

## 12. Services

### New Materials and Compounds:

- **Solid State Chemistry and Physics**

Supervision of the Helium liquefaction service.

### Environmental Sciences:

- **Environmental Analytical Chemistry**

Energy-dispersive X-ray fluorescence spectrometry analysis ( $Z > 11$ , solid samples);  
 - Mass spectrometry for light isotope determinations in water samples and sediments ( $^2\text{H}/^1\text{H}$ ,  $^{13}\text{C}/^{12}\text{C}$  e  $^{18}\text{O}/^{16}\text{O}$ );  
 -  $^3\text{H}$  determination in water samples.

### Industrial Technologies:

- **Nuclear Instruments and Methods**

A summary of the more relevant services rendered in 1999 by the project “**Nuclear instrumentation**” is presented in the following Table.

Activity	Quantity	Client
Supply of Personal Dosimeters RAD X 100	12 1 4 10 2 5	Portuguese Navy Clidiral (RITAGRA) ITN/UTR ITN/Reactor SATIS Angola (RITAGRA)
Supply of $^{192}\text{Ir}$ gamma sources	15	Siderurgia Nacional
Supply of plating electrode disks	500	ITN/DPSRN
Supply of laboratory equipment for determination of radioactive element traces by electrodeposition	1	URENCO/UK
Supply of cells for polonium determination	12	Linköping Univ./Sweden
Source recharging	3	CIMPOR/Alhandra
Supply of gamma level detector units	2	CIMPOR/Souselas
Measuring and control of sources activity	25	SOPORCEL
Transfer and storage of radioactive sources	4	CIMPOR/Souselas
Supply of $^{60}\text{Co}$ gamma sources	1	SAGEMA
Technical assistance	1 1	SOLVAY Portugal PORTUCEL/Setúbal

- **Radiation Technologies: Processes and Products**

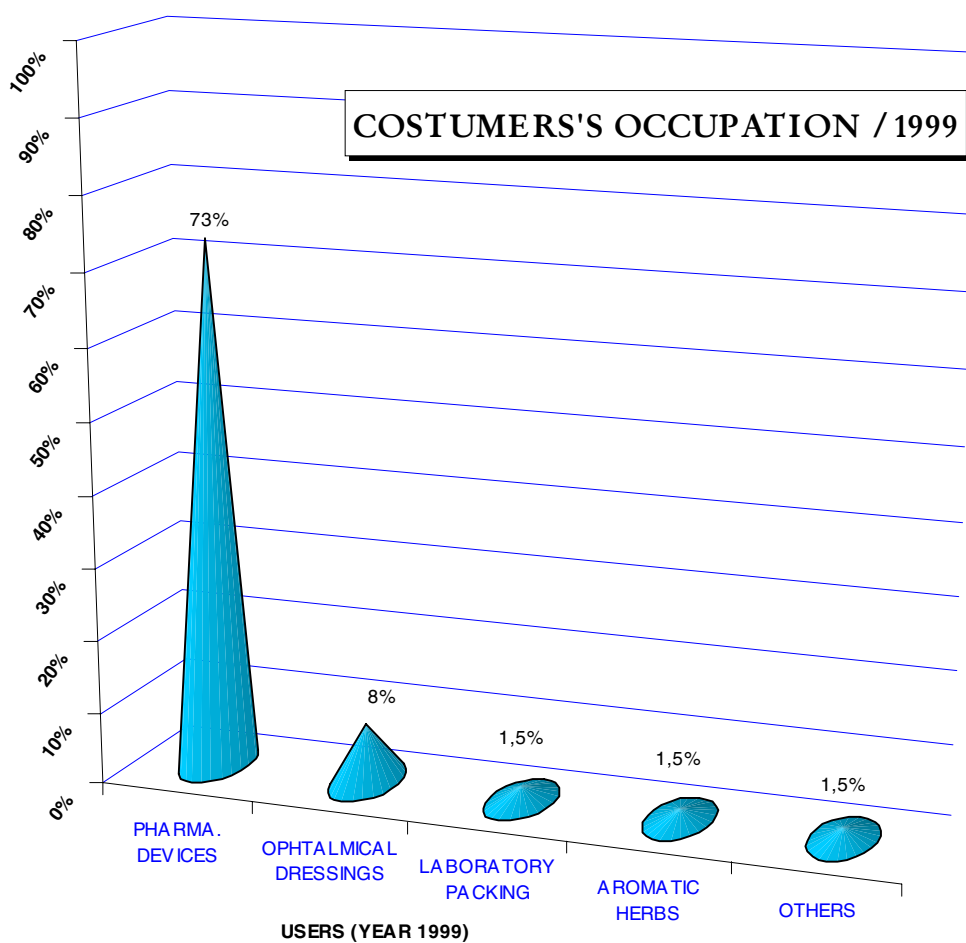
Technical Audits were performed to environmental assays Company, under invitation of IPQ (Portuguese Institute of Quality).

