

## INFORMATION SYSTEM ON INTEGRATED RADIATION SAFETY (ISIRS) AND ORPHAN SOURCES CONTROL IN KOREA

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**Abstract** - An Orphan Sources Control program controlled by a web based information system in Korea has been developed to satisfy the national demand on a total management of and integrated radiation safety. There are, currently, three approaches going on to control and manage the orphan sources in Korea. First, Korean regulatory authority has been conducting scrutinizing investigation on and thoroughly monitoring the possession of unlicensed radioactive sources from the late 1990s. Second, the regulatory authority will fully operate an information system on radiation safety to effectively trace and monitor all radioactive sources in the country by the mid 2001. Finally, the regulatory authority strongly advises steel mill companies to closely scrutinize and inspect the scrap metals when they attempt to reutilize metals to prevent from being contaminated by uncontrolled sources through the scrap monitoring systems.

### INTRODUCTION

As many industrialized countries do, radioactive sources are used in a variety of sectors such as industries, industrial radiographers, medical centers, research laboratories, educational institutions and public or governmental user organizations in Korea. The types of the sources are generally classified into various sealed, unsealed radioisotopes, x-ray generators, ion implanters, medical accelerators and so on.

Ministry of Science and Technology (MOST), Korea regulatory authority, launched its radiation regulatory action on radioactive sources in 1962 when it first issued licenses for few radioactive source user organizations. There are currently about seventeen hundreds nuclear and radiation facilities, including medical centers, which use radiation sources, and these radioactive source applications are increasing by 15-20% annually. However, the users of radiation generators for diagnostic purposes at medical centers are not included in the number of licensees by the

Ministry (MOST), and they are under the regulation by different authority, called, Korean Food and Drug Administration (KFDA). Table 1 shows an increase in the number of radioactive source user organizations in Korea, while Table 2 shows the number of the licensees by user groups.

**Table 1.** Annual number of user organizations of radioactive sources (including various radioisotopes) and radiation generators in Korea

Year	1962	1990	1995	1996	1997	1998	1999	2000 Sept
No. of Licensees	2	698	1064	1175	1315	1394	1570	1660

**Table 2.** Number of organizations by user group as of the end of August 2000 in Korea

	General Use	Movable Use	Use/Supply	Supply only	Total
Medical Institutes <sup>1)</sup>	122	-	2	-	124
Industries	813	37	12	30	892
Research Laboratories	210	-	2	-	212
Educational	192	-	-	-	192

	General Use	Movable Use	Use/Supply	Supply only	Total
Institutes					
Public or Gov. Organizations	230	-	-	-	230
Others	10	-	-	-	10
Total	1,577	37	16	30	1,660

1) Except uses of radiation generators for diagnostic purpose

As the number of radioactive source user organizations rapidly grows and becomes huge, Ministry decided to entrust part of its duty of the regulation on radiation safety to Korea Institute of Nuclear Safety (KINS), a regulatory expert organization in 1985. Henceforth, MOST and KINS are now both responsible for controlling and regulating the radioactive sources in Korea. KINS reviews and assesses the various types of safety reports such as environmental reports for sites, those for the construction permit and other safety analysis reports for the operating license. When KINS completely finishes its regulatory reviews on all reports, which include the radiation protection program for radiation workers at a perspective facility, they report the results of the regulatory reviews to the Ministry. The MOST decides the final license type according to the results. Licenses issued by the Ministry are generally classified into a permit, authorization, or license depending on applications and uses of the radioactive substances and sources. KINS has conducted periodic inspections on the licensees' facilities by annual, tri-annual, or five-year term period depending on the degree of the risk involved at licensees' facilities. During the inspection, they judge the compliance of licensees, who use the radioactive sources, with regulatory codes and standards and report the result to the Ministry. A Task Force Team consisted of special inspectors both from MOST and KINS usually intervenes in an emergency case broken by an incident or accident from radiation sources to resolve the crisis safely. Most of the radioactive sources are imported from foreign countries, and only small portion of

