2017 International Nuclear Atlantic Conference - INAC 2017
Belo Horizonte, MG, Brazil, October 22-27, 2017
ASSOCIAÇÃO BRASILEIRA DE ENERGIA NUCLEAR – ABEN

Agência Brasileira do ISBN
ISBN 978-85-99141-07-6

OVERVIEW OF ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM OF INSTITUTE OF RADIATION PROTECTION AND DOSIMETRY – IRD

Gomes, Sarah Barreto Oliveira de Christo[1] and Peres, Sueli da Silva[1]

[1] Instituto de Radioproteção e Dosimetria (IRD/CNEN)
Divisão de Radioproteção
Av. Salvador Allende, s/n, Barra da Tijuca
22783-127 Rio de Janeiro, RJ
suelip@ird.gov.br and sarah.barreto1@gmail.com

ABSTRACT

As a branch of the Brazilian Nuclear Energy Commission (CNEN), the Institute of Radiation Protection and Dosimetry (IRD) performs extensive activities in the fields of radiation protection, metrology, and dosimetry, as well as specific education, onto a wide operational scope that includes the technical support to national regulatory authorities in the licensing process for nationwide nuclear and radioactive facilities. IRD has several laboratories where are performed radiometric and radiochemical analyses and others radioactivity evaluation procedures in different types of samples obtained in the inspection activities, production of radioactivity metrological standards and reference material by National Laboratory of Metrology of Ionizing Radiation (LMNRI), besides others research activities. In this laboratories can be used sealed or unsealed radioactive sources and radiation-producing devices and are classified with radioactive installations in accordance to national regulations. This way, radioactive liquid effluents can be eventually produced and released into the environment in the course of such activities and an effluent monitoring program to control and reduce the releases to environment is carried out. Additionally, IRD maintains the Radioactive Waste Management Program and Environmental Radiological Monitoring Program (ERMP) in accordance to national regulations requirements. The primary focus of ERMP comprises the validation of the dose prognostics for the public members due to effluents discharge and the provision of consistent projections of the radiation levels at the monitoring sites. In this study, a long term ERMP data survey is discussed, spanning the last thirteen years of activities. On the basis of such discussions and prognostics, it could be observed that the radiological environmental radiological impact due to operation of IRD installations is negligible.

1. INTRODUCTION

Created in 1972, the Institute of Radioprotection and Dosimetry (IRD) originated in the *sixties* as a Dosimetry Laboratory at the Pontifical Catholic University of Rio de Janeiro (PUC-RJ). Nowadays, a branch of the National Nuclear Energy Commission (CNEN), it is one of the most important institutions in Latin America dedicated to the radiation protection, dosimetry and metrology of ionizing radiations. From 1979 to 2007 was subordinated to the Radiation Protection and Nuclear Safety Directorate (DRS/CNEN), from 2008 to 2016 was part of the Research and Development Directorate (DPD/CNEN), and in late 2016 returned to the DRS/CNEN.

IRD occupies a total area of about 350,000 m^2 in the Barra da Tijuca neighbourhood at Rio de Janeiro County, Brazil. It is situated near the Jacarepaguá Lagoon and residential areas. Figure 1 shows the location of the IRD in Barra da Tijuca area.

