# Life–Cycle Assessment of the Romanian Reference Standard for Dosimetric Quantities

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## INTRODUCTION

The measuring instruments are an instrumentation class with some special features, which come from their main function-the measurement of different quantities, in any specific field of activity.

The measurement process of any quantity involves two main aspects:

- the indication of the numerical value of the measured quantity;
- the evaluation of the measurement uncertainty.

In order to assure the correct measurement of a quantity, any measuring instrument must have traceability; this traceability is accomplished by calibration. If the instrument is dedicated to the calibration of the other instruments measuring the same quantity that is it is a standard instrument, its traceability must be assured by calibration and intercomparison.

## THE LIFE-CYCLE ASSESSMENT OF THE MEASURING PERFORMANCES OF THE REFERENCE STANDARD INSTRUMENT

of a standard for a specified quantity includes, besides the traceability, another specific operation; the monitoring of the operating mode and of the metrological characteristics of the instrument.

The reference standard of Romania for the dosimetric quantities is a PTW doserate /dose meters UNIDOS 10001 with the several ionization chamber.

This instrument is periodically calibrated at PTB, Germany. For the assessment of the operation of this instrument, between two successive calibration, a special programmed of monitoring of the instrument was developed.

The monitoring operation consists in the invalidations of each detector, connected to the UNIDOS, with the ionizing radiation produced by the same radioactive source, in a very reproducible geometry and the recording the instrument's indications.

This paper deals with the method used for the monitoring of this standard instrument and with the results obtained during these measurements. Tables with the results of the measurements, their uncertainties and representative graphics with these data are also included.

The correct measurement of any quantity (including the quantities used in dosimetry) is assured also by the traceability of the measuring instrument. This traceability is given, mainly, by the calibration of the instruments. The calibration is done at specified time intervals, but the calibration laboratory has to month periodically the operation of the standard instrument, in order to detect in time any deviation of the instrument's parameters from the values obtained during the calibration.

The Calibration Laboratory (CMRID) from the Horia Hulubei National Institute for Physics and Nuclear Engineering (IFIN-HH), as an accredited laboratory for ionizing radiation, must provide the traceability for dosimetric quantities to the measuring instruments in Romania. The national reference standard used for the calibration of these instruments is the doseratemeters / dosemeter UNIDOS type 10001 with different ionization chamber (for different quantities and measuring ranges, respectively). The traceability of this standard instrument is assured basically by periodical calibration at PTB-Germany.

But the laboratory is also obliged to demonstrate that the standard pressures its metrological characteristics during the time between two successive calibrations. This task of the laboratory is accomplished by another quality management tool, the maintenance program /1/. This program consists in the assessment of the standard instrument, by monitoring its response, in given irradiation conditions.

The requirement for the standard is that its response (reading), at any moment after to calibration for the check source, in the same irradiation geometry, does not differ from the value given immediately after the calibration, by more the ± 2%.

The reference standard instrument.

For the assessment of the instrument's operation, four ionization chambers were used /2/. But, in this paper we present only the results obtained when using the IM 32003 type (10 l volume) and T 34035 type ($H_p(10)$) chamber.

The experimental method for the assessment of the standard instrument for dosimetric quantities.

The assessment of the UNIDOS standard instrument was done by monitoring the instrument response (for each ionization chamber), in identical conditions.

For the TM32003 type ionization chamber, the monitoring was done using the ß-ray produced by a radioactive source of (Sr-Y)-90. Using the radioactive source and the experimental arrangement presented in the

next section (Fig.1), we recorded the response of the standard instrument, immediately after the calibration at PTB and then, at different moments ( generally to each three months).

Each time when the instrument's response was obtained, a set of ten values of $\dot{H}$ , statistically independent, were recorded. These values were automatically corrected by the soft of the UNIDOS, for the air temperature and pressure. Then, the average values of $\dot{H}$, $\overline{\dot{H}}$ were calculated as well as the standard deviation of the average value, $s_n$.

For the T34035 type ($H_p(10)$) ionization chamber, the monitoring was done by using the gamma-ray produced by a radioactive source of Cs-137. Using this radioactive source and the experimental arrangement presented in the next section (Fig.2), we recorded the response of the standard instrument, in the same conditions as for the TM 32003 type ionization chamber.

