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DETERMINATION OF DOSE EQUIVALENT LEVELS AT A LABORATORY FOR NEUTRON DETECTOR TESTS

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ABSTRACT

With the increase in the demand for the calibration of neutron detectors, there is a need for a calibration service. In this context, the Calibration Laboratory of Instituto de Pesquisas Energéticas e Nucleares (IPEN), São Paulo, which already offers calibration services of radiation detectors with standard X, gamma, beta and alpha beams, has recently projected a new test laboratory for neutron detectors. In this work the equivalent dose levels for the staff and public at the Neutron Tests Laboratory (LTN) were evaluated with an ^{241}Am(Be) radioactive source. The evaluations were performed according to the Brazilian regulations of the Comissão Nacional de Energia Nuclear (CNEN). Two gamma and neutron radiation detectors were used for the measurements. They were taken in different positions at the LTN, considering the source exposed and inside its shielding. The results obtained were all within the Brazilian recommended limits, showing that the shielding of the LTN guarantees the safety to the staff and general public.

1. INTRODUCTION

Currently, there is a large demand for the use of neutron radiation, especially in oil exploration, nuclear reactors and production of radiopharmaceuticals. To ensure the safety of workers and individuals from the public, the safety standards recommend that the maximum acceptable limits for these individuals should be followed according to the legislation of each country.

The neutron radiation dosimetry may be performed by means of ionization chambers, fission chambers, liquid scintillators coupled to photomultiplier tubes, gas proportional detectors and semiconductor detectors. They are used in the determination and monitoring of the dose equivalent rates in places where occupational exposure to neutron radiation is present.

Therefore, the calibration of measuring instruments is obligatory by an authorized institution that complies with specific standards, thus ensuring that the detector is working properly [1]. In Brazil, currently there is only one calibration laboratory of neutron radiation detectors, responsible for the custody and maintenance of the Brazilian standard of fluency of neutrons, located at the Laboratório Nacional de Metrologia das Radiações Ionizantes (LNMRI), of the Instituto de Radioproteção e Dosimetria (IRD / CNEN), Rio de Janeiro.

With the aim of decentralizing the offer of calibration services of the institute and considering that at the IPEN there are over 30 neutron radiation detectors used by workers of the two nuclear reactors and two cyclotrons, besides various neutron sources, arose the need of another calibration laboratory with neutrons at the IPEN, for use initially for testing portable detectors with neutron radiation.

2. MATERIALS AND METHODS

2.1. Radioactive source

The LTN radiation system is composed of a ^{241}Am(Be) AMNK128- model AMN200 source with activity of 3.7×10^{10} Bq (1Ci) and neutron emission rate of 2.46×10^{6} n / s [2]. The source was calibrated at the primary standard system at the LNMRI (IRD/CNEN). Figure 1 shows the dimensions of the ^{241} Am (Be) source used in this work.

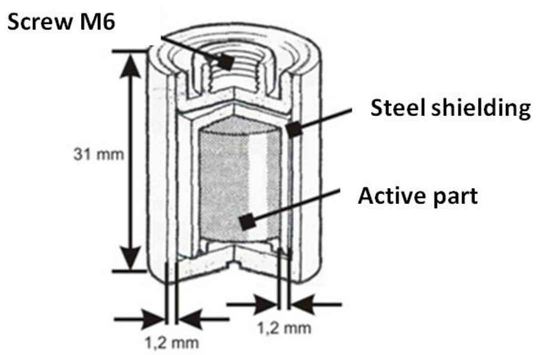

Figure1: Neutron source of ^{241}Am(Be) at the Neutron Test Laboratory (LTN) .

2.2. Test laboratory

The laboratory is located in a Bunker (underground), and it presents walls of concrete with 15.0 cm of thickness, covered with 2.5 cm thick plates of drywall, with the exception of the control room wall, which is made entirely of two drywall plates with 1.25 cm of thickness, separated by a 9.0 cm thick air layer. There are also two wooden doors with 3.4 cm thickness and a back door of a source storage room, with 2.0 cm thickness of lead covered with two iron layers of 3.0 cm thickness. The ceiling is made of concrete and the floor of granite.

Measurements were taken in the laboratory internal area with the source inside the shielding, and in the control room and in the hallway (which gives access to other laboratories), with the exposed source. The LTN room project is shown in Figure 2 [3].

