

Environmental Radioactivity

Maria José Madruga

One of the main activities of the Environmental Radioactivity Group was to perform the Radiological Environmental Monitoring Programmes in collaboration with the Measurement Laboratories (LM), the Dosimetry and Radiobiology (GDR) and the Radiological Protection and Radioactive Waste Management (GRRR) Groups. These surveys were established according to Articles 35 and 36 of the EURATOM Treaty Recommendations and its execution legally attributed to ITN (Decree-Law 138/2005 of 17th August). To carry out these programmes a considerable effort of the Group has been made in terms of human resources (about 75% of the time consumed). This programme involved a financial cost of about 300 k€.

Current research activities are ongoing to investigate the levels of radioactive contamination in the atmosphere (aerosols) aquatic and terrestrial environments.

The Group participated in collaboration with the Measurement Laboratories in the following international inter-comparison exercises: determination of natural and artificial radionuclides in moss-soil and spiked water organized by the IAEA/ALMERA (Seibersdorf, Austria); determination of natural radioactivity, ¹³⁷Cs and ⁹⁰Sr in soil organized by the EC (IRMM, Geel, Belgium) and determination of natural and artificial radionuclides in foodstuff (ash) organized by the Consejo de Seguridad Nuclear (CSN, Spain). The results published in 2010 were in good agreement/compatible with the reference values.

In 2010, was given continuation to the collaboration with the Radioactivity Environmental Monitoring (REM) group of the European Commission located at the JRC (Joint Research Centre) in Ispra (Italy), on the development of a European Atlas of Natural

Radiation, including radon mapping based on indoor radon measurements.

During 2010, several interventions were carried out on the Radionuclide Particulate Station (RN53) at S. Miguel, Azores. A new detector was installed and calibrated. The problems detected during the testing phase were addressed and solved and a new testing and tuning phase begins. On November 2010 the certification visit was carried out (by CTBTO, Alenia and ITN) and all the required tests were performed. The station was now formally certified since 23rd of December and providing data to the International Monitoring System in the framework of the CTBT (Comprehensive Nuclear Test Ban Treaty).

The technical services developed by the Group were carried out under contract with companies or by request from enterprises or Government organizations. The technical services concern the evaluation of the radioactivity levels in public water supplies (Decree-Law 306/2007), mineral waters and indoor radon measurements (Decree-Law 78/2006; NT-SCE-02). The Group income of these technical services was about 54 k€.

The accreditation procedure of three radioanalytical techniques was submitted to the accreditation body (IPAC) in October 2009 and the quality audit concession was foreseen for 2010. This year, an internal quality audit to these techniques, according to the ISO/IEC 17025 requirements, was performed by two auditors from ISQ (Instituto Soldadura e Qualidade).

Members of the Group were involved in several committees from IAEA and CTBT.

During this year members of the Group were involved in education and training activities in the fields of environmental radioactivity and radiological protection.

Research Team

Researchers

M. J. MADRUGA, Princ., Group Leader
F. P. CARVALHO, Princ.
M. J. REIS, Aux. (25%)
J. A. CORISCO, Aux.

Fellows

A.R. GOMES, FCT grant
E. ANDRADE, FCT grant (since October 2010)
H. FONSECA, FCT grant (until August 2010)
J. MELO, FCT grant

Technical Personnel

A. LIBÂNIO
A. MOURATO
I. LOPES
J. M. OLIVEIRA (70%)
M. M. MALTA

Radiological Environmental Monitoring Programmes

M.J. Madruga, F.P. Carvalho, M. Reis, J.G. Alves, J.A. Corisco, R. Trindade, I. Lopes, J. Abrantes, L. Silva, L. Torres, L. Portugal, M. Malta, A. Libânio, A. Mourato, G. Silva, J.M. Oliveira, L. Santos, A. Batista, A.R. Gomes, G. Carvalhal, H. Fonseca, J. Melo, M. Pereira

Objectives

The Article 35 of the EURATOM Treaty stipulates that “each Member State shall have the facilities necessary to carry out the continuous monitoring of the levels of radioactivity in the air, water and soil and to ensure the compliance with the Basic Safety Standards”. The Article 36 of the same Treaty stipulates that “the appropriate authorities shall periodically communicate information on the checks referred to in Article 35 to the Commission so that it is kept informed of the level of radioactivity to which the public is exposed”.

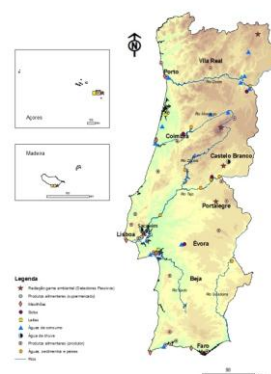
The Radiological Environmental Monitoring Programmes planned according to Article 35 of the EURATOM Treaty include the Programme at a National Level, established by law in 2005 and which execution was legally attributed to ITN (Decree-Law 138/2005, 17th August), the Source Related Programme for the ITN *Campus* and the Specific Programme for the Regions Around Old Uranium Mining Sites.

