

Manual of Procedures for Radioactive Waste Management General Recommendations

DGIES/ITN-DPRSN, Contract n° 6/01/Part2

R.Trindade, I.Paiva, L.Portugal

Objectives

This Contract-Project was signed between General Directorate for Health's Facilities and Equipments (Direcção Geral das Instalações e Equipamentos para a Saúde, DGIES) and Nuclear and Technological Institute/Radiological Protection and Nuclear Safety Department (ITN/DPRSN). The study had two main objectives where the first was to collect samples in order to identify and quantify, by gamma spectrometry, radioisotopes used in the main State medical establishments in the Country as well as to assess their radioactive waste management systems. Results of this study were thoroughly analysed in the Report "A Study of Radioactive Liquid Discharges from the Medical Facilities", already presented at the DGIES "Panel about Liquid Effluents and Medical Solid wastes" and to be shortly published by the Ministry for Health.

In the second objective of the framework of this Contract-Project,, the document "Manual of

Procedures for Radioactive Waste Management. General Recommendations" was produced. In this document, the main concern was to present an ensemble of general recommendations to be used as starting point for each medical establishment to produce its own Manual of Procedures related the radioactive waste management activities.

Published, accepted or in press work

1. R. Trindade, I. Paiva, L. Portugal, "2A Study of Radioactive Liquid Discharges from the Medical Facilities", Contract-Project No. 6/01, Part 1, DGIES/ITN/DPRSN/SPROGeRR, Lisbon, 2003, Ed. Ministry for Health (in press)
2. R. Trindade, I. Paiva, L. Portugal, "Manual of Procedures for Radioactive Waste Management. General Recommendations", Contract-Project No. 6/01, Part 2, DGIES/ITN/DPRSN/PRGRR, Lisbon, 2004, Ed. Ministry for Health (in press)

Radioactive Liquid Discharges from Hospitals in Public Sewage of Lisbon Borough Council (CML)

R.Trindade, L.Portugal, I.Paiva, L.Silva, L.Brás, J.Venâncio, F.Gomes

Objectives

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 112 samples of liquid effluents were collected and analysed by quantitative and qualitative gamma spectrometry. This monitoring programme was requested by CML.

Results

The monitoring programme was divided in two different programmes, I and II. In Programme I was involved the sequential collection of 4 discrete samples in 5 sampling points: Portuguese Institute of Oncology Francisco Gentil (IPOFG); Atomical

(private nuclear medicine); Santa Maria Hospital (HSM); Air Force Hospital (HFA) and Imaclear (private nuclear medicine). In Programme II, 4 discrete samples were taken at the ETAR's of Alcântara, Beírolas and Chelas.

Samples were analysed for gamma spectrometry using a sodium iodine detector, 3" x 3" and associated electronic. Spectra acquisition and analyse was carried out using the dMCA-Card and the software for gamma spectrometry winTMCA32, both from Target systemelectronic gmbh.

Published, accepted or in press work

1. R. Trindade, L. Portugal, I. Paiva, "Radioactive Liquid Discharges from Hospitals in Public Sewage of Lisbon Borough Council (CML)", 2003 (in press)

Analysis of the Activity Distribution from an Orphan Source in Molten Scrap Metal using the MCNPX Code

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

Objectives

Over the last few years, orphan sources, activated materials or contaminated materials with natural or artificial radionuclides have been detected in scrap metal products destined to recycling. If the radioactivity in the scrap metal is not detected beforehand, the products and by-products would be contaminated, with serious consequences for the company's economy, the environment and public health. This work proposes a method based on the Monte Carlo simulation using the MCNPX code to estimate the activity distribution in a specific volume of molten metal when an orphan source is trapped inside the melting plant during the recycling process. The data obtained allow previewing if the object is totally contaminated or if the source activity is confined to a reduced volume. In order to be able to apply this methodology, it will be necessary to perform the simulation with a model corresponding to the real scenario (contaminated molten metal) and obtain the experimental ratio between the doses at different distances from the object.

Results

The methodology proposed in this work is based on Monte Carlo simulations [7]. This method allows to consider any source distribution inside any material and to study some important quantities such as doses as well as to search for correlations between their variation with the distance and the source distribution inside the material. In order to validate this approach a pilot-scale drum was constructed. Cobalt sources have been introduced inside the drum and dose measurements have been performed. Experimental values have been compared with the corresponding Monte Carlo simulation results.