sources are domestically produced. When perspective users or suppliers want to purchase radioactive sources from abroad, first, they shall apply for a recommendation letter for importing sources to Korean Radioisotope Association (KRIA), who is a non-governmental organization of private interests with the objectives of radiation safety. Then, sellers or suppliers shall submit an import application with the attaching the Said recommendation from KRIA to Ministry for custom clearance. As a general practice around the world, Korea Custom Services (KCS) inspects and clears all foreign-made products. When the products identified as radioactive sources, they are notified and informed to organizations such as MOST, KINS and KRIA as are done with all other imported products to the competent authority, if it is necessary. Since the Korea Customs Service's integrated network, called Electronic Data Interchange (EDI) shares data on imported radiation source with other organizations, the KRIA is able to track radiation source following their arrival in Korea. In addition, the MOST and KINS are capable of monitoring the attributes of radiation sources as well as the routes and time of their domestic entrance.

Licensed radiation sources should not be dumped, released, or disposed without a legal permission from the Ministry in Korea, even if they are completely decayed out. All licensed sealed sources as well as solid radioactive wastes from medical centers must be transported to an authorized disposal site in Taejon, called, Nuclear Environment Technology Center (NETEC) for interim storage and disposal.

Orphan Sources are often found when the radiation sources are out of the regulatory control. They are usually classified into three categories: (1) Illicitly trafficked sources, (2) domestic loss of sources caused by the bankruptcy of licensee or suppliers, and (3) contaminated metal scraps imported for recycling.

Illicit trafficking of radioactive sources and

substances comes from the violation of domestic rules on the life cycle of radioactive materials, which are stipulated, in detail, in Korea Atomic Energy Law, Atomic Energy Act, Enforcement Decree, Enforcement Regulation, Provisions, or Ministerial Notices. The radiation sources are often found to be disposed without legal permission or abandoned when a licensee is bankrupted. Recently, these happen quite often because many licensed users or authorized suppliers have severe financial difficulties due to slow economy from a low growth in Korea.

It is important that metal products should be free from the radioactive contamination as much as possible, because ten percent of raw metal materials come from recycling. Recent years, there are many nuclear facilities, equipment, or devices encapsulated with radioactive sources around the world that have been dismantled, and those dismantled materials were sold as scrap metals for recycling.

There are currently two approaches going on to control the orphan sources in Korea: First, regulatory authority has conducted a 3-year project to build an information system on the web basis, which is supposed to be in full operation by the middle of 2001. By then, the regulatory authority will be able to effectively oversee the safe management and control of all radiation sources at the licensees facilities through the system on a real time basis. Second, we are also stipulating a strict implementation and regulation on the reutilization of scrap metals to be free from any uncontrolled sources. To verify this, all licensees for steel milling should install and monitor all imported scrap metals with some fixed type radiation detecting systems at their yards and docks before either shipping for supply or melting scrap metals for reutilization.

Since Ministry is entrusted with a solemn mission and has an absolute duty to protect Korean people and environment from radiation, KINS and MOST have jointly conducted a study to determine any potential effects on the general public from the recycling of the scrap metals at these facilities since late 1990s. As

we investigate the domestic metal recycling processes, we found and became more concerned about the following two potential sources of the contamination in scrap metals: contaminated metals imported from foreign countries, and sealed radioactive sources, both domestic and foreign made, that became illegally released and flew into and mixed into the scrap metal stream (orphaned sources).

Finally, Ministry drew a conclusion that we absolutely need to take some concrete measure and physical action to bring these unwanted radioactive sources under the regulatory control and thus reduce the potential of unnecessary exposure to the general public, workers and our environment from radiation of these radioactive sources.

This paper introduces the orphan source control program that is intended to reduce the number of radioactive sources that enter into the scrap metal stream in Republic of Korea.