The main goals of the radiological environmental survey are to determine the artificial and natural radionuclide levels in environmental compartments (aquatic, terrestrial and atmospheric environments) considered as direct pathways of contamination to man and to evaluate the external radiation levels in order to provide information for the assessment of the potential exposure of the Portuguese population.

Results

The monitoring programme at a national level concerns the radioactivity measurements of environmental and foodstuff samples collected along the country. The monitoring programme carried out for the ITN *campus* includes measurements of external radiation levels (gamma dose) and determination of radionuclide activity concentrations in relevant environmental samples (aerosols, rain water and soils) in order to check the operation conditions and discharge controls adequacy and to maintain a continuing record on environmental radionuclide levels related to the source. Monitoring of the regions around old uranium mining and milling sites in Portugal was performed. Field missions were carried out in several counties of the North-centre of Portugal in the regions of Guarda, Nelas, Mangualde, and in the hydrographic basin of Mondego River. Water, soil, and vegetable samples were analysed for uranium series radionuclides. Radon measurements and aerosol samples were collected near the uranium mining waste dumps. Particular attention was paid to contamination of agriculture soil and irrigation water near uranium mining waste, and radionuclide soil-to-plant transfer. In mine pits that are now permanent ponds with aquatic fauna including fish, radionuclide accumulation by fish was investigated in order to

assess the risk of radiation exposure to fish consumers. Radionuclide transfer to vegetation spontaneously growing on sludge from acid and radioactive mine water treatment was investigated as well.



During 2010 about 650 samples (aerosols, rainwater, surface water, drinking water, sediments, fish, mixed diet, complete meals, milk, soils, etc.) were collected accordingly to international sampling procedures and a total of about 2000 analyses were performed for the determination of artificial and natural radionuclides, using gamma and alpha spectrometry, alpha/beta measurements and liquid scintillation technique. Integrated measurements of the ambient dose equivalent with thermoluminescent dosimeters were also performed. The results show that the Portuguese population was not exposed to radioactive contamination levels higher than the radioactive background. Therefore, there is no need to adopt any measures for radiological protection of the population. All the data are published in Internal Reports made available in the ITN website (<http://www.itn.pt>) and included in the European Radioactivity Environmental Monitoring Database (REM) located at the EU Joint Research Centre, ISPRA (Italy).

Published work

M. J. Madruga, F.P. Carvalho, M. Reis, J. Alves, J.A. Corisco, R. Trindade, I. Lopes, J. Abrantes, L. Silva, L. Torres, L. Portugal, M. Malta, A. Libânio, A. Mourato, G. Silva, J.M. Oliveira, L. Santos, A. Batista, A.R. Gomes, G. Carvalhal, H. Fonseca, J. Melo, M. Pereira. Programas de Monitorização Radiológica Ambiental (Ano 2009). *Internal Report UPSR, Série A, n°37/10, ISBN 978-989-96542-5-9, Depósito Legal 194022/03, pp. 146.*

Biomass Combustion and Release of Radionuclides into the Atmosphere

F.P. Carvalho, J. M. Oliveira

A collaborative project with University of Aveiro, funded by FCT, was given continuation to evaluate the release into the atmosphere of several contaminants including organic substances, toxic metals and radionuclides. The extension of forest fires in Portugal as well as around the entire Mediterranean basin is a non negligible source of toxic substances and contaminants, including natural radionuclides and artificial radionuclides deposited on surface soils following the Chernobyl accident. Several experimental approaches were assessed including measurements during true forest fires, measurements during small scale programmed fires, and laboratory burning of plant biomass.

Marine Radioactivity

F.P. Carvalho, J. M. Oliveira, M. Malta

Man-made, such as ^{137}Cs and $^{239+240}\text{Pu}$, and naturally-occurring radionuclides such as ^{210}Pb and ^{210}Po , are introduced in the ocean by atmospheric deposition and coastal discharges. Research and monitoring of radioactivity in marine organisms was carried out in order to pursue the assessment of radiation doses from naturally-occurring and man-made radionuclides to biota and to the human population through ingestion of sea food. Monitoring of radionuclide levels along the Portuguese coast was performed using mussels as bioindicator organisms collected at various sites on the open coast and in the main harbours. Determination of radionuclides in mussels, fish and marine mammals (dolphins) was used to compute radiation doses to biota.

Project “CAPTAR”

F.P. Carvalho

Participation in the web-based education project coordinated by the University of Aveiro and funded by the Calouste Gulbenkian Foundation. The project aims at producing a scientific periodical (Captar: ciência e ambiente para todos) available on line (<http://captar.web.ua.pt/>) for education and motivation of students and young researchers in environmental sciences. Two journal issues were released in 2009.

