

ENVIRONMENTAL RADIATION FREE REFERENCE FOR THERMOLUMINESCENCE MONITORING ESSAY

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ABSTRACT

Measurement of environmental radiation, from natural sources only or without human activities influence, is a very difficult task. It could vary from place to place and is not easy to guarantee that no source from human activities is present, besides low background calibration complexity. Another difficulty is to evaluate precisely non-desired radiation absorbed by dosimeter during the transport from thermoluminescence analysis/fabrication laboratory to the monitoring field. In this work it is shown the procedure adopted by the Thermoluminescence Dosimetry Laboratory (LDT-IPEN/CNEN) in order to measure this *environmental radiation free reference for thermoluminescence monitoring essay* (call *Ref.Amb.*). It was adopted a place in a residential area at a medium city as the *field point* to the measurement, far some kilometers from industries, clinics, universities and hospitals. Measurements occur since year 2003, at time intervals of six months. In order to correct non-desired transport doses, it has been used the "environmental monitoring algorithm"[1]. Results, although comprising very equivalent values, pointed to some seasonal effects. The value for *Ref.Amb.* established at each semester has been used to analyze environmental monitoring results of certain client places, where no study is available concerning radiation level before human activities begin to happen at that point.

1. INTRODUCTION

How to measure a quantity by an equipment that could not be turned off until it reaches the measurement field point? And if the measurand will have values inside intervals close to its lower measurement limit? For these situations, that could be found in measurements in air or water pollution, or any environmental studies, it was proposed an algorithm to correctly travel and place the passive detector, using more than one auxiliary meters, in order to minimize spurious effects on the measurement. This algorithm was published in Metrology 2003 [1] and was used in this work to measure *environmental radiation free reference for thermoluminescence (TL) monitoring essay* (from now on *Ref.Amb.*).

Ref.Amb. is a value most used for comparisons with monitoring measurements in places or environments where no radiation measurements were done before human activities established in. This is a questionable comparison unless it happens in a point field with similar geological or environmental conditions.

Ref.Amb. point used in this work is situated at outskirts of Araraquara, a medium city in the geographical center of São Paulo state. The point field where measurements was done is far some kilometers from industries, hospitals or clinics with radiological or radiotherapy activities, and is placed two meters above floor and closed to a wood rafter outside the house. Such a placement prevents undesired radiation absorption from radon or backscattering [2]. This work shows a period of monitoring from April of 2003 to March of 2005.

2. METHODOLOGY

2.1 Dosimeter and TL Measurements

It was used the same TL dosimeter (TLD) used in routine environmental monitoring for mines, industries or nuclear plants in Brazil, shown in Figure 1. This TLD is also used in personal dosimetry and is fully described in [3]. Its lower limit of measurement is $0,12 \mu\text{C/kg}$ [4], in photon exposure quantity.



Figure 1: TLD opened used for environmental monitoring. It is shown the three phosphors, as small white discs inside the badge. Three TLDs are used in the Ref.Amb. point field.

2.2 Experimental Procedure

The algorithm to travel and position TLDs to minimize spurious measurements of radiation is fully explained in [1]. In such an algorithm, the alternative trajectory for the travel dosimeter is by post. Measurements are been done each six months since year 2003.

3. RESULTS

An example of electronic table used for data register and calculus at each period of monitoring (six months), when TLDs are changed and analysed, is in Figure 2. It was made a mean of three dosimeters, A1 to A3, to obtain the Ref.Amb. Each TLD has three phosphor discs too. TL reader machine gives an answer in units of nC and so it is used the laboratory process calibration curve of the evaluation date to convert units into photon exposure.

In Figure 3 it is shown the Ref.Amb. in the monitored period, values monthly, although each measurement was completed in six months. The mean value of this period from 2003-April to 2005-September was $1,56 \mu\text{C}/\text{kg month}^{-1}$ of photon exposure. From April to September periods seem to be lower values of Ref.Amb., but the measurement uncertainties do not permit an effective affirmation of this seasonality.

Datas:

Dosímetros:	IDA				VOLTA					Leitura em:
	Tratamento:	Envio ao Campo:	Colocação no Campo:	Envio ao LDT:	Colocação na Blindagem:	Saída p/ Busca:	Retirada do Campo:	Envio ao LDT:	Colocação na Blindagem:	
A1	28/3/2003	29/3/2003	29/3/2003				13/10/2003	14/10/2003		15/10/2003
A2	28/3/2003	29/3/2003	29/3/2003				13/10/2003	14/10/2003		15/10/2003
A3	28/3/2003	29/3/2003	29/3/2003				13/10/2003	14/10/2003		15/10/2003
Bi	1/4/2003					2/4/2003				15/10/2003
Bf	28/3/2003	29/3/2003	29/3/2003	1/4/2003	1/4/2003					7/10/2003
Vi-1	28/3/2003	29/3/2003	29/3/2003	1/4/2003						1/4/2003
Vi-2	28/3/2003	29/3/2003	29/3/2003	1/4/2003						1/4/2003
Vf-1	28/3/2003	29/3/2003	29/3/2003	1/4/2003	1/4/2003	11/10/2003		14/10/2003		15/10/2003
Vf-2	28/3/2003	29/3/2003	29/3/2003	1/4/2003		1/4/2003	7/10/2003	14/10/2003		15/10/2003
E	28/3/2003	29/3/2003	29/3/2003	1/4/2003	1/4/2003			14/10/2003		15/10/2003

