

## ENVIRONMENTAL GAMMA RADIATION IN CENTRO EXPERIMENTAL ARAMAR

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### ABSTRACT

The experimental results are described obtained with  $\text{CaF}_2$ : Dy thermoluminescence dosimeters ( TLD-200 ) for the measurement of natural outdoor gamma radiation background in Centro Experimental Aramar ( CTMSP ) and surroundings , from 1994 to 1997 . The Centro Tecnológico da Marinha ( CTMSP) is a military research organisation, located in S.Paulo city , whose objectives are to develop nuclear and energy systems for Brazilian Naval Ship propulsion. The estimated average outdoor gamma dose rate in air is  $405 \pm 71 \mu\text{Gy}\cdot\text{y}^{-1}$ . This value indicates a low outdoor gamma dose rate in air in Centro Experimental Aramar and region.

### I. INTRODUCTION

The Centro Tecnológico da Marinha ( CTMSP) is a military research organisation, located in S.Paulo city whose objectives are to develop nuclear and energy systems for Brazilian Naval Ship propulsion. Two separate projects are being developed in Centro Experimental Aramar, located at Iperó city ( 100 km from S.Paulo) , called Ciclone and Remo. The Ciclone project is related to the fuel cycle plant and the Remo project is related to a PWR prototype power station to be used in a submarine propulsion [ 1 , 2 ] .

Environmental monitoring is concerned with the measurement of the natural radiation arising from natural

radioactive materials present in the surroundings, and from cosmic rays [ 3 ] .

The investigation of background radiation in Centro Experimental Aramar is of great significance , because this industrial nuclear research programme is being developed in this centre . Therefore, passive integrating  $\text{CaF}_2$  : Dy thermoluminescence dosimeters were exposed outdoors monthly , in several environmental stations distributed inside and outside the research centre , from 1994 to 1997. This study provides a reference level for the purposes of comparative monitoring and, specifically, knowledge of radioactive concentrations is a basic task in determining background levels, transfer and dosimetry implications.

## II - MATERIALS AND METHODS

In the vicinity of this nuclear research centre about 23 environmental stations equipped with  $\text{CaF}_2 : \text{Dy}$  thermoluminescence dosimeters were used in order to estimate the dose rates in air from outdoor gamma radiation. Five stations were located outside the centre and 18 stations inside the centre. The monitoring station was a wood stick with a wood box. One PVC plastic badge containing three detector chips hung in free air inside the box, 1 m above the ground. A calibration check was carried out for each field cycle in order to reach a high precision for exposure conversion and to correct for fading effects., transit exposure, laboratory background and sensitivity changes of the reader and detectors. The procedure adopted for field measurement has been already described in reference [ 4 ]. The environmental dosimeter is made of three chips detectors 3 x 3 x 0.8 mm<sup>3</sup>, encapsulated in a transparent plastic which is inserted inside a black polyethylene pouch in order to protect the dosimeters from light and humidity.

In order to reduce the signal accumulation during transport, all the dosimeters were placed in a lead casket.

The badges with TLD chips were placed on the selected points around the centre. The distance between any two points was at least 500 m ( inside points ) and several km ( outside points ).

The individual calibration factor was adjusted every field cycle. The exposure measured at each station was taken as the mean value of the three TL detectors.

The TL readings were converted to the evaluated dose value according to the TL response of the same batch of TLDs.

## III - RESULTS AND DISCUSSION

The measured values of gamma dose rates (  $\mu\text{Gy.y}^{-1}$  ) obtained for each one of the 23 environmental stations in Centro Experimental are given in Table 1 . These values are mean values and respective standard deviations for the period from 1994 to 1997 ( available data from 1997 are relative to the first and second semester only ) . Standard deviations calculated for each sample point were lower than 10 % , indicating homogeneous annual doses, excepting the measurements done in points 1, 2 and 21 , about 25-30 % .The explanation for these higher standard deviations are not well understood yet. The cosmic ray contribution is included in the measured results of dose.

The measured values of gamma dose rates , in terms of  $\mu\text{Gy}$  per trimester, obtained in the environmental stations are shown in figure 1 . The results of this paper are compared with the data obtained in several places in the world, by other authors ,using the same kind of dosimeters,and are of the same order as those from Germany , USA, Austria , Belgium and Italy, while lower than Portugal , France ,Hungary, Greece and Finland. The average value for S.Paulo city is 480  $\mu\text{Gy.y}^{-1}$  [ 4, 5 ] .

## IV- CONCLUSIONS

Passive dosimeters based on  $\text{CaF}_2 : \text{Dy}$  TLD detectors were used in the period from 1994 to 1997 to measure the natural background outdoor gamma radiation in Centro Experimental Aramar. Twenty three environmental stations were studied, 18 located inside in the centre and 5 located outside. The results of this study provide an estimate of average outdoor absorbed dose rate in air of  $405 \pm 71 \mu\text{Gy.y}^{-1}$  [ 4 ] , calculated for the 23 environmental stations. This average value obtained are of the same order or lower than background values obtained in other places, indicating a low outdoor gamma dose rate in air in Centro Experimental Aramar and region.

## V - REFERENCES

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Table 1 - Annual average outdoor gamma dose in air in environmental stations located in Centro Experimental Aramar and region.

sample point	annual dose $\mu\text{Gy.y}^{-1}$	sample point	annual dose $\mu\text{Gy.y}^{-1}$
1	$366 \pm 120$	13	$497 \pm 7$
2	$341 \pm 143$	14	$404 \pm 5$
3	$281 \pm 10$	15	$339 \pm 30$
4	$424 \pm 28$	16	$468 \pm 26$
5	$305 \pm 45$	17	$419 \pm 15$
6	$492 \pm 18$	18	$411 \pm 15$
7	$457 \pm 2$	19	$442 \pm 33$
8	$451 \pm 17$	20	$464 \pm 28$
9	$449 \pm 21$	21	$311 \pm 83$
10	$457 \pm 4$	22	$271 \pm 19$
11	$429 \pm 11$	23	$337 \pm 19$
12	$496 \pm 8$	average	$405 \pm 71$