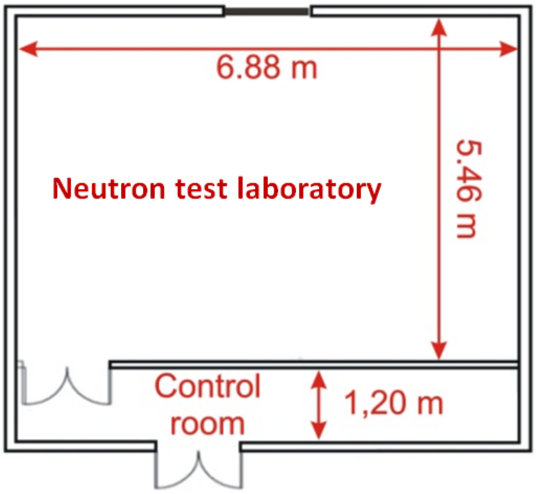

Figure 2: Simplified floor plan of the Neutron Test Laboratory.

To evaluate the dose equivalent levels, to which workers and the public may be exposed, fifteen positions were selected, called measurement points, as shown in Figure 3.

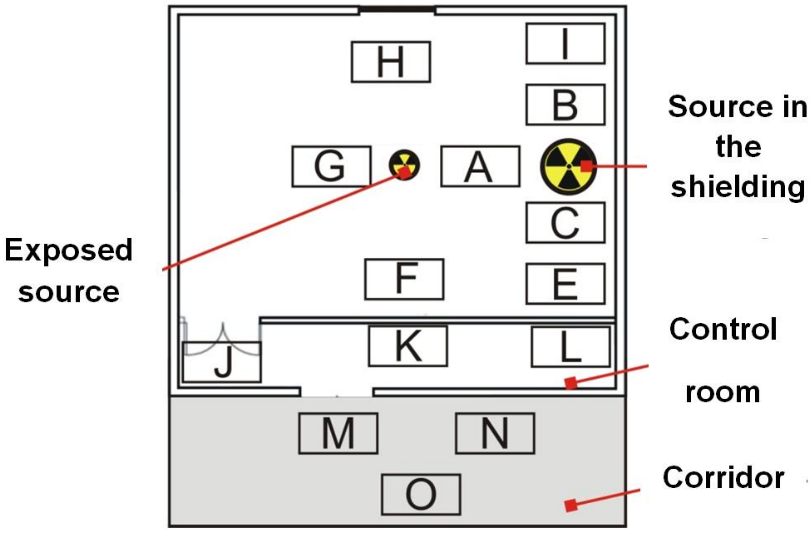

Figure 3: Floor plan of LTN, identifying the points for the radiometric survey. The measuring point D is located at the top of the source shielding, and can not be seen in this figure.

2.3. Radiation detectors

The portable radiation monitors used in this work were Geiger-Müller/Graetz 6150 ADS and Canberra model Dineutron. Measurements were carried out with the source exposed and inside its shielding.

3. RESULTS

Table 1 shows the results obtained of the radiometric survey.

Table 1: The LTN radiation levels, with the ^{241}Am(Be) source.

Measuring point	Dose equivalent rate (μSv/h)			
	Gamma Radiation		Neutron Radiation	
	Value	Uncertainty (%)	Value	Uncertainty (%)
Measurements with the source inside its shielding				
A	7.19	3.3	0.60	2.5
B	6.09	3.0	0.70	3.0
C	6.59	4.3	0.81	2.6
D	8.31	2.5	12.3	2.1
E	0.61	3.0	0.51	4.1
F	0.52	2.8	0.48	3.4
G	0.35	2.7	0.41	3.3
H	0.52	2.8	0.38	2.9
I	0.80	1.3	0.45	3.0
Measurements with exposed source				
J	0.51	2.3	0.44	2.8
K	0.81	2.6	0.42	2.6
L	0.49	2.7	0.41	2.0
M	0.21	2.4	0.10	3.2
N	0.17	3.0	0.10	3.1
O	0.14	3.0	0.10	4.3

The points A, B, C and D showed high dose rates, to gamma radiation, due to the distance between the measuring point and the source (10 cm, in the case of points A, B and C, from the shielding). The point D, located at the top of the shielding, was the point with the highest radiation level, (both for neutron and gamma radiations) although all of the values obtained were within the limits of the CNEN standard [4].

At the points F, G, H and I, inside the laboratory, with the source inside its shielding, the radioactive levels are well below the limits established by the CNEN standard for workers. In the control room and hallway, with the exposed source in the test position, inside the LTN, the levels were within the limits in supervised areas [4].

4. CONCLUSIONS

Through a radiometric survey it was possible to observe the working conditions in LTN and its classification. The results showed that the radiation levels are within the limits established by the Comissão Nacional de Energia Nuclear.

ACKNOWLEDGMENTS

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