The experimental data concerning this ionization chamber were obtained by the same method as for the previous detector. Also for this chamber, the average values of $\dot{H}$ , $\vec{\dot{H}}$ were calculated, as well as the standard deviation of the average value, $s_n$.

**THE EXPERIMENTAL SETUP FOR THE STANDARD INSTRUMENT MONITORING.**

The sketches of the experimental setup for each ionization chamber are given in Fig. 1 (for the TM32003 ionization chamber) and in Fig. 3 (for the T34035 ionization chamber) and in Fig. 3 (for the T34035 ionization chamber). In Fig. 2 and Fig. 4 we also present the photos of the experimental arrangements.

During all the measuring all the measurements, the same radioactive sources and the same irradiation geometrics were used.

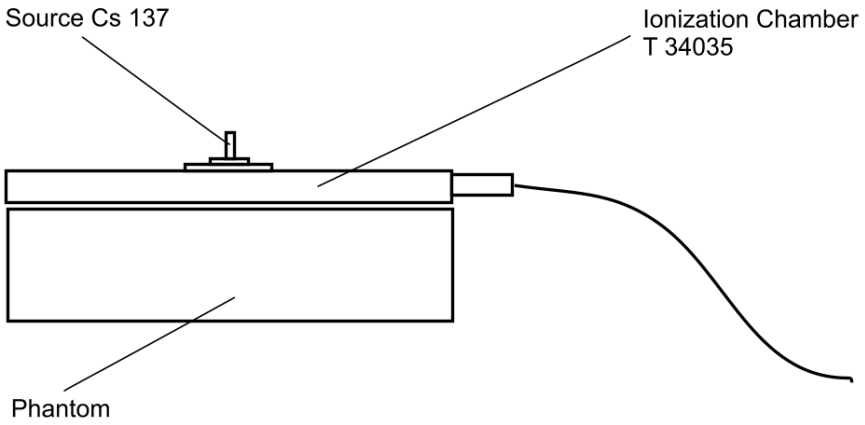


**Fig.1**

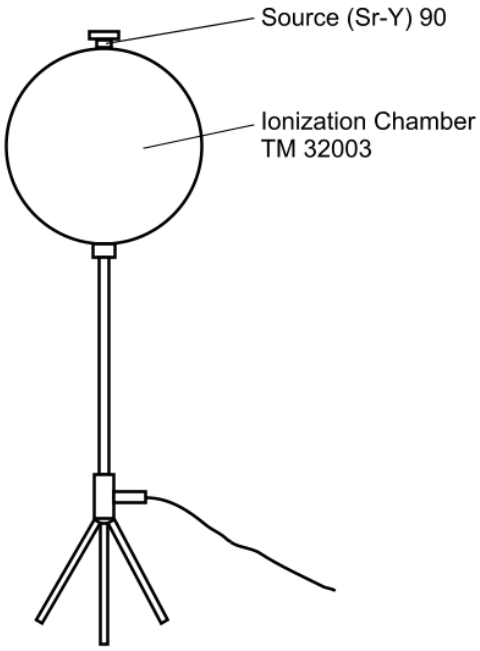


**Fig.2**

**REZULTS**

In this section we give the results which were obtained for along time monitoring of the standard (for each of the ionization chambers).

In Table 1, we give the results of the monitoring of the UNIDOS with the TM32003 type ionization chamber. For the monitoring of the instrument with the T34035 type ionization chamber, the results are given in Table 2.

