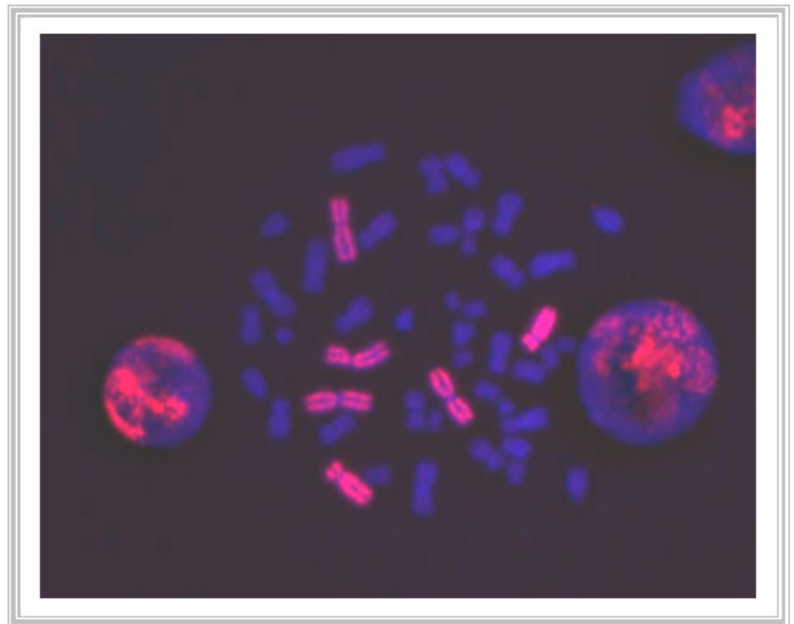


Department of Radiological Protection and Nuclear Safety



Department of Radiological Protection and Nuclear Safety

C. Oliveira

The main activities developed are mainly oriented to comply with the national and international duties, to perform services to the community and to answer to the technical and scientific solicitations, in the radiological protection field. Participation in international and national committees as technical and scientific advisers continues to have a significant importance in the Department activities. The main activities have been developed in the following Units:

Environmental Radioactivity, that is responsible to conduct the National Radiological Environmental Programme. The main objective is the determination of the artificial and natural radionuclide concentrations in environmental compartments considered as a direct pathways of human contamination. New analytical methods are being implemented for the determination of Sr-90 in milk.

Measurement Unit comprises four laboratories: Gamma and Alpha Spectrometry, Total Alpha and Beta Counting and Ion Chromatography. In a close contact with the Environmental Radioactivity Unit, this unit carries out the National Radiological Environmental Programme.

Metrological Laboratory of Ionizing Radiation activity deals with the ionising radiation National Standards. This unit is recognized by EUROMET as the National Metrological institution for ionization radiation, and is registered in EURADOS Database of the European Irradiation Facilities.

All these three Units have participated in inter-comparison exercises.

Dose Assessment and Dose Registry activities are directed towards the assessment of doses to the Portuguese population performed by the Individual Monitoring Service. New capacities for extremity dosimeters have been implemented. This unit also, keeps the Central Dose Registry data of occupationally exposed workers. This group participate in EURADOS(WG2) and ESOREX activities.

All these four units have dedicated a large amount of efforts to the implementation or maintenance of a Quality System. These efforts are inserted in the aiming at reach of the accreditation of their activities.

Radiological Risk and Safety Assessment activities ensure an important technical support to the DGS performing Radiation Risk Assessments of radiation facilities of radiation facilities. Efforts have been made to realize this activity in agreement with the Fundamental Safety Principles recently published by IAEA. The potentialities existing on the cytogenetic area has been used on epidemiological studies applied to genotoxic effects induced in population living near uranium mines.

The Radiological Protection and Radioactive Waste Management is responsible for several services as: interim storage of radioactive waste, licence request of sealed sources, detection of radioactive substances in scrap metal, verifications of the radiological conditions and the detection of radioactive contamination on medical, research and industrial facilities. One of the most important tasks is the involvement of Group members in EU, IAEA, OECD, and national committees, projects, working groups and task forces.

The EURATOM 35th Article Verification Commission has checked the implementation of previous recommendations, concerning environment radioactivity monitoring including uranium mines sites. The Commission could appreciate the new equipments, methodologies and procedures, as well the environmental data base and the quality control programmes.

Besides all the limitations, mainly in human resources, national and EU research projects are running namely under the 6th FP programme, and therewere as also an involvement in education and training activities, the efforts developed by DPRSN to foster the research to create the conditions to improve the quality of the services

DPRSN Staff

Researchers

C. OLIVEIRA, Principal
F.P. CARVALHO, Principal
J. P. VAZ, Principal
M. A. NEVES, Principal
M. B. MARTINS, Principal
M.J. MADRUGA, Principal
A. D. OLIVEIRA, Aux
E. M.M. AMARAL, Aux (retired 31.07.2006)
J. ALVES, Aux
I. PAIVA, Aux
M. REIS, Aux
N. PINHÃO, Aux (80%)
O. GIL, Aux
R. TRINDADE, Aux
J. A. CORISCO, Assistant

Technical and Administrative Personnel

J. CARDOSO
L. M. PORTUGAL
T. ANTUNES
G. L. SILVA
D. ALVES
E. F. GONÇALVES (leave on 30.11.06)
J. OLIVEIRA
J. SEBASTIÃO
J. VENANCIO
L. SANTOS
M. A. LIBÂNIO
M.M. SEQUEIRA (retired 31.01.06)
M. E. PACHECO
M.A. JORDAO
M. MARTINS
M. SARAIVA
V. CORDEIRO

Dose Assessment and Dose Registry

João Garcia Alves

The activity of the Dose Assessment and Dose Registry unit is directed towards the assessment of doses to the Portuguese population due to several types of exposure to external radiation.

The activities developed in 2006 were mainly concentrated on the performance of the individual monitoring service of ITN in the fields of individual and environmental monitoring. Care was also given to the Chairmanship of Subgroup1 of EURADOS WG2, including the co-preparation of a proposal on the review of the European technical recommendations submitted to EC-DGTREN.

In 2006 the main activities were focused on:

Assessment of the occupational radiation doses: In 2006 the Individual Monitoring Service (IMS) of ITN provided whole body dosimeters to approx. 3,200 workers on a monthly basis. In mid 2006 a recently appointed trainee and a MSc student started the performance tests of two different TLD varieties of extremity dosimeters with the aim of establishing the appropriate technique for this type of measurement, which is due to be ready in early 2007. Performance tests of the whole body dosimeter were also re-evaluated, and improvements to the dose evaluation routine were considered. Although Quality Assessment/Quality Control has always been of the utmost importance to the IMS, the necessary work for accreditation according to the ISO/IEC 17025 was resumed.

Improvements to the Central Dose Registry and analysis of the occupational exposure data:

In 2006 the CDR has increased the frequency of data collection from the dosimetry companies operating in Portugal. At present, the CDR contains the

accumulated dose data of occupationally exposed workers from 1957 to the first semester of 2006, inclusive. The analysis of the occupational exposure data is also one of the aims of this work.

Assessment of the cosmic radiation dose received by aircrew: A collaboration with the Serviço de Ginecologia e Obstetrícia of the Hospital da Força Aérea Portuguesa, for the estimation of in-flight cosmic radiation doses received by aircrew in military transport flights with specific software programs was maintained. A research project entitled *Cosmic radiation dose assessment for military transport aircraft crew and at ground level*, (ref. PTDC/FIS/72617/2006) was submitted to Fundação para a Ciência e Tecnologia for financial support and is presently under evaluation.

Assessment of the environmental gamma radiation dose to the Portuguese population: This Unit collaborated to the Environment Radiological Surveillance Programme of the entrusted to ITN, by regularly performing measurements of the environment dose equivalent rate in the ITN *campus* and in several locations in Portugal. A poster on the setup of this activity was presented.

