

# Radiological Protection and Radioactive Waste Management

*Romão Trindade*

The Radiological Protection and Radioactive Waste Management Group (PRGRR) pursued the development of the main activities already mentioned in the 2004 Annual Report

In general numbers, there was an increase in the requests panorama in all fields of assistance.

The licensing (entrance in national territory, possession, transport and transfer) of sealed sources for industrial, research, medical or other applications issued by PRGRR reached the number of 170 in the current year. The transport of radioactive materials is also another of the activities of this Group that is established in the Law.

Concerning the radioactive waste management activities in the National territory about 150 requests, for collection, segregation and treatment for interim storage were received at the Radioactive Waste Facility during 2005.

Ten incidents related to the detection of radioactive substances in scrap metal were reported by the industry and controlled by PRGRR

The verification of the radiological conditions of medical and industrial facilities (seven, in 2005) is undergoing strong modifications at different levels to better comply with the national legislation.

The PRGRR also developed intensive contacts with clients in all fields related to radiological protection and radioactive waste management, explaining what is required by Law, providing all the important paper work such as legislation, technical requirements, practical procedures and administrative steps as well as clarifying any doubts that might arise. This work is of paramount importance for the conclusion of the processes mainly in the case of radioactive wastes and sealed sources but also in all the other fields of intervention.

The activity of monitoring is another activity of the Group. The development of monitoring programmes for radioactive liquid discharges from hospitals in the public sewage of Lisbon Borough Council (CML) was continued in 2005 as well as the monitoring of the Campus radioactive liquid discharges.

Also in 2005 and in order to comply with both Articles 35° and 36° of the Euratom Treaty, PRGRR has installed the Campus gamma monitoring network (GAMMANET) to measure gamma radiation due to abnormal discharges in the environment.

A total of 296 gamma spectrometry analyses were carried out during 2005.

A new monitoring equipment has also been installed to more efficiently monitoring the radioactive liquid discharges of the Campus into the public sewer. To assist with both equipments, a grant was award by FCT to a graduate in Physics.

Continuing from the previous year, the PRGRR is participating in the co-coordination of a Degree thesis in Physics (University of Algarve) to study the application of Monte Carlo method to simulate and correlate different geometries and matrices for NaI detectors. This work has been accepted to be presented at the American Nuclear Society's 14<sup>th</sup> Biennial Topical Meeting of the Radiation Protection and Shielding Division.

The involvement of Group members in EU and IAEA projects, committees, working groups and task forces has increased in 2005 with the involvement in the Ad Hoc Working Party on Nuclear Safety (WPNS) EU.

In 2005, a PhD, in the field of radioactive waste management, was initiated with Faculdade de Ciências (FCUL) collaboration. Also this year, a member of the Group is starting a Master degree in Radiological Protection and Dosimetry (ITN/IST).

The Group has been involved in several training courses on Radiological Protection for industrial professionals.

Still concerning education and training, members of PRGRR have also been involved in a post-graduate course for Ordem dos Médicos in the field of radioactive wastes from medicine and in two Master Courses. One on Biomedical Inorganic Chemistry: Diagnostic and Therapeutical Applications (ITN/FCUL) and another on Radiological Protection and Dosimetry (ITN/IST).

## Research Team

### Researchers

R. TRINDADE, Aux. , Group Leader  
M. I. PAIVA, Aux.

### Technical Personnel (Graduate)

L.M. PORTUGAL

### Technicians

J. SEBASTIÃO  
J. VENÂNCIO

### Grants

P. DUARTE, ITN Grant (since Dec. 2004)  
L. MADUREIRA, ITN Grant (since Nov. 2004 until Jul.2005)  
L. BRÁS, ITN Grant (since Nov. 2002)

