ICMP 2011
April 17-20 · Porto Alegre - RS - Brazil

Study of Calibrations Factors $N_{d,w}$ to Ionization Chambers Type Thimble of volume 0.60 cm^3 in gamma radiation - 60Co

W. B. Damatto[1,2], M. P. A. Potiens[1], G. P. Santos[1] and V. Vivolo[1]

[1] Instituto de Pesquisa Energéticas e Nucleares/CNEN, Centro de Gerenciamento de Metrologia das Radiações, São Paulo, Brasil

[2] Pontifícia Universidade Católica de São Paulo, Centro de Ciências Exatas e Tecnológicas, São Paulo, Brasil

***Abstract*— This paper presents the partial results of a scientific initiation whose theme is of adequacy in quality system calibration laboratory (LCI-IPEN) of dosimeters clinical in 60Co, gamma radiation beams, to the protocols of the International Atomic Energy Agency (IAEA), which is the new protocol Calibration of Reference for External Beam Radiotherapy Dosimeters (Technical Reports Series No. 469), which is a new update of Absorbed Dose Determination Protocol in External Beam Radiotherapy (Technical Reports Series No. 398).The calibration factors for different dosimeters clinical were acquired during the calibrations performed by the LCI-IPEN its customers. As the LCI-IPEN possess a great demand of calibrations and possess descriptions of the equipment that had been calibrated in the institute, it was possible to get a great sampling of calibration factors of different clinical sets, thus being able, if to determine average values of the factors of calibration with its respective uncertainties of each existing model in the market. Finally it was determined the range of variation of all existing models of clinical sets of ionization chamber type thimble volume of 0.60 cm^3 and was used to determine which equipment is less variation of the calibration factor, and this equipment will have better reproducibility between their models.**

***Keywords*— ionization chamber, gamma 60Co, quality system, radiation calibration.**

INTRODUCTION

The work will demonstrate the calibration factors [1, 2] of the main equipment used by hospitals and clinics radiotherapy. It was determined the range of energy dependence of each model of dosimeter clinical and its possible variation, determining which equipment has a better repeatability [2] and reproducibility [3] as compared to their same set of clinical models. Some models have a good sampling can determine the maximum and minimum values of each model of dosimeter clinical with reliability. LCI-IPEN these data will be added as a criterion for calibration of equipment to be calibrated.

The importance of performing the calibration and the calibration factor is the role assigned to clinical dosimeter in hospitals and clinics. Function to give the absorbed dose to water at the reference depth [2]:

$$D_{w,Q} = M \, .f_{(t,p)} \, .N_{D,w,Qo} \, .k_{Q,Qo} \qquad (1)$$

M: Reading on the instrument in units of scale;
$f_{(t,p)}$: Normalization factor of environmental conditions for the temperature of 20^{o}C and pressure of101.3 kPa;
$N_{D,w,Qo}$: Calibration coefficient in terms of dose in water into a Cobalt-60 beam;
$k_{Q,Qo}$: Correction factor for the difference enters the quality of Qo reference and the quality of the using Q. [2]

WRITING THE PAPER

A. Materials and Methods

It this work was performed tests in the many dosimeter of the Calibration Laboratory (IPEN-CNEN/SP). Clinical dosimeters used in this work consisting of one ionization chamber (0.6 cm^3) from different manufactures, electrometer from different manufacturers, with traceability of the Laboratório de Calibração de Instrumentos (LCI-IPEN), belonging to hospitals, clinics, and other. The irradiator used in the calibration of dosimeters is a teletherapy system from Siemens, model Gamatron, with gamma radioactive source of 60Co (1250 keV), activity of 0.34 TBq (1999).