On-going collaboration in international working groups was developed in the framework of both **EURADOS** (European Radiation Dosimetry Group) and **ESOREX** (European Study on Occupational Exposure) activities.

Collaboration in a national working group on radiation protection created by the Portuguese institute for accreditation was initiated in the end of 2006.

Research Team

Researchers

J.G. ALVES, Aux. Researcher
M.B. MARTINS, Princ. Researcher

Students

L. FREIRE, MSc student

Technical Personnel

A.M. CALADO (PEPAP Trainee, since 31-May-06)
E. FLORES (until 30-Nov-06)
L.C. NOVAIS (Trainee FCT-Euratom grant)
M.R. MARTINS (since 01-Jun-06)
S. RANGEL (Consultancy contract)

EURADOS WG2: Harmonisation of Individual Monitoring in Europe

V.Kamenopoulou¹, J.G. Alves², P. Ambrosi³, D. Bartlett⁴, L. Currivan⁵, J.W. van Dijk⁶,
E. Fantuzzi⁷, M. Figel⁸, A. McWhan⁹, H. Roed¹⁰, A.M. Romero¹¹, H. Stadtmann¹²,
E. Vartiainen¹³, B. Vekic¹⁴

Objectives

The Eurados Council assigned to Working Groups 2 two tasks: to revise the EUR 14852 document and to prepare a proposal on regular self-sustained intercomparisons of personal dosimeters.

Both tasks should be completed until the end of 2006. Should there be a call for a tender issued by the European Commission, Directorate-General Energy and Transport (EC-DGTREN) on the revision of the EUR 14852, Subgroup 1 should be prepared and present a proposal.

Results

EURADOS Working Group 2 on *Harmonization of Individual Monitoring in Europe* two tasks to be completed until the end of 2006: the review of the EUR 14852 document entitled *Technical recommendations for monitoring individuals occupationally exposed to external radiation*, and the preparation of a proposal on the organization of self-sustained intercomparisons for whole body and extremity dosimeters in Europe, on a regular basis.

WG2 was chaired by V. Kamenopoulou from GAEC and two subgroups were created for the preparation of each task Subgroup 1 and Subgroup 2, respectively chaired by J.G. Alves and M. Figel. Both activities were organized and successfully completed.

In September 2006, the EC-DGTREN issued a call for a tender on the *Establishment of the European Technical Recommendations for Monitoring Individuals Exposed to External Radiation*.

Subgroup 1 prepared and submitted a proposal to EC-DGTREN in early November which is presently under evaluation. A Consortium agreement was established

between GAEC and EURADOS comprising a Task Group (GAEC, ITN, HPA, NRG, PTB, RPII and ENEA) for the preparation and writing of the new document and an Extended Group of European Countries (with contact persons in all member states and candidate member states) for inputs of necessary information and comments on the drafts. Liaisons with international and European organizations like the IAEA, IEC, ISO, ICRU, ICRP, ESOREX, EUROMET and EAN was also ensured.

Subgroup 2 analysed the feasibility of EURADOS to organize self sustained intercomparisons on a regular basis. All important issues were addressed, a budget was prepared and an organization group for launching the first intercomparison was suggested.

Although several issues have been identified and deserve further attention, the activity of both Subgroups finalized and a report to the EURADOS Council is due for January 2007.

Published work

V. Kamenopoulou et al., Aspects of Harmonization of Individual Monitoring for External Radiation in Europe: Conclusions of a EURADOS Action. *Radiat. Prot. Dosim.* 118, 2, 139-143 (2006).

GAEC-EURADOS Consortium. Proposal submitted to the European Commission, Directorate-General Energy and Transport: Tender n. TREN/H4/98-2006, on the Establishment of European Technical Recommendations for Monitoring Individuals Exposed to External Radiation, presently under evaluation (November 2006).

¹GAEC, 15310 Ag. Paraskevi-Attiki, PO Box 60092, Athens, Greece. ²ITN-DPRSN, Estrada Nacional 10, 2686-953 Sacavém, Portugal. ³PTB, Bundesallee 100, D-38116 Braunschweig, Germany. ⁴HPA, Chilton, Didcot, Oxon OX11, United Kingdom. ⁵RPII, 3 Clonskeagh Square, Dublin 14, Ireland. ⁶NRG-RE, Utrechtsseweg 310, PO Box 9034, 6800 ES Arnhem, The Netherlands. ⁷ENEA-IRP, Via dei Colli 16, 40136 Bologna, Italy. ⁸GSF, Ingolstadter Landstrasse 1, 85764 Neuherberg, Germany. ⁹BNFL RVT, Berkley Centre, 4L13 4PB Berkley Gloucestershire, United Kingdom. ¹⁰HNO Knalpmo 7, D-2730 Herlev, Denmark. ¹¹CIEMAT, Avda Complutense 22, 28040 Madrid, Spain. ¹²ARCS, A-2444 Seibersdorf, Austria. ¹³STUK-Personal Dosimetry, PL 4, FIN 00881 Helsinki, Finland. ¹⁴RBI-Rudjer Boskovic Institute, Zagreb, Croatia.

Individual Monitoring Service: QA/QC, improvements and developments

J.G. Alves, S. Rangel, E. Flores, M.R. Martins, L. Novais, A.M. Calado, L. Freire

The Individual Monitoring Service (IMS) at ITN is based on a TLD dosimetry system, that consists of two 6600 Harshaw TLD readers and on the Harshaw 8814 TL card and holder containing two LiF:Mg,Ti (TLD-100) detectors for the evaluation of Hp(10) and Hp(0.07). In 2006 the IMS provided monitoring for external radiation to 3222 workers from 216 facilities in Portugal, on a monthly basis.

In 2006 two varieties of extremity ring dosimeters, based on LiF:Mg,Ti (TLD-100) and LiF:Mg,Cu,P (TLD-100H) both from Thermo Electron Corporation (USA), were tested for compliance to the requirements issued in the national legislation and the ISO 12794 standard. The set up of a methodology for monitoring extremities is currently under development and was an output of the work assigned to a trainee integrated in the IMS and to a MSc student as part of the preparation of his thesis.

Further improvements were also introduced to the QA/QC programme currently in use at the IMS. The full time involvement of a trainee allowed the identification and description of the main tasks and processes performed at the IMS. The aim of applying for accreditation according to the ISO/IEC 17025 Standard and related activity was resumed.

Assessment of the Environmental Gamma Radiation Dose to the Portuguese Population

J.G. Alves, L. Novais, S. Rangel, A.M. Calado

Environmental monitoring for evaluation of the gamma radiation dose to the Portuguese population is one of the tasks assigned to ITN for the accomplishment of Article 35 of the Euratom Treaty. This Unit collaborated to the environmental surveillance of Portugal by performing measurements of the ambient dose equivalent rate with passive dosimeters (TLDs) evaluated on a quarterly basis. The measurement of the ambient dose equivalent rate was performed by the individual monitoring service using the same dosimetry system as described above. The methodology was adapted to the environmental exposures, e.g., implementation of site-specific corrections for fading and sensitivity changes, longer monitoring periods.

In 2006 a net of measurement sites located at meteorological stations (Bragança, Beja, Castelo Branco, Faro, Funchal, Penhas Douradas, Portalegre and Vila Nova de Gaia) and covering the whole country was established. Dosimeters were issued and evaluated on a quarterly basis. The three measurement sites monitored at ITN during 2005 were used as reference points and evaluated on a monthly basis.

Assessment of the Cosmic Radiation Dose Received by Military Aircrew in Transport Missions

J.G. Alves, J. Mairos¹

The estimation of cosmic radiation doses received by aircrew in military transport flights is one of the aims of the collaboration established between ITN and the Serviço de Ginecologia e Obstetrícia of the Hospital da Força Aérea Portuguesa. Specific software programs are used and special attention is given to the case of a pregnant crew member.