## Characterization Of Suitable Areas For A Long-Term Radioactive Waste Repository Facility In Portugal

*P. Duarte., I. Paiva, R. Trindade, A.Mateus<sup>1</sup>*

### Introduction

Radioactive wastes in Portugal result mainly from the application of radioactive materials in medicine, research, industry, contaminated or irradiated scrap metal and from U-ores mining and milling activities. Sealed and unsealed sources (including liquid effluents and NORM) classified as radioactive wastes have been collected, segregated, conditioned and stored in the Radioactive Waste Interim Storage Facility (RWISF) since the sixties. The Department of Radiological Protection and Nuclear Safety (DPRSN) of the Nuclear and Technological Institute (ITN) is responsible for the RWISF management, located nearby Lisbon (Sacavém). Despite recent improvements performed at RWISF, the 300 m<sup>3</sup> storage capacity will be soon used up if current average store-rate remains unaltered. Only in the last five years, about 700 requests to collect radioactive wastes were received at DPRSN and the number of conditioned sealed sources increased significantly for the same timeframe. Up to now, besides the 140 drums containing mostly <sup>60</sup>Co, <sup>137</sup>Cs, <sup>126</sup>Ra and <sup>241</sup>Am (incorporated in a cement matrix, Figure 1) that are stored at RWISF there are also 290 metallic drums containing compacted materials (such as gloves, papers, clothing and other contaminated items). Being aware of the tendency for radioactive waste production increase in Portugal and of the international rules and recommendations on disposal sites for this kind of wastes, it becomes clear that the Portuguese Radioactive Waste Interim Storage Facility must be updated. In this work, a Ph. D student is developing a study involving the DPRSN/ITN and Dpt.Geology/FCUL.

### Objectives

The main objectives of this study are: to identify and select the most suitable area(s) to host near-surface repositories for low and intermediate radioactive wastes; to characterize the reference situation in geological and hydrogeological terms; to identify the radionuclide migration pathways in the selected areas and to apply and validate objective criteria to monitor the environmental impacts related to the disposal facility. Finally, it is expected this study to be part of the efforts to develop the future measures that will contribute for the practical resolution of the problems involving the radioactive waste management activities in Portugal.

### Preliminary Findings

A first evaluation of suitable areas to host a new long-term radioactive waste storage facility was already been carried out using a Geographic Information System (GIS) base. Preference and exclusionary criteria were applied, keeping constant the map scale.

After processing exclusionary criteria (protected lands, aquifer systems and active faults), remaining areas (polygons) were scored by overlaying the preference criteria (population density, maximum seismic intensity, and annual average precipitation).

A composite score was determined for each polygon by summing the scores for all of the three preference criteria. Starting with an 80% cut-off of the maximum composite score, an area of 16049 km<sup>2</sup> was obtained ( $\approx 18\%$  of the Portuguese mainland territory). In order to limit further more the calculated area, the results were re-analysed using a 90% cut-off, thus resulting a potential area of 8487 km<sup>2</sup> ( $\approx 10\%$  of the Portuguese mainland territory). Work in progress will use this area as reference for site selection, crisscrossing appropriate criteria for scales ranging from 1:50000 to 1:25000.



Figure 1 – Examples of sealed sources conditioning within concrete drums to be disposed in a near surface repository.

<sup>1</sup>. Dept. of Geology, FCUL.

**A Contribution to the Analysis of the Activity Distribution of a Radioactive Source Trapped Inside a Cylindrical Volume, Using The Mcnpx Code**

*L.Portugal., C. Oliveira, R. Trindade, I. Paiva*

The increasing use of radioactive sources worldwide also increases the risk of an accident resulting from the loss of control of these sources. Orphan sources, activated materials or contaminated materials with natural or artificial radionuclides have been detected in scrap metal products destined to recycling. The consequences of the melting of a source during the process could result in economical, environmental and social impacts. From the point of view of the radioactive waste management, a scenario of 100 ton of contaminated steel in one piece is a major problem. So, it is of great importance to develop a methodology that would allow us to predict the activity distribution inside a volume of steel. It is our goal to distinguish different radius of spherical source geometries trapped inside the cylinder. For this we propose a methodology, using the Monte Carlo simulation and again the MCNPX Code, based on the ratio of the counts of two regions of the gamma spectrum. From a spectrum obtained with a sodium iodide detector, it is possible to calculate the ratio of the counts in the region of the characteristic photons of the source (for cobalt, between 1100 and 1400 keV) and the counts of a selected region in the lower energies. These calculated ratios allow us to determine a function  $r = aR^2 + bR + c$ , where R is the ratio between the counts of the two regions of the gamma spectrum and r is the radius of the source. To apply this methodology in a real scenario, it is necessary to acquire a spectrum of a cylinder containing the source. Based on the spectrum, the ratio between the counts of the two regions of the gamma spectrum is calculated. With the ratio and the function  $r=f(R)$ , previously determined, we are able to estimate the source radius.

