verification and validation are under continuous review, and are being improved as required. Statistics show a 19% increase in the number of transactions from 2009. This indicates an ongoing licensee commitment to the NSSR and SSTS and reflects the systems effectiveness.

Appendix: 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 (which the sealed source is made of) takes into account factors such as the following:

1. 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].

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

Category 1 (very high risk):

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 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 *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: Co-60 teletherapy

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

Category 2 (high risk):

This radioactive material, if not safely managed or securely protected, could cause permanent injury to a person handling it or 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 *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" that contains a radioactive sealed source	**Image 6:** NDT pipeline inspection using industrial radiography equipment

Category 3 sources are classified as "personally dangerous".

Category 3 (moderate risk):

This radioactive material, if not safely managed or securely protected, could cause permanent injury to a person either handling it, or otherwise in contact with it, for some hours. It could possibly — although unlikely — 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 *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

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

Category 4 (low risk):

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, it could temporarily injure someone either handling it, in contact with it, or is who close to it for a period of several weeks — although injury is unlikely. Category 4 sources are associated with licensed activities to which the CNSC *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

Category 5 sources are classified as "not dangerous".

Category 5 (very low risk):

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

Examples of Category 5 source usage:

- Electron capture detector Ni-63 sources 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: electron capture detector

- 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