In 2006 a research project entitled *Cosmic radiation dose assessment for military transport aircraft crew and at ground level*, ref. PTDC/FIS/72617/2006 was prepared, submitted to Fundação para a Ciência e Tecnologia for financial support and is presently under evaluation.

¹ Hospital da Força Aérea, Serviço de Ginecologia e Obstetrícia, Az. dos Ulmeiros, 1649-050 Lisboa.

Environmental Radioactivity

Maria José Madruga

Under Articles 35 and 36 of the EURATOM Treaty, Portugal has an obligation to conduct a national environmental radiological survey each year. This survey was established in the Decree-Law 138/2005 of 17th August and its execution legally assigned to ITN. The National Radiological Environmental Monitoring Programme has been carried out by the Environmental Radioactivity Unit in collaboration with the Measurement Unit and the Dose Assessment and Dose Registry Unit. Following the work developed in the last years the survey in 2006, consisted on the determination of the artificial and natural radionuclides in the atmosphere, aquatic and terrestrial environments. To carry out this programme a considerable effort of the group has been made in terms of human resources (about 50% of the time consumed). This programme involves a financial cost of about 68 000 €.

In November 2006, under the Article 35 of the EURATOM Treaty an EC verification team visited the ITN and in particular, the Environmental Radioactivity Group. The main objective of this visit was to verify the actions undertaken and the levels of implementation achieved as a result of the 2002 EC Recommendations. The team verified the adequacy of the sampling programmes in place, the laboratory infrastructure and methodologies in use, the analytical written procedures and the data management (traceability and data reporting).

Current research activities are on going to assess the levels of radioactive contamination in the atmosphere (aerosols) aquatic and terrestrial environments. The development and validation of new analytical methods using liquid scintillation counting technique are in progress mainly for the determination of strontium-90 in milk. Studies concerning the determination of indoor radon concentrations, radon exhalation from building materials and radon countermeasures are on going.

The technical services developed by this 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 nº243/2001) and mineral waters, the radioactivity analyses of foodstuffs and goods to export and building materials, indoor radon measurements and the determination of ²¹⁰Po in humans. The group income of these technical services was about 70 000 €.

During this year the group has given continuity to the elaboration of the analytical technical procedures following the NP EN ISO/IEC 17025 and to the implementation of quality control procedures. The environmental database has been improved.

The group participated in collaboration with the DPRSN/Measurement Unit in an international inter-comparison exercise in the framework of the IAEA/ALMERA group with good results. The results published in 2006 (the determination of ⁴⁰K, ⁹⁰Sr and ¹³⁷Cs in milk powder and the measurements of anthropogenic and natural radionuclides in mussel samples) concerning previous exercises were good.

During this year, the civil works for the construction of the infrastructure for the installation of the Radionuclide Particulate Station at S. Miguel, Azores were concluded. This station will be part of the International Monitoring System, established in the framework of the CTBT (Comprehensive Nuclear Test Ban Treaty).

The main concern of the group is the lack of human resources. To fulfil the State's national and international obligations (Artº 35 and Artº 36 EURATOM Treaty) it is absolutely necessary specialized technical personnel. In the last two years the group lost five technicians. In the mean time an effort has been done to train young students. In 2004, in the framework of the EURATOM/Radiological Environmental Monitoring Programme, five fellows were awarded with FCT grants. However During this year three of these fellows left.

Research Team

Researchers

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

Students

A.R. GOMES, FCT grant
A.S. LEMOS, FCT grant (left in Dec. 2006)
E. OLIVEIRA, FCT grant (left in Sept. 2006)
F. RODRIGUES, FCT grant (left in Nov. 2006)
H. FONSECA, FCT grant
J. MELO, FCT grant (since March 2006)

Technical Personnel

M.M. SEQUEIRA, (Specialist Principal) retired in Jan. 2006
J.M. OLIVEIRA, Technician (1ª) (70%)
A.LIBÂNIO, Professional Technician (1ª)
M.A. PEREIRA, Auxiliar Technician, retired in Dec. 2006

Collaborators

I. LOPES
M. M. MALTA

Environmental Radioactivity National Survey

M.J. Madruga, F.P. Carvalho, M. Reis, N. Pinhão¹, J.G. Alves², J.M. Oliveira, A. Libânio, M.A. Pereira, G. Silva¹, I. Lopes, L. Silva¹, J. Abrantes¹, L. Torres¹, A.R. Gomes, A. S. Lemos, E. Oliveira, F. Rodrigues, G. Carvalhal¹, H. Fonseca, J. Melo, L. Novais²

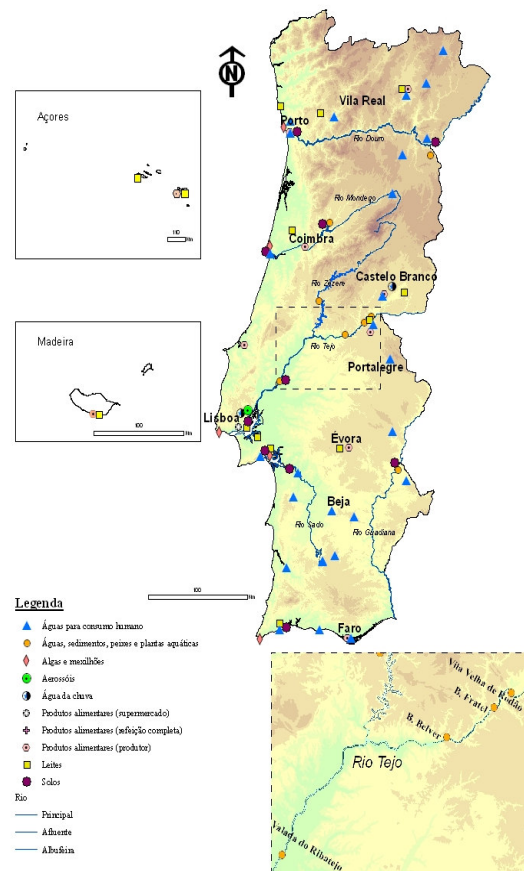
Objectives

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. Furthermore, Commission Recommendation 2000/473/EURATOM of 8 June 2000 on the application of Article 36 considers that the exposure related to soil contamination is more directly assessed on the basis of foodstuffs contamination. The radioactivity environmental monitoring programme, which has been planned in according to the Articles 35 and 36 of the EURATOM Treaty requirements and performed since several years ago by DPRSN/ITN, 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 objective of this national radiological survey consists on the determination of the artificial and natural radionuclide concentrations in environmental compartments (aquatic, terrestrial and atmospheric environments) considered as direct pathways of contamination to man.

Results

During 2006 about 400 samples (aerosols, rainwater, surface water, drinking water, sediments, fish, mixed diet, complete meals, milk, soils, etc.) were collected (Figure 1) accordingly to international sampling procedures and a total of about 1000 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. The estimated radiation dose to the Portuguese population due to the inhalation and ingestion of the artificial and natural radionuclides measured in these samples has no significance from the point of view of radiological protection. The values obtained are much lower than the radiation dose limits recommended to the radiological protection of the population (96/29 EURATOM Directive). Therefore, there is no need to adopt any measures for radiological protection of the population. All the data were published in Internal Reports (1), inserted into the database Easy Proteo 4.11 and sent to

the EU Joint Research Centre, ISPRA, to be included in the European Database (REM).