---

**Radioactive Liquid Discharges From Hospitals In Public Sewage Of Lisbon Borough Council (CML)**

*R.Trindade, L.Portugal, L.Brás, J.Venâncio, F.Gomes, P. Duarte, I.Paiva*

A monitoring programme of radioactive liquid discharges from hospitals in the public sewage and Residual Water Treatment Plant (ETAR) of Lisbon was carried out in order to identify the radionuclides present and their activities. About 153 samples of liquid effluents were collected and analysed by quantitative and qualitative gamma spectrometry. This monitoring programme was requested by CML and this year also involved collection and analysis of samples from IPO's sewage. The monitoring programme was divided in two different programmes. In Programme I was involved the sequential collection of 4 discrete samples in 5 sampling points from nuclear medicine. In Programme II, 4 discrete samples were taken at the ETAR's of Lisbon. Sample were analysed by gamma spectrometry

## Services

### 1. Radioactive waste management

Radioactive wastes from the national producers were collected, segregated, transported and conditioned in cement matrix or iron drums for interim storage at Radioactive Waste Facility. During 2005 about 150 requests for radioactive waste collection were received.

### 2. Radioactive liquid discharges from Nuclear and Technological Institute (ITN)

Samples of liquid effluents are analysed by gamma spectrometry. It was installed a submersible probe in Central Tanks, to carry out a radiological survey of radioactive liquid effluents from RPI, Chemistry Sector and Central Tanks before being discharged to the Residual Water Treatment Plant. The activities discharged are reported to the Radioactive Substances Committee of OSPAR Convention and art. 35° of Euratom Treaty.

### 3. Radioactive liquid discharges from Oncology Portuguese Institute (IPO), Coimbra

A radiological survey requested by IPO/Coimbra of radioactive liquid waste from the Retention Tanks before being discharged into the public sewage. Samples of liquid effluents were analysed by quantitative and qualitative gamma spectrometry.

### 4. Gamma network of Nuclear and Technological Institute (ITN)

In 2005 it was installed a gamma network, GAMMANET, to measure dose radiation in the environment in order to comply with art. 35° and 36° of Euratom Treaty.

### 5. Nuclear vessels radiological monitoring

An environmental radioactivity survey is carried out each time a nuclear vessel stayed at national harbours. The programme consisted on continuous monitoring of radioactive aerosols and airborne radioiodine, sampling of water, sediments and biological species for gamma spectrometry analysis. Sampling was done before, during and after the stay of the vessel. Results are reported to Ministry of Defence. In 2005, five nuclear vessels stayed at Portinho da Costa harbour, near Lisbon

### 6. Radioactivity in scrap metal

Radioactive material was detected and collected during a radiological survey, requested by the industry, of trucks containing scrap metal at a smelting factory. Ten cases of radioactive materials in scrap metal were detected this year.

### 7. Radiological safety verification at medical, industrial and research facilities

During 2005, the PRGRR carried out the verification of radiological safety conditions at seven public and private medical, industrial and research facilities.

### 8. Sealed sources licensing

According to Decree-Law n° 153/96 and Decree-Law n° 165/2002, requests of sealed sources were analysed and licences of entrance in the national territory (72), transfer (16), transport (18) and possession (62) were issued.

### 9. Radioactive cargo in transit

A radiological monitoring and the verification of international rules compliance were carried out when ships transporting radioactive cargo called Portuguese harbours.