Radiocaesium Adsorption/Desorption on Geomaterials from “Raña” Deposits

M.J. Madruga, E. Andrade, I. Paiva, M. Gonçalves¹

This study concerns the characterization of geomaterials from “Raña” deposits for radiocaesium adsorption and is part of a research project KADRWaste, funded by FCT² whose aim is to establishing methodologies for the characterization of medium and low activity radioactive waste repositories. It is very important to select geomaterials which can be used as effective barriers in radioactive waste disposal sites, in order to avoid migration of radionuclides in case of accident/incidents. During this year adsorption/desorption experiments of caesium in “Rañas” (fraction <63µm) using continuous flow Teflon reactors were carried out at different pH values, ionic strength and initial caesium concentrations. The caesium in liquid phase was quantified by ICP-MS at APA (Agência Portuguesa do Ambiente) laboratories. The experimental scheme using the Teflon reactors designed and adapted to this study have shown to be suitable for the proposed objective. These experiments were performed at the Faculty of Sciences of Lisbon, Geology Department. The results obtained were essential to plan the long term experiments with radiocaesium that will be carried out at ITN to study the influence of contact time, flow, ionic strength, radiocaesium concentrations, etc., in the ^{137}Cs adsorption/desorption on geomaterials.

¹Geology Department, Faculty of Sciences, University of Lisbon

²Portuguese Foundation for Science and Technology

Accreditation of Radioanalytical Techniques

M.J. Madruga, I. Lopes, A. R. Gomes, J. Melo, J. A. Corisco

Regarding the quality assurance of radioanalytical techniques and following the work developed in 2009, improvements were introduced on the management and technical procedures, for instance, on the preparation of radioactive standard solutions to be used on analytical standards or for radiochemical purposes. In February 2010, an internal quality audit, according to the ISO/IEC 17025 requirements, was performed for the three techniques, global alpha/beta in waters using proportional counters or Liquid Scintillation Counting (LSC) and tritium determination in waters by LSC. The audit was carried out by two auditors from ISQ (Instituto de Soldadura e Qualidade). During the audit a systematic and independent examination was carried out to determine whether quality activities are implemented effectively and are suitable to achieve the objectives. Small nonconformities were identified and corrective actions were implemented.

Three papers concerning the quality assurance of these radioanalytical techniques were presented at the Liquid Scintillation Conference held in Paris (France) in September 2010. Two members of the GRA participated at the

“VI Jornadas sobre Calidad en el Control de la Radiactividad Ambiental” held in Cáceres (Spain) from 20 to 23th September 2010.

In the framework of the quality system some improvements were introduced in the laboratorial infrastructures. The laboratory for the manipulation of radioactive sources (LMFR) intended to serve as a common facility in support of all the activities of the UPSR, whenever manipulations of standard radioactive solutions and intercomparison radioactive samples are implicated, was recently (2009-2010) through extensive remodelling. New equipment – table tops, storage cabinets, gas extraction cabinet, air conditioning and temperature/humidity probe were installed. The samples storage room was refurbished and air conditioning and temperature/humidity probe were also fixed in order to maintain the samples in a good state.

Total column and surface ozone variability over the Iberian Peninsula: Dynamical and chemical atmospheric factors - DYNOZONE

M. Reis, M. J. Madruga, H. Fonseca, L. Silva

The DYNOZONE project was approved and funded by FCT. Is a cooperation project between New University of Lisbon, Nuclear and Technological Institute, Aveiro University and Fernando Pessoa Foundation for Teaching and Culture. The project officially started on October 2010. The main objectives of the project are to identify and justify, on a scientific base, the no photochemical origin of some ozone events, namely the stratosphere-troposphere exchange contribution to elevated surface ozone concentrations, as opposed to local production or long range transport from external pollution sources. The project team will analyse surface ozone concentration long records along with radionuclides time series available for Lisbon. The chemical-dynamical processes of such events will be studied by means of the EURAD model applications, for which a data assimilation procedure will be developed.

Indoor Radon Mapping

M. Reis, H. Fonseca

Continuation of the collaboration with the REM (Radioactivity Environmental Monitoring) group of the JRC (Joint Research Centre) on the development of a European Atlas of Natural Radiation, including radon mapping based on indoor radon measurements.

SERVICES

1. Radioactivity in Drinking and Mineral Waters

M.J. Madruga, J. Melo, A.R. Gomes, A. Libânio, I. Lopes, F.P. Carvalho, J.M. Oliveira

Regarding the evaluation of the radioactivity levels in drinking waters (Decree-Law n°306/2007) the UPSR was requested by Water Suppliers to carry out the determinations of global alpha, global beta, Tritium, ^{238}U , ^{234}Th , ^{226}Ra and ^{210}Po and the Total Indicative Dose parameter in waters. The determination of Radon in same water samples was also carried out. To license the mineral waters trade an evaluation of its radioactive levels should be performed (Decree-Law n°84/90). The radiological study included analyses of ^{226}Ra and global beta. Several enterprises often request this radiological study.

During 2010, a total of about 300 analyses were performed.

2. Indoor Radon

M. Reis, H. Fonseca, E. Andrade

Following the National System of Building Energetic Certification for the Indoor Air Quality (Decree-Law 78/2006, 4th April) public and private enterprises request to GRA the measurements of indoor radon. Besides, since November 2003 a collaborative Protocol was established between UPSR-ITN and DECO to answer the associate's indoor radon requests.

In 2010, about 900 measurements were performed.
