

**ALARA PRINCIPLE IN COLLECTING RADIOACTIVE SOURCES:
THE SPANISH EXPERIENCE**

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ABSTRACT

Safe collection and transport of spent radiation sources to temporal storage before their disposal or return to a supplier requires an adequate application of the radiation protection rules. The activities to be performed vary widely and they are sometimes carried out in abandoned installations and outside regulated installations. Apart from that, it could also be necessary to handle the source in order to find out what its characteristics are or to put it inside a container which is suitable for the transport. This paper describes the activities, which the Spanish National Waste Management Company (ENRESA) is carrying out in this field, together with the established Radiation Protection and ALARA Programme.

1. General

The Spanish National Waste Management Company (ENRESA) was established in 1984 as responsible entity for radioactive waste management in Spain. Wastes produced in Nuclear Power Plants are conditioned at the installations that generated them, but wastes generated in radioactive installations, resulting from application of radioisotopes in research, medicine, industry and agriculture are conditioned by ENRESA. These conditioning activities are mainly carried out in the existing disposal facility. Sometimes it is necessary to handle these wastes to make sure the Transport Regulations are fulfilled. Before transportation it is also necessary to demonstrate that wastes meet the specific acceptance criteria of the disposal facility or any applicable regulations for temporal storage in other facilities.

These activities are easy to carry out in authorised radioactive installations, where there is good knowledge about the radioactive material, but in many cases wastes result from old practices and they could be found in old installations that have never been authorised. This is the case of radiation spent sources that have been found in areas and buildings of hospitals, process industries and research institutes where these spent radiation sources had been used in the past. Some of these had never been subject to regulatory control; or they had, but had been abandoned, lost or misplaced. In this context in February of 2007 started, in Spain, a campaign for the recover of orphan sources. This campaign continues until now and more than 200 sources has been reviewed, conditioned and removed by ENRESA.

Also from 1999 there is in Spain a protocol for collaboration on the radiological surveillance of metallic materials. Applying this protocol in the melting facilities and in the scrap yards radioactive materials can be detected. These materials are characterized and removed by ENRESA. Most of these materials are pieces contaminated with NORM and can be processed in the facility but a certain percentage are radioactive sources, some of them without shielding, so high dose rates can be measured.

The best option, for spent radiation sources management is return to the supplier, but this is not possible for many sources because the original supplier is unknown or no longer exists. Also, in some cases the owner says that he has not money to finance the returning of the spent source to the supplier. In these cases it is ENRESA's responsibility to collect the sources and transport them to a temporal storage or to return them to the supplier or to another organisation with proper recovery or disposal facilities.

The ENRESA personnel who carry out all the activities of collecting and transporting sources have good training in radiation protection. They are properly instructed in operational aspects and are controlled, from the radiological point of view, by personnel of the Radiation Protection Technical Unit (RPTU).

The activities carried out by the RPTU for management of spent radiation sources are also described in this paper.

2. Activities

For the management of spent radiation sources in the ways indicated before the following information it is necessary: type of source, identification number, radionuclide, activity and date. Also the source must be arranged in a suitable form for transportation. The main activities carried out by the RPTU to obtain this information and prepare transport are the following:

a) Characterisation of spent radioactive sources:

When the Activity Certificate is not available or the source is not marked with the isotope and activity dates or this mark is not visible, it is necessary to determine these dates. If the activity of the source is low enough; the source is removed from its shielding; then it is measured to determine the activity and the isotope using portable equipments. If activity is too high, theoretical models are applied to estimate the activity through external measurements.

b) Dismantling of equipments which contain sources:

In some cases ENRESA has to remove from the equipment the source together with its shielding or remove the source from the shielding to transport it in a suitable transport container (figure 1). In general, only alpha sources are removed from their shielding using conventional methods.



Figure 1 Removal of an Am-Be source keeping inside a Cs-137 source of a density and moisture measurement equipment.

c) Conditioning of sources:

Includes all operations needed to prepare the source for transport and storage (Figure 2). They may include cutting part of the shielding, putting an additional shielding, when the source is not in a safe position, extracting the source from the container, etc. In case of the transfer of sources of high activity to a transport container the task is carried out by contracting a supplier of sealed radiation sources to the international market. This contractor has all technical and personnel resources necessary for safe management of spent radiation sources.



Figure 2 Removal of the head of a teletherapy equipment with Co-60 source.

3. Radiation protection and ALARA programme

The RPTU is a Unit which is authorised by the Spanish Regulatory Body (CSN) and is responsible for the fulfilment of Radiation Protection Regulations. The specialist in charge of RPTU holds a specific license from the CSN and has direct access to higher management levels. The RPTU include sufficient number of experts and technicians who are qualified in radiation protection.

