Assessment of Radioactive Liquid Effluents Release at IPEN-CNEN/SP

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Abstract. A continuous effluent monitoring program has been established at IPEN's plant in order to allow an environmental impact assessment due to radioactive liquid effluent discharge to sanitary system. Representative samples of radioactive liquid effluents are analyzed by using high resolution gamma spectroscopy and instrumental neutron activation analysis, facing to Brazilian radioprotection regulatory rules. The results are consolidating yearly in the Institute source-term. In this paper, results of the source-term are presented, concerning to years 2004, 2005 and 2006. The total activity discharged was 8.5 $\times 10^8$Bq, 5.7$\times 10^8$Bq and 2.7$\times 10^8$ Bq, respectively. As the release is strongly dependent on the total amount of the effluent and on the dilution factor, special attention is needed in order to obtain the correct value of that last one. The estimated inside plant dilution factor, considering the recent facilities and the reshaping of the sewerage system was 80, 180 and 130, for period of 2004, 2005 and 2006 discharged liquid radioactive effluent.

Keywords: radioactive liquid effluent, dilution factor, monitoring effluent programme.
PACS: 89.60-K

INTRODUCTION

The Instituto de Pesquisas Energéticas e Nucleares, IPEN (Nuclear and Energy Researche Institute) belonging to the Comissão Nacional de Energia Nuclear, CNEN, (National Commission for Nuclear Energy), was built 50 years ago, in a remote site in the city of São Paulo, Brazil. Nowadays, with the growth of the city, the institute is surrounded by industrial and residential areas. IPEN-CNEN-SP comprises several nuclear and radioactive facilities including a research reactor, two cyclotrons and the radioisotopes and radiopharmaceuticals production plant. Activities related with the nuclear fuel cycle are also developed at the Institute, as well as research in cited fields.

In order to estimate the release amount to the sanitary system, a liquid effluent monitoring programme was established, in a continuous way. It allowed an evaluation of the adequacy of the radioactive liquid effluent emission and assessment of the environmental impact due to this practice [1, 2, 3, 4, 5]. Consideration of dilution factors liquid effluents released from nuclear and radiactive facility in Brazil is a recent rule [3, 4, 5]. Then, as the release is strongly dependent on the total amount of the effluent and on the dilution factor, special attention is needed in order to obtain the correct value of that last one [6]. The present paper presents an evaluation of the dilution factor, considering the recent facilities, the reshaping of the sewerage system and the aquatic environment under the IPEN–CNEN/SP influence.

CP1034, *The Natural Radiation Environment—8th International Symposium,* edited by A. S. Paschoa

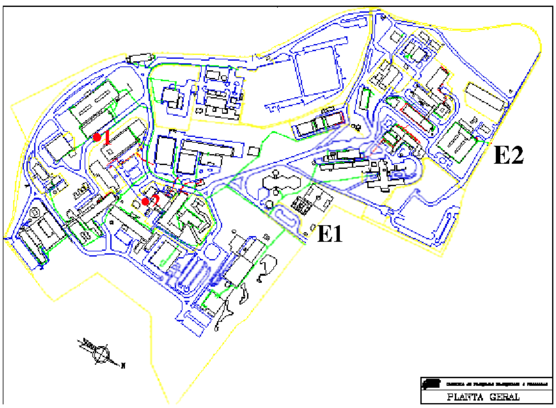
METHODOLOGY

Regarding liquid releases, all the radioactive liquid effluents generated at IPEN`s facilities or laboratories are stored and monitored in their respective retention tanks. Each batch of the effluents generated is representatively sampled and analyzed prior to discharge. Within this programme, liquid effluents are analyzed on a regular basis by using high resolution gamma spectrometry and instrumental neutron activation analysis [7].

The total activity together with the total volume of wastewater released by year is consolidated in an annual source-term. These procedures possibilities accurately determine the types and quantities of radioactive materials being released to the receptor sewerage. Special attention has been given to effluent concentration discharge limits and to discharge dilution factor [3, 4, 5]. The radioactive liquid effluent dilution factor was estimated using the yearly integrated aquatic consumption for individual facility and total dispersion release volume source-term available data.

RESULTS AND DISCUSSION

Figure 1 presents a distribution of the actual sewerage system and location of main plants, considering the recent facilities, the reshaping of the sewerage system and the discharge sanitary points.



