EURADOS INTERCOMPARISON RESULTS FOR INDIVIDUAL MONITORING LABORATORY IN ALBANIA

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Abstract

The Dosimetry Laboratory of the Department of Radiation Protection and Monitoring Network (Institute of Applied Nuclear Physics) took part in the EURADOS IC2018ph intercomparison exercise for the whole body for photon fields. The participation in this event was supported by the International Atomic Energy Agency (IAEA) within the framework of the TC regional project "Strengthening Protection of Radiation Workers and Occupational Exposure Monitoring". In total, 22 personal dosimeters were irradiated in photon reference radiation fields on the ISO water slab phantom in terms of personal dose equivalent Hp (10) and Hp (0.07). For irradiation are used ^{137}Cs and ^{60}Co radionuclide irradiation systems and a 225 kV X-ray radiation unit. The dosimeters were irradiated according the irradiation plan: the photon irradiation qualities were chosen from the ISO 4037-1 and IEC 61267, including S-Cs, S-Co, RQR7, W-80 and W-150 and two different angles of radiation incidence (0° and 60°). Reference dose equivalent values were in the range of ~1 - 400 mSv. The paper describes and analyses the individual results for the personal dose equivalent quantities Hp (10) and Hp (0.07), and compares these results with the ISO 14146 'trumpet curve' performance criteria. This paper presents the EURADOS IC2018 intercomparion results for whole body dosimeters in photon fields.

Key words: Individual monitoring, photon fields, whole body dosimeters, radiation protection.

Introduction

The regular participation in intercomparison exercises (ICs) of Individual Monitoring Service (IMS) is recommended in the European Commission's technical recommendations and these ICs are helping the IMSs to comply with EN ISO/IEC 17025 (EC, RP 160, Luxembourg, 2009; ISO 17025, 2005). The European Radiation Dosimetry Group (EURADOS), through its Working Group 2 (WG2), over the last decade has been carrying out a number of different intercomparison exercises with the aims of improving the harmonization of individual monitoring in Europe. Since 2008 are performed five intercomparisons for whole body dosimeters and two intercomparisons for extremity dosimeters by the EURADOS some of them in cooperation with the International Atomic Energy Agency (Christensen P, et al., 2001; Figel M. et al., 2016; Stadtmann H., et al., 2016). The ICs stimulate the IMSs to improve the quality of their results, providing so the information on IMS quality throughout the EU and assist harmonization of IMS quality control standards. The Dosimetry Laboratory of the Department of Radiation Protection and Monitoring Network (Institute of Applied Nuclear Physics) took part in the EURADOS IC2018ph intercomparison exercise for the whole body for photon fields. The participation in this event was supported by the International Atomic Energy Agency (IAEA) within the framework of the TC regional project "Strengthening

Protection of Radiation Workers and Occupational Exposure Monitoring". In this ICs exercise a total of 101 IMSs from 40 countries participated with a total of 121 different dosimetric systems: 9 photographic film (Film), 82 thermoluminescence dosimeters (TLD), 18 optically stimulated luminescence (OSL) and 12 other techniques such as radiophotoluminiscence (RPL), active personal dosimeters (APD), etc. This paper presents the EURADOS IC2018 intercomparion results for whole body dosimeters in photon fields for Dosimetry Laboratory at the IANP.

Materials and methods

External individual monitoring of the ionizing exposure is a mandatory requirement for all organizations working with radiation sources. In Albania the dosimetry laboratory in the Institute of Applied Nuclear Physics (IANP) is involved in providing personal dosimetry services at national level concerning the assessment of occupational exposure of medical staff and all workers who works with ionizing radiation sources. In this study for the whole body ICs exercise in total 34 thermoluminishent detectors TLD-100 were used, 22 TLD-100 were used for the irradiations and 12 dosimeters were used as spare and transport dosimeters. The 22 dosimeters were irradiated in photon reference radiation fields on the ISO water slab phantom in terms of personal dose equivalent Hp (10) and Hp (0.07). For irradiation were used ^{137}Cs and ^{60}Co radionuclide irradiation systems and a 225 kV X-ray radiation unit. The dosimeters were irradiated according the irradiation plan Table 1. The irradiation plan had been established to enable participants to obtain information about the performance of their systems with respect to linearity, reproducibility, energy dependence and angular measurement capability in mixed fields.

