

Management of Spent and Disused Sealed Radioactive Sources in the Czech Republic - 12124

J. Podlaha

Nuclear Research Institute Rez, Husinec-Rez 130, CZ 250 68, Czech Republic

ABSTRACT

The Czech Republic is a country with a well-developed peaceful utilization of nuclear energy and ionizing radiation. Sealed Radioactive Sources (further also SRS) are broadly used in many areas in the Czech Republic, e.g. in research, industry, medicine, education, agriculture, etc. Legislation in the field of ionizing radiation source utilization has been fully harmonized with European Community legislation.

SRS utilization demands a proper system which must ensure the safe use of SRS, including the management of disused (spent) and orphaned SRS. In the Czech Republic, a comprehensive system of SRS management has been established that is comparable with systems in other developed countries. The system covers both legal and institutional aspects.

The Central Register of Ionizing Radiation Sources is an important part of the system. It is a tracking system that covers all activities related to SRS, from their production or import to the end of their use (recycling or disposal). Many spent SRS are recycled and can be used for other purposes after inspection, repacking or reprocessing. When the disused SRS are not intended for further use, they are managed as radioactive waste (RAW).

The system of SRS management also ensures the suitable resolution of situations connected with improper SRS handling (in the case of orphaned sources, accidents, etc.).

INTRODUCTION

The Czech Republic is a country with a well-developed peaceful utilization of nuclear energy and ionizing radiation. SRS are broadly used in many areas in the Czech Republic, e.g. in research, industry, medicine, education, agriculture, etc.

SRS utilization demands a proper system which must ensure the safe use of SRS, including the management of disused and orphaned SRS. In the Czech Republic at the end of the year 2010 there were 5,300 SRS registered, of which 3,119 were in use, 486 were stored and 1,645 were stored before processing and disposal; this also includes approximately 1,125 high activity SRS such as defectoscopy instruments and industrial and therapeutic irradiators.

All costs associated with SRS management are borne by a licensee who holds a license for their management, i.e., starting from their acquisition to their disposal into a RAW repository.

LEGAL ASPECTS

Legislation

Act No. 18/1997 Coll. on the peaceful use of nuclear energy and ionizing radiation (Atomic Act) [1] as well as all related decrees are based on the internationally adopted principles of nuclear safety and radiation protection, which are implemented in recommendations of the International Atomic Energy Agency (Safety Series No. 115/1994), International Commission for Radiological Protection (Report No. 60/1990), World Health Organization, etc. This new comprehensive legislation was harmonized with similar legislation of the European Union Directives during the years 2000 – 2005. From the point of view of the safety and security of radionuclide sources, the most important is Decree No. 307/2002 Coll., amended by Decree No. 499/2005 Coll. [2], which contains a transposition of Directive 2003/122/Euratom on High Activity Sealed Sources.

The SUJB (State Office for Nuclear Safety) is an independent central state administrative body for the area of nuclear safety and radiation protection. It has its own budget item, approved by the parliament of the Czech Republic within the state budget. The SUJB is headed by a chairperson appointed by the Czech government.

Pursuant to the Atomic Act, a Radioactive Waste Repository Authority (SURA) was established by the Ministry of Industry and Trade. It functions as a state organization responsible for ensuring the safe disposal of RAW and the monitoring and control of repositories during their operation and after their closure. SURA is funded through levies imposed on RAW producers. It is charged with organizing the disposal of all RAW, as well as spent fuel that has been declared to be RAW.

More information can be found in [3].

Categorization of sources of ionizing radiation

Pursuant to the Atomic Act, the sources are classified, according to the increasing degree of possible personal health hazards, environmental hazards and other relevant factors, into five classes - insignificant sources, minor sources, simple sources, significant sources and very significant sources. For the higher class of sources, more rigid and extensive requirements are defined in order to ensure radiation protection; the licensing procedure is also more sophisticated and requires a thorough professional knowledge. Inspections performed by SUJB inspectors are primarily focused on management of the potentially most hazardous sources, and the relevant inspections are more frequent, extensive and detailed.

Recently, the categorization of SRS has not been fully compatible with the categorization of SRS used in [4] and [5]; however, the parameters registered in the central register of sources allowed this categorization to also be introduced into the system and use the recommended D-values. This was done during the year 2005, together with implementation of the requirements of EU Directive on High Activity Sealed Sources (HASS) [6] into Decree 307/2002 on Radiation Protection [2].

Central Register of Ionizing Radiation Sources [7]

The Central Register of Ionizing Radiation Sources (CRIRS) is a part of the complex information system of SUJB, which includes the register of licensees, sources, licenses and inspections. It is a tracking system that covers all activities related to sources, from their production or import to the end of their use (recycling or disposal).