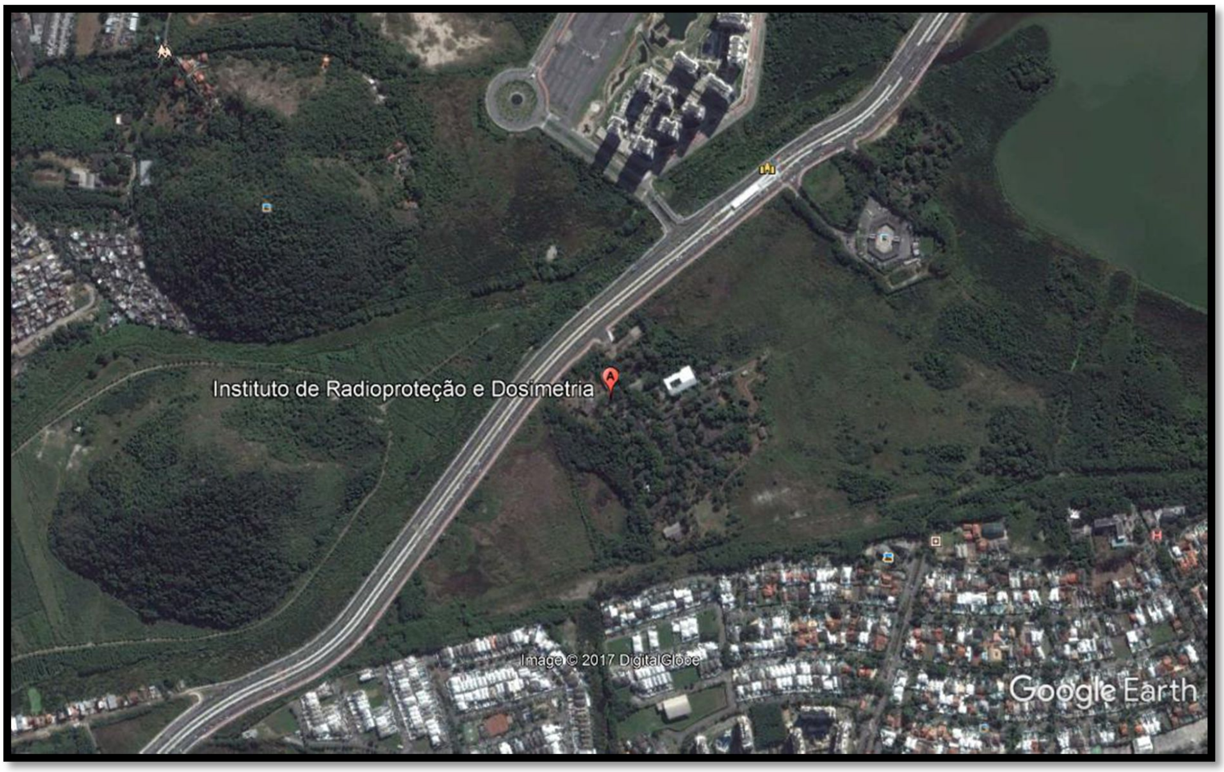

Figure 1: Location of the IRD in Barra da Tijuca area.

IRD provides technical support to the regulatory activities of CNEN and performs extensive scientific researches. Besides, post-graduate courses and specialized education on radiation protection, dosimetry and metrology of ionizing radiation are included in the academic activities at IRD. Its activities have contributed for the development of technologies and the implementation of solutions for problems of radiation protection that ensure the safe use of radiation in Brazil.

Due to growing retirements and the insufficient personnel replacement in the Brazilian nuclear area, IRD currently has around 190 professionals working in its different areas. Renewal of human resources has been one of the major challenges of Brazilian nuclear sector; the average age of staff is about 55 years. In the last ten years, IRD lost around 40% of its personal, moreover, the budget has been severely cut. In both, activities typically performed could be stopped and the efforts to preserve the operation of IRD in accordance with national environmental regulations could be compromised. This situation is much worry for the IRD role in Brazil.

IRD laboratories perform radiochemical and radiometric analyses of different samples, elaborate metrological standards and reference materials, among other activities. Sealed and unsealed sources are used and so these laboratories are classified as radioactive facilities, according to national standards (CNEN, 2014). It has no nuclear facilities.

Two potential sources of data on radiation releases could be used to estimate environmental radiological impact due the operation IRD radioactive facilities:

- Measurements of radioactivity contained in effluents that can be released by IRD laboratories.
- Measurements of radiation in the environment around nuclear facilities.

In accordance with the regulations, IRD maintains Programs for Radioactive Waste Management, Radioactive Effluents Monitoring and Environmental Radiological Monitoring.