#### Radiation Technology Unit - Irradiation Services

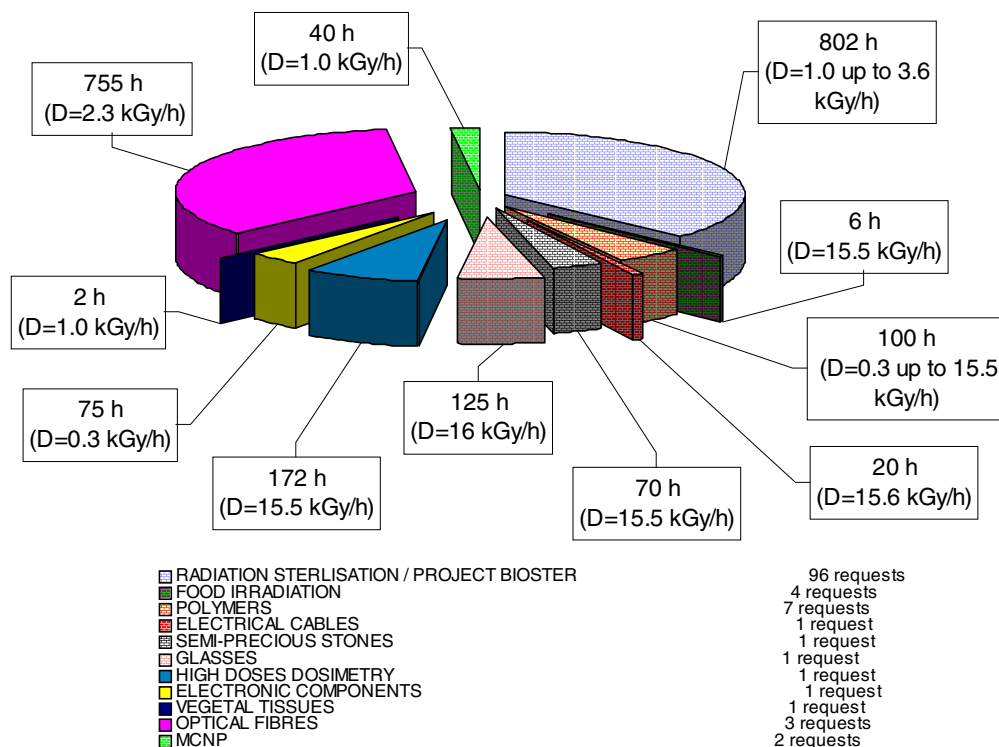
Industry	
Name	Type of service
Jaba Farmacêutica, S.A.	Sterilisation of pharmaceutical devices
Oftalder - Prod. Farmacêuticos, S.A.	Sterilisation of ophthalmical dressings
Hovione - Sociedade Química, S.A.	Sterilisation of laboratory packing devices
Lecifarma, Lda	Decontamination of aromatic herbs
Others	Sterilisation of medical devices and pharmaceuticals