To perform the calibration procedures are applied the short and long term stabilities tests, following the brazilian and international recommendations. The calibration of clinical dosimeters is performed by the method of substitution, being;

it performed measures readings with the reference dosimeter of institute are compared with those of the dosimeter to be calibrated.[2]

Fig. 1 Example of dosimeter clinical: (a) electrometer. (b) Cables. (c) connectors.(d) ionization chamber

Fig. 2 Irradiation Room consists a Gamatron radiator system of Co-60, acrylic phantom with distilled water and holder's, thermometers, air conditioning, humidifier, hygrometer and a table for support

B. Results

The tables below present shall go analyzed the amount of equipment in the calibration performed by the LCI-IPEN, the average Nd,w factors [2] of each clinical group, the standard deviation and final uncertainty, which in this case we used the standard deviation as uncertainty type "a", and as "b" is used the factor of uncertainty in the calibration certificate provided (± 1.5) [3], determined by the rule of propagation of uncertainties in the final uncertainty. In the charts we can see each value of $N_{d,w}$ for each set clinical calibrated with its respective manufacturer and model in common.

Table 1 Data from calibration factor, $N_{d,w}$, for ionization chamber model Victoreen 580

Number of equipment	**Nd,w Average**	**Average Standard Deviation**	**Final Uncertainty**
11	**54,1102**	**0,2082**	**1,5144**

Nd,w máx.:	**55,6245**	mGy/ue	***Nd,w :***	**54,1102 ± 1,5144**	mGy/ue
Nd,w mín.:	**52,5958**	mGy/ue			

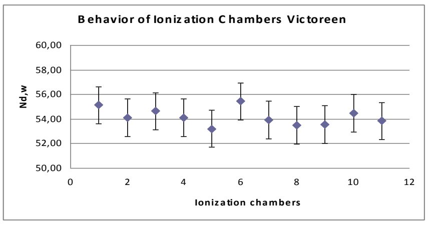

Fig. 3 Graphic behavior of ionization chambers model Victoreen

Table 2 Data from calibration factor, $N_{d,w}$, for ionization chamber model Wellhöfer-IBA

Number of equipment	**Nd,w Average**	**Average Standard Deviation**	**Final Uncertainty**
26	**48,0771**	**0,1224**	**1,5050**

Nd,w máx.:	**49,5820**	mGy/ue	***Nd,w :***	**48,0771 ± 1,5050**	mGy/ue
Nd,w mín.:	**46,5721**	mGy/ue			

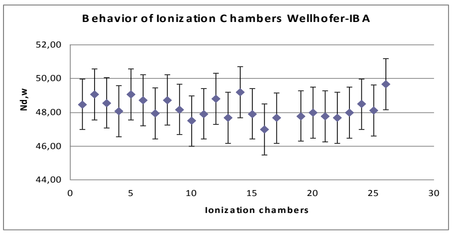

Fig. 4 Graphic behavior of ionization chambers model Wellhöfer-IBA

Table 3 Data from calibration factor, $N_{d,w}$, for ionization chamber model NE 2505/3B

Number of equipment	Nd,w Average	Average Standard Deviation	Final Uncertainty
24	46,1600	0,1867	1,5116

Nd,w máx.:	47,6716	mGy/ue	*Nd,w :*	46,1600	±	1,5116	mGy/ue
Nd,w mín.:	44,6484	mGy/ue					

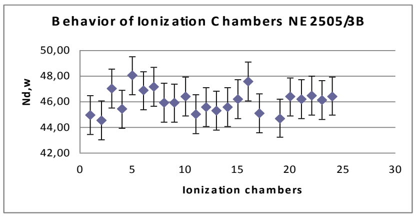

Fig. 5 Graphic behavior of ionization chambers model NE 2505/3B

Table 5 Data from calibration factor, $N_{d,w}$, for ionization chamber model PTW TN30013

Number of equipment	Nd,w Average	Average Standard Deviation	Final Uncertainty
41	53,5561	0,0682	1,5015

Nd,w máx.:	55,0576	mGy/ue	*Nd,w :*	53,5561	±	1,5015	mGy/ue
Nd,w mín.:	52,0545	mGy/ue					

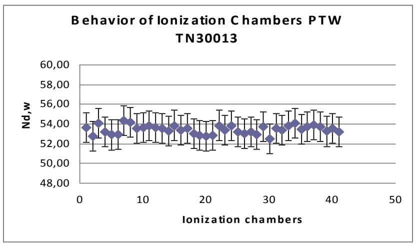

Fig. 7 Graphic behavior of ionization chambers model PTW TN30013

Table 6 Data from calibration factor, $N_{d,w}$, for ionization chamber model PTW TN3001