In general, small quantities of radioactive wastes are generated at laboratories and they are frequently of low level. The solid radioactive wastes include items that have become contaminated with radioactive material and typically consist of paper, plastics material, liquid scintillation vials, protective clothing, wiping rags, treatment residues of liquid wastes and other supplies used in laboratories where radioactive material is present. The most common liquid waste generated is aqueous. Only aqueous liquid effluents from the treatment of the aqueous liquid wastes and wash water wastes of laboratory materials may be disposed into the sewage system if the radionuclide concentrations are low enough. The other, less common form of liquid radioactive waste is composed of organic material that cannot be disposed of through the sewage system under any circumstances. Toluene and xylene-based liquid scintillation cocktails and some organic solvents fall into this category. Non-aqueous wastes are collected, filtered to separate all filterable solids and stored in appropriate containers. After segregation, treatment and conditioning all wastes are stored onsite in the small facility, where such materials are maintained under control.

Besides this, a sewage system has been constructed, separating sanitary sewage from chemical sewage generated in the laboratories, in order to perform release control on laboratories liquid effluents. In the effluent monitoring program samples are taking weekly to form monthly composite samples, which are then analysed. Daily measurements of physical and chemical parameters are also carried out on these samples. Based on the source term, are defined the radiometric and radiochemical analyses and the radionuclides of interest to the ERMP. Release data are recorded in a database for effluent release control.

The air sampling is performed continuously under the CTBT Laboratory, located at NE sector, and the results are provided to be included in the environmental monitoring program. There is no radioactive atmospheric release in amount above of the detectable minimum activities of analyse method (Melo, Rochedo, Magalhães, Peres, & Ferreira, 2005).

The Environmental Radiological Monitoring Program (ERMP) based on region characteristics, habits of the population, source term, exposure pathways, release types and dispersion of effluent. ERMP comprises measurements of environmental gamma radiation, activity concentration levels in food and the environment and other parameters (CNEN, 2011, 2014).

2. Environmental Radiological Monitoring Program for IRD – ERMP

The development of Environmental Radiological Monitoring Program was initiated in 2003, after a survey of radionuclides used in each laboratory in order to estimate the radionuclides amount in effluents that could potentially be released into the environment (Melo, Rochedo, Magalhães, Peres, & Ferreira, 2005). The ERMP is an instrument that integrates the environmental radiological control performed by the IRD and its main objectives are (Peres, Reis, & Ribeiro, 2013):

- To verify if the operational practices are in accordance to the applicable regulatory requirements;
- To support the environmental radiological impact assessment, resulting from IRD activities in the surrounding environment;
- Provide means to demonstrate that the source and release of radioactive effluents are under control;
- Perform the supervision of the surrounding region in order to identify changes in environmental parameters that indicate the need ERMP revision;
- To evaluate the need to implement corrective actions.

In the ERMP soil samples, surface and underground water, sediment and vegetation are collected and analysed. The sampling frequency is semester. Samples are analysed by gamma spectrometry, trace element determinations by ICP-MS, radiochemical analysis for determination of Ra-226, Ra-228, Pb-210 and Pb-212.

For the vegetation matrix, are analysed in banana tree leaves, present in sampling points, and "taboa" leaves, abundant in the area near to the discharge point of liquid effluents. Groundwater samples are collected from two IRD wells, one at SW sector (upstream) and one at E sector (downstream). It should be noted that no liquid effluents are released into the Jacarepaguá Lagoon by IRD. However, due the proximity among Institute and lagoon, to demonstrate that there is no water body impact due IRD operation and provide information to stakeholders, the ERMP contemplates the sediment and surface water monitoring of Jacarepaguá lagoon.

The Jacarepaguá Lagoon has an area of 11 square kilometres and rivers feeding into her are heavily polluted with untreated domestic waste, sanitary sewage and other industrial waste water. Due pollution, eutrophication has been observed in the monitored points.

The levels of environmental gamma radiation are evaluated within the property area of the IRD using Thermoluminescent Dosimeters (TLD). Eleven measurement stations were installed, being eight located in eight sectors of wind direction and three are close to places of greater public access in the IRD. The sampling frequency is semester.

