RADIOPROTECTION PROCEDURES APPLIED IN LABORATORY FOR BRACHYTHERAPY SOURCES DEVELOPMENT

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Abstract. The Brazil's Energy and Nuclear Research Institute is developing a national prototype of iodine-125 seeds used in brachitherapy.This study aim is to evaluate the radiological protection requirements used with imported Iodine-125 sources. All the resoults show no contamination and very low exposure, proving the method valid.

Keywords: radiation protection, brachytherapy, Iodine-125, seeds manufacture.

1. INTRODUCTION

The prostate cancer treatment with iodine-125 radiactive seeds uses about 100 seeds. Those seeds are imported at US$ 26.00 each, what is not affordable to all people [1,2].

A multidisciplinary team was created in IPEN to develop a national 125-iodine souce and to implement the facity for local production. This will make possible to lower the treatment cost and make it viable for more patients [2]. The development of a radioactive souce laboratory implies: to establish radioprotection parameters; to structure radioactive seeds procedures. While the laboratory is being assembled, IPEN has distributed imported 125-Iodine seeds to be used in Brazilian hospitals.

2. METHODOLOGY AND EXPERIMENTAL PROCEDURE

The methodology used in this work is the evaluation of Laboratory radioprotection system, in accordance with rules CNEN 3.01 [3] . It will be presented:

- Characteristics of the seeds distributed by IPEN;
- Location of the main monitoring point;
- Characteristics of the groups of workers and the results of personal dosimetry;

2.1 Characteristics of Iodine-125 seeds

The process of radionuclides production in nuclear reactors is based on the capture of thermal neutrons (i.e, neutrons with low kinetic energy, of the order of 0.025 eV) for atoms of a given element [4,5]. The Iodine-125 is produced in a nuclear reactor from Xenon-124. It decays by electron capture and internal conversion to Tellurium-125. Photons of 27keV, 31keV and 35keV (mean 29keV) are issued. Given the low average energy of emission, their photons have low power of penetration [2,5].

The Iodine-125 is placed in a small titanium capsule of 0.8 mm external diameter, 0.05 mm of wall thickness and 4.5 mm in length. In Brazil, approximately 33,413 Amersham / GE seeds were purchased in 2008 and distributed by IPEN to 19 clinics [1].

2.2 Dosimeters

- **Area control – A-15**

A TLD dosimeter is used for local control. They are placed in areas of highest risk in the installation. He is positioned on the wall, where the radioactive material leaves for transport (* ouside room 49, in Fig.1). They are evaluated quarterly. Different sources, usually, pass by this dosimeter, such as: Iodine-125 (55% ***), Iridium-192 (30% ***), Bromine-82, Barium-133, Cesium-137, Cobalt-60, Cobalt-57 and Iodine-131 (15 % ***). *** estimates

- **Occupational Control**

All individuals have a personal dosimeter to enter controlled or supervised areas. The classification of the assessment locals are showed in Fig.1.

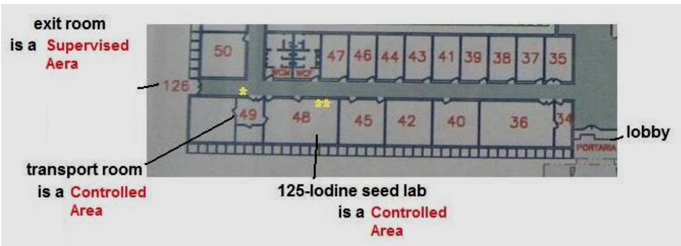

Figure 1: Classification of areas and location of rooms and dosimeter. Souce: Building Layout by Botelho /CTR-IPEN

2.3 Occupational Exposure

All technicians, trainees, researchers and members of radiation protection staff use a personal dosimeter, which is evaluated monthly, to monitor the received dose.

3. RESULTS

3.1 Area Dosimeters

The 4 years results of A-15 dosimeter readings are presented in graph (Fig.2).

- Highlighted peak in the graph represents:
- Iodine-125 sources prototype test;
- Intense studies with Iodine-131;
- Highest Iridium-192 thread production.

Table 2: Percentage of exposure per year compared with the annual ceiling of permissible 20mSv.

	% de 20mSv
2007	4,9
2008	10,9
2009	7,8
2010	6,9

Since the dosimeter is located in a controlled area, the data were compared with the maximum annual limit (20mSv).

