

Environmental Radioactivity

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Under Articles 35 and 36 of the EURATOM Treaty, Portugal has an obligation to conduct yearly a national radiological environmental survey. This survey was established in the Decree-Law 138/2005 of 17th August and its execution legally attributed to ITN. The National Radiological Environmental Monitoring Programme has been performed by the Environmental Radioactivity Unit in collaboration with the Measurement, the Dose Assessment and Dose Registry and the Radiological Protection and Radioactive Waste Management Units. In 2007, the programme has been enlarged with the creation of two specific programmes one for the ITN *campus* and other one for the regions around old uranium mining sites. To carry out this programme a considerable effort of the group has been made in terms of human resources (about 65% of the time consumed). This programme involves a financial cost of about 193 000 €.

In November 2006, in the framework of the EURATOM Treaty Article 35 an EC verification team visited the ITN and in particular, the Environmental Radioactivity Group. The verification team focussed on the degree of implementation of the recommendations of the verification activities performed in 2002. The report of the Commission's Article 35 verification was published in 2007. In this report it is emphasized the appropriate response given by the group to the 2002 recommendations and the noteworthy improvements achieved. The verification team endorses also the initiative to conduct a specific and systematic radiological surveillance programme in the former uranium mining region of Portugal.

In the framework of the EURATOM Treaty Article 35 the group has been participating in the elaboration of the European Atlas of Natural Radiation. Our contribution consisted in the treatment of the Portuguese indoor radon data to be included in a grid defined by the EC.

Current research activities are on going to investigate the levels of radioactive contamination in the atmosphere (aerosols) aquatic and terrestrial environments. Improvements have been introduced on the technique for alpha/beta measurements in drinking

waters using proportional counters. Quality control tests of recovery and accuracy were performed.

The group participated in coordination with the DPRSN/Measurement Unit in an certification exercise of a reference material (spinach) organized by the IAEA and in three international inter-comparison exercises concerning environmental matrices, two organized in the framework of the IAEA/ALMERA and one, in the framework of the OSPAR/IAEA. The results published in 2007 were in good agreement/compatible with the reference values.

The construction of the infrastructure for housing the Radionuclide Particulate Station (RN53) at S. Miguel, Azores, was concluded. The CINDERELA station and all the related equipment (detector, meteo station, VSAT antenna, etc) was installed during this year. The station is now ready to initiate the testing phase, in order to be certified in 2008. This station will be part of the International Monitoring System, established in the framework of the CTBT (Comprehensive Nuclear Test Ban Treaty).

During this year the group begins collaboration with the Medical Physics and Environmental Radioactivity Laboratory (FIMERALL), La Laguna (Tenerife) regarding the **ATRC** (Atmospheric Tracer Research Collaboration) Project. The main goal is the cooperation between participants from Europe, USA and Japan to develop an international data base on atmospheric radioactive tracers.

The technical services developed by the group are carried out under contract with companies or, by request from enterprises or Government organizations. Some of these technical services are: the evaluation of the radioactivity levels in public water supplies (Decree-Law n°306/2007) and mineral waters, the radioactivity analyses of foodstuffs and indoor radon measurements. The group income of these technical services was about 83 000 €.

One of the tasks of the group is the education and training of staff and young students. During this year one MSc thesis was concluded and two were submitted

Research Team

Researchers

M. J. MADRUGA, Princ., Group Leader
F. P. CARVALHO, Princ.
M. J. REIS, Aux.
J. A. CORISCO, Assistant

Students

A. R. GOMES, FCT grant
H. FONSECA, FCT grant
J. MELO, FCT grant

Technical Personnel

J. M. OLIVEIRA, Technician (1^o) (70%)
A. LIBÂNIO, Professional Technician (1^o)
A. MOURATO, Professional Technician (Principal)

Collaborators

I. LOPES
M. M. MALTA

National Radiological Environmental Monitoring Programme

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Objectives

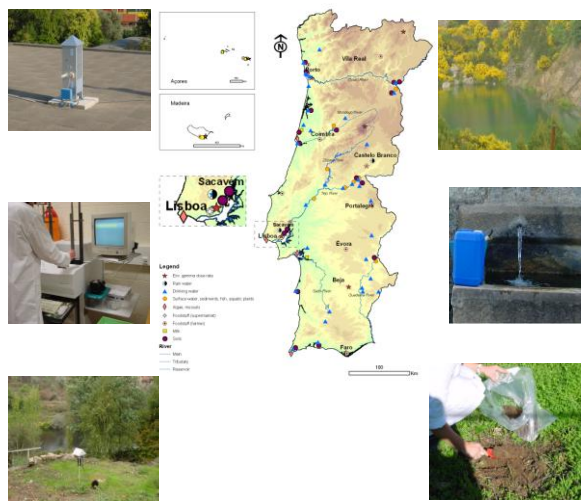
The Article 35 of the EURATOM Treaty stipulates that each Member State shall have the facilities necessary to carry out the continuous monitoring of the levels of radioactivity in the air, water and soil and to ensure the compliance with the basic standards. The Article 36 of the same treaty stipulates 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 national radiological monitoring programme planned according to the Articles 35 of the EURATOM Treaty requirements has been established by law in 2005 and the competency for its execution legally attributed to ITN (Decree-Law 138/2005, 17th August). The main objectives of the radiological environmental survey were 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. This radiological monitoring programme has been enlarged with the introduction of an environmental source related programme for the ITN *campus* and a specific programme for the regions around old uranium mining sites.