All ERMP results are recorded in the database of environmental data to assess trends and to support to results comparison and the decision-making process if anomalous results are detected. The ERMP is summarized in the Table 1.

Table 1: Summary of ERMP of IRD

Sample Type	Sampling Point Localization	Sampling Frequency
Air (gases and aerosols)	NE	Continuous
Underground water	SW and E	Semester
Soil	S, N and release point of liquid effluent	
Vegetation – “Taboa” leaves	release point of liquid effluent	
Vegetation - Banana tree leaves	S and N	
Sediment	Jacarepaguá Lagoon	
Surface water		
Air (Kerma rate)	11 stations (W, SW, S, SE, E, NE, NW, N sector and R, D and points)	

3. RESULTS AND DISCUSSION

One kerma rate measurement at SW point was higher than the previous values measured in this station and other points. As this station is located near to the IRD Neutron Laboratory and away from areas of public access, it must be relocated to another location. The average rate of kerma at southwest point was estimated at 140.5 nGy.h^{-1}. Figure 2 shows the average rate of kerma in the air for each measuring station. The average rate of kerma to all stations of TLD is approximately 131.5 ± 18 nGy.h^{-1}.

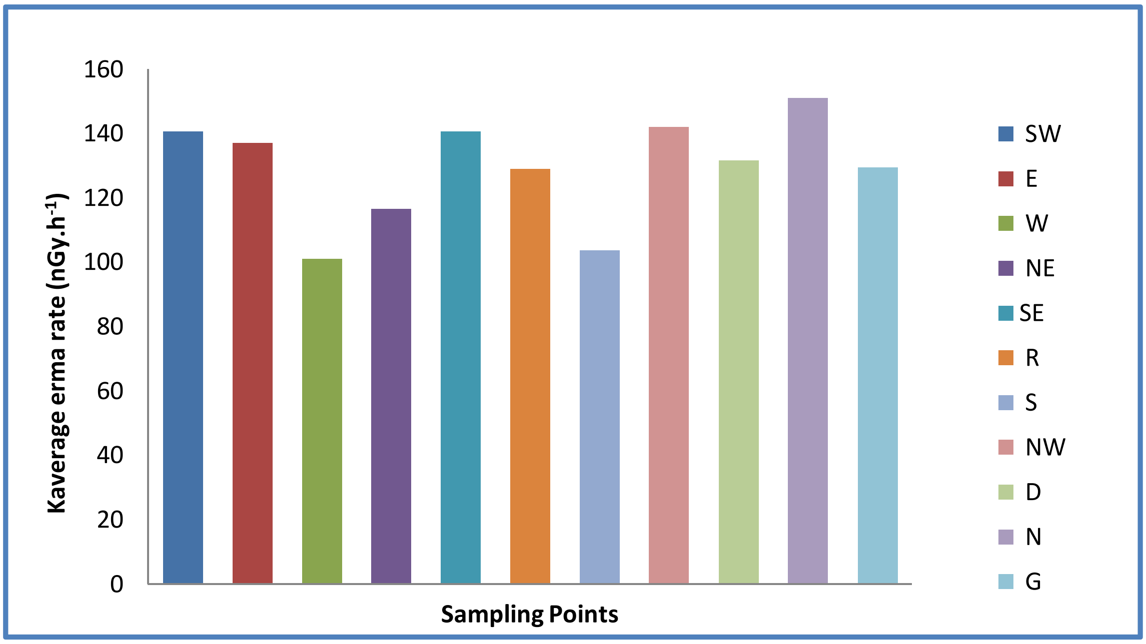

Figure 2: Measurements of environmental gamma radiation level using TLD.

For all samples, only natural radionuclides were detected in levels above detectable minimum activity. The activity concentrations present in all samples are consistent with worldwide reference values (UNSCEAR, 2008). Table 2 summarize the results of ERMP sampler's analyses. As reference, the activity concentrations in liquid effluent released are also showed in the Table 2.

Table 2: Samples analyses results of the ERMP.

