International Conference
Nuclear Energy for New Europe 2005
Bled, Slovenia, September 5-8, 2005

Orphan Sources in Slovenia

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ABSTRACT

For decades the international standards and requirements postulate severe control over all lifecycle phases of radioactive sources in order to prevent risks associated with exposure of people and the environment. Despite this fact the orphan sources became a serious problem as a consequence of enlargement of economic transactions in many countries in Europe as well as in the world. The countries as well as international organisations, aware of this emerging problem, are trying to gain control over orphan sources using different approaches. These approaches include control over sources before they could become orphan sources. In addition, countries are also developing action plans in case that an orphan source could be found.

The problems related to orphan sources in Slovenia is discussed based on the case studies from the last years. While in the nineties of the last century just a few cases of orphan sources were identified their number has increased substantially since 2003.

The paper discusses the general reasons for the phenomena of orphan sources as well as the experience related to regaining control over orphan sources.

1 INTRODUCTION

The definition of an orphan source is given in [1] where it is stated: "*Orphan source is a radioactive source which is not under regulatory control, either because it has never been under regulatory control, or because it has been abandoned, lost, misplaced, stolen or transferred without proper authorisation*." The orphan sources became an international problem after the increase of the international trade which made impossible to control every transfer of the material between countries. In addition, the phenomenon of a terrorist attack using radioactive material made this issue even more provoking.

The international organisations found out that an action plan is needed in order to cope with these issues. Their actions are focused on three main tasks:

- the maintenance of databases related to events with orphan sources and the publications of such events
- the preparation of recommendations and guidelines to national regulatory bodies in order to prevent and detect the events related to orphan sources as well as to develop the response strategies to radiological or nuclear emergency
- the appraisals of the national strategies of the radioactive sources control.

The purpose of the databases is to inform regulatory authorities as well as the users of radioactive material about past events associated with handling radioactive material which could pose a risk to the people. The International Atomic Energy Agency (IAEA) established in 1995 the *Illicit Trafficking Database* which is focused on the trafficking incidents and is a complementary database to the *International Nuclear Events Scale* from 1990 which is related to all events connected to radioactive material. Some analysis of the data from the databases could be also found elsewhere. In [2] a list of 60 cases related to the melting of a radioactive source in the period from 1983 to 1998 is given. Moreover, the European Union started with the EURAIDE pilot study - *European Accident and Incident Data Exchange System* with the help of the European ALARA Network. Some of the national bodies also run the databases related to the events concerning orphan sources such as given in [3].

A list of publications concerning the regulations and guidelines related to different aspects of regaining control over orphan sources shows that the IAEA has published more than 10 publications since the year 2002 [1, 2, 4, 5, 6, 7, 8, 9, 10]. The *Code of Conduct on the Safety and Security of Radioactive Sources* was published in 2004 and the last IAEA publication related to safety and security of radioactive source entitled *Guidance on the Import and Export of Radioactive Sources* has been published recently. The European Union published in 2003 the Council Directive 2003/122/EURATOM *on the Control of High-Activity Sealed Radioactive Sources and Orphan Sources* in order to limit the risk associated with incorrect handling of sources [11].

The IAEA is also assessing the effectiveness of the national regulatory infrastructure for radiation safety including the safety and security of radioactive sources in a State through Radiation Safety and Security of Radioactive Sources Infrastructure Appraisals [12].

Moreover in the last ten years a few international conferences were dedicated to the improvement of the safety and security of radioactive sources such us the *International Conference on Nuclear Security, Global Directions for the Future,* held from 16 to 18 March 2005 in London [13] or the *International Conference on Safety and Security of Radioactive Sources: Towards a Global System for the Continuous Control of Sources throughout their Life Cycle* held from 27 June to 1 July 2005 in Bordeaux [14] .

In addition, the intention of the International Source Suppliers and Producers Association which has been established recently is to contribute to the safety and security of radioactive sources as expressed in the draft of the *Code of Good Practice* [12].