Published work

M.J. Madruga, F.P. Carvalho, M. Reis, N. Pinhão, J. Alves, M.M. Sequeira, G. Ferrador, M.A. Gameiro, J.M. Oliveira A. Libânio, M.A. Pereira, G. Silva, I. Lopes, L. Silva, J. Abrantes, L. Machado, A.R. Gomes, A.S. Lemos, E. Oliveira, F. Rodrigues, G. Carvalhal, H. Fonseca, L. Novais, *Vigilância Radiológica a Nível Nacional (Ano 2005). Internal Report DPRSN, Série A, n°30/2006, ISBN 972-8660-31-6, Depósito Legal 194022/03, pp. 83.*

¹DPRSN/Masurement Unit; ²DPRSN/Dose Assessment and Dose Registry Unit

Atmospheric Radioactivity¹*M. Reis, F. P. Carvalho, J. M. Oliveira, H. Fonseca, M. Malta*

Sampling of the atmosphere in situ atmospheric measurements over Portugal and of the East Atlantic were performed on board of the BAe450 airplane, operated by European Union Facilities for Atmospheric Research (EUFAR) in the framework of an EU funded project (VPRACOP). Aerosol samples were analyzed for naturally occurring radionuclides and trace metals. Results will be used to assist with the interpretation of the influence of desert dust from North Africa in the summer period.

Environmental Radioactivity in Alentejo¹*F. P. Carvalho, J. M. Oliveira, M. Reis, M. Malta*

Two counties, Serpa and Ourique, were investigated in 2006 as an extension of the work carried out in the framework of MinUrar project for comparison of the natural radiation background with the region of past uranium mining. Naturally-occurring radionuclides were measured in samples of soils, water, vegetable products, and aerosols. Radon was measured in indoor and outdoor air in a selection of sites. Samples of human blood and hair were collected also in inhabitants of these counties for measurement of biological parameters and radioactivity in the hair.

Radioactivity in the Marine Environment¹*F. P. Carvalho, J. M. Oliveira, M. Malta, A. Sousa, A. Libânio*

Research on the radioactivity in the marine environment has continued as part of the effort to deepening the knowledge on cycling of radionuclides in the marine environment and as part of the environmental radiological surveillance. Marine mammals (common dolphin) found along shore were sampled and analyzed for radioactivity. Common fish species from the harbour of Peniche, were sampled for radionuclide analysis. Bio-indicator species from the shore (mussels) were collected also in several points along the west and south coast and in estuaries of rivers and analyzed for naturally-occurring radionuclides and long lived radionuclides, such as plutonium isotopes and ¹³⁷Cs, in order to follow trends of radioactive contamination from past dumping operations of radioactive waste in the marine environment.

SERVICES**1. Radioactivity in Drinking and Mineral Waters¹***M.J. Madruga, E. Oliveira, J. Melo, A.R. Gomes, F. Rodrigues, J.M. Oliveira, I. Lopes*

Following the Portuguese Law (Decree-Law nº243/2001) it is compulsory the evaluation of the radioactivity levels in drinking waters. For this purpose 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 drinking waters. The determination of Radon in same water samples was also carried out. In order to obtain license to the commercialisation of mineral waters, an evaluation of its radioactive levels should be performed (Decree-Law nº84/90). The radiological study included analyses of ²³⁸U, ²³⁴Th, ²²⁶Ra, ²¹⁰Po and global beta. Several enterprises often request this radiological study.

During 2006, a total of about 1200 analyses were performed.

2. Radioactivity in Foodstuffs and other Samples¹*M.J. Madruga, A.S. Lemos, A. Libânio*

By request of public and private enterprises, different kind of samples, mainly food samples to be exported and building materials were monitored. In 2006, 67 samples were analysed.

3. 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 66 measurements were performed during this year.

4. Polonium-210 in Humans Following a Poisoning Act in London¹*F. P. Carvalho, J. M. Oliveira*

Following the poisoning act against a Russian citizen exiled in London, carried out in November 2006 using ²¹⁰Po, DPRSN was requested to assess internal contamination by ²¹⁰Po of several Portuguese that were in London at the time of events. It was possible to provide in a timely manner an assessment of the contamination (negative) of those people. An international analytical intercomparison, organized by the IAEA, is now underway amongst laboratories to test the capability to measure ²¹⁰Po in human samples.

¹ In collaboration with DPRSN/Measurement Unit

Radiological Protection and Radioactive Waste Management

Romão Trindade

The Radiological Protection and Radioactive Waste Management Group (PRGRR) has pursued in developing the main activities mentioned in previous Annual Reports.

Concerning the radioactive waste management activities, about 135 requests for collection, segregation and treatment for interim storage were received at the Pavilhão para Armazenamento Interino de Resíduos Radioactivos, PAIRR, (Radioactive Waste Interim Storage Facility, RWISF) during 2006. The licensing requests (entrance in national territory, possession, transport and transfer) of sealed sources for industrial, research and medical proposes, analyzed by ITN/DPRSN/PRGRR reached the number of 263 in the current year.

Eight (8) events related to the detection of radioactive substances in scrap metal were reported by the industry and controlled by PRGRR.

Seventeen (17) verifications of the radiological conditions and the detection of radioactive contamination on medical, research and industrial facilities were carried out in 2006.

The development of monitoring programmes for radioactive liquid discharges from hospitals in the public sewage of Lisbon Borough Council (CML) was continued in 2006 as well as the monitoring of radioactive liquid discharges of the ITN *Campus* before being released into Estação de Tratamento de Águas Residuais Residual, ETAR, (Residual Water Treatment Plant, RWTP). A proposal to carry out a complete revision of the existent facility Estação de Controlo das Descargas dos Efluentes Líquidos Radioactivos, ECoDELiR, (Radioactive Liquid Discharge Control Plant, RLDCP) was submitted to the ITN Directive Board for appreciation and decision.

The *Campus* environmental dose gamma radiation is assured through the gamma monitoring network, GAMMANET, operated and maintained by PRGRR Group and data are reported to the EU according to articles 35° and 36° of the Euratom Treaty.

The involvement of Group members in EU, IAEA, OECD committees, projects, working groups and task forces has increased in 2006 with the involvement in the Ad Hoc Working Party on Nuclear Safety (WPNS), EU.

While a member of the Group is carrying out a PhD in the field of radioactive waste management in collaboration with Faculdade de Ciências (FCUL/ITN), other is finishing a Master Degree in Radiological Protection and Dosimetry with Instituto Superior Técnico (IST/ITN). A Post Graduation Thesis in the area of health and safety of workers dealing with ionizing radiation in collaboration with Nova Etapa was also developed and finalized.

The Group has been involved in several training courses to provide professionals in the field of medical and industrial applications of ionizing radiation with knowledge on Radiological Protection. Still concerning education and training, members of PRGRR have also participated in the teaching activities of post-graduation activities: Master Course on “Biomedical Inorganic Chemistry: Diagnostic and Therapeutical Applications” (FCUL/ITN-Química) Master Course on “Radiological Protection and Dosimetry” (IST/ITN-DPRSN) and in a Post-Graduation Course, “Curso Pós Graduado em Protecção Civil-Riscos Naturais e Tecnológicos” (FCL/ISEL/ITN-DPRSN).

Concerning research activities, the PRGRR Group, in collaboration with Portuguese universities and Associated Laboratories, has submitted six projects to the FCT funding.

Included within the framework of the “Projecto de Plano Nacional de Acção Ambiente e Saúde, PNAAS”, PRGRR Group has submitted one project concerning the harmonization of radioactive waste management practices, in collaboration with Direcção Geral de Saúde and Instituto do Ambiente

Research Team

Researchers

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

Technical Personnel (Graduate)

L.M. PORTUGAL

Grants

P. DUARTE
L. BRÁS
A. BAPTISTA, ITN Grant (since 1 Mar 2005)

Technicians

J. SEBASTIÃO
J. VENÂNCIO

Characterization of Suitable Areas for a Long-Term Radioactive Waste Repository Facility in Portugal

P. Duarte, I. Paiva, R. Trindade, A. Mateus¹

This project makes part of a Ph.D thesis whose main objectives 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. This work project is expected to contribute to the development and implementation of future actions in the field of the radioactive waste management at national level.