The monitoring programme carried out for the ITN *campus* includes measurements of external radiation levels (gamma dose) and measurements of radionuclide activity concentrations in relevant environmental samples (aerosols, rain water and soils). The main objectives of the programme were to verify the compliance with the authorized discharge limits, to check the operation conditions and discharge controls adequacy, to maintain a continuing record on environmental radionuclide levels related to the sources under consideration and to provide information for the public.

The environmental surveillance around old uranium mining sites was implemented to monitor radioactivity levels around the major old uranium mining and milling sites. Three field missions were performed in the regions of Urgeiriça/Canas de Senhorim, Aguiar da Beira-Sabugal, and Urgeiriça/Canas de Senhorim - Mondego River basin. Samples of water, soils and vegetables were collected for radioactivity analysis in the laboratory. Particular attention was paid to the enhancement of concentrations of uranium series radionuclides in water and foodstuffs. Aerosols and atmospheric radon were measured also in Spring and late Summer in the region of Urgeiriça to monitor eventual changes of radioactivity levels during the remediation works of milling waste heaps currently in

progress in this area. Fish from Mondego River basin, receiving surface runoff and discharges from the area of Urgeiriça and from other old mines, were also monitored.



Results

During 2007 about 800 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 2700 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 (1) 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, N. Pinhão, J. Alves, J.M. Oliveira, A. Libânio, G. Silva, I. Lopes, L. Silva, J. Abrantes, L. Machado, A.R. Gomes, A.S. Lemos, E. Oliveira, F. Rodrigues, G. Carvalhal, H. Fonseca, J. Melo, L. Novais. *Vigilância Radiológica a Nível Nacional (Ano 2006)*. Internal Report DPRSN, Série A, n°31/2007, ISBN 978-972-8660-32-1, Depósito Legal 194022/03, pp. 89.

¹DPRSN/Measurement Unit;

²DPRSN/Dose Assessment and Dose Registry Unit

Radioactivity in Foodstuffs¹*M.J. Madruga, I. Lopes*

Research on the radioactivity in foodstuffs was performed in order to develop and implement a new technique to the determination of ⁹⁰Sr in milk matrix. The method is based on the strontium separation from the other interfering elements using ion exchange chromatography (Sr-SPEC Eichrom resin). The ⁹⁰Sr/⁹⁰Y beta activity in the samples is measured by Liquid Scintillation Counting. The chemical yield is determined by adding ⁸⁵Sr as tracer to the milk samples. The recovery of the method, defined as the ratio of ⁹⁰Sr activity measured and ⁹⁰Sr activity added is evaluated and the methodology accuracy is tested in an IAEA 152 reference milk sample. In order to improve the minimum detectable activity (MDA) different amounts of sample and resin were tested. This methodology was applied to milk samples within the radiological environmental monitoring survey.

Marine Radioactivity¹*F.P. Carvalho, J. M. Oliveira, M. Malta, A. F. Sousa*

Research and monitoring of radioactivity levels in the marine environment was performed in order to expand the data base on levels of naturally-occurring radionuclides and to investigate current levels of man made radionuclides from nuclear discharges and nuclear accidents. Research on radionuclides in commercial marine fish species, such as sardines, horse-mackerel, and pouting, including inter-organ variation and monthly fluctuation of concentrations, was part of a Master Thesis (A.F. Sousa) on veterinary control of seafood landings for consumption by the Portuguese population. Research on radionuclides in marine mammals, mainly dolphins, was performed on specimens found on the shoreline. This aimed at investigating the transfer of radionuclides from marine species to mammals by ingestion, allowing for insights into radiation dose levels in tissues resulting from food chain transfer of radioactivity. This research is also part of a Master Thesis (M. Malta) in radiation protection. Monitoring of radionuclide levels and record of temporal trends was performed through the analysis of radionuclides in the tissues of molluscs (mussels) collected along the shoreline at the Portuguese coast in several locations and analyzed for natural and artificial radionuclides.

Completion of the *MinUrar* Project¹*F.P. Carvalho, M. Malta, S. Rábais, J. M. Falcão et. al.*

In February 2007 the Final Report of *MinUrar* project was issued. This report included the results of ²¹⁰Po and ²¹⁰Pb measurement in human hair samples collected in the populations of Canas de Senhorim and of other counties for the purpose of identifying enhancement of radionuclide burden in the human body. Results of the research on genotoxic effects in chromosomes from blood cells in a population group living near uranium mining and milling residues showed distinct features when compared with a reference group. Recommendations were presented in order to improve the radiation protection of the population and of the environment in this region.

SERVICES**1. Radioactivity in Drinking and Mineral Waters¹***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 DPRSN was requested by Water Suppliers to carry out the determinations of global alpha, global beta, Tritium, ²³⁸U, ²³⁴Th, ²²⁶Ra and ²¹⁰Po and the Total Indicative Dose parameter in these 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 ²²⁶Ra and global beta. Several enterprises often request this radiological study. During 2007, a total of about 1200 analyses were performed.

2. Radioactivity in Groundwaters¹*M.J. Madruga, A.R. Gomes, A. Libânio*

In collaboration with INETI (ex IGM) the tritium levels in groundwater samples were determined within the FCT-IMAGES Project. The main aim of the project is the identification and characterization of strategic groundwater bodies to be used for emergency situations as a result of extreme hydrological events and in case of conflicts or catastrophes. Ten aquifer systems were studied in the littoral centre region of Portugal and 42 water samples analysed.

2. Indoor Radon*M.J. Reis, H. Fonseca*

By request of public and private enterprises indoor radon measurements were performed in buildings. Since November 2003 a collaborative Protocol was established between DPRSN-ITN and DECO to answer the associate's indoor radon requests. A total of 116 measurements were performed during this year.

¹ In collaboration with DPRSN/Measurement Unit