Table 1: Irradiation Plan for IC2018ph

Rad. Type	Rad. Quality	Angle of incidence	Hp (10), Hp(0.07) mSv	No. of dosimeters
X-ray	N-60	0°	1.51, 1.42	2
	N-60	60°	1.28, 1.43	2
	W-110	0°	5.50, 5.03	2
mixed field	N-150	60°	1.51, 1.59	2
	N-150/Cs-137	0°	5.30, 5.12	2
Gamma	Cs-137-S	0°	0.90	2
	Cs-137-L	0°	4.80	4
	Co-60-L	0°	4.80, 4.88	2
	Co-60-M	0°	48.00, 48.80	2
	Co-60-H	0°	350.00, 356.00	2

Legend: S... small, L... low, M... medium, H... high dose

Radiation qualities and average photon energy were chosen according to ISO 4037-1 and IEC 61267 (ISO 4037-1, Part 1, 1996; ISO 4037-1, Part 2, 1997; ISO 4037-1, Part 3, 1999). The doses of the received TLDs are measured in the Harshaw 4500 Reader by using hot nitrogen gas flow. The gas heating system uses a stream of hot nitrogen at precisely controlled, linearly ramped temperatures to a maximum of 300°C. The TLD cards are read and the records are processed by the WinREMS software.

The dose for whole body dosimeters is determined using the formula (1):

$$H_{p,participant}(\mu Sv) = \frac{(D_i - D_{av,0})}{(RCF)} - H_{p,transport} \quad (1)$$

Where, D_i is the measured value of the detector i in nC given by the Reader, $D_{av,0}$ is the average zero dose reading in nC, RCF is the reader calibration factor in nC/µSv, $H_{p,\,transport}$ is the transport dose in µSv.

Response Values

Response values R for the results were calculated according to formula 2:

$$R = \frac{H_{p,participant}}{H_{p,reference}} \quad (2)$$

Where $H_{p,reference}$ the irradiated reference dose and $H_{p,participant}$ the reported dose value by the participant. There were irradiated two dosimeters for different doses and qualities.

Number of outliers

In all intercomparision, the outliers were calculated according to the trumpet curve criteria defined in ISO 14146 (ISO 14146, 2000).

$$\frac{1}{F}\left(1 - \frac{2H_0}{H_0 + H_{p,reference}}\right) \leq R \leq F\left(1 + \frac{H_0}{2H_0 + H_{p,reference}}\right) \quad (3)$$

Where F=1.5 and H_0 is a parameter defining the lower limit of the dose range.

Results and discussion

The irradiation plan for Hp (10) showed in the Table 2 give the information about the performance of the system with respect to linearity, reproducibility, energy dependence and angular measurement capability in mixed fields. The mean response value ranges from 0.74 to 1.38 with maximum value 1.47 and minimum value 0.54. The mean and median of the response value for the total of measurements is 0.90 and 0.83, respectively. The coefficient of variation of all measurements is 26% and one outlier from the total of 22 measurements.

Table 2: Irradiation Plan for Hp (10)

Hp (10)						
radiation quality	**number of values**	**mean (R)**	**median (R)**	**max. (R)**	**min. (R)**	**Coefficient of Variation R**
N-60/0°	2	1.17	1.17	1.30	1.03	17%
N-60/60°	2	1.38	1.38	1.49	1.27	11%
W-110/0°	2	0.95	0.95	1.04	0.87	13%
N-150/60°	2	1.09	1.09	0.80	1.05	5%
S-Cs/0°	6	0.74	0.76	0.87	0.54	15%
S-Co/0°	6	0.78	0.79	0.87	0.69	9%
N-150/Cs-137	2	0.74	0.74	0.80	0.69	10%
Total	22	0.90	0.83	1.49	0.54	26%
Outliers		1 of 22		**fraction of outliers**		5%

Figure 1 shows the results of the dosimeters as a function of the dose quantities Hp (10) together with the representation of the trumpet curve derived by equation (3). The obtain values fall inside the trumped curve, with one outlier observed at lower dose. Most of the results are within acceptable limits.