The IPEN-CNEN/SP has its facilities spread over an area of about 500,000 m^2, the buildings covering 85,000 m^2. The main objectives are to perform research and developments in the field of the peaceful uses of nuclear energy and renovated sources of energy.

•**1** – **CR**:Radioisotopes and Radiopharmaceuticals Production Center.
•**2** – **CRPq**: Research Reactor (IEA-R1) Center.
E1 and E2: liquid discharge to site sanitary system.

FIGURE 1. Main Recent Facilities, and Actual Reshaping of the Sewerage System.

The IPEN-CNEN/SP is a Brazilian reference in the nuclear fuel cycle researches. This development field began in 1970, having dominancy in the fuel cycle steps pilot scale from Yellow Cake to Uranium Hexafluoride technology in the 1990 decade. In the past, the discharge point E2 has been the most important due to operations of several pilot plants and the radionuclide from decay series of uranium and thorium were critical.

Nowadays, the reshaping of the sewer, presented in the figure 1, has characterized the discharge point E1 as that receiving the significant amount of radioactive liquid effluent, being principal contributors the Radioisotopes and Radiopharmaceuticals

Production Center (CR) and the Research Reactor Center (CRPq), when considers the total release activity (Bq) and volume (m^3), as below.

Table 1 shows the source-term percent contribution concerning to radionuclide, facility and sanitary discharge place. The results from table 1 shows that CRPq and CR have contributed with about 98% of total released activity present in the liquid discharge.

TABLE 1. Percent Contribution to Source-term by Radionuclide and Facility.

	Contribution ($\% \cdot y^{-1}$)			
Radionuclide	**2004**	**2005**	**2006**	**Facility/Discharge Point**
^{60}Co	76.4	72.5	50.9	CRPq/E1
^{58}Co	0.1	1.3	0.6	CRPq/E1
^{137}Cs	8.3	4.1	6.8	CRPq/E1
^{54}Mn	nd	1.1	2.4	CRPq/E1
^{124}Sb	0.7	0.4	2.3	CRPq/E1
^{65}Zn	4.3	4.0	20.9	CRPq/E1
Contribution (%)	89.8	83.4	83.9	
^{51}Cr	1.0	0.3	0.2	CR/E1
^{67}Ga	5.9	14.3	8.6	CR/E1
^{131}I	1.8	0.7	1.6	CR/E1
^{65}Zn	nd	0.07	4.6	CR/E1
Contribution (%)	8.7	15.4	15.0	

Table 2 presents the consolidated yearly source-term. The total activity, total volume, estimated dilution factor and activity after dilution factor applying are showed for to entire plant.

TABLE 2. Radioactive Liquid Effluent Release Data at IPEN-CNEN/SP.

Year	**Source-term (Bq)**	**Source-term (m^3)**	**Dilution Factor**	**Source-term dilution ($Bq \cdot m^{-3}$)**
2004	8.0×10^8	550	80	2.1×10^4
2005	5.7×10^8	293	180	1.1×10^4
2006	2.7×10^8	406	130	5.2×10^3

The dilutional volume determined contribute to decreasing the total concentration activity ($Bq \cdot m^{-3}$), by a dilution factor of about 1×10^2 to 2×10^2.

CONCLUSIONS

Effluent monitoring data are effective to determine the degree of regulatory compliance for each facility or the entire plant, as appropriate. The evaluations are also useful in assessing the effectiveness of effluent monitoring program, handling procedures and management practices.

All results are in good agreement with Brazilian regulatory rules, values expected for the area, showing the effectiveness of the radiological effluent monitoring program concerning IPEN's facilities.

Major facilities have their own individual retention tanks, which are linked to sanitary discharge system, being possible to estimate the dilution factor relative to liquid radioactive discharge.

An inside-field dilution factor calculated by this study appears to be a reasonable assumption to management and decisions concerning on radioprotection practices and regulatory adjustment.

Previously assumed dilution factors were for shoreline points, outside the plant. It is the first study contributing to internal dilution factor statement.

The dilutional volume (or flow) must be determined specifically for each plant, case to case. In addition, a table of expected dilution volumes may be prepared by continuous monitoring.

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