3.2 Occupational Exposure

Figure 3 shows the results of the monitoring of individuals involved in handling and distribution of sources over 4 years. Table 3 presents de reference levels.

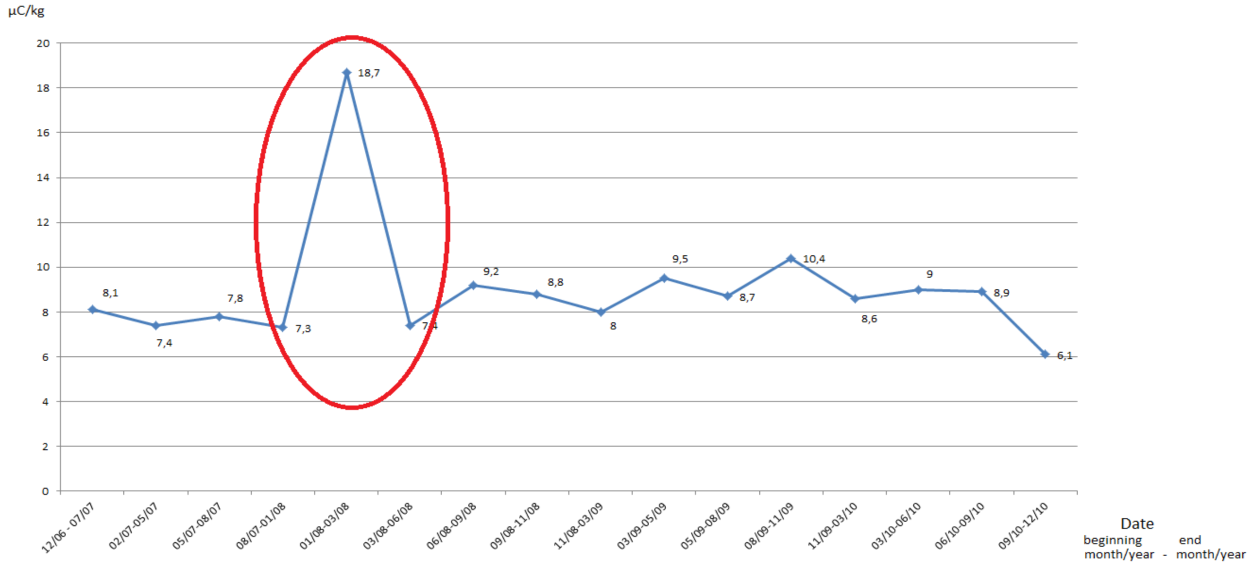

Figure 2: Graph for 6 years of exposures of the dosimeter-15.

To quantify this exposure, assuming that a worker has received all the exposure that the dosimeter has received, discarding the natural exposure, the following calculation was made, in accordance with *Sanches* [6]:

$$D_{AR} (Sv) = 33.7. X(C/kg). 1.27^* \qquad (01)$$

* (converting factor Gy → Sv)

Table 1: Results of the measures in µC / kg converted to Sv.

	X(µC/Kg)	D_{AR}(mSv)
2007	23,3	1,0
2008	51,4	2,2
2009	36,6	1,6
2010	32,6	1, 4

For a workload of 2000 hours/year, the highest amount of exposure is 11% of the maximum permitted dose (Tab. 2).

Table 3: Reference Levels used by IPEN*.

Restriction of dose levels**: 10 mSv/year**
Levels of dose Registration**: 0.20 mSv/month**
Investigation Levels:
Effective dose: 6 mSv / year or 1 mSv in any month
Dose Equivalent: Skin / Hands and Feet: 150 mSv / year or 20 mSv in any month.
Dose Equivalent: Crystalline: 50 mSv / year or 6 mSv in any month

As it can be observed, no individual has reached the level of the research presented in table 3. Many individuals were below the method levels of log-dose.