| Date of measurement | No of month | $\dot{H}_p(10)$ (mSv/h) |
|---|---|---|
| 09/01/2003 | 0.00 | 5.234 |
| 12/02/2003 | 3.02 | 5.252 |
| 02/20/2004 | 5.65 | 5.172 |
| 08/23/2004 | 11.73 | 5.261 |
| 03/14/2005 | 18.40 | 5.240 |
| 05/11/2005 | 20.30 | 5.161 |
| 07/20/2005 | 22.60 | 5.157 |
| 10/21/2005 | 25.66 | 5.201 |
| 03/15/2006 | 30.42 | 5.224 |
| 01/04/2007 | 40.11 | 5.164 |
| 04/24/2007 | 43.73 | 5.215 |
| 07/07/2007 | 46.16 | 5.238 |
| 09/13/2007 | 48.39 | 5.238 |
| 01/10/2008 | 52.30 | 5.266 |
| 03/20/2008 | 54.60 | 5.254 |
| 04/14/2008 | 55.43 | 5.273 |
| 08/31/2008 | 59.99 | 5.276 |
| 11/14/2008 | 62.46 | 5.285 |
| 07/31/2009 | 70.97 | 5.248 |
| 11/17/2009 | 74.55 | 5.253 |
| 03/04/2010 | 78.06 | 5.228 |
| 06/07/2010 | 81.18 | 5.222 |
| 09/21/2010 | 84.67 | 5.246 |
| 01/06/2011 | 88.18 | 5.219 |
| 04/05/2011 | 91.10 | 5.210 |
| 06/23/2011 | 93.70 | 5.210 |
| 10/05/2011 | 97.12 | 5.233 |
| 01/19/2012 | 100.60 | 5.206 |
| 04/11/2012 | 103.33 | 5.217 |

**Table1**

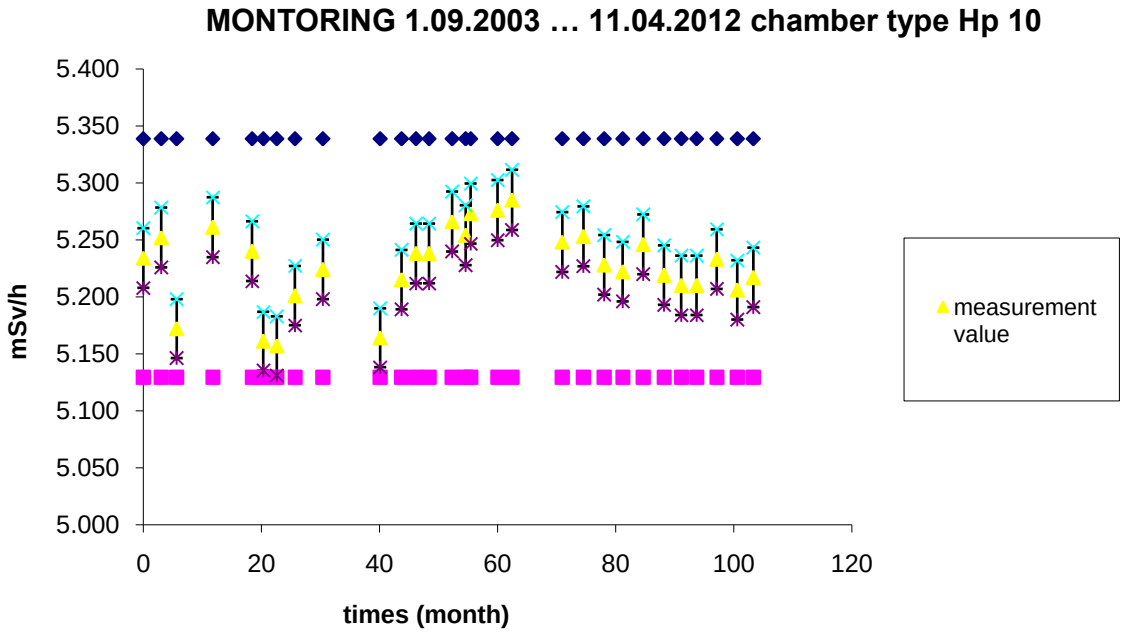


**Fig. 3**

| Date of measurement | No of month | $\dot{H}$ (mSv/h) |
|---|---|---|
| 03/15/2006 | 0.00 | 13.63 |
| 01/04/2007 | 9.69 | 13.65 |
| 04/24/2007 | 13.31 | 13.64 |
| 07/07/2007 | 15.74 | 13.63 |
| 09/13/2007 | 17.97 | 13.63 |
| 03/20/2008 | 24.18 | 13.77 |
| 08/31/2008 | 29.57 | 13.67 |
| 11/14/2008 | 32.03 | 13.71 |
| 07/20/2009 | 40.18 | 13.64 |
| 11/17/2009 | 44.12 | 13.73 |
| 03/03/2010 | 47.61 | 13.75 |
| 05/12/2010 | 49.91 | 13.81 |
| 06/04/2010 | 50.66 | 13.79 |
| 06/07/2010 | 50.76 | 13.78 |
| 09/21/2010 | 54.24 | 13.70 |
| 01/06/2011 | 57.76 | 13.64 |
| 04/08/2011 | 60.78 | 13.75 |
| 07/08/2011 | 63.77 | 13.82 |
| 10/04/2011 | 66.66 | 13.71 |
| 12/16/2011 | 69.06 | 13.59 |
| 04/10/2012 | 72.87 | 13.78 |