In the pursuit of the above mentioned objectives, an *in locu* appreciation of the most suitable areas accordingly to a set of defined criteria (resulting from the first evaluation ITN Annual Progress Report 2005) was carried out during 2006. Rocks and soils' samples from those areas were collected and analyzed by different techniques: ED-XRF for the chemical analysis of the fraction <63µm; Gamma Spectrometry for the identification and quantification of gamma emitters also in the fraction <63µm and DRX for mineralogical analysis of total sample and fraction <10µm, in special for the identification and characterization of the clay minerals. ED-XRF studies were carried out with the collaboration of the Environmental Analytical Chemistry Group of the ITN's Chemistry Department; Gamma Spectrometry studies were developed in collaboration with the Measurement Unit of ITN's DPRSN and the ED-XRF studies were supervised by the Department of Geology of FCUP.

¹ Dept. of Geology, FCUL

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

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 115 samples of liquid effluents were collected and analysed by quantitative and qualitative gamma spectrometry. This monitoring programme was requested by CML. 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 facilities. In Programme II, 4 discrete samples were taken at one single point of each Lisbon's ETAR.

1. Radioactive waste management

Radioactive wastes from the national producers were collected, segregated, transported and conditioned in cement matrix for interim storage at the Radioactive Waste Interim Storage Facility (RWISF) located at ITN *Campus*

During 2006 about 135 requests for radioactive waste collection were received, corresponding to 148 sealed sources, 347 ^{99m}Tc generators, 22 lightning rods, 12201 smoke detectors and other heterogeneous radioactive waste.

2. Sealed sources licensing

In order to verify the compliance with Decree-Law n° 153/96, Ministry for Environment, and Decree-Law n° 165/2002, Ministry for Health, 263 sealed sources licensing requests were analysed and issued: 92 national territory entrance licences, 56 of transfer, 41 of transport and 74 of possession.

3. Gamma network of Nuclear and Technological Institute (ITN)

The environmental dose gamma radiation at ITN *Campus* is measured continuously by the gamma network, GAMMANET. The data are collected, analysed and reported to the EU, according articles 35° and 36° of the Euratom Treaty.

4. Radiological safety verification at medical, industrial and research facilities

The verification of radiological safety conditions and detection of contamination with radioactive substances at public and private medical, industrial and research facilities was pursued in 2006. During the last year 17 verifications were carried out.

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

The total activity of radioactive liquid discharges, from ITN to the Residual Water Treatment Plant, is reported to the EU according article 35° of Euratom Treaty and the Radioactive Substances Committee of OSPAR Convention.

In 2006 a project proposal involving a complete technical revision and auditing the existent facility “Estação de Controlo das Descargas dos Efluentes Líquidos Radioactivos” (ECoDELiR) including a new control system, has been submitted to the ITN Directive Board for appreciation and decision.

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

In 2006 and as requested by IPOFG-CROC, EPE, Coimbra, the radiological survey of radioactive liquid waste from the Medicine Nuclear Retention Tanks, was carried out by the Group before discharge into the public sewage.

7. Nuclear vessels radiological monitoring

In 2006, three nuclear vessels (2 submarines and 1 sea-plane carrier) stayed at Portinho da Costa harbour and estuary of Rio Tejo. 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. Reports were sent to Ministry of Defence.

8. Radioactivity in scrap metal

In 2006, and as result of radiological surveys requested by the smelting industry, eight (8) events related to the detection of radioactive materials in scrap metal at smelting factories have been reported. The material collected has been stored at ITN as radioactive waste. Reports were sent to the smelting company.

Radiological Risk and Safety Assessment

A. D. Oliveira

In 2006 IAEA published the “Fundamental Safety Principles”, report N.º SF-1. This publication has provided a major opportunity to take a top-down approach for further developments of safety standards in order to improve their structure. The publication of this fundamental report provided also a great opportunity to change procedures that misapply the IAEA safety standards in the activities of ITN and also at national level. For a long time the General Directorate of Health (DGS) of the Ministry of Health, the entity with the legal competence to license facilities and activities, asked to ITN to assure some of the regulatory competences such as the technical validation of all the radiological facilities and activities in the country. However, at the same time the ITN also assumed some of the responsibility for safety of the owners of the radiation facilities. During the year 2006 we gave further steps forwards in order to implement the safety fundamental report SF-1, mainly the principles 1 and 2.

The first aim was to implement the principle 1, responsibility for safety: “The prime responsibility for safety must rest with the person or organization responsible for facilities and activities that give rise to radiation risk”.

The principle 3 of the report SF-1 is about leadership and management for safety: “Effective leadership and management for safety must be established and sustained in organizations concerned with, and

facilities and activities that give rise to, radiation risks”.

Concerning the principle 2, which is about the role of government, while research institute and radiation user, ITN should not belong to the regulatory body, hence we didn't make any actions.

As a service provider it was decided to concentrate in radiation safety assessments only for more complex facilities such as radiation therapy and nuclear medicine, in order to allow an increase in the research activities. Concerning scientific topics in radiation protection our scope are radiation dosimetry, biological effects of radiation and the relationship with risk estimation.

The research activity of the group included biologic effects of radiation, interventional radiology, radiation dosimetry with simulations and the application of the entropy concept and cellular dosimetry. Several projects were submitted to FCT.

A main concern is the application of techniques of chromosome painting with DNA fish probes which includes the cytogenetic analysis in blood samples of people exposed to radiation. This work needs urgent funds and human resources in order to avoid their disappearance. In that sense some projects were submitted to FCT.

Research Team

Researchers

A. D. OLIVEIRA, Aux Researcher, Group Leader
M. A. NEVES, Princ. Researcher
P. VAZ, Princ. Researcher
O. GIL, Aux. Researcher

Students

P. CARDOSO, grantee FCT
L. FERNANDES, grantee PEPAP

Technical Personnel

T. ANTUNES, superior technician

Collaborators

M. M. SARAIVA
D. ALVES

Radiological Safety Assessment

A.D. Oliveira, P. Vaz, T. Antunes, M. Saraiva

Objectives and activity

Application of the IAEA “Fundamental Safety Principles”, report N.º SF-1.

In accord with principle 1, the ITN is responsible for the safety of its facilities and activities. It should not assume the responsibility for safety of others. It was in development the internal radiation protection program and this group was collaborated in that task.

One of the changes introduced were to furnish to the General Directorate of Health (DGS) some basic recommendations for simple radiological facilities and activities, for example, some application of sealed sources in industry, or intra-oral facilities in dental radiology. For these facilities the DGS stopped the technical advisory request in a case-by-case base.

We focus the technical advisory in the general requirements and the trend is to stop the case by case assessment.

For the implementation of the principle 3, we elaborated a general basic radiation protection program that all of the owners of radiation protection facilities and activities should implement. This general radiation protection program was furnished to the DGS in order to be used in their authorizations activities.

The international trend is to add the radiation protection procedures to the general quality system.

IAEA Safety Standards

for protecting people and the environment

Fundamental Safety Principles

Jointly sponsored by



Safety Fundamentals

No. SF-1

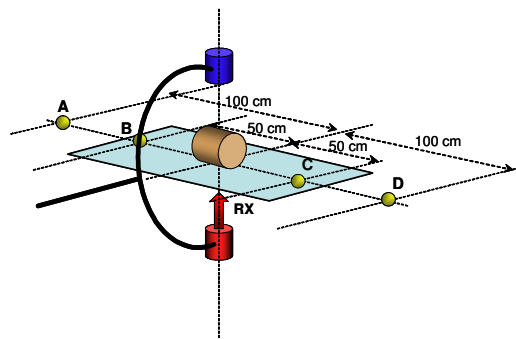


Risk Evaluation in Interventional Radiology

A. D. Oliveira, L. Fernandes

This project started in 2006 by the characterization of interventional radiology: facilities, activities and procedures. Plans were made for the physical and dosimetric characterization of the radiation field through several methodologies: theoretical, experimental and computational. Preparations were also taken for the field work and metrological verification of the equipment to be used.