## ILLICIT TRAFFICKING SOURCE CONTROL IN KOREA

Korea finds that illicitly trafficked radiation sources are usually either under the possession of an unlicensed organization or of a licensee, who is not authorized to possess those particular radioactive materials. These sources can be categorized, depending on the cases we found, as follows:

- Items not declared, identified or legally cleared by the Korea Custom Services (KCS). Usually these sources had been imported, not as an individual item but cleared through custom services as part of an equipment, assemblies, or devices;
- Tax-free items imported by public or government organizations;
- Items illegally administered by the supply agent intended to be cleared over custom control without due charges and taxes; or
- Items considered as exemption items by KCS officers own discretion, without the recommendation or inspection by either

qualified radiation safety officer or nuclear regulatory authority.

We thoroughly investigated all the illicit trafficking source events in 1999 and were successful in convincing the owners to inform and report all illicitly trafficked sources under their possession to the regulatory body (in this case, to the KINS) for registration. When sources are reported, regulatory authority did not ask informers whether sources have been acknowledged as radioactive before or belatedly identified as illegal sources. Korea has conducted the mission in the following manner: Regulatory authority announce the information to the public by mass media and urge the unidentified owners to report all the sources illegally possessed or without permission to KINS for the registration;

- Order the unlicensed users, who were identified by the records of the sales agents as supplying the radiation sources without permission or authorization, to register all sources under their possession at KINS; and
- Encourage user organizations to report and register all the sources imported before without permission or authorization to KINS. These kinds of sources are often identified when the end users submit the applications to purchase new sources for replacing the old ones. Old sources are usually found to be almost decayed down to null and no longer in use since their radioactivity levels are not strong enough as a source.

Table 3 shows actions done by the regulatory authority, the number of cases and radiation sources registered when the equipment or device are identified either to contain radioactive sources or be radiation generators. More than 300 users registered their about 5 hundreds equipment, including measuring devices containing radioactive sources or radiation generators. These include electron capture detectors in gas chromatography, sulfur-analyzers in oil, nuclear gauges, x-ray generators for industrial or

laboratory radiography, x-ray diffractometer or fluorescence spectrometers, and so on.

**Table 3.** Authority action on the cases of equipment or devices identified to contain radiation sources or radiation generators in Korea during 1999.

Authority Actions	Number of cases investigated	Radiation sources registered
Announcement through mass media for registration	90	<ul style="list-style-type: none"> <li>• Radiological devices equipped with sealed sources</li> <li>• X-ray generators for industrial radiography</li> <li>• Cabinet type x-ray generators for laboratory analysis and radiography</li> <li>• Accelerators made domestically, but not authorized by government</li> </ul>
Regulatory investigation by the authority	400	<ul style="list-style-type: none"> <li>• Sealed source contained in radiological devices, such as gas chromatography, potable analyzer, etc</li> <li>• X-ray diffractometer or fluorescence spectrometer, etc</li> </ul>
Register, when being identified	Less than 10	<ul style="list-style-type: none"> <li>• Nuclear gauges</li> </ul>

## INFORMATION SYSTEM ON RADIATION SOURCES IN KOREA

The KINS, a regulatory expert organization has been carrying out a 3-year multi-phase project to control and monitor all orphan sources imported in Korea. The system, called, Information System on Integrated Radiation Safety (ISIRS) on the web basis using both the inter- and intra-net has been developed to effectively control and accurately monitor radioactive sources on a real time basis since 1998. If the system is successfully set up and operating as scheduled by the middle of July 2001, the regulatory authority can efficiently and actively control any reutilization of uncontrolled sources through the system. At the same time, the system can also not only provide licensees, authorized suppliers, or perspective end users but also Korean general public of interests with information on radiation safety, safe radiation management tools and public services.

The system comes from an absolute necessity to effectively control the radioactive sources safely, while it serves well to prepare necessary protective measures in a timely manner for the abnormal events of uncontrolled radiation from radioactive sources such as loss of radioisotopes. By the end of the year 2001, the system will be able to provide both licensees and the general public with information on radiation safety more actively and effectively. At the same time, it will serve to guarantee the right-of-knowledge of Korean people and facilitate and make not only the regulatory authority but also licensee actively control the radioactive sources in a positive manner at the same time.