<i>Universities and Research Institutes</i>	
Name	Type of service
LIP	Irradiation tests of optical fibers
CERN	Irradiation tests of polymeric samples for high doses dosimetry
Univ. Complutense of Madrid / CERN	Irradiation tests of electronic components
University of Évora	Irradiation tests of vegetal tissues

<i>ITN</i>	
Name	Type of service
Radiation Sterilisation / Project BIOSTER	Irradiation tests of medical devices and pharmaceuticals
PhD Thesis work	Irradiation tests of natural and synthetic polymeric samples
Final year thesis work	Irradiation tests of electrical cables
Nuclear Instruments and Methods - Computational Physics	Irradiation tests for Monte Carlo simulations
Inorganic and Organometallic Chemistry	Irradiation tests of special glaces
Condensed Matter Physics	Irradiations tests of semi-precious stones
INIA	Irradiation tests of food



## RESEARCH AREAS - 1999 (Radiation Technology)



### Cultural Heritage and Sciences

#### Chemical analyses by INAA and radiocarbon dating

The absolute dating commonly serves the national and international communities. Services have been done to industry, namely in the chemical characterisation of environmental samples in the vicinity of an urban solid residues power plant (CTRSU, S. João da Talha) for VALORSUL and fuel samples for PETROGAL.

### Radiological Protection, Environmental Radioactivity and Nuclear Safety

#### Artificial Radioactivity Levels in Foodstuffs and Other Samples

*M.C.Faisca, A. Brogueira, C. Pires, M.A. Tavares*

Under request of the Direcção Geral de Fiscalização e Controlo da Qualidade Alimentar, public or private organisations, different kind of samples, mainly food samples imported or to be exported, are monitored (gamma espectrometry analysis) in order to determine concentrations of artificial radionuclides.

During 1999, a total of 72 samples were analysed.

Under these activities a 1999 IRC-CEC intercomparison exercise, coordinated by World Health Organization, was carried out.

#### Radioactivity in Drinking Waters

*G. Ferrador, M.C. Faisca, M. A. Tavares*

Following the Portuguese Law (Dec. Lei N° 236/98), the evaluation of the radioactivity levels in public waters (human consumption) should be performed.

Some water suppliers as “Emprese Pública de Águas de Lisboa – EPAL”, “Serviços Municipalizados de Abastecimento de Água do Porto – SMASP”, “Águas do Cávado, S.A.” and “Águas do Douro e Paiva, S.A.” requested regularly, measurements of global alpha and beta activities.

A total of 113 total alpha and 113 total beta measurements were performed in 1999.

## **Natural Radioactivity in Mineral Waters**

*G.Ferrador, M.C. Faisca, M. A. Tavares*

In order to obtain license concerning the commercialisation of mineral waters, an evaluation of the radioactive levels, consisting in determination of  $^{226}\text{Ra}$  concentration and global beta activity should be performed (Dec.-Lei N° 84/90).

Several enterprises of the sector or the national authority concerning the commercialisation of such waters request this radioactive study.

During 1999, 15 radiochemical analysis of  $^{226}\text{Ra}$  and 15 global beta measurements were carried out in mineral waters.

## **Nuclear Ships Staying at National Harbours**

*J. M. Oliveira, M. C. Faisca, C. Pires, M. A. Tavares*

An environmental radioactivity survey is carried out every time a nuclear ship is stays in a national harbour. A monitoring programme consisting if a continuous monitoring of aerosol radioactivity and of airborne radioiodine, as well as on sampling and further gamma spectrometry analysis of water, sediment and biological samples is performed. These last samples are collected before the arrival of the ship and after its departure.

Rreports with results and conclusions are elaborated and sent to Ministério da Defesa.

In 1999, three nuclear submarines had stayed at Cais Militar do Portinho da Costa.

## **Environmental Monitoring of the ITN Campus**

*M.C. Faisca, C. Pires, M. A. Tavares*

An environmental radioactive survey has been implemented at ITN Campus in order to detect any possible atmosphere release of radionuclides by ITN facilities. Air, rain water and grass samples are regularly collected and analysed by gamma spectrometry.