Sample	Point	^{40}K	^{7}Be	^{226}Ra	^{232}Th	^{228}Ac
Underground water (Bq/L)	SW	<AMD	<AMD	**1.75E-02**	<AMD	<AMD
Underground water (Bq/L)	E	**3.83E+00**	<AMD	**1.50E-02**	<AMD	<AMD
Soil (Bq/Kg)	S	**1.06E+02**	**4.96E+00**	**1.60E+01**	<AMD	**5.81E+01**
Soil (Bq/Kg)	N	**6.99E+02**	<AMD	**5.05E+01**	**5.61E+02**	**1.85E+02**
Soil (Bq/Kg)	ETE	**1.21E+03**	<AMD	**1.12E+01**	<AMD	**1.87E+02**
Vegetation – "Taboa" leaves(Bq/Kg)	ETE	**1,05E+04**	**1.44E+02**	**1.37E+00**	<AMD	**1.93E+02**
Vegetation - Banana tree leaves (Bq/Kg)	S	**1.23E+04**	**1.52E+03**	**3.55E-01**	<AMD	**1.17E+02**
Vegetação - Banana tree leaves (Bq/Kg)	N	**1.15E+02**	**2.32E+03**	**5.66E-01**	<AMD	**1.15E+02**
Sediment (Bq/Kg)	LJ	**4.24E+01**	<AMD	**4.21E+00**	**5.17E+02**	**1.02E+01**
Surface water (Bq/L)	LJ	**4.23E+00**	<AMD	**1.45E-02**	<AMD	<AMD
Effluent	ETE	**2.62E+01**	<AMD	**2.02E-02**	<AMD	**1.20E+01**

AMD: Minimum Detectable Activity
LJ: Jacarepaguá Lagoon
ETE: IRD Sewage Treatment Station. Point is near to ETE.

4. CONCLUSION

After thirteen years, it can be inferred that the ERMP of IRD is fulfilling its main goals. The results have demonstrated that the environmental radiological impact arising from the facilities operation of the IRD can be considered irrelevant. Although the levels of radiation are those expected for the area, due to the interference of the laboratory operation of neutrons in point SW, the repositioning of the sampling point is necessary. The results of the ERMP, in particular of the lagoon of Jacarepaguá samples, contribute to improving the transparency with the interested parties and show that the IRD activities have been carried out safely.

However, the loss of human and budgetary resources, through growing retirements, lack of staff renewal and government cuts, may affect the environmental performance so far achieved. Actions need to be taken to avoid this threat.

5. REFERENCES

CNEN. (2011). Posição Regulatória 3.01/008:2011. *Programa de Monitoração Radiológica Ambiental*. Rio de Janeiro, RJ, Brasil: CNEN.

CNEN. (2014, Março). Norma CNEN NN 3.01 - Diretrizes Básicas de Proteção Radiológica. *Resolução CNEN 27/04*. Rio de Janeiro, RJ, Brasil: CNEN.

CNEN. (2014, abril 16). Resolução nº 166. *Norma CNEN NN 6.02 - Licenciamento de Instalações Radiativas*. Rio de Janeiro, RJ, Brasil.

Melo, V. P., Rochedo, E. R., Magalhães, E. S., Peres, S. S., & Ferreira, A. C. (2005, August 28 to September 2,). DEVELOPMENT OF AN ENVIRONMENTAL MONITORING PROGRAM FOR IRD – INSTITUTO DE RADIOPROTEÇÃO E DOSIMETRIA, CNEN. *Analls of International Nuclear Atlantic Conference - INAC 2005, Santos, SP, Brazil*. Santos, SP, Brazil.

Peres, S. S., Reis, R. G., & Ribeiro, F. C. (2013). IRD, DIRAD. *Programa de Monitoração Radiológica Ambiental Operacional*. Rio de Janeiro, RJ, Brazil.

UNSCEAR. (2008). Sources and Effects of Ionizing Radiation. *Report to the General Assembly with scientific annexes, Volume I*. New York, USA: United Nations Scientific Committee on the effects of Atomic Radiation – UNSCEAR.