Fig. 1 shows layout of the System. The system consisted of three subsystems: 1) 'Information System on Regulatory Activities for Radioactive Sources including Radiation Generators'; 2) 'Cyber Information System on Radiation Safety', and 3) 'Radioactive Source Life-Cycle Tracking and Inventory Management System'.

First two parts of the ISIRS system have been set up during the third quarter of the year 1998 till the second quarter of 2000, and are now in full operation. The information being currently managed by the data in the System are as follow:

- Regulatory activities such as review of licensing application to use, handle or supply the radioactive sources (or radioisotopes) and radiation generators;
- Full control and complete tracing down of any source transfer between licensees and the transportation among licensed sites;
- Management of information on routine or special inspection activities by the Authority at the licensee facilities;
- Management of licensees activities including the radiation protection programs at the facilities; and
- Data acquisition on the management of radiation sources such as approval for import, distribution/supply report, and

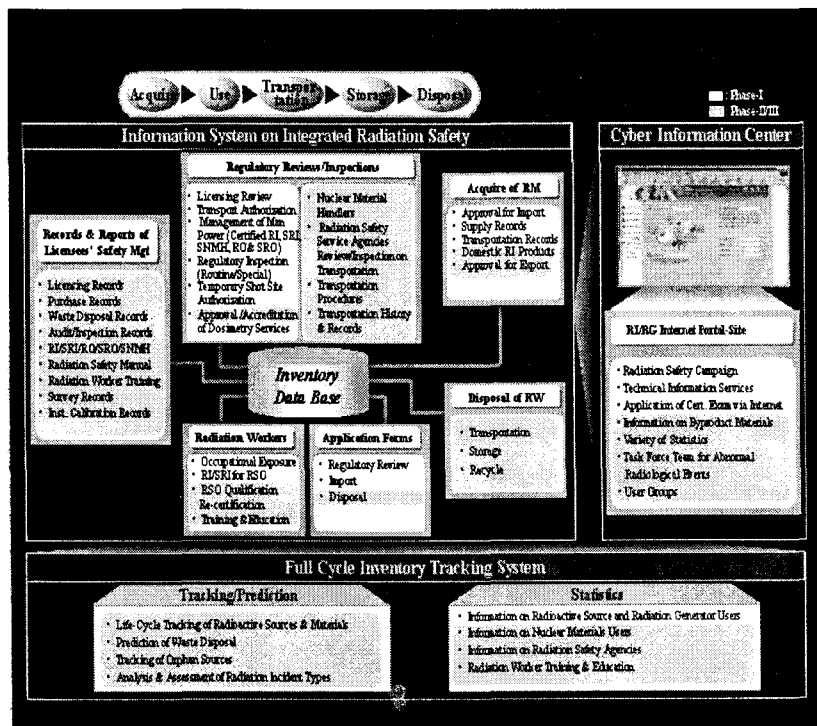


Fig. 1. Layout of Information System on Integrated Radiation Safety (ISIRS) in Korea

transportation report.

By using the User Safety Management system of the ISIRS, users can undertake the entire safety management activities. For instance, when users decide to scrap the used radioisotope, the User Safety Management system deal with the overall process of handling over the used radioisotope to the NETEC, which is responsible for disposal of used radioactive materials.

The NETEC disposes the commissioned radioisotope after checking its conditions. When there are reusable radiation sources among the disposed materials, they are advertised through the Cyber Radiation Safety Information Center so that other organizations can make use of them.

Comprehensive information on radiation sources currently being used or owned by licensees in Korea is now accurately collected on an almost real time basis through the system. All the

information on licensing activities done by the regulatory authority since 1996 have been stored in the system, and earlier licensing information will be done by the late quarter of 2001. The Korean regulatory body can now conduct many multi-phase statistical analyses with the data in the Information System. They also can effectively oversee the licensing situation on a real time basis through the System.