## **Radon in Workplaces**

*M. C. Faisca*

Requested by Sociedade de Água do Luso, a study concerning indoor radon levels in four working rooms was carried out and finished during 1999.

The effective dose resulting for the workers was evaluated.

## **Radon Exhalation from Building Materials**

*M. C. Faisca*

Under request or collaboration with private enterprises or users, some kinds of building materials, as well as granites, granitic sands and phosphogypsum mixtures were analysed in order to evaluate their radon exhalation rates.

## **Radiological Survey of Lisboa Sewage System**

*M.C.V. Carreiro, M.M.A. Sequeira, A.L.M. Brogueira, R. Trindade, J.B. Gomes, M.A. Pereira*

Since 1988 a radiological survey of residual waters from Lisboa sewage pumping system is carried out concerning artificial radioactivity. This work is performed at the request of Câmara Municipal de Lisboa, through the Divisão de Controlo de Qualidade, from the Departamento de Saneamento, from the Direcção Municipal de Infra-estruturas e Saneamento.

When collecting samples (CML) a radiological control is always carried out (DPSR).

Four residual water samples are monthly analysed at the DPSR by qualitative and quantitative gamma-spectrometry, which is carried out in a Ge detector linked to a 8000 channel analyser.

*Collaboration previously established between Câmara Municipal de Lisboa and Direcção-Geral do Ambiente, which was formalized by means of a Protocol signed by a representative of CML and by the Director-Geral do Ambiente.*

## Radiological Survey of Residual Waters of IPO

*M.C.V. Carreiro, M.M.A. Sequeira, A.L.M. Brogueira, M.A. Pereira*

A radiological survey of residual waters from Instituto Português de Oncologia (IPO) is carried out since 1996 concerning artificial radioactivity. This work is performed at the request of the IPO.

Monthly sampling of residual waters is done by IPO in several retention reservoirs before the IPO outlet and analysis by qualitative and quantitative gamma-spectrometry are done at the DPSR. Gamma-spectrometry is carried out in a Ge detector linked to a 8000 channel analyser.

This radiological survey is carried out at the request of the Instituto Português de Oncologia.

## Radiological Impact of Uranium Mills

*A.Brogueira, M.J. Madruga*

Requested by the Direcção Regional do Ambiente do Alentejo a technical report concerning the study of the environmental impact of *Nisa* uranium mill exploitation was elaborated.

## Radiation Dosimetry

### External Personal Dosimetry

*M.B. Martins (Coordinator), E.M. Amaral, J.G. Alves, A.D. Oliveira, G.C. Rangel, M.A. Gameiro, J.M. Paiva, M.A. Libânio, J.V. Monteiro, M.T. Luzio, V.I. Batel\*, D.J. Miranda\*, S.B. Rosa\*, S.S. Rangel\*, H.M. Cordeiro\* (\*-Bourses)*

The main line of activity concerns the Evaluation of Radiation Dose to the Portuguese Population, and conceals both research and service activities.

Service activities in this area performed on a routine basis are individual monitoring and environmental monitoring.

The main aim of individual monitoring is the measurement of the occupationally received radiation doses and the compliance to the established regulations. At DPRSN there are two on-going control methodologies, film and thermoluminescence dosimetry (TLD).

During 1999, about 8,800 workers (aprox.) from 783 facilities were controled on a monthly or quarterly basis by the Department corresponding to approximately 49,750 assessed doses.

### 1. Film Dosimetry

During 1999 about 2,800 workers from 222 facilities professionally exposed to ionizing radiations were controled meaning approximately 11,200 assessed doses (Fig.1). The personal monitor used was the Kodak type II film, changed on a quarterly basis, for the measurement of X ray and  $\gamma$  radiation.

