Ministerio de Industria, Energía y Minería

# Implementing $H_p(3)$ in Uruguay: DXT-100 compliance for IEC 62387 Coefficient of Variation and Non Linearity

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## Introduction

Almost 20% of the occupationally exposed workers assessed are interventional radiology professionals. Although lens of the eye radiological surveillance is not mandatory, implementing this type of dosimetry in the country is an important asset in prevention of lens of the eye injuries due to radiation and in the establishment of a national reference level. The aim of this study was to evaluate DXT-100 extremity dosemeters suitability for lens of the eye dosimetry by compliance of IEC 62387 for photon radiation requirements of Coefficent of variation (CV) and Non linearity.

## Materials and Methods

Element correction coefficients were determined previously at the laboratory using a 0.5 mCi Sr-90 source incorporated in TLD Reader according to user´s manual.

68 DXT-100 Thermo Fisher ® dosemeters where assembled on a 42mg/cm2 cap with an orange holder attached to a band and delivered to the national SSDL to be irradiated with a Cs-137 source at reference conditions for measuring $H_p(3)$. (Fig 1)

*Figure 1. Left: $H_p(3)$ dosemeter assambled Right: dosemeters allocated in water phantom for irradiation*

Table 1. Evaluated dose values

| Order of magnitude (mSv) | Dose delivered (mSv) | | | |
|---|---|---|---|---|
| | 20% | 40% | 80% | Others |
| 0-0.1 | 0.02 | 0.04 | 0.08 | 0.1 |
| 0.1-1.00 | 0.2 | 0.4 | 0.8 | 1.00 |
| 1.00-10 | 2 | 4 | 8 | 10 |
| 10-100 | 20 | 40 | 80 | 100 |

Dose values (w=16) were selected considering IEC 62387 section 11.3.2 (Table 1). For each dose value, 4 DXT-100 dosemeters were irradiated. 4 DXT-100 were assigned to background measurement.

All readings were performed in a Harshaw 6600 plus model with acquisition set up and Time Temperature Profile as suggested in user´s manual.

Coefficient of variation was calculated as follow (eq 3.3 IEC 62387):

$$v = \frac{s}{\bar{G}} = \frac{1}{\bar{G}}\sqrt{\frac{1}{n-1}\sum_{j=1}^{n}(G_j - \bar{G})^2}$$

s= standard deviation, $\bar{G}$ = average dose for each dose value *n*. For Non Linearity doses from 0.1 to 100 mSv where evaluated. Percentage of relative response was calculated (eq. 3.35, IEC 62387): $r = \frac{R}{R_0}$ where R = reader value, $R_0$= dose delivered

## Results and Discussion

*Coefficient of Variation*

Results are shown in Table 2. Requirements are met when CV is equal or below c1 column for w-2 evaluated doses and the last 2 (no adjacent doses) equal or below c2 column.

Table 2. Calculated Coefficient of Variation for $H_p(3)$

| Evaluated dose$_i$ (mSv) | Coefficient of variation ecc applied (%) | Coefficient of variation no ecc (%) | IEC 62387 Requirement c1 (%) | IEC 62387 Requirement c2 (%) |
|---|---|---|---|---|
| 0,02 | 5,84 | 4.19 | 20.00 | 28,77 |
| 0,04 | 4,1 | 9.18 | | |
| 0,08 | 0,96 | 4.72 | | |
| 0,1 | 11,4 | 8.03 | | |
| 0,2 | 4,45 | 10.50 | 18,66 | 26,85 |
| 0,4 | 8,74 | 8.48 | 16.00 | 23,02 |
| 0,8 | 2,05 | 2.25 | 10,66 | 15.34 |
| 1 | 0,14 | **3.79** | 8.00 | 11,64 |
| 2 | 0,6 | 3.19 | 6,76 | 9,59 |
| 4 | 3,43 | 11.83 | 6,67 | |
| 8 | 0,84 | **5.18** | | |
| 10 | 2,71 | 4.36 | | |
| 20 | 4,5 | 1.34 | | |
| 40 | 4,44 | 2.00 | | |
| 80 | 11,59 | 3.36 | | |
| 100 | 10.47 | 2.24 | | |

(*)not met

In general, requirements were met with or without ecc correction. When ecc where applied better CV values where obtained. Three evaluated doses (shown in red) didn´t met the requirements. In these cases, further analysis with a greater number of dosemeters tested would be needed.

*Non Linearity*

Non linearity shall be between -9% and +11%. Results are shown in table 3.

Table 3. Relative response -non linearity (difference in %)

| Evaluated Dose (mSv) | ecc (%) | No ecc (%) |
|---|---|---|
| 0,1 | 10.79 | 8.78 |
| 0,2 | 11.78 | 3.63 |
| 0,4 | 13.43 | 4.57 |
| 0,8 | 3.65 | 2.76 |
| 1 | 5.29 | -2.27 |
| 2 | -0.15 | 0.57 |
| 4 | -0.16 | -1.90 |
| 8 | 2.49 | -2.12 |
| 10 | 7.05 | 0.38 |
| 20 | 17.26 | -3.61 |
| 40 | 12.31 | -2.48 |
| 80 | -1.40 | -1.00 |
| 100 | 12.34 | 0.93 |

(*) not met

Better linearity was achieved when ecc´s where applied.

## Conclusion

DXT-100 extremity dosemeters are suitable for $H_p(3)$ determination in terms of coefficient of variation and Non linearity requirements of IEC 62387. Best results were obtained when no ecc´s were applied.

Further type test- like angle of incidence and energy dependence - must be perform. In the future, the use of DXT-100 for evaluate $H_p(3)$ will allow to set national reference levels for lens of the eye.