It was submitted a project to FCT which involves 12 persons of the DPRSN and 4 persons of the “Hospital S.ta Maria” in Lisbon, aiming a full characterization of the risks of this activity. A master student is developing work within this project.

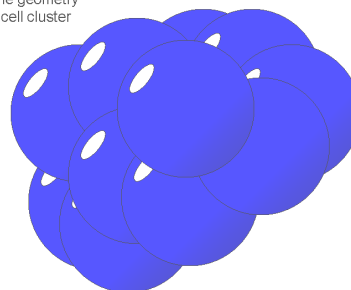


Cellular Dosimetry

A. D. Oliveira, M. A. Neves

The aim of this work is to develop an analytical algorithm suitable for computational implementation in cellular dosimetry based on the MIRD approach, allowing several degrees of freedom such as the number and position of cells, the number of cells contaminated and the modes of contamination. The user can apply the values of S-factor that he wants, allowing it to compare different values of S-factors and their importance for the cell cluster dose. The absorbed dose to a cell cluster is obtained from all the basic unit of dosimetry that exists in the cluster. Applications to several cell clusters will be tested

Example of the geometry involved in a cell cluster

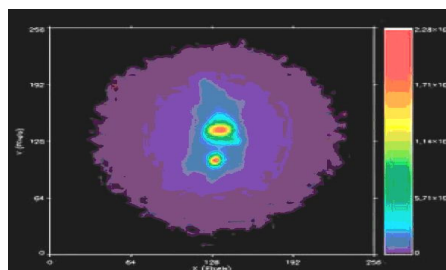


Targeted radiotherapy

M. Neves

This project involves radionuclide production of Sm-153, Re-186 and Lu-177, to assist other projects. In collaboration with national institutions (INETI-Instituto Nacional de Engenharia e Tecnologia Industrial, Lisboa, Portugal and IBFBM - Instituto de Biofísica e Biomatemática, Faculdade de Medicina da Universidade de Coimbra.

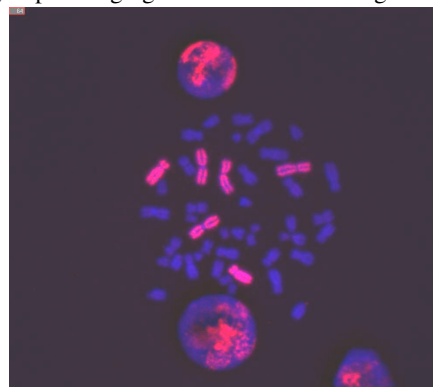
- Novel hidroxi- and aminobisphosphonates: quelation, molecular modelling and biologic studies-INETI
- Lanthanide(III) Complexes of Glycoconjugates for Lectin-Mediated Medical Imaging-IBFBM.
- Assessment of Gd(III)-EPTPA, a new self-assembling Gd(III)-chelate: biodistribution and gamma imaging of the $^{153}\text{Sm(III)}$ -labeled ligand - IBFBM.
- Biodistribution and pharmacokinetics of variously molecular sized ^{186}Re -polyethyleneiminomethylphosphonate complexes as potential selective therapeutic bone agents in the normal rats and in nude mice with xenotransplant of osteosarcoma model - IBFBM. Also in collaboration with University of Pretória and NECSA-Nuclear Energy Corporation of South Africa.



Radiobiology and dosimetry by cytogenetic methods applied to populations living near old uranium mining areas and compared with population living in areas without uranium mines

P.A. Cardoso Painço, O. Monteiro Gil

We proceeded with the work, started in partnership with INSA, into the evaluation of the biological effects of low-level ionizing radiation and genotoxic damage as a result of chronic exposure to ionizing radiation in populations living near old uranium mines and tailings (Canas de Senhorim). The project, funded by the Ministry of Health (Resolução da Assembleia da República nº 34/2001) - call «MinUrar» (“Minas de urânio e seus resíduos: efeitos na saúde da população”) aims at investigating the health effects in this population due to exposure to radon and other radioactive elements. Up to now we have already two groups completely studied, one from people living near the uranium mines, the other a control group belonging to the centre-north region of the country, but not living near uranium mines. The report with the results have already been sent for publication. A third populational group, belonging to a region from Alentejo (without uranium mines) was incorporated in this study to serve as reference population. For these populations, for each individual (a total of 30 individuals will be studied) we will study 2000 metaphases for the unirradiated samples and 700 for the samples of the same blood irradiated *in vitro* with 2 Gy gamma radiation for the challenge assay. This assay aims to determine the cell's competence for DNA damage repair. Equally in this study, chromosomes 1, 2, 4 were analysed for chromosomal translocations, by the FISH technique (Fluorescent *In Situ* Hybridization). For this group and until this moment in ITN we have already studied 25598 metaphases in unirradiated samples and 10401 in irradiated ones.



EUROpean Research Programme for the TRANsmutation of High Level Nuclear Waste in an Accelerator Driven System (IP-EUROTRANS)

P. Vaz¹, I.F. Gonçalves², I. Paiva³, R. Pires³, Y. Romanets⁴, R. Trindade¹

IP EUROTRANS is a European Union co-financed project (ref. FI6W-CT-2004-516520) in the 6th Framework Program EURATOM. The work is focused on the transmutation of high-level waste from nuclear power plants using an Accelerator Driven System (ADS). Due to the fact that the strategy of partitioning and transmutation could reduce the radiotoxicity of high-level wastes dramatically and thus ease the discussion about the long-term safety assessment of a final repository, any step towards the technological realisation of transmutation in Europe will have a positive influence on the improvement of public acceptance of nuclear electricity production. The objective of IP EUROTRANS is the design and the feasibility assessment of an industrial ADS prototype dedicated to transmutation, together with the definition of a backup solution. The necessary R&D results in the areas of fuel, technology and nuclear data will be made available, together with the experimental demonstration of the ADS component coupling. The outcome of this work will allow to provide a reasonably reliable assessment of feasibility and an estimate of cost for an ADS based transmutation, and to decide on the detailed design of an ADS and its further construction, if there is a more general decision to go ahead with ADS-based transmutation. The Portuguese team, led by ITN, participates in the following Domains:

- DM1-DESIGN – “*Development of a detailed design of XT-ADS and a conceptual design of the European Facility for Industrial Transmutation EFIT with heavy liquid metal cooling*” – participating in:
 - WP 1.2 (“Development and Assessment of XT-ADS and EFIT Designs”)
 - WP 1.3 (“High Power Proton Accelerator (HPPA) Development”)
- DM2 – ECATS – “*Experiment on the Coupling of an Accelerator, a spallation Target and a Sub-critical blanket*”, participating in:
 - WP 2.1 (Experiments at YALINA – current to flux reactivity on-line monitoring techniques, interim calibration techniques used at beam trips and full calibration techniques for kinetic parameters during loading/start-up procedures)
 - WP2.3 (The GUINEVERE project – Study of reactivity monitoring methodology for an ADS in a modified lead VENUS reactor coupled to a modified continuous-beam GENEPI accelerator)

1 – ITN / DPRSN; 2 - ITN/ Physics Sector; 3 – Fac. de Engenharia / Univ. Católica Portuguesa; 4- project fellow

Participation of ITN in the n-TOF experiment (PS213) at CERN (fourth year)

P. Vaz¹, I.F. Gonçalves², C. Cruz², J. Neves², C. Carrapiço³, C. Santos³, L. Ferreira⁴, L. Távora⁵

The n-TOF Collaboration, a consortium of 40 laboratories in Europe and U.S.A., has proposed an ambitious programme to perform high accuracy measurements of neutron cross-sections in the range from 1 eV to 250 MeV. An experimental programme (PS213) is being carried out since 2001 at the neutron time of flight (TOF) facility at CERN, using the CERN/PS accelerator complex. A single proton pulse of $7 \cdot 10^{12}$ protons of 20 GeV impinges on a lead target every 2.4 seconds. After collimation, a neutron flux of the order of 10^5 neutrons/cm²/pulse is available for cross section measurements in the detectors station located 185 m downstream the target area.