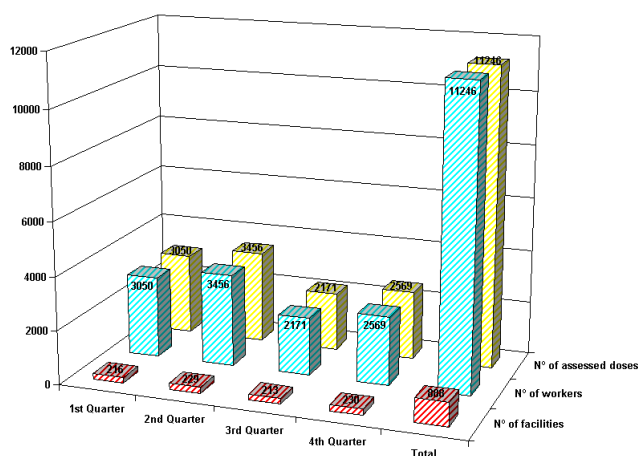


Fig. 1

This control reports the annual mean effective doses received for the monitored and exposed workers in different fields of activity, namely, health, industry and research laboratories (Fig. 2).

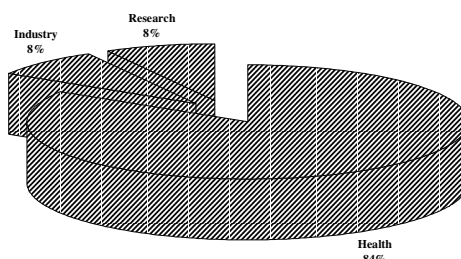


Fig. 2

The distributions of doses by dose intervals are presented in chart-3. It can be seen that most of the annual doses are distributed in two intervals  $D < 0.5$  mSv ( $\sim 96\%$ ) and  $0.5 \leq D < 5$  mSv ( $\sim 4\%$ ). Annual doses over 30 mSv were not registered and the percentage of workers that received occupational doses over 15 mSv is less than 0.1% of the total number of controlled workers (Fig.3).

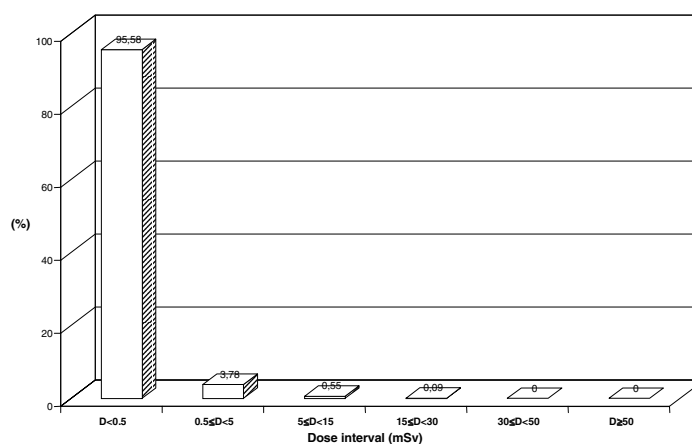


Fig. 3

### Thermoluminescence Dosimetry

The evaluation of occupationally received radiation doses using thermoluminescence dosimetry is based on the Harshaw 8814 dosimeter card and holder which contains LiF:Mg,Ti detectors. The system allows the measurement of the operational quantities  $H_p(10)$  and  $H_p(0.07)$ , the personal dose equivalents at the depth of 10 and 0.07 mm, respectively.

In 1999, 5437 workers and 553 facilities (aprox.) were controlled with this method on a monthly or quarterly basis (Fig. 4).

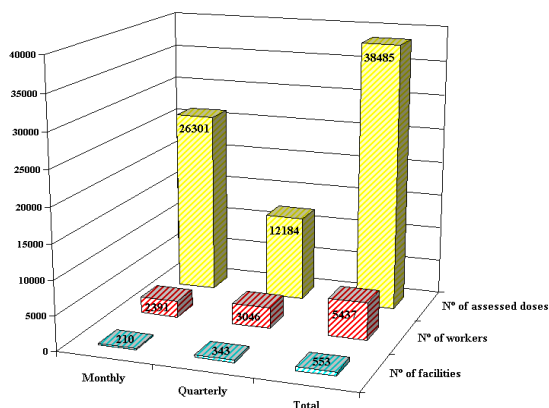


Fig. 4

This control is also distributed by the same fields of activity than film dosimetry: health, industry and research laboratories (Fig. 5).