CRIRS registers SRS, devices with SRS, generators and specification of workplaces with unsealed radioactive sources. Users are obliged to provide them with relevant information about a new source in use (specified by Decree on Radiation Protection [2]) within one month. Users shall also report all changes to registered data, including transfer of the source to another user or to long-term storage or final disposal. The registration of the source is based on the registration of its type and serial and/or certificate number.

Special registration cards are distributed by SUJB and filled in directly by users. Users send the completed cards to SUJB, and the data are introduced into the register. Once every half year, manufacturers, importers, exporters and distributors submit to SUJB a list of the sources delivered. This system serves as a control of the completeness of the register and enables monitoring of the movement of the source during its whole lifetime.

CRIRS is applied for registration of individual sources used in the Czech Republic and monitoring of their movement, statistical evaluation based on selected parameters of the source, information on the location of sources for fire rescue brigades, and information on possible producers of RAW.

MANAGEMENT OF DISUSED SEALED RADIOACTIVE SOURCES

The activities of disused SRS usually range from kBqs to tens of TBqs. Some disused SRS are returned to the producers for further management. Many SRS are recycled and can be used for other purposes after inspection, repacking or reprocessing.

When the disused SRS are not intended for further use, they are managed as RAW and must be transferred to a licensee holding a license for RAW management. There are several companies in the Czech Republic that provide safe management of disused SRS. The Nuclear Research Institute Rez (NRI) is a leading institution in the area of management of institutional RAW, which also includes management of disused SRS. NRI is an integral part of the system of managing institutional RAW in the Czech Republic, and ensures the safe management of the majority of institutional RAW

produced in the Czech Republic (approx. 90%) by providing comprehensive services such as RAW acquisition, as well as its characterization, storage, treatment and conditioning into a form allowing for its disposal into a RAW repository.

The disused SRS are usually conditioned into 200l drums by cementation and then sent for disposal. If the SRS fails to meet acceptance conditions for disposal in a given repository, the disused SRS are sent for long-term storage (usually without conditioning) at the repository site and will be disposed into the deep geological repository in the future. To store these disused SRS, separate premises in the repository have been dedicated for this type of SRS, in the form defined in the acceptance conditions for their storage. Among other conditions, the cask of such SRS shall be leak-tight and easy to handle throughout the storage time.

According to legislative requirements, NRI must send the information about the SRS processing to the SUJB. When the SRS is transferred to SURAO for disposal or long-term storage, all information and documents about the SRS must also be transferred to SURAO. All information about managed RAW in the NRI is stored in a special database system which is connected to a similar system operated by SURAO.

EXAMPLES OF DISUSED SRS MANAGEMENT

Management of SRS from therapeutic irradiators

Old therapeutic irradiators are decommissioned in the Czech Republic after their retirement. These irradiators contained Co-60 SRS with activity up to 250 TBq. The remaining activities after retirement were on the order of tens of TBq.

The decommissioning of the irradiators consists of removal of the irradiator head with the SRS. The weight of the head is approx 1.2 t, and the head also contains approx. 40 kg of depleted uranium as shielding (see Fig. 1).



Fig. 1. Therapeutic irradiator head.

The head is then transported in the special transportation container to a workplace with hot cells, where the SRS is removed and can then be used for other purposes. When the activity of the SRS is too low and cannot be reused, the head is transported to the disposal site for long-term storage.

The irradiator without the head is dismantled after dosimetric measurement and sent to the metal scrap yard. The irradiator can contain dangerous chemicals or oils. These materials must be treated in a proper way.

Radiotherapeutic irradiators equipped with Cs-137, with activity of tens of TBq, are also decommissioned in a similar way to the irradiators described above.

New therapeutic irradiators are now used in the Czech Republic with Co-60 activity of up to 450 TBq. The Co-60 SRS must be regularly changed, and the old SRS are usually recycled – used for other purposes.

Reuse of small industrial irradiator

Small industrial irradiator Gamacell 220 was determined for liquidation in 2009. The Small industrial irradiator Gamacell 220 was determined for liquidation in 2009. The initial activity of Co-60 was 597 TBq; the activity before liquidation was 4.3 TBq. Finally

it was decided not to dismantle the irradiator, but rather donate it to a university for research and education. This was a good example of reuse.

Research laboratory with neutron sources

The research laboratory was operated by a university and had been used in the past for research in the field of neutron physics. The laboratory had not been used for a long time, and the owner decided to decommission it. There were several small Cf-252 and Ra/Be sources and one big Pu-239/Be source with activity of 1.25 TBq (see Fig. 2).



Fig. 2. Pu/Be source.

