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EURADOS intercomparison of passive $H^*(10)$ area dosemeters 2014

Harald Dombrowski [a, *], Maria A. Duch [b], Christian Hranitzky [c], Philip Kleinau [d], Stefan Neumaier [a], Mária Ranogajec-Komor [e], Rafael Rodriguez [f]

[a] Physikalisch-Technische Bundesanstalt (PTB), Bundesallee 100, 38116 Braunschweig, Germany
[b] Universitat Politècnica de Catalunya, Diagonal 647, 08028 Barcelona, Spain
[c] Seibersdorf Labor GmbH, 2444 Seibersdorf, Austria
[d] Helmholtz Zentrum München, Otto-Hahn-Ring 6, 81739 Munich, Germany
[e] Ruder Boškovic Institute, Bijenicka 54, 10000 Zagreb, Croatia
[f] CIEMAT, Avenida Complutense 40, 28040 Madrid, Spain

HIGHLIGHTS

- In an intercomparison, the performance of 32 passive area dosimetry systems was tested under real environmental conditions.
- The dosemeters were exposed at dosimetry reference sites of PTB, while independent $H^*(10)$ reference values were established.
- The response of the systems to terrestrial as well as to secondary cosmic radiation was measured.
- The results provide information on the accuracy of typical passive area dose measurements in Europe.
- Deviations of the absolute dose values of different systems from each other are partly caused by the dissimilar response to cosmic radiation.

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ABSTRACT

Under the umbrella of the European Radiation Dosimetry Group (EURADOS), different working groups have responded to the requests of monitoring services in Europe for independent tests of dosimetry systems for harmonization and quality assurance. After having performed regular intercomparisons of personal dosemeters, EURADOS Working Group 3, "Environmental Dosimetry", performed the first EURADOS intercomparison for passive ambient dose equivalent, abbreviated $H^*(10)$, area dosemeters used for environmental monitoring in 2014 (IC2014env). Such dosimetry systems are generally used to monitor nuclear installations, besides other applications. The results of this intercomparison with a total of more than 500 dosemeters help to better understand influence parameters and the possible accuracy of typical dosimetric measurements using passive dosemeters.

1. Introduction

The aim of this intercomparison was to study the long-term behaviour of passive dosemeters, which are typically used for the monitoring of nuclear facilities in the natural environment or for workplace monitoring. Especially the precision of measurements using passive dosemeters, which last over several months, is studied. In addition, some sources of flawed data were uncovered. The EURADOS Intercomparison 2014 for passive area dosemeters (IC2014env) was managed and coordinated on behalf of EURADOS by the WG3-SG2 Intercomparison Organization Group. This group decided on the irradiation plan and on details of the realization of the intercomparison. The participants, 30 European dosimetry services and official measuring bodies, supplied dosemeters to the coordinator, PTB, and provided diverse information including data on the route cards. The coordinator was responsible for communication between the IC2014env project and the participants, supervised the implementation of the measurements, supplied forms and route cards, collected the results and evaluated the data. PTB established the reference values for all measured data traceable to the primary PTB standards.

The motivation to conduct such an intercomparison was the broad use of solid state ambient dose equivalent meters for the monitoring of nuclear facilities and accelerators all over Europe, which serves the purpose to observe the compliance with the limits

* Corresponding author.
E-mail address: harald.dombrowski@ptb.de (H. Dombrowski).

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of the effective dose of the population defined by the European Basic Safety Standards (Council of the European Union, 2013). The problem of all these measurements is the deduction of the natural dose from the measured total dose to possibly determine an additional dose caused by artificial, man-made radiation. Information can be derived from the intercomparison described in this article on the typical precision of environmental monitoring if solid state detectors are applied.

The following measuring sites were used to expose dosemeters during the intercomparison: The PTB reference measuring site for cosmic radiation (a floating platform on a lake) to measure the response of the dosemeters to secondary cosmic radiation, the reference measuring site for environmental radiation (a free-field installation) to measure the response to terrestrial radiation, and a gamma irradiation facility to check the home calibration in a ^{137}Cs photon field. The transport dose was measured very precisely by storing transport dosemeters in the PTB underground laboratory (UDO II) in parallel to the other irradiations, because at this place, the dose accumulated in some months can be neglected.