A pilot-scale cylindrical drum was made of cement, water, and sand in a coarse aggregate similar in composition to a real radioactive waste concrete drum. Twenty four ^{60}Co sources, nominal activity about 1.4 GBq were introduced in the drum central void space. Dose rate measurements were carried out every 10 cm from the middle surface drum up to 100 cm total distance from it. In this study the MCNPX version 2.5.d was used. Six different distributions for the two gamma sources, ^{137}Cs and ^{60}Co centred with the cylinder, were considered: a point source; four spherical source distributions with radius of 5 cm, 10

cm, 15 cm and 20 cm and finally, a source distribution filling the overall stainless steel cylindrical volume.

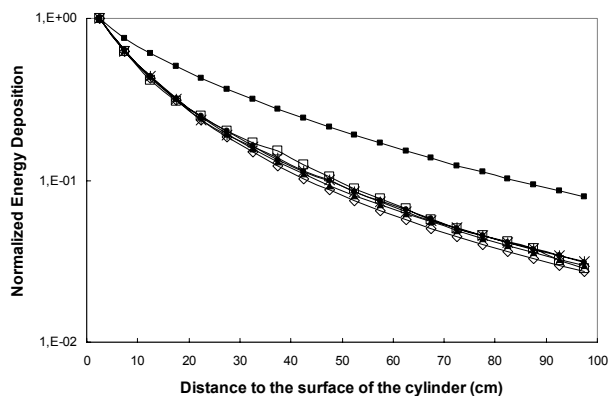


Fig.1. Normalized energy deposition for ^{137}Cs sources as function of the distance to the surface of the cylinder for six different source dimensions: contaminated cylinder (■), 20cm radius sphere (◇), 15cm radius sphere (▲), 10cm radius sphere (●), 5cm radius sphere (*) and point source (□).

The results reported in this paper show that Monte Carlo simulations can be used as a predictive tool for activity distribution inside a stainless steel cylinder as it is the case of a radioactive source trapped in a specific volume of molten metal during the recycling process.

However, the methodology is limited once it does not allow to clearly identify or to detail the source distribution.

In order to be able to apply this methodology it will be necessary to perform the simulation with a model corresponding to the real scenario (contaminated molten metal) and obtain the experimental ratio between the doses at different distances from the cylinder. Care should be given to this approach once it is only valid if the source distribution and the activity distribution is coincident which is the case of a single source.

Published, accepted or in press work

1. C. Oliveira, L. Portugal, I. Paiva, R. Trindade Analysis of the Activity Distribution from an Orphan Source in Molten Scrap Metal using the MCNPX Code, *Proc. 11th ISPRA Congress*, Madrid, Spain, 2004.

Interim Storage Of Spent And Disused Sealed Sources: Optimization Of External Dose Distribution In Waste Grids Using The Mcnpx Code

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

Objectives

Radioactive sealed sources are used worldwide in different fields of application. When no further use is foreseen for these sources, they become spent or disused sealed sources and are subject to a specific waste management scheme. Portugal does have a Radioactive Waste Interim Storage Facility where spent or disused sealed sources are conditioning in a cement matrix inside concrete drums and following geometrical disposition of a grid. The gamma dose values around each grid depend on the drums distribution in the various layers of the grid. In this work is proposed a method based on the Monte Carlo simulation using the MCNPX code to estimate the best drum arrangement through the optimization of dose distribution in a grid. Measured dose rates were used to validate the corresponding computational grid model.

Results

Simulation results were considered from four different drums distribution. Figure 1 shows the drum distribution that provided the lowest dose rate values around any grid considered. With this distribution, the dose rate to which the workers are exposed at the Radioactive Waste Interim Storage Facility can be reduced and, as a consequence, the effective dose will also be reduced.