With this system, we are going to actively trace the life cycle of radioactive sources and its inventory, to prepare prophylactic measures for accidents or abnormal events such as ones from loss of radioactive sources, and trace usage history, transportation, and waste management. In other words, the system serves as a comprehensive tool to trace the radioactive sources 'from a cradle to the grave', and we expect to prevent the illegal trafficking of all the radioactive sources. Fig. 2 shows not only a layout of networking among different

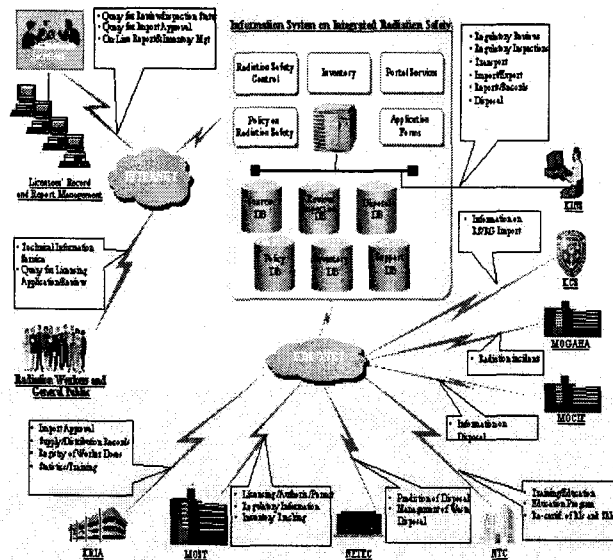


Fig. 2. Layout of the network of the ISIRS, which shows the inter- or intra- net among the organizations related to the life cycle of radiation sources.

government offices, regulatory authority, competent organizations, licensees and general public of interests but also information available either through inter- or intranet when the System is completely set up.

The real time-basis radiation source tracking system effectively precludes the cases of orphan radiation sources, which often take place owing to bankruptcies of user organizations. Moreover, the system guarantees the utmost security of radiation sources, for it can track down the routes of a particular source in the fastest possible way.

### MONITORING OF RADIATION SOURCES IN SCRAP METALS

All steel mill companies and suppliers of the scrap metals in Korea shall install the fixed-type scrap monitoring systems to detect the contamination of the recycled metals in the nearest future. Currently, large numbers of the major steel mill companies have installed the fixed-type scrap monitoring systems and operate

them to detect any contaminated scrap metals existed before melting for reutilization. Figure 3 shows a typical scrap monitoring system installed at a steel mill company's yard in Korea.



Fig. 3. Fixed type scrap monitoring system installed in a steel mill company in Korea, picture taken in November 1999

Many steel mill companies detected radioactivity in the scrap metals or found the radioactive substances included in the recycled scrap metals

Table 4. Monitoring of radioactive substances in recycled scrap metals in Korea

Date	Company imported	Radioactive Materials	Imported from	Arrangement
'98.03.13	POSCO	Unknown	Japan	Returned
'98.04.03	POSCO	NORM	Japan	Stored by NETEC
'98.06.04	POSCO	<sup>131</sup> I	Domestic	KINS
'98.07.13	Young-il Industry	<sup>226</sup> Ra	Indonesia	NETEC
'98.08.14	Young-il Industry	<sup>226</sup> Ra	Hong-Kong	NETEC
'98.10.03	POSCO	NORM	Ukraine	NETEC
'98.10.16	Young-il Industry	Unknown	Malaysia	Returned
'98.11.05	POSCO	NORM	Ukraine	Returned
'98.12.10	POSCO	NORM	USA	NETEC
'99.11.01	Kwangwon Industry	<sup>226</sup> Ra	Domestic	NETEC
'99.05.10	Kia steel Co.	<sup>137</sup> Cs	Russia	NETEC
'00.01.10	Inchon Steel Co.	NORM	USA	NETEC
'00.02.20	Inchon Steel Co.	NORM	Netherlands	NETEC
'00.03.30	Inchon Steel Co.	NORM	USA	NETEC
'00.05.29	Young-il Industry	Unknown	Mexico	Returned
'00.06.16	Young-il Industry	Unknown	Indonesia	Returned

♣ Other ten cases of the detection of the radioactive contamination were found in recycled scrap metals imported from Thailand, Philippines, or UAE, etc.