**Table 2**

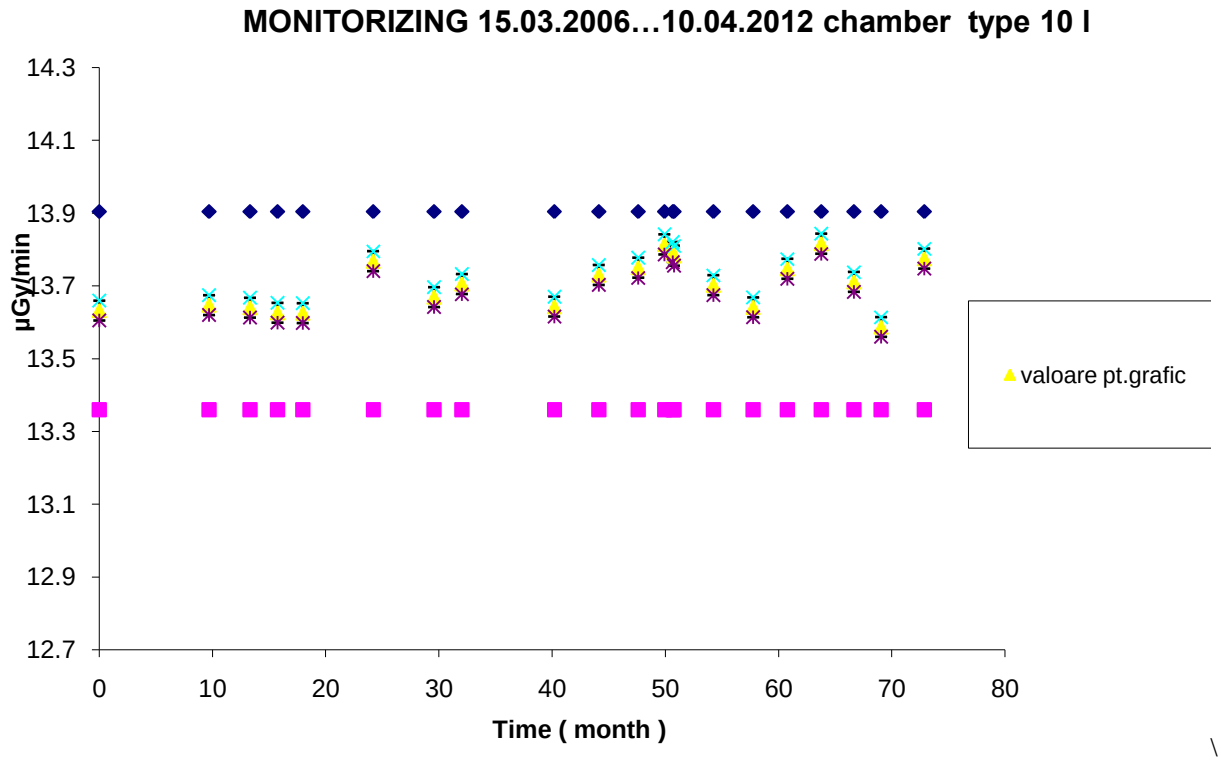


**Fig. 4**

The graphic presentation of the these data are give in Fig. 3 (for the TM32003 chamber) and in Fig.4 (for the T34035 chamber).

## CONCLUSIONS

The analysis of the experimental data presented for each ionization chamber lead to the conclusion that, for the mentioned time interval, the standard instrument presented its measuring characteristics, as the were stated by calibration and were recorded in the Calibration Certificated. These results confirm that during all the time when the data were recorded, the standard presented its metrological characteristics and maintained its traceability to the primary standard of the PTB.


## ACKNOWLEDGEMENT

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