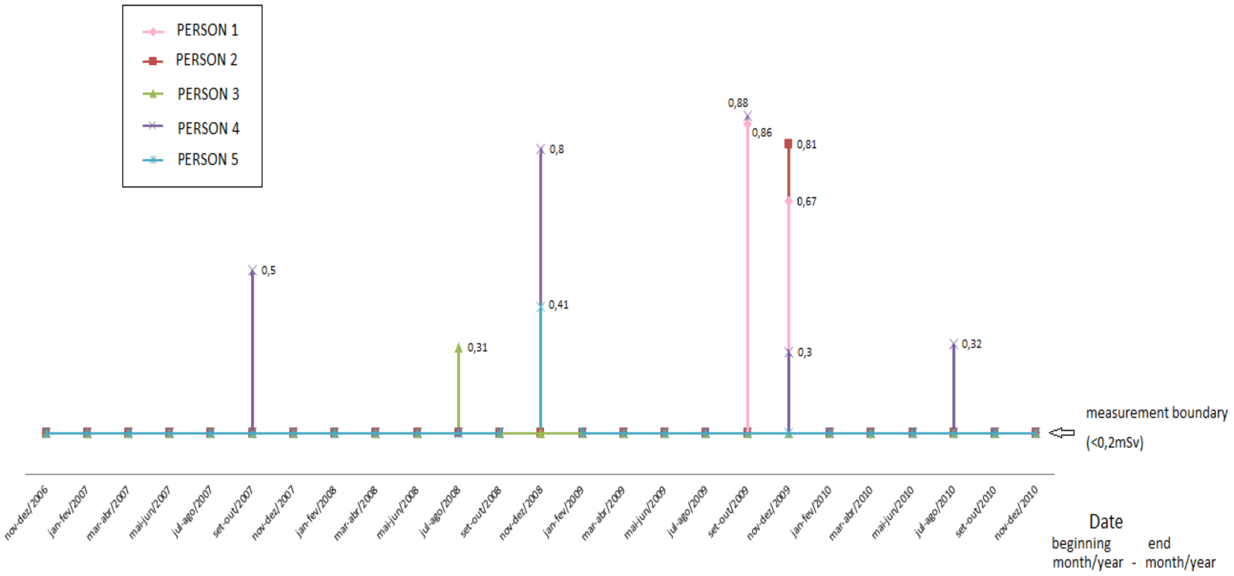

Figure 3: Results of 4 years of personal dosimeters of individuals involved with the handling and transport of sources of Iodine-125.

4. DISCUSSION AND CONCLUSION

This work presented the results of occupational and area dosimetry and the transport procedures used in handling the imported source of iodine-125. This analysis will help researchers to develop the system to be employed in the new laboratory that will produce these sources in Brazil.

The existing area dosimeters are in contact with various radioactive isotopes. Ratings of 4 years showed very low exposures. The maximum value per year allowable by the NN 3.01 CNEN standard is 20mSv.

The evaluation of occupational exposures shows that low or no exposure was received by the workers during the 4 years surveyed. This shows that individuals are aware of the effects and necessary cares that they must have, when handling radioactive elements. Most of them manipulate other isotopes. A new proportional dosimeter will be installed at the manufacture laboratory. The work will continue during the laboratory construction. When production begins, few changes should be made. Since production costs in Brazil will made the treatment more accessible, the tendency is to increase the flow of materials for transport. Given this new reality into focus, a monitoring dosimeter and TLD area control (at location ** 48, showed in Fig.1) should be installed in the room. More results will be evaluated in future work.

ACKNOWLEDGMENTS

Thanks to: Matias Sanches, Estanislau Vianna, Laércio Carvalho, João Trencher, Vladimir Lepki e Samir Somessari.

REFERENCES

[1] Souza CD. Braquiterapia com sementes de Iodo-125: Manufatura e Tratamento. [Tese de Conclusão de Curso]. São Paulo: Instituto de Biociências da UNESP Botucatu; 2009.

[2] Rostelato MECM. Estudo e Desenvolvimento de uma nova Metodologia para Confecção de Sementes de Iodo-125 para Aplicação em Braquiterapia. [Tese de Doutorado]. São Paulo: Instituto de Pesquisas Energéticas e Nucleares; 2006.

[3] Comissão Nacional de Energia Nuclear. Diretrizes Básicas de Proteção Radiológica. 2005. (CNEN-NN-3.01).

[4] Podgorsak EB. Radiation Oncology Physics: A Handbook for Teachers and Students; VIENNA: International Atomic Energy Agency; 2005.

[5] Kaplan I. Física nuclear. v 2. Rio de Janeiro: Guanabara Dois, 1978.

[6] Sanches MP. Fundamentos de Radioproteção: Cálculo de Dose Apostila APO-NP-028, 2002.