2 ORIGIN OF ORPHAN SOURCES

Three origins of orphan sources exist:

1. import of an orphan source
2. abandoning control over a source which was under control in the past
3. finding of sources, which were not under control in the past, including domestic NORM sources.

In order to prevent the import of an orphan source, any country should develop a system of recognising the ways through which such sources could come in the country and develop a system of defence using administrative or physical control such as a use of detection equipment. Control of illicit trafficking is a challenge since collaboration between several organisation within and outside countries is needed.

In order to prevent the existence of sources which were under control in the past to become orphan sources, regulatory authorities should develop a comprehensive system related to all life phases of a source. Each source goes through some or all of the life phases during its lifetime. The main life phases of a source are the production, import, export, transport, distribution, use of a source, maintenance and repair, handling, dismantling and

storage. Regulatory authorities should control a source in all of the mentioned phases with a system of national registers of sources connected to a system of registration and licensing and a system of inspection.

The analyses of databases related to orphan sources shows that a source is in some of the lifetime phases more vulnerable than in others. Very often sources become orphan sources when they are just stored after their effective use and an owner of a storage was changed. In addition, if more exchanges of owners happened the probability that a source would become orphan is higher. Besides, the vulnerability of a source in all lifetime phases strongly depends on economic status of owners. When the owners are affected by a natural or artificial reverse as for instance war sources became usually very vulnerable.

The analysis of databases related to orphan sources also shows that consciousness of indispensability of strict control over sources is very often not on a very high level especially in institutions which used sources in the past. At that time institutions such as research institutes or universities were not strongly connected to other institutions, so that a transfer of a source from one owner to another did not occur very often. Moreover, at that time also safety standards were less rigorous.

3 STRENGHTENED CONTROL OVER ORPHAN SOURCES

Regulatory authorities in Slovenia followed the same route in order to strengthen control of nuclear and other radioactive material as those being applied by the majority of other European countries. The approach required several harmonised steps which significantly decreased the possibility of the existence of orphan sources. The approach included control of illicit trafficking and a renewal of control over abandoned sources which were under control in the past. The approach also included control of sources which have been never under control in the past, but should have been. Such sources have technical characteristics which due to old legislation did not require control in the past or there was a lack of technical knowledge related to source characteristics. In all steps of the action plan related to the strengthened control over orphan sources quite a few Slovenian institutions were involved.

- New legislation was prepared. Slovenia adopted the new act related to nuclear and radiation safety in autumn 2002 and second-level legislation is prepared. The national registers of sources was developed as well as national registers of organisations involved in a practice with radiation sources.
- From the year 2002 the Slovenian Nuclear Safety Administration (SNSA) has been providing 24-hour on-duty inspector which could act in case that an orphan source is found or illicit trafficking is identified. In addition, the on-duty officer who gives the advice if such cases emerge is also provided by the SNSA. The SNSA on-duty officer was called for about twenty-five times up to July 2005. Ten to fifteen percent of these cases were related to lost orphan sources or contaminated items while the others were not related to orphan sources. Figure 1 shows inspection at the border and the inspection of a source in an abandoned factory provided by the SNSA inspection. The detailed measurements and arranging the transport of a source to the state storage for radioactive waste is always provided by technical support organisations and the Agency for Radwaste Management (ARAO), respectively. In case of a radiological emergency, the rarest possible event, a special ecological laboratory with a mobile unit is notified through the state system of emergency notification.

Figure 1**:** Inspection on the border and in an abandoned factory provided by the SNSA