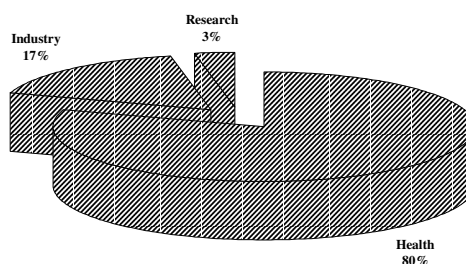


Fig. 5

The distributions of doses by dose intervals are presented in chart-6. It can be seen that most of the annual doses are distributed in two intervals  $D < 0.5$  mSv ( $\sim 70\%$ ) and  $0.5 \leq D < 5$  mSv ( $\sim 19\%$ ). Annual doses over 30 mSv were registered only for 6 workers ( $\sim 0.1\%$ ).

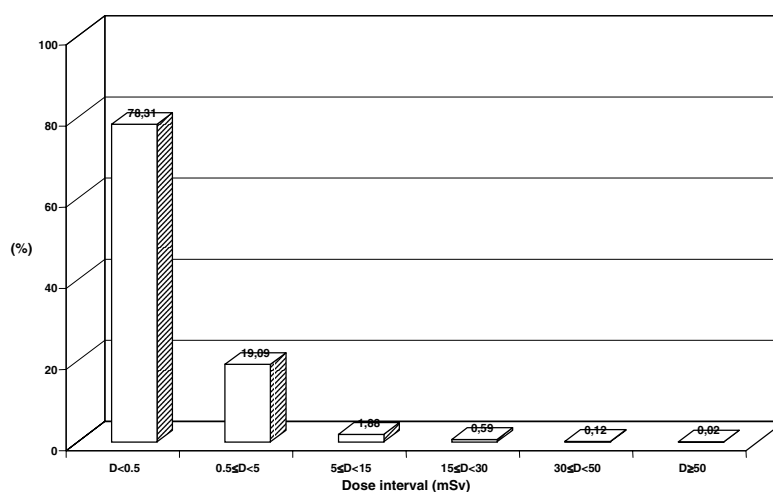


Fig. 6

### Shipment of RPI Spent Fuel

*R.Trindade, A Brogueira, F. Barreira Gomes, L. Portugal,*

A radiological monitoring programme was implemented when RPI spent fuel was transferred. Water and air samples, to detect leakage and contamination, as well measures of doses were done during the transfer. Contamination tests of cask, containers, tools and trucks were carried out. A continuous monitoring of aerosols and airborne was done at the harbour and the transport of the spent fuel was controlled. The cargo of ship was verified and doses were measured. People involved in the operation was monitored and controlled by film dosimetry.

### Radiological Control of Effluents discharged from the “Campus de Sacavém”

*R.Trindade, A. Brogueira, C. Pires, A. Costa, F. Barreira Gomes*

A radiological survey of “Campus” is carried out specially on liquids effluents discharged from RPI research laboratories to Tagus River. Several contamination and radiation controls were done on ITN facilities.

## **Radioactive Waste Management**

*Severo, A., Trindade, R., Paiva, M. I., Ribeiro, J., Teixeira, F.*

Radioactive waste has always been a matter of great concern for the DPRSN. Therefore, besides the waste management of small producers DPRSN has been participating in NEA/OCDE and in EC committees and working groups.

In pursuing the work developed on this matter in previous years, radioactive waste from small producers was collected throughout 1999. After collection the waste was treated, conditioned and put in interim storage.

Concerning the wastes from the handling of open sources, about 11 m<sup>3</sup> of radioactive wastes were collected containing different radioactive elements. Concerning the sealed sources, about 28 sources were collected containing the radioisotopes: <sup>55</sup>Fe, <sup>60</sup>Co, <sup>109</sup>Cd, <sup>137</sup>Cs, <sup>147</sup>Pm, <sup>192</sup>Ir, <sup>226</sup>Ra, <sup>241</sup>Am. Besides these sources, 3 lightning conductors, 277 Tc generators, 9 electronic valves and 2538 smoke detectors were also collected.