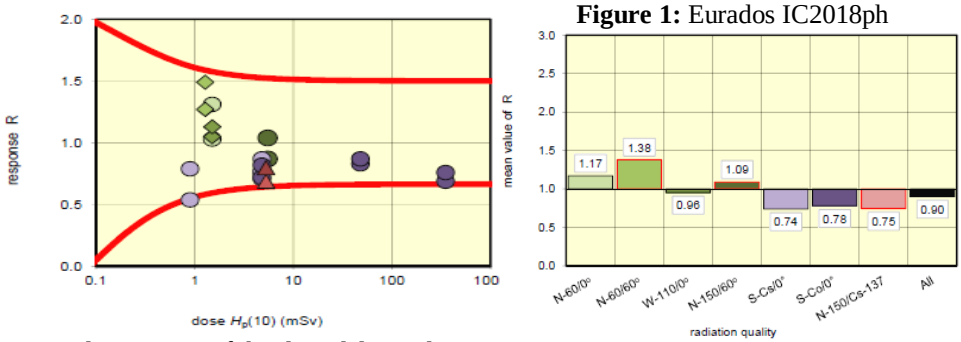

Figure 1: Eurados IC2018ph

results in terms of the dose delivered
represented together with the trumpet curves

The irradiation plan for Hp (0.07) showed in the Table 3 give the information about the performance of the system with respect to linearity, reproducibility, energy dependence and angular measurement capability in mixed fields. The mean response value ranges from 0.84 to 1.26 with maximum value 1.48 and minimum value 0.77. The mean and median of the response value for the total of measurements is 0.99 and 0.95, respectively.

The coefficient of variation is 18% and no outliers from the total of 22 measurements.

Table 3: Irradiation Plan for Hp (0.07)

Hp (0.07)						
radiation quality	**number of values**	**mean (R)**	**median (R)**	**max. (R)**	**min. (R)**	**Coefficient of Variation R**
N-60/0°	2	1.26	1.26	1.48	1.04	25%
N-60/60°	2	1.12	1.12	1.29	0.96	21%
W-110/0°	2	1.12	1.12	1.29	0.95	22%
N-150/60°	2	0.95	0.95	0.99	0.90	7%
S-Cs/0°	6	0.99	0.98	1.15	0.86	10%
S-Co/0°	6	0.84	0.82	0.95	0.77	8%
N-150/Cs-137	2	0.91	0.91	1.48	0.81	15%
Total	22	0.99	0.95	1.48	0.77	18%
Outliers		0 of 22		**fraction of outliers**		0%

Figure 2 shows the results of the dosimeters as a function of the dose quantities Hp (0.07) together with the representation of the trumpet curve derived by equation (3). The obtain values fall inside the trumped curve with no outlier, all measurements are within acceptable limits.

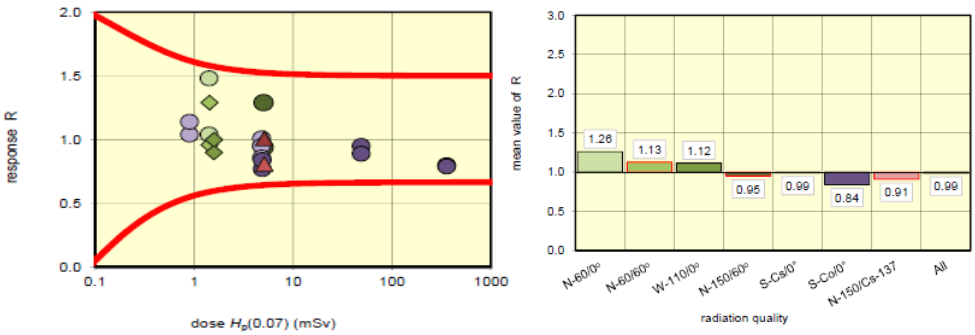

Figure 2: Eurados IC2018ph results in terms of the dose delivered represented together with the trumpet curves

Conclusion

The increasing number of participating systems confirms the interest and the need for IMS to participate in international intercomparison exercises to demonstrate the competence of their services.

The mean and median of all response values for Hp (10) and Hp (0.07) was close to unity.

The system showed a satisfactory performance with one outlier for Hp (10) in lower dose from the total reported values.

The system met the ISO 14146:2010 performance criteria (max. 2 outliers are allowed).

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