- The co-operation between regulatory authorities and other stakeholders in Slovenia was established. Several Slovenian institutions have been involved in the prevention of illicit trafficking and prevention of orphan sources since 2002. At the state border the first responders are mainly customs and police officers. The SNSA also co-ordinates other state institutions and organisations and calls for regular semi-annual meetings related to the illicit trafficking. With the help of technical support organisations several educational seminars and training were organised. At the end of 2004, the SNSA also included in the process of co-operation and response the Slovenian railways, metal collecting and processing enterprises who showed substantial interest.
- In order to inform stakeholders the information leaflets have been published by the SNSA since 2004. In addition, all administrators in bankruptcy in industry were officially informed about the possibility of presence of orphan sources.
- The SNSA follows the international experience related to orphan sources. It is the contact point for the IAEA and it prepares reports for the *Illicit Trafficking Database* and *International Nuclear Events Scale* database. From the perspective of enforcement, administrative penalties are covered in the 2002 nuclear act, and deliberate criminal offences are covered by the Slovenian Penal code. In the last decade, no deliberate criminal offences have occurred and nobody has been condemned by the court.
- The detection devices were purchased. Before 2002, there was little detection equipment at borders and the first pioneer steps were done back in early-90's. The situation substantially changed in 2002, when customs and police were granted by the US government with small pocket devices for gamma dose rate measurement. The pre-set alarm of devices is at around triple background. The SNSA together with customs prepared a written procedure of response and a short training course was carried out for about half of the users in order to familiarise them with radiation, practical response and the instrument itself. The equipment commonly used by the SNSA inspectors is shown in figure 2. A TL dosimeter not shown in the figure is used for monitoring personal dose of an inspector. No portal monitors have been installed on borders till now. They are planned to be installed in the near future with the help of the US International Security Program - Second line of defence. At the moment, there are a few portal monitors for rail or trucks at metal collectors and processors' premises. Recently, the Slovenian Customs has purchased half a dozen of hand-held devices, and they will be fully deployed later this year.

Figure 2**:** The equipment commonly used by the SNSA inspectors. The TL dosimeter not shown in the figure is used for the dose record of the inspector.

In 2003, extensive campaign of the SNSA and the ARAO started in order to put all disused sources which were stored at small users in the state in the Central Interim Storage for Radioactive Waste. The campaign resulted in a substantial increase of items stored in the storage in 2003 comparing to the years before 2003 and consequently in a decrease of the possibility that these sources could become orphan sources. Figure 3 shows the annual number of stored items in the storage from 2000 to 2004.

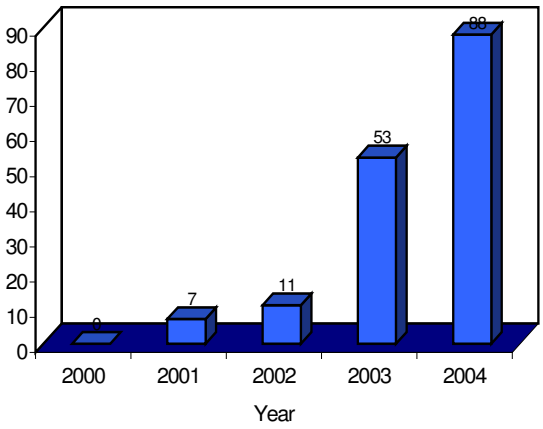

Figure 3**:** The annual number of items stored in the Central Interim Storage for Radioactive Waste from 2000 to 2004

4 INCIDENTS WITH ORPHAN SOURCES IN SLOVENIA

An analyses of data related to incidents with orphan sources which has been kept by the SNSA since the year 2002 shows that the number of incidents with orphan sources increased due to the better detection capabilities at borders customs, scrap yard owners and other enterprises as well as due to a renewed system of control after the adoption of the 2002 Nuclear Act. In the year 2003, three cases related to orphan sources were detected while in the year 2004 eight cases, among them one case was still in progress in the year 2004. The analysis takes into account all closed cases solved in 2004.

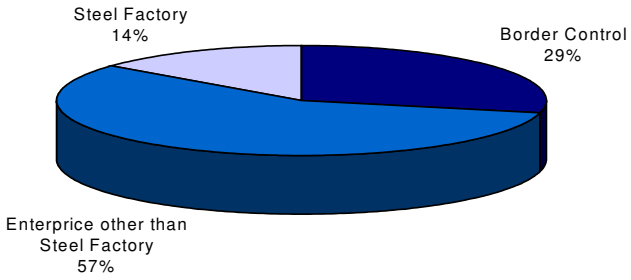

Figure 4**:** The distribution of the number of events related to orphan sources found in 2004 regarding the place where they were found