These cross-section measurements are required in many emerging applications that require the use of high-intensity and medium-energy (in the hundreds of MeV) proton beams impinging on a thick target of an heavy element. These applications range from the design of innovative Accelerator Driven Systems (ADS) for incineration of nuclear waste and energy production, radioisotope production for medical and industrial applications and to many other subjects in Astrophysics, Nuclear Physics and Nuclear Technology. New or improved measurements of neutron cross-sections will also be very valuable for Radiation Shielding, Dosimetry and Monte Carlo Radiation Transport calculations. During 2006, ITN researchers in cooperation with researchers from CIEMAT/Madrid and CEA/Saclay:

- Participated in the checks of the time stability of the behaviour of the the TAC calorimeter and the Silicon monitors and assessed the quality of the data taken during 2004
- Participated in the design studies of the new shielding system for the TAC calorimeter, performing simulations using the state-of-the-art Monte Carlo program GEANT4
- Performed Monte Carlo simulation studies of the neutron and gamma fluxes for alternative targets at n-TOF, for different materials (e.g. Tungsten) and geometries, using the Monte Carlo program MCNPX
- Participated in the analysis of the ²³³U data
- Contributed to the proposal for new measurements during n-TOF-Phase 2, to start during 2007, namely the measurements of the neutron capture cross-sections for iron and nickel isotopes.

1- ITN / DPRSN; 2 – IST / Physics Department; 3 – project fellow; 4- DF/ IST; 5 –C. de Instrumentação / U. Coimbra

PATEROS - Partitioning and Transmutation European Roadmap for Sustainable Nuclear Energy

P. Vaz

PATEROS is a European Union co-financed Coordinated Action (ref. FP6-036418) in the 6th Framework Program EURATOM, under the specific programme for Research and Training in Nuclear Energy.

The World Energy Council's *WEC Statement 2000* points out that although global reliance on fossil fuels and large hydro will remain strong through 2020, these will not be able to meet the world's longterm electricity demand in a sustainable manner. A closed fuel cycle is a prerequisite for making nuclear energy a sustainable one. This can be reached by deploying advanced partitioning and efficient transmutation systems to reduce the burden on the geological storage. This objective is of relevance both for countries committed to nuclear energy in the future and for countries not committed to a further deployment of nuclear energy. The objectives of this Coordinated Action is to deliver a European vision for the deployment of the partitioning and transmutation technology up to the scale level of pilot plants for all its components. ITN contributes to the activities of:

- WP1: Rational and added value of P&T for waste management policies
- WP2: Review & selection of Relevant Fuel Cycle Strategies in Europe supplemented by Regional Context for Development and Deployment.
- WP6: Integration and Evaluation of Resources and Time Planning.

CONRAD – COordinated Network for RADiation Dosimetry

P. Vaz, I.F. Gonçalves¹, C. Carrapiço² – SG4/WP4/WP7

A.D. Oliveira¹, L.T. Fernandes³ – SG2/WP7

The Project CONRAD is a collaborative effort led by the Technical University of Delft and involving several European institutions under the umbrella of EURADOS (the European Radiation Dosimetry group). Its activities are funded by the European Union in the 6th Framework Programme for Research and Development.

The ITN team participates in the determination of patient and staff doses in interventional radiology in collaboration with the “Hospital de Santa Maria” concerned with the following Work Packages of CONRAD:

- WP4 - Assessment of Uncertainties in Computational Dosimetry
- WP7 – Dosimetry for Radiation Protection of Medical Staff

In this context, it participates in the computation of two exercises entitled “Medical Staff Dosimetry in Interventional Cardiology” and in the measurement of staff doses, aiming at estimating the effective dose to the cardiologist due to the X-ray machine and to compare it with the personal dosimeter readings. The importance of wearing protective clothes (lead equivalent apron, thyroid collar, etc.) are used, as well as the influence of parameters such as the beam geometry and quality, the position of the dosimeter (above or below the apron) and the relevance of the usage of double dosimetry (one dosimeter above and another below the apron) will be performed. The ultimate goal is the determination of the effective dose to the professionals exposed.

1 – ITN / Physics Sector; 2 – ITN Fellow

EURISOL DS - Design Study of an European Isotope Separation On-Line Radioactive Ion Beam Facility

P. Vaz, J.G. Correia¹, I.F. Gonçalves¹

The Project EURISOL-DS is a Collaboration of twenty institutions and laboratories in European countries and CERN. Its activities are funded by the European Union in the 6th Framework Programme for Research and Development (“Research Infrastructures Action”).

EURISOL DS aims at performing the detailed design studies for the deployment in Europe of a world class Radioactive Ion Beam Facility, able to produce radioactive beams with much higher intensities than the ones currently available in other facilities worldwide. Very selective extraction methods combined to the high intensity of the beams will allow the discovery and study of new isotopes as well as the production of isotopes for a wide range of applications ranging from Fundamental Nuclear Physics and Astrophysics studies to Life Sciences, in particular Medicine. The innovative characteristics of such a facility are also associated to its multi-MegaWatt target unit where a high-intensity beam of protons of energy in the 1-2 GeV range will impinge on a high-Z material, mercury, tungsten or tantalum being currently considered as potential candidates. ITN is participating in the computational activities of the following sub-groups:

- WP2 (“Target Design Studies”)
- WP5 (“Radiation Protection Issues”)

In the near future, it is foreseen the involvement in the project of other ITN teams and the utilization of several infrastructures available at the ITN campus in support of the project activities.

1 – ITN / Physics Sector

Metrological Laboratory of Ionizing Radiation

João Cardoso

The main activities of the Metrology Laboratory of Ionising Radiation (LMRI) can be described as:

- Research and training in metrology of ionising radiations;
- Maintenance of the ionising radiation national standards, under a protocol with the Portuguese Institute for Quality (IPQ);
- International cooperation with EUROMET, EURADOS BIPM, IAEA, WHO and EA, in the field of interlaboratory comparison of standards and measurements;
- Collaboration and support of other research groups performing measurements or irradiations;
- Services of metrological control of measuring instruments, according to national regulation (Portaria 423/98).

In 2006, the LMRI, has made one of its top priorities the maintenance of the Quality System (QS) according to the ISO 17025 standard and adapting it to the new standard, ISO 17025:2005. The LMRI QS is essential to the project named Mutual Recognition Agreement (MRA). This international project, now implemented in the five continents, mutually recognizes the national measurements standards of calibration and measurement certificates issued by the national metrology laboratories of the States that signed the Metre Convention.

In order to maintain and improve the equivalence of standards between national metrological laboratories, the LMRI has participated in two intercomparisons promoted by EUROMET. One in the radiation protection area for the quantity personal dose equivalent, $H_p(10)$, for the X-ray radiation qualities N-30, N-60 and N-120, described in the standard ISO 4037-1, called EUROMET project No. 738. The other intercomparison named, EUROMET project 813 and is a comparison of air kerma and absorbed dose to water for ^{60}Co radiation in radiotherapy.

Regular collaboration with IAEA and WHO is maintained. The LMRI is a member of the Secondary Standard Dosimetry Laboratory (SSDL) network, a joint project between IAEA and WHO, and performs annually TLD audit of doses at radiotherapy level.