The volume of conditioned waste at the end of 1998 was about 90 m<sup>3</sup> corresponding to radioactive waste from the handling of open sources and 20 m<sup>3</sup> corresponding to sealed sources. The sealed sources were conditioned in 200 l cement containers and the others in 200 l iron containers.

## **Radiological Safety Assessment and Sealed Sources Licensing**

*Severo, A., Oliveira, A., Jesus, J. S., Pacheco, M. E., Rosa, A. M.*

As a technical service this activity has been necessary for licensing of installations and equipment by the General Directorate for the Health of Ministry of Health. According to Decree-Law N° 348/89 and Regulamentar-Decree No 9/90 the General Directorate for the Health requires DPRSN's radiological safety assessment to give permission for legally allow the operation of any installation or equipment using or producing ionising radiation.

Therefore, radiological safety assessments of installations or equipment during planning, implementation and operational phases, as well as the radiological inspections of those installations and equipments are DPRSN's activities essentially requested by the General Directorate for the Health. Radiological inspection can also be requested directly by the owners of equipment and installations.

Sealed sources licensing and control concerns the enforcement of Decree-Law N° 153/96. This law is applicable to all activities involving the use of radioactive sealed sources. Its objective is the radiological protection of man and environment against the dangers arising from loss, misleading or accident with any radioactive sealed source whenever the activity exceed the levels laid down in Regulatory Decree N° 9/90 of 19 April.

In what concerns the radiological safety assessment activity during 1999, about 300 studies were requested to DPRSN. These studies involved equipment and installations with different characteristics, both for medical and industrial purposes (see table below).

Concerning the sealed sources licensing and control, according to the Decree-Law No 153/96, possession, utilisation, transportation and importation of any radioactive sealed source need to be licensing . The licenses must pay a deposit for each source in their possession. This deposit is refunded when the source is sent back to the original producer or for disposal/storage. Besides that a register of emitted permissions has to be maintained.



About 160 licenses were issued in 1999. There is no charge fee for licensing.

<b>Type of equipment</b>	<b>No.</b>
Osteodensitometry	40
Mammography	41
Industrial radiology	9
Intraoral radiology	50
Orthopantomography	17
Conventional radiology	46
Tommography	23
Angiography	3
Braquitherapy	3
Industrial equipment using sealed sources	29
Radioisotope laboratories	9
Outras	4
Inspections	30
<b>TOTAL</b>	<b>304</b>

## **Medical Services**

*Ribeiro e Costa, J.E., Fragoso, M.F., Santos, H.*

Medical doctor – 1\* ( PhD or equivalent)  
 Technicians – 1 (nurse)  
 Auxiliary Technician - 1

The medical services develop four different kinds of activities:

- Occupational medicine, in particular concerning radiation protection, including medical inspections for workers exposed to ionising radiation;
- Clinical medicine, as a complimentary service to ITN workers;
- Laboratorial medicine as support to the occupational medicine and clinical medicine;
- Education in medical and biological aspects of radiation protection and medical advise in case of over-exposure;

The number of medical examinations and clinical analyses done in 1999 are presented in the following table:

<b>1. Clinical analyses: total number of analysed parameters</b>	<b>1 608</b>	
	ITN & external	TOTAL
<b>2. Total medical examinations</b>		<b>1110</b>
2.1. Pré-placement health examinations	53	
2.2. Periodical health examinations	62	
2.3. Terminal health examinations	18	
2.4. Occasional health examinations	977	
<b>3. Worker position reclassifications</b>	6	
<b>4. Visits to work places</b>	10	
<b>5. Occupational injuries registered in the Individual Process</b>	6	

## **Metrological Control Service**

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 de 21 de Julho. Metrological control includes calibration and type testing, During 1999 were calibrated 46 dosimeters and performed type testing of 1 dosimetric system of Armed Forces. About 200 TLD dosimeters were irradiated.