Number of equipment	Nd,w Average	Average Standard Deviation	Final Uncertainty
18	53,6179	0,1741	1,5101

Nd,w máx.:	55,1280	mGy/ue	*Nd,w :*	53,6179	±	1,5101	mGy/ue
Nd,w mín.:	52,1078	mGy/ue					

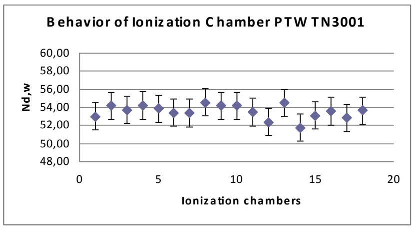

Fig. 8 Graphic behavior of ionization chambers model PTW TN3001

Table 7 Data from calibration factor, $N_{d,w}$, for ionization chamber model Exradin A12-Ns.: Only Number

Number of equipment	Nd,w Average	Average Standard Deviation	Final Uncertainty
24	49,3949	0,2164	1,5155

Nd,w máx.:	50,9104	mGy/ue	*Nd,w :*	49,3949	±	1,5155	mGy/ue
Nd,w mín.:	47,8793	mGy/ue					

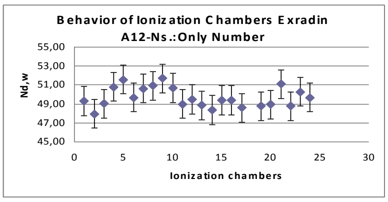

Fig. 9 Graphic behavior of ionization chambers model Exradin A12-Ns.: Only Number

Table 8 Data from calibration factor, $N_{d,w}$, for ionization chamber model Exradin A12-Ns.: XA

Number of equipment	**Nd,w Average**	**Average Standard Deviation**	**Final Uncertainty**
23	**48,4902**	**0,1521**	**1,5077**

Nd,w máx.:	**49,9979**	mGy/ue	***Nd,w :***	**48,4902 ± 1,5077**	mGy/ue
Nd,w mín.:	**46,9825**	mGy/ue			

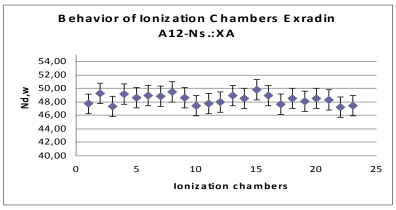

Fig. 10 Graphic behavior of ionization chambers model Exradin A12-Ns.: XA

CONCLUSIONS

From the results presented we can see the range of energy dependence of each type of clinical set by determining a mean value of calibration factor with its respective uncertainty for each existing model. The overall clinical model with the smallest variation of $N_{d,w}$ between its maximum and minimum was the model PTW TN30013 and the model of clinical set that had the biggest change was the model Exradin A12 Ns.: Only Number, but because they were calibrated equipment changes in maximum and minimum were very close between the models, but the model PTW TN30013 for having the largest sample would tend to possess the greatest range of variation between the maximum and minimum values of the calibration factor. However the results were contrary showing stable behavior of the model PTW TN30013.

ACKNOWLEDGMENT

The authors thank of Agência Internacional de Energia Atômica (IAEA), Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP), Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) e Ministério da Ciência e Tecnologia (MCT, Projeto: Instituto Nacional de Ciência e Tecnologia (INCT) em Metrologia das Radiações na Medicina) the partial financial support.

REFERENCES

1. IEC-60731 (1997) Medical Electrical Equipment Dosemeters with Ionization Chambers as Used in Radiotherapy
2. International Atomic Energy Agency (2000) Absorbed Dose Determination in External Beam Radiotherapy, IAEA, Vienna, (Technical Report Series No. 398).
3. International Atomic Energy Agency (2009) Calibration of Reference Dosimeters for External Beam Radiotherapy.IAEA, Vienna, (Technical Reports Series No. 469)

CORRESPONDING AUTHOR:

Author: Willian Behling Damatto
Institute: Instituto de Pesquisa Energéticas e Nucleares (IPEN-CNEN/SP)
Street: Av. Prof. Dr. Lineu Prestes, nº 2242
City: São Paulo
Country: Brasil
Email: wbdamatto@ipen.br