The collaboration with the European Radiation Dosimetry Group (EURADOS) has been improved in 2006. The LMRI was registered in Database of European Irradiation Facilities. This database provides information about the irradiation facilities for dosimetry research in Europe. This information is useful to researchers in radiation dosimetry to enable them to choose the most appropriate facilities to work.

The LMRI well-type ionization chamber, used mainly in radionuclide metrology in nuclear medicine, is being object of study, by experimental and simulation studies, in order to have a complete characterization of the ionization chamber response for different radionuclides and for different types of containers (syringes, ampoules, vials. This work is being made with the collaboration of the Nuclear Medicine Department of the Hospital Garcia da Horta, in Almada.

The LMRI website was improved during 2006. A new webpage was constructed with new information about the LMRI activities, laboratory equipment, services provided to the community and much more information and is now available to the public.

The LMRI calibration services are our more visible activity and we provided to the community, mainly for industry, universities, hospitals, armed forces and departments of ITN, services of metrological control. This metrological control of instruments for measurement of ionising radiation is being carried out under a contract with Portuguese Institute of Quality and is the enforcement of Portaria 423/98 from 21 of July. During 2006 were calibrated 114 dosimeters and about 700 TLD dosimeters were irradiated. The following figures can quantify the work done in this particular area.

Instruments calibrated by type of use

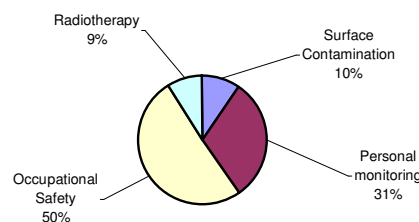


Figure 1: Distribution of calibrated instruments by type of use.

Instruments calibrated by users activity

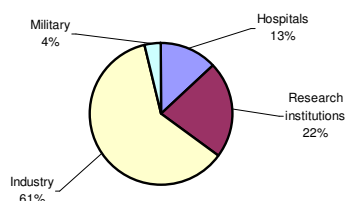


Figure 2: Distribution of calibrated instruments by area of activity.

Research Team

Technical Personnel

J. CARDOSO, physicist
L. SANTOS, technician

Collaborators

A. CASTRO, technician

Measurement Unit

Nuno Rombert Pinhão

The Measurement Unit (MU) provides **analytical services in the area of radioactive control of low and medium activity samples**.

The techniques used are high resolution gamma spectrometry; total alpha and beta counting; beta counting of specific radionuclide and alpha spectrometry. Ion chromatography is also used to assist on the evaluation of the residual beta activity.

Together with the laboratories of the Environment Radioactivity group (which is responsible for the collection and chemical preparation of the samples), the MU carries out the Portuguese obligations under Article 35 of the EURATOM Treaty, which requires member states to conduct an annual national environmental radiological survey.

Additionally, the MU provides ion chromatography analysis to other research groups in ITN.

The MU is composed of four laboratories with the following major facilities:

- Gamma Spectrometry laboratory, equipped with six germanium detectors and one Si(Li) detector;
- Alpha Spectrometry laboratory, with a total of 41 surface barrier detectors;
- Total Alpha and Beta Counting laboratory, with two systems equipped with gas flow proportional counters, two liquid scintillation systems and two ZnS solid scintillators;
- Ion Chromatography laboratory, equipped with an ion exchange chromatograph and an ultra-pure water system.

The MU provides radioactivity measurement services:

- For the national environmental radiological survey;
- to assist in the surveillance of the ITN research reactor;
- to support economic activities, such as the control of foodstuff for exporting and of building materials, and
- to support and collaborate with other groups on their research activities.

The MU conducts research and development on the analytical techniques used in this field. The Unit also promotes the professional qualification of the personnel, and other related educational activities.

In the short term, the MU is involved in the accreditation of the laboratories according to the ISO/IEC 17025 standard. A project for financing the reorganization of the laboratories and for equipment upgrade is expected to be approved in the beginning of 2007.

In 2006, the MU has undergone several transformation:

Equipment acquisition and repair:

- Acquisition of a detector for alpha spectrometry;
- repair of ion chromatography equipment.

Measures to implement the ISO 17025 standard:

- Development of a data reporting software application to allow the reporting of the upper limit of activity in gamma spectrometry;
- requirements analysis for the development of a LIMS (Laboratory Information Management System) adapted to the needs of DPRSN;
- acquisition of calibration sources for gamma spectrometry and ion chromatography;
- development of new routines for the reporting of analysis results and data archiving;
- analysis of the uncertainties and detection levels in total alpha and beta counting;
- implementation of procedures to eliminate gamma – X-ray sums and matrix effects in gamma spectrometry;
- definition of procedures for the measurement of alpha and beta activity with gas proportional detectors;
- organization of equipment records;
- participation in intercomparison exercises.

Training and education:

- Some of the group members have been supervising undergraduate and post-graduate thesis and involved in course teaching;
- two group members have attended Master degrees programs;
- one FCUL student is making the final year training in the MU.

Research Team

Researchers

N.R. PINHÃO, Auxiliary Researcher

Analysis Contractors

L. SILVA, physicist

J. ABRANTES, graduation student in physics engineering

L. TORRES, chemical engineer

Technical Personnel

J. M. OLIVEIRA, Senior Technician (30%)

G. SILVA, Technician [1*]

Informatics Consultant

J. P. SARAIVA (between June and October)

Students

G. CARVALHAL, FCT grantee

R. MENDES, FC/UL graduation student in physics

Analytical Services on Radioactivity Measurement and Liquid Ion Chromatography

J. Abrantes, G. Carvalhal, J.M. Oliveira, N.R. Pinhão, L. Silva, G. Silva and L. Torres

Objectives

The Measurement Unit provides analytical services on radioactivity measurement and evaluation of ion concentration in liquid samples to ITN groups and external entities. These services aim:

- to provide analytical services to support the national environmental radiological survey;
- to assist in the surveillance of the ITN research reactor;
- to provide analytical services to support economic activities, such as export certificates or the control of construction materials, and
- to support and collaborate with other groups on their research activities.

Results

In 2006, the MU continued efforts to improve the accuracy of the results reported through improvements on the statistical treatment of data, introduction of procedures to eliminate gamma – X-ray sums and matrix effects in gamma spectrometry, and the introduction of quality control practices on laboratory work.

The gamma spectrometry laboratory took part in an proficiency test (IAEA-CU-2006-04 ALMERA) with good overall results.

Analysis services

In 2006 around 3500 measurement report were emitted. These measurements have required the performance of a total of 9300 analyses, including analysis for calibration, quality control and validation. These analyses were conducted using the following techniques: alpha spectrometry (14%), total alpha or

beta counting techniques (16%), gamma spectrometry (30%), liquid scintillation (39%), and ion chromatography (2%).

About 28% of these analyses were for the national environmental radiological survey, 30% were services for external entities, 22% for research projects, either of DPRSN or other ITN sectors, and the remaining for quality control of the techniques.

It is worth mentioning that, excluding the quality control analysis, 78% of the alpha spectrometry, 22% of the gamma spectrometry analysis and 16% of the liquid scintillation and total alpha or beta counting techniques were on samples for research projects of the DPRSN, Chemistry or Physics sectors. Comparing with last year, this represents a decrease of the number of analyses for research projects and is regarded as a consequence of the freezing of research funds for the last two (2) years.

Services for external entities, mostly companies in the private sector, represent 51% of the analysis based on total alpha or beta counting or liquid scintillation techniques, 6% of the gamma spectrometry analysis and 15% of the alpha spectrometry analysis.

The analytical services provided by the MU to the National Radiological Surveillance Program represent a total net value of 79 kEuros.

The services provided to external entities represent a net income generation to ITN of around 89 kEuros. Considering the operational costs (including salaries and overheads), we estimate that the results obtained in the MU laboratories represent a net added value of over 61 kEuros.