before melting more than 20 times since 1998. Most of scrap metals found to be contaminated were suspected to be either demolition debris from chemical plants and contaminated with a low level of radioactivity. In some cases, we suspect some orphan sources from industrial radiographers included in scrap metal. In few cases, we were not able to identify the sources. Almost of all cases in contaminated scrap metals were found to be imported from foreign countries. In about a half of the cases among contaminated scrap metals, we found that the radioactivity usually comes from the accumulated precipitations on the inner wall of piping with 'naturally occurred radioactive materials (NORMs)'. Table 4 shows the list of findings on the contaminated scrap metals before melting in Korea. It also shows one typical case of the orphan sources found in scrap metals were identified as being imported from the former Soviet Union. The levels of the radioactivity from the scrap metals, which we monitored, were usually very low except few cases. In few cases, we detected that orphan sources of either  $^{226}\text{Ra}$  or  $^{137}\text{Cs}$  for industrial radiographers were included in the scrap metals.

When Korean steel mill companies or suppliers find the scrap metals contaminated with radioactive substances before melting or at the docks, they shall return all the scrap metals to the original supplying countries as soon as possible. Otherwise, steel mill companies must transport contaminated scrap metals to the NETEC in Taejon for disposal. The NETEC is the one-and-only organization licensed by Korean Government for the radioactive waste disposal and interim storage of high level radioactive waste such as spent fuels.

There are clear technical standards on the exemption level for the disposal of radioactive wastes contaminated with extremely low radioactive materials in Ministry Notices and Korean Atomic Energy Act. According to the standards, 100 Bq/g are stipulated for some special radionuclides. Yet, we stipulate no standards on contamination of the scrap metals.

So regulatory authority advises to return all scrap metals to the original suppliers if they are monitored as contaminated above the background level.

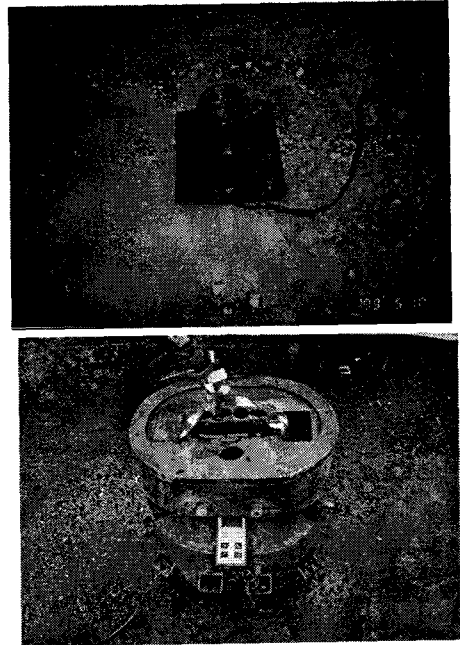


Fig. 4. Orphan sources among the scrap metals imported from foreign countries found before melting at steel mill companies in Korea. The suspected object on the left is identified as a  $^{226}\text{Ra}$ -source while the right is  $^{137}\text{Cs}$ -source in a container.

Korea is going to prepare the provisions for reutilization of the recycled materials, such as standards on scrap metals for recycling, and regulatory guidelines how to monitor and control the scrap metals from the radioactive contamination soon. In those provisions and guidelines, procedures on purchase, monitoring and returning contaminated metals, record keeping, reporting and so on will be described.

## CONCLUSIONS

The orphan source control program under the current development in Korea will bring all orphan sources under the regulatory control as much as possible in a timely and efficient



manner soon. The dissemination of information to the general public and industry will raise their awareness about the problems of orphan sources. We believe that the improved oversight method of licensed devices by the regulatory authority will help positively reducing the number of sources that become orphan. And the Korean regulatory authority is encouraging industry to install additional fixed type radiation monitoring systems at the docks of Korean seaports and at other locations, where radiation sources may appear. Finally, we strongly believe that a strong and close international cooperation among countries of interests is absolutely required to control orphan sources, and the cooperation will greatly contribute to reducing many events and accidents from orphan sources around the world.