30 measuring services and institutions from 16 countries took part in this intercomparison using 33 dosimetry systems of different types (mostly TLD). In total, about 510 dosemeters were exposed at the different PTB reference measuring sites. PTB determined all reference dose values independently from the data of the participants by using active dosemeters and detectors, which are traceable to PTB's primary standards.

2. Methodical procedure

Each participant dispatched 16 passive dosemeters of one type to PTB, including 12 dosemeters for the irradiation in three different ways and 4 transport dosemeters. One dosemeter means one physical holder, which actually may contain several “internal” detectors (e.g. TLD or RPL). In this case, the participant calculates a mean value of all “internal” detectors, so that only one result per holder is reported. Two different measuring periods were possible: The participant had the choice between 3 months or 6 months. The participants had to fill in route cards (including serial numbers) so that all relevant dates in the measuring cycle are documented. The intercomparison took place in 2014, starting in April and ending in July (3-month irradiation) or October (6-month irradiation). A list of the used dosemeter types of the participants is found in Table 1 and Table 2. The following measurements were performed:

1) 8 dosemeters of each participant were exposed at the reference site for environmental radiation (Fig. 1), i.e. to the terrestrial and the cosmic component of the environmental radiation, for the complete measuring period. This extended free-field site is equipped with a number of active detectors which are operated permanently around the clock, like photon detectors and particle detectors (more details can be found in Dombrowski and Neumaier, 2012). The latter are used to measure the dose (rate) produced by the secondary cosmic radiation. All reference instruments are calibrated in terms of $H^*(10)$ traceable to the primary PTB standards. The dosemeters of the participants were fixed on rods at the height of 1 m above ground. The rods were exchanged weekly to exclude local effects.
2) 4 dosemeters of each participant were exposed at the reference site for cosmic radiation for the complete measuring period, where they were only exposed to the cosmic component of the environmental radiation. This site is realized as a floating platform on a lake. The border of the lake is rather flat and the minimal distance from the platform to the shore is 100 m.
3) 4 dosemeters of the 8 dosemeters of each participant from 1) were irradiated additionally in a primary ^{137}Cs photon field of PTB with a dose of about 5.5 mSv. The additional dose dominates the total dose because it is more than 10 times larger than the accumulated environmental dose.
4) 4 dosemeters of each participant served as transport dosemeters. They were stored in a lead castle in the underground laboratory of PTB, UDO II, while the other dosemeters were exposed above ground. They had to be of the same type as the other dosemeters. The accumulated dose in UDO II, less than 0.5 μSv, is negligible, so that the transport dosemeters display only the transport dose in a good approximation. Only two participants used active dosemeters to detect an unusual irradiation during transport (the respective reading cannot be used for quantitative data evaluation).

After the dosemeters were sent back to their owners, the latter read out the dose values and PTB provided reference values and finally certificates. A more detailed description of the PTB reference measuring sites for environmental radiation is found in Dombrowski and Neumaier (2012). In this reference, the calculation of the reference values for all measurements is explained in addition. PTB made sure that all dosemeters were exactly irradiated for the same time by storing dosemeters which arrived earlier in a

Table 1
Information on dosimeters exposed for 3 months.

Code	Det. principle	Type
A	TLD	TLD-100 in four element in holder by Seibersdorf Labor GmbH
B	TLD + TLD	LiF:Mg,Cu,P. GR-200A by Conqueror Electronics Technology + LiF:Mg,Ti. TLD-100 by Thermo
C	TLD	Panasonic UD-804AS
D	TLD	TLD-UD802A
E	RPL	GBF-JO1, environmental dosemeter, Technol
F	TLD	LPS-TLD-DU 02 (Gamma7777); 4-element TLD-700 card in Seibersdorf holder
G	TLD	TLD-100H, HARSHAW
H	OSL	Inlight model 2 case type GN by Landauer
I	OSL	Inlight model 2 case type GN by Landauer
J	OSL	InLight EX9
K	TLD	Harshaw TLD type 8855
L	TLD	TLD-100
M	TLD	OD-A1203-J92
N	TLD	LiF:Mg,Cu,P TLD in self-constructed badge
O	TLD	Photon Neutron Area Dosemeter Seibersdorf TLD-2K-V4
P	TLD	LiF: Mg,Cu,P (MCP-N)
Q	TLD	LiF:Mg,Cu,P; TLD-700H Harshaw
R	Film badge + TLD	Film AGFA - 22MUO Personal monitoring + TLD-100 Harshaw

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