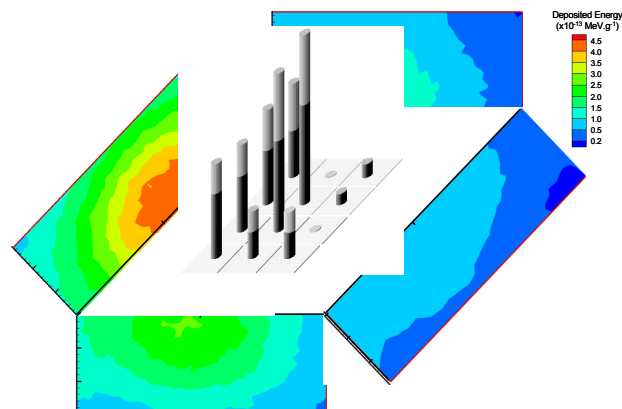


Fig. 1. Deposited energy by unit mass along the planes located 1 meter distance from Grid 1.

Published, accepted or in press work

1. I.Paiva, C.Oliveira, R.Trindade, L. Portugal Interim storage of spent and disused sealed sources: optimization of external dose distribution in waste grids using the MCNPX code, *Rad. Prot. Dosimetry* (in press)

Application of *in-situ* Gamma Spectrometry in Hydrogeology

P.Duarte, I.Paiva, R.Trindade, L.Portugal

Objectives

Requested by CERN – Engineering and Natural Resources Consultants, (Consultores em Engenharia e Recursos Naturais, Lda.), an *In Situ* Gamma Spectrometry methodology was tested concerning the identification of permeable zones in a granitic area of Viseu (Portugal). The identified permeable zones were considered as the more favourable places to prospect groundwater and eventually construct new wells.

Results

Spectra acquisition and analyse was carried out using the dMCApro-Card and the software for gamma spectrometry winTMCA32, both from Target systemelectronic gmbh. The portable nanoSPEC spectrometer from Target was used for dose rate measures and spectra. Nine profiles were studied. The collected data has shown that gamma spectrometry using this specific equipment could be an useful and

appropriate tool to hydrogeologic prospection, mainly in urban areas where others geophysical methods are impossible or inadvisable to use.

As an example, at three parallel profiles (Figure 1), the connect of the anomalies agree with a previous *in situ* recognized direction of regional fractures.

Future work is already planned in order to improve the methodology applied and broad the application field.

Published, accepted or in press work

1. P. Duarte, I. Paiva, L. Portugal, R. Trindade A Viability Study of the Portable Gamma Spectrometer nano SPEC for Hydrogeological Prospection. Internal Report (in press).