The biggest problem was the Pu/Be source. It was not only a source of ionizing radiation, but the nuclear material and its processing and disposal could also be problematic. Fortunately, the source was transferred to a new user and is now being used for metrology. The other SRS were removed from the laboratory, processed and sent for disposal in 2007.

ORPHANED OR SEIZURED SRS MANAGEMENT

According to the Atomic Law, a licensee secures sources for which he has a license against theft, damage, or destruction. In addition, he ensures that:

- no unauthorized person handles the source;

- any loss of control over the source, its theft, loss, disappearance or destruction is reported with no delay to the SUJB and the police of the Czech Republic;
- the source is not distributed or in any way handed over, unless the person taking over the source has a relevant license to handle such sources; this provision does not apply to insignificant and minor sources;
- the location, movement, consumption, security against theft, loss, disappearance or destruction of the source has been controlled by physical inventory on a regular basis every six months.

The system of SRS management in the Czech Republic also ensures the suitable resolution of situations connected with improper SRS handling (in the case of orphaned SRS, accidents, etc.). Today, all metallurgical plants in the Czech Republic are equipped with stable detectors of ionizing radiation at the entry to the plant, and samples of the produced metal are collected and measured. In addition, many scrap collecting centers, border crossings and municipal waste disposal sites with incinerating facilities are equipped with measuring devices. All these companies are obliged to report every radioactive material found to SUJB.

This is why the number of cases of improper SRS handling is decreasing; however, there are still some cases when orphaned SRS are discovered at former ionizing radiation workplaces, in metal scrap or municipal waste, etc. The Integrated Rescue System of the Czech Republic involves institutions (fire rescue brigades, police, mobile teams operated by SUJB or private companies) necessary for gaining and regaining control over orphaned SRS.

SUJB carefully investigates all events involving SRS as unusual events, paying attention to the evaluation of root causes and the presentation of lessons learned. The first step is to search for the owner of the orphan source found. If the owner is not found, the government is responsible for the treatment and final disposal of the source. In such cases, SUJB authorizes those companies which are able to manage all necessary steps.

During the year 2002, SUJB issued a special recommendation/guidance on the procedure in the case of radioactive materials seizure [8]. It contains the procedure in case of suspicion of the presence of radioactive materials under different scenarios. It also contains very valuable charts of decision procedures and pictures of many objects which are potentially radioactive, or could be found to contain radioactive material. This material has been distributed to all involved parties and serves as a very useful tool in the system. All cases of improper SRS handling are described in the SUJB Annual Reports [9]

NRI is one of several private companies taking part in the system, and provides emergency services for SUJB as well as for companies operating municipal waste disposal sites, scrap yards, incinerating plants, etc. NRI provides a mobile group which is equipped with cars having measuring devices and equipment for eliminating accidents related to ionizing radiation sources. NRI also ensures processing of SRS

when the owner is not found. The processed SRS is then disposed of. The activities of NRI in the field of seizure of radioactive materials were described in [10].

The following sources with Cs-137, Co-60, Sr-90, Am-241 or Ra-226 of somewhat lower activity are usually discovered: military devices (lighting paints in the devices of airplanes, compasses, etc.), smoke detectors, industrial sources (static electricity eliminators, densitometers, thickness meters, level indicators, etc.), and objects and equipment related to radionuclide utilization (SRS, equipment of ionizing radiation workplaces, etc.). But some incidents related to SRS having higher activity have also occurred in the past. Some examples are described below.

Seizure of high activity SRS in Italy

In 1996, a railway carriage with metal scrap from the Czech Republic was captured on the Italian border. The carriage was returned to the Czech Republic. Four SRS with total activity of Co-60 of 1.79 TBq were discovered in the carriage. The loss of the SRS had been reported earlier by a Czech company. The SRS were stolen and sold as metal scrap. This was the most serious case of seizure of SRS in the Czech Republic.

Workshop for handling and storage of SRS

The workshop was operated by a company which had produced therapeutic irradiators. After the bankruptcy of the company, it was decided to decommission the workshop. The workshop was equipped with two pools for storage of Co-60 and Cs-137 SRS and manipulators for manipulating SRS.

Before the decommissioning of the workshop, two old Co-60 SRS with total activity of 67 TBq stored in the pool had to be removed. All employees who had operated the facility in the past were now retired, so the decommissioning began with a search for these employees. Because the workshop had not been used for a long time, it was necessary to check the workshop equipment (manipulators, cranes, etc.) and put the equipment into service again. Then in 2003, the SRS were removed and sent for long-term storage.