In that year two cases were related to more than one radioactive source, in one exceptional case the number of found sources was even several tens. While orphan sources in a scrap metal were found two times at the border control and once at a steel factory the majority of the events were actually related to past activities. Figure 4 shows the distribution of number of events with orphan sources related to the place where they were found in 2004. According to the origin of the orphan sources discovered in the year 2004 three scenarios could be identified: illicit trafficking, storage of abandoned sources and contamination due to past activities.

a) Three cases were related to illicit trafficking. A steel factory and in two cases the customs at the Slovenian border reported the SNSA about the illicit trafficking of a source. Both reporters were equipped with detectors. The Co-60 with the activity in the range of 370-3700 MBq was found in a truck at the Slovenian border and after the inspection the entry of the truck into the state was not allowed. The radioisotope Co-60 was also found in scrap metal at the steel factory which detected an increase of the dose rate using hand held detector. The assessed activity of the radioactive source mentioned was 1 GBq and the source was stored in the Central Interim Storage for Radioactive Waste. The increased dose rate on the truck at the Slovenian border was detected due to the presence of a radioactive source containing Eu 152-154 with an activity of approximately 4 GBq. The entry of the truck into the state was not allowed.
b) Three cases were related to the storage of orphan sources without proper regulatory control. Storage facilities did not satisfy safety standards. In all cases owners of the building and consequently the owners of sources were not aware of the presence of stored sources. In two cases owners of sources who were also users of sources in the past moved the sources from one location to another and later on they abandoned the sources. One of these owners stored three Sr-90 sources, two sources with activities of 0.15 GBq each and one with activity of 0.13 GBq . In addition it also stored two Kr-85 sources with activities 0.56 GBq and 0.84 GBq. The other owner was in possession of 61 radioactive sources with a set of radioisotopes namely H-3, Na-22, Co-57, Co-60, Sr-90, Nb-93m, Nb-94, Cs-137, Pm-147, Gd-153, Bi-207, Ra-266, Th-232, U-238, Pu-238 and Am-241 of the total activity of approximately 160 GBq. In one case related to the storage of orphan sources, an owner bought a storage facility without a notification that a source containing the radioisotope Cs-137 with an activity of 5 GBq was abandoned inside the facility. In all the above

mentioned cases the sources were later stored in the Central Interim Storage for Radioactive Waste.

c) In the year 2004 the contamination of floor with the Am-241 was also found in an abandoned workshop. The contamination was a result of past activities related to repair of smoke detectors. The undertaking already sold the workshop together with other parts of facility without any notification to the regulatory authority or to a buyer and a new owner planed to transform the facility to an administrative building. The inspection of the SNSA required decontamination of the workshop which has a maximum level of contamination of around 130 Bq/100 cm^2. The decontamination was successful and around 0.5 m^3 of radioactive waste was produced and stored in the Central Interim Storage for Radioactive Waste.

The SNSA inspection found orphan sources in enterprises either during inspection control based on the documents from the past or during the inspections of a site.

5 CONCLUSIONS

Strengthening control over orphan sources in Slovenia was carried on through several tasks including legal area, national and international co-operation as well as education, deployment of detection equipment and last but not least enforcement. The new 2002 Nuclear Act has brought about several new provisions e.g. additional licensing provisions, registries of radioactive sources, security plan for high activity sources within radiation facilities, etc. It is obvious that maintaining security of radioactive sources is a permanent task, however, results over the past years have shown a relatively stable situation. All Slovenian organisations, co-operating in this area, have gained valuable knowledge.

The lesson learned from Slovenia showed that the majority of orphan sources originate in the past activities. The regulatory control of the closure of an activity involving radioactive sources is a comprehensive task which requires close collaboration of users, regulatory authorities, technical support organisations and waste management facilities. In order to strengthening control over orphan sources it is also necessary to detect radioactive sources and contaminated materials which may enter the state - either in transit or being imported - legally or illegally, with a deliberate intent or without it. The detection capabilities introduced in 2002 along the borders and within the country were an important step in the right direction.

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