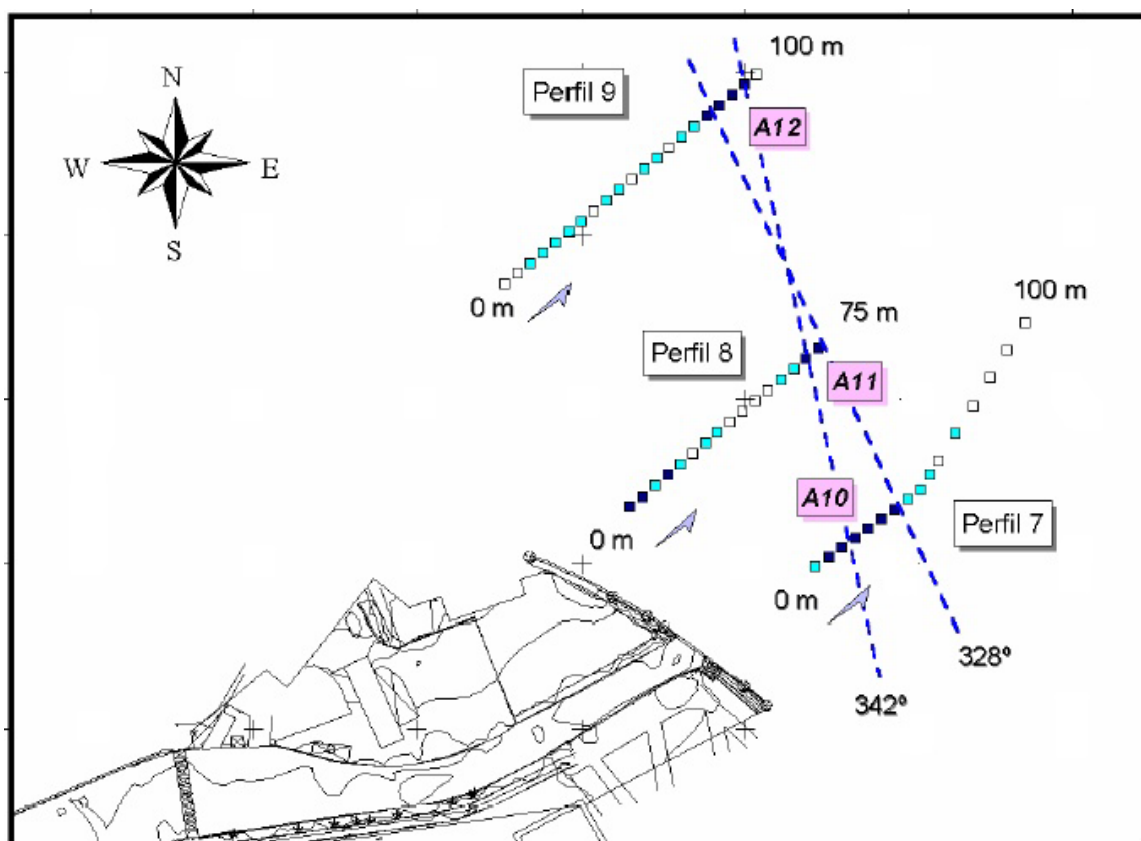


Fig. 1. Localization of radiometric profiles.

Services

Radioactive waste management

R.Trindade, I.Paiva, L.Portugal, J. Venâncio, L.Brás

Radioactive wastes from the national producers were collected, treated and conditioned in cement matrix or iron drums for interim storage. During this year about 150 requests for radioactive waste collection were received.

Radioactive liquid discharges from the Oncology Portuguese Institute, IPO, Lisboa

R.Trindade, I.Paiva, L.Portugal, L. Silva, L.Brás, J. Venâncio

A radiological survey requested by IPO/Lisboa of radioactive liquid waste from the Retention Tanks was carried out before being discharged into the public sewage. Samples of liquid effluents (6) were analysed by quantitative and qualitative gamma spectrometry.

Radioactive liquid discharges from IPO, Coimbra

R.Trindade, I.Paiva, L.Portugal, L. Silva, L.Brás, J. Venâncio

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 (6) were analysed by quantitative and qualitative gamma spectrometry.

Radioactive liquid discharges from ITN

R.Trindade, I.Paiva, L.Portugal, L.Brás, J. Venâncio, R.Pombo, L. Silva, L. Madureira

A radiological survey is carried out of radioactive liquid effluents from RPI, Chemistry Sector and Central Tanks before being discharged to the Residual Water Treatment Plant. Samples of liquid effluents (68) are analysed by quantitative and qualitative gamma spectrometry. The activities discharged are reported to the Radioactive Substances Committee of OSPAR Convention and art. 35° of Euratom Treaty.

Sealed sources licensing

R. Trindade, L. Portugal, I. Paiva, A. Rosa

According to Decree-Law n° 153/96 and Decree-Law n° 165/2002, requests related to import, export, utilization and transfer of sealed sources were analysed and licences of entrance in the national

territory (85), transfer (20), transport (22) and possession (86) were issued.

Radioactivity in scrap metal

R.Trindade, L.Portugal, I.Paiva, J. Venâncio, L. Brás, J. Sebastião, P. Duarte

Radioactive material was detected and collected during a radiological survey, requested by the industry, of trucks containing scrap metal at a smelting factory. Fifteen (15) cases of radioactive materials in scrap metal were detected this year.

Radioactive cargo in transit

R.Trindade, L.Portugal, I.Paiva, D. Alves

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

Nuclear vessels

R.Trindade, I.Paiva, L.Portugal, J. Venâncio, L.Brás, M.Reis, L.Silva, L.Madureira

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 2004, two nuclear submarines, Torbay and Albuquerque, stayed at Portinho da Costa harbour, near Lisbon.

Radiological control of a uranium shipment from ENU-SA, Urgeiriça

R.Trindade, I.Paiva, L.Portugal, L.Brás

A radiological control and the verification on compliance of international rules for transport of radioactive material were carried out when a uranium shipment was transported by road and sea abroad.

Radiological Safety verification at medical, industrial & research facilities

R.Trindade, I.Paiva, L.Portugal, J.Sebastião, J. Venâncio, L.Brás

During 2004, the PRGRR carried out the verification of radiological safety conditions at 14 public and private medical, industrial and research facilities