Orphaned SRS in ironworks

Many level detectors were used in the ironworks. The ironworks was sold to another company, and this company became bankrupt. After a certain period, the ironworks premises were sold to a real estate company. Because the factory was situated in an attractive area, it was decided to demolish all buildings and to use the area for building new houses. During the demolition work which started this year, some SRS were discovered. The demolition was stopped and 10 SRS were discovered on the site. After investigation, two more SRS were found in a metal scrap yard as well as one more in Germany. The actual activity of the SRS was from 40 MBq to 1250 MBq; the total activity was approx. 5 GBq.

Two level detectors were damaged during processing at the metal scrap yard; fortunately, the SRS were not released from the shielding. One shielding damaged by oxyacetylene cutting is shown in Fig. 3.



Fig. 3. Damaged level indicator with activity of 1.25 GBq of Co-60.

Workshop for SRS handling and storage

The workshop was used for storage and handling of sealed Co-60, Sr-90, Cs-137, Ra-226 and Am-241 sources used in several instruments such as smoke detectors, water level detectors, density and thickness meters, etc. The company that produced the described instruments also performed collection of disused SRS from these instruments. But these disused SRS were not processed and sent for disposal. This explains why a large number of disused SRS were accumulated. The company then became bankrupt, and before a decision could be made about what to do with the company, all the SRS had to be removed and sent for processing and disposal.

The workshop was equipped with a hot cell serving for SRS handling and storage. More than 48,000 SRS, with total activity of 296 MBq, of Ra-226, 1.3 TBq of Co-60, 10 TBq of Cs-137 and 1.3 GBq of Am-241 were stored in the workshop. All these SRS were removed, processed and sent for disposal. The workshop was then decommissioned.

Seizure of a radium tube at a playground

In September 2011, an increased level of radiation was casually detected at a playground in Prague. A spot with an equivalent dose rate of 19 mSv/h in contact was then identified, and an SRS of Ra-226 was discovered approx. 8 cm below ground. It was a cylinder with length of 28 mm and diameter of 4.5 mm. The contact equivalent dose rate was 150 mSv/h, within 1 m, then 150 μ Sv/h.

The SRS was characterized and cleaned. The activity was estimated to be 600 MBq of Ra-226. The SRS after cleaning is shown in Fig. 4. It had probably been used in the past for radiotherapy. Unfortunately, no marking was discovered, and for this reason the origin of the SRS is unknown. It is not clear why the SRS was deposited at the site. The SUJB also performed an analysis of a dose obtained by a member of the public who was exposed on the site, in the immediate vicinity of the deposited source. A very conservative estimation was 3.5 mSv/year, which corresponded to the dose obtained from the background in the Czech Republic.



Fig. 4. Radium tube.

IMPROVEMENT OF SRS MANAGEMENT SYSTEM

As mentioned above, the system of SRS management in the Czech Republic is at a high level, but is still being improved, with additional assistance from the USA within the framework of the Global Threat Reduction Initiative (GTRI).

Within the framework of the GTRI program, physical protection enhancement recommendations based on IAEA and EU recommendations are provided, and recommended physical protection enhancements are purchased and installed through a local Czech security company, which works cooperatively with the site manager and the SUJB. The staff is trained in the use of the new physical protection system.

For example, in NRI a new storage room for disused SRS and nuclear material will be built. The SRS and nuclear materials are currently being stored in several rooms; when collected into one room equipped with a new system of physical protection, the physical protection will be improved. A new system of physical protection will also be installed at NRI's irradiators with high activity SRS.

Similar arrangements will also be implemented at other workplaces containing SRS, such as hospitals with radiotherapeutic irradiators, companies with industrial irradiators and defectoscopy instruments, etc.

CONCLUSIONS

The Czech Republic is a country with a well-developed peaceful utilization of nuclear energy and ionizing radiation. SRS are broadly used in many areas in the Czech Republic. Legislation in the field of ionizing radiation source utilization has been fully harmonized with European Community legislation and IAEA recommendations.

A proper system which ensures the safe use of SRS, including the management of disused and orphaned SRS, has been established.

The Central Register of Ionizing Radiation Sources is an important part of the system. It is a tracking system that covers all activities related to SRS, from their production or import to the end of their use (recycling or disposal).

Disused SRS are safely managed in the Czech Republic. Some disused SRS are returned to the producers for further management. Many SRS are recycled and can be used for other purposes after inspection, repacking or reprocessing. When the disused SRS are not intended for further use, they are managed as RAW, and after processing are disposed into RAW repositories.

The system of SRS management in the Czech Republic also ensures the suitable resolution of situations connected with improper SRS handling (in the case of orphaned SRS, accidents, etc.). The Integrated Rescue System of the Czech Republic involves all governmental institutions necessary for gaining and regaining control over orphaned SRS.

The system of SRS management in the Czech Republic is at a high level, but is still being improved with additional assistance from the USA within the framework of the Global Threat Reduction Initiative (GTRI) and the IAEA.

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