The objectives of the radiation protection and ALARA programme are to reduce exposure to external radiation to the lowest possible level and prevent intake of radioactive materials in the body. All the methods established to meet these objects are applied in practice, taking into account that the characteristics of exposure may vary considerably according to the situation: type of installation, safety conditions of the source, user's knowledge about the source, etc. Also, the Programme takes into account that personnel do not work in fixed installations where it is possible to classify, to post working areas and to establish standard procedures. For this reason the Programme was based on a prior radiological evaluation of the activities and it is continuously being re-evaluated.

The main aspects of this Programme are the following:

- a) Classification of areas:
All working areas are considered controlled areas because there is always risk of contamination spreading.
- b) Work planning and procedures:
There are general written procedures for handling radiation sources. In some situations specific procedures are established after appropriate work evaluation and planning.

- c) **Monitoring and dose assessment:**
It is one of the most important aspects of the Programme. In addition to standard TL-dosimeters, workers use direct reading dosimeters with alarms and extremity dosimeters. A programme for internal contamination control is also established.
- d) **Surveillance of working areas:**
Before and during the job, radiation levels are continuously measured. Devices with acoustic alarms are also used when the activity of the source is very high.
- e) **Contamination control:**
Workers are regularly checked for contamination on hands during the job. When the work has finished, a complete control is carried out in a low background area.
- f) **Protective clothing:**
Workers usually wear conventional white cotton drill or nylon coats. When the process involves working with spread contamination or liquids workers wear one-use "TYVEK" overalls or aprons together with overshoes. Also, they use surgical or rubber gloves. When necessary they use respiratory protection devices and organ shields.
- g) **Information and training:**
All workers involved in spent sources management are trained in radiation protection. Specific information and training is prepared when the activity of the source is relevant or when the operation is carried out for the first time.

The RPTU disposes of several types of detection equipment for their work. The most important ones are the following:

- a) **Radiation detectors:** Hand-held Geiger-Müller detector, ionization chambers and neutron detectors.
- b) **Contamination detectors:** Thin window proportional counter and scintillation detectors.
- c) **System of spectrometry:** Portable spectrometers with NaI of 3"x3" and 1"x1".
- d) **Direct reading dosimeters:** Acoustic alarm digital dosimeters.

4. Results

From 1989 the RPTU of ENRESA has reviewed more than five thousands and seven hundred of spent radiation sources most of which came from radioactive installations (figure 3). During this time 24 teletherapy sources and 2 industrial irradiators have been transported for temporal storage or have been removed from their shielding in order to return them to a supplier.

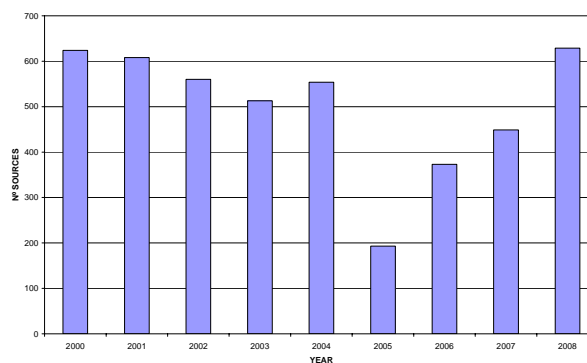


Figure 3 Radioactive sources yearly reviewed from year 2000

The results of the application of the Spanish protocol are 2327 pieces detected, between 1998 and 2008, 269 were radioactive sources. The majority were Ra-226 sources (64,3%) although only cover the 0,4% of the activity removed (figure 4).

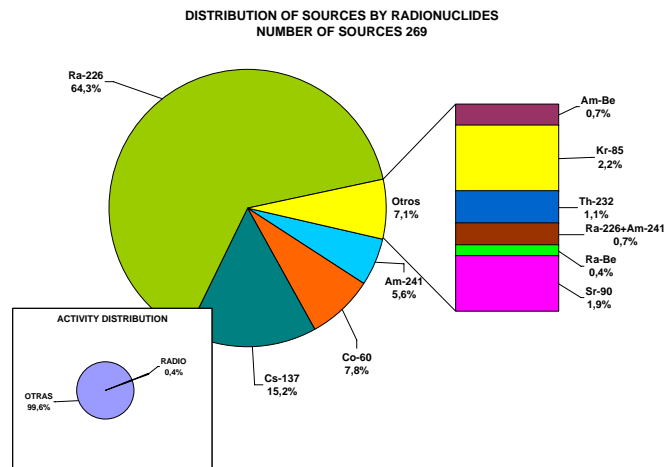


Figure 4 Sources detected in facilities of metallic industry (1998-2008)

During the campaign of orphan sources 251 sources has been characterized and removed with a total activity decayed to the removal date of 99 GBq.

The individual and collective dose to personnel is very low; it is far below the regulatory limit. The medium annual collective dose is below 1 mSv.p and the number of exposed workers is about 8. The applied Radiation Protection and ALARA Programme has proven to be adequate for these activities.