Leituras:	Plástico:	Chumbo:	Pb-furo:	Exposição bruta:	Desvio padrão:	ruido	luz	fat.cal.	lote
	(nC)	(nC)	(nC)	($\mu\text{C}/\text{kg}$)	($\mu\text{C}/\text{kg}$)	(nC)	(nC)	(mSv/nC)	
A1	2,885	2,756	2,562	12,028	0,143	0,0216-0,0219	30,40-30,32	0,166	R
A2	2,323	2,676	2,605	11,169	0,254	"	"	0,166	R
A3	2,141	2,831	2,318	10,719	0,428	"	"	0,166	R
Bi	0,5462	0,7117	0,7936	3,017	0,142	"	"	0,166	R
Bf	0,6048	0,9836	0,8915	3,653	0,222	0,0269-0,0282	29,92-29,54	0,166	R
Vi-1	0,1517	0,1415	0,1332	0,700	0,008	0,026-0,0313	30,8-30,54	0,186	R
Vi-2	0,1531	0,149	0,1173	0,689	0,020	"	"	0,186	R
Vf-1	0,9046	1,34	0,7325	4,381	0,342	0,0216-0,0219	30,4-30,32	0,166	R
Vf-2	0,9021	1,037	1,093	4,454	0,121	"	"	0,166	R
E	0,9561	0,9716	1,038	4,352	0,058	"	"	0,166	R

menor dos Vis:	0,689
menor dos Vfs:	4,381

Exposição mensal	
(Referência) =	1,582 ($\mu\text{C}/\text{kg}$)
desv.pad. =	0,056 ($\mu\text{C}/\text{kg}$)

radiação média mensal na blindagem ($\mu\text{C}/\text{kg}$):	desv.pad.:
0,460	0,041

Figure 2: Electronic table example used for data register at each TLD change (used for each six months).

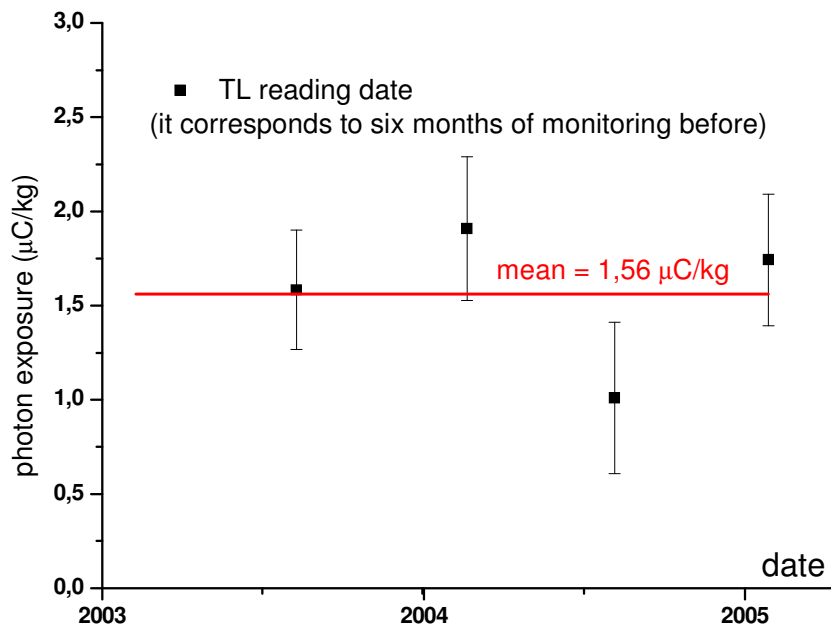


Figure 2: Values of monthly Ref.Amb.. Each point correspond to monitoring occurred in the last six months from that date.

4. CONCLUSIONS

The environmental radiation free reference for thermoluminescence monitoring essay was described and its mean value measured from April-2003 to September-2005 was $1,56\mu\text{C}/\text{kg month}^{-1} \pm 20\%$ (confidence level of 90%).

REFERENCES

1. J.E.Manzoli and O.Manzoli Neto, "Algoritmo para Monitoramento Ambiental com Detector Passivo na Impossibilidade de Blindagem", - *Proceedings of METROLOGIA-2003 – Metrologia para a Vida - Sociedade Brasileira de Metrologia (SBM)*, Recife, Pernambuco - Brazil, CDROM, September 01–05, 2003.
2. G.F. Knoll, "Radiation Detection and Measurement", 2 ed. Michigan. John Weley & Sons, 1955.
3. José Eduardo Manzoli and Ricardo Nunes de Carvalho THE THERMOLUMINESCENT DOSIMETER OF IPEN - A DESCRIPTIVE WORK OF BASIC OPERATION AND PRODUCTION "*International Conference on Occupational Radiation Protection:*

Protecting Workers against Exposure to Ionizing Radiation" Genebra, na Suíça, de 26 à 30 de agosto de 2002

4. *José Eduardo Manzoli, Vicente de Paulo de Campos and Mirian Saori Doi*
EVALUATION OF REPRODUCIBILITY AND DETECTION LIMIT OF CaSO₄:Dy
RADIATION DETECTORS METROSUL IV – IV Congresso Latino-Americano de
Metrologia “A METROLOGIA E A COMPETITIVIDADE NO MERCADO
GLOBALIZADO” 09 a 12 de Novembro, 2004, Foz do Iguaçu, Paraná – BRASIL Rede
Paranaense de Metrologia e Ensaios