TA6 - Radiation Protection of the Public and the Environment

RESULT OF THE INTERCOMPARISON EXERCISE ON RADON MEASURING INSTRUMENTS AND RADON DETECTORS 'BEV- RADONRING 2005'

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Abstract: In spring 2005 the Federal Office of Metrology and Surveying (BEV) invited all in Austria working radon measuring institutes to an intercomparison exercise at the radon calibration laboratory in the Arsenal. The aim of this intercomparison was on the one hand an objective inquiry and documentation of the current metrological potential on the section of radon measurement in Austria - both quantitative and qualitative- and on the other hand an initiative for the participating laboratories to optimize and improve their applied calibration-, measurement and analyse technics. Ten contacted Austrian radon laboratories were prepared to participate on the radon intercomparison exercise. The intercomparison exercise was carried out from 14th till 29th June at the radon calibration laboratory in the Arsenal of the BEV. As radon emanation source a five stepped arranged, at the Arsenal built radon source was used. The source (‚RADOTTO 1') is filled with a certified Ra-226-standard solution of the Czech Metrological Institute (CMI), Prag. A simple statistic based model was used for the evaluation and assessment of the results from the participants, which consider the statistic nature of the radioactive decay combined uncertainty. Altogether 183 measuring instruments participated the intercomparison exercise. Two reference measuring instruments, 22 active and 159 passive measuring instruments. The active measuring instruments formed 6 types of instruments and as passive radon detectors were 7 different types used from the participants. The positioning of the radon measuring instruments and detectors in the radon calibration laboratory was executed in regard to statistic points of view. From the active measuring instruments 17 could qualify and from the passive methods six from eight participants were in compliance to the given criteria. Radon measurements, which could have financial and economics relating implications (e.g. architectural redevelopment or precautionary measures), should have assured quality of the used measuring systems. In this respect the findings from this intercomparison exercise are used for an actual control, improvement of the calibration and optimization to ensure the correct application of the used radon measuring systems in Austria.

1. Introduction

In Austria activity measuring instruments which are used in legal transactions, public health, environmental protection and traffic or security affairs have to be legal verified. From this legal verification excepted are only measuring instruments used by accredited services. For these measuring instruments a calibration certificate to proof the traceability to the national standards is needed. With regard to the national legislation on measuring and surveying *the Federal Office of Metrology and Surveying (BEV) arranged an intercomparison exercise on radon measuring instruments and radon detectors. Therefore all in Austria working radon measuring services were invited. The intercomparison was carried out from 14th till 29th June at the radon calibration laboratory of the BEV at the Arsenal.*

2. Methods

The execution of the radon intercomparison exercise was in reference to earlier done intercomparison exercises at the Arsenal and internationally [1], [2], [5], [6] [7], [8], [9], [13]. For this intercomparison exercise the radon measurements were done in three exposition intervals with different Rn-222 concentrations. In the first interval the Rn-222 concentration should be between 1000 Bq/m^3 - 2000 Bq/m^3 in the second interval between 100 Bq/m^3 - 400 Bq/m^3 and in the third interval between 400 Bq/m^3 - 1000 Bq/m^3. For the generation of the radon concentrations a five step radon emanation source was used. The radon emanation source ('RADOTTO 1') was built at the Arsenal and is filled with a certified Ra-226-standard solution of the Czech Metrological Institute (CMI), Prag. The positions of the radon measuring instruments during the intercomparison exercise in the radon calibration laboratory resulted from a statistic arrangement of the instruments. Fig. 1 shows the statistically placed radon measuring instruments in the radon calibration chamber.

Fig. 1: Radon measuring instruments and detectors placed in the radon calibration laboratory, BEV Arsenal, Vienna

The radon measuring instruments and detectors used by the participants are representative for the variety of existing radon measuring methods [10]. Altogether ten institutions and the BEV as reference laboratory participated on the intercomparison exercise. Two reference measuring instruments, 22 active and 159 passive measuring instruments. The active measuring instruments from the participants formed 6 types of measuring instruments. As radon detectors 7 different detector types were used from the participants. Tab.1 shows the participating institutions and the radon measuring instruments which have been used by them.

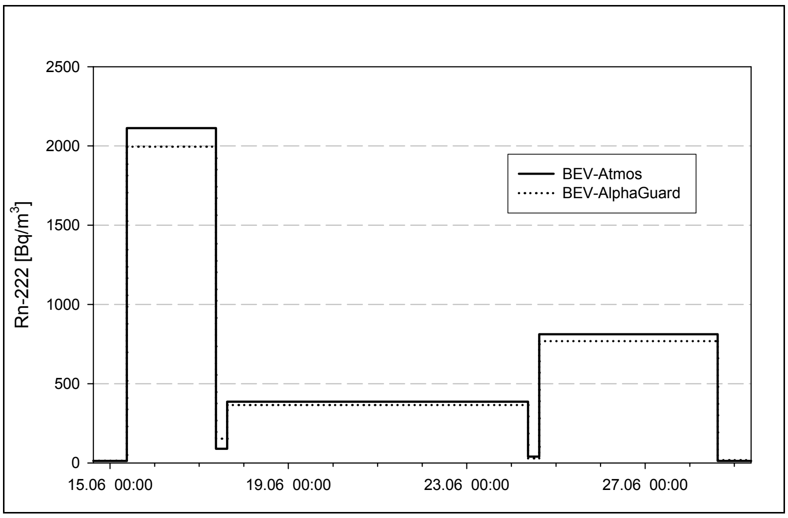
Tab. 1: Institutions and instruments

participants	active						passive						
	Alpha-Guard	Atmos	Doseman	Sarad EQF 3120	Radim-3A	Ramon 2.2	charcoal Picorad	charcoal canisters	electret SST	electret LST	electret SLT	track etch open dosimeter	track etch closed dosimeter
Austrian Social Insurance for Occupational Risks	✓	✓	✓										
Office of the Upper Austria Government	✓						✓						
ARC Seibersdorf Research GmbH							✓						✓
GT-Analytic KEG					✓	✓						✓	✓
University of Natural Resources and Applied Life Sciences, Vienna	✓												
University of Innsbruck	✓												
University of Osijek												✓	
University of Regensburg					✓			✓					
Austrian Agency for Health and Food Safety	✓			✓					✓	✓	✓		
Austrian Institute for Applied Ecology								✓					

3. Results

At the end of the Intercomparison exercise the measured Rn-222 values of the reference measuring instruments were evaluated. An Atmos and an AlphaGuard of the BEV were used as reference instruments. The BEV-AlphaGuard is the Austrian standard for Rn-222 concentrations in air. In case of the Atmos mean values from 10 minutes intervals and for the BEV-AlphaGuard hour mean values were used for the evaluation of the measured values. Fig. 2 shows the mean values of the reference measuring instruments for the three exposition intervals.
The participants were asked to send their exposition mean values for the active measuring instruments and detectors for the different exposition periods. The exposition periods were the three major intervals, the hole intercomparison time with and without the fresh air intervals and some special short time intervals for the detectors. In addition to all values the total uncertainty according to ÖNORM S5250-1:2002 [11], S5250-2:2003 [12] with k = 1 and an uncertainty budget according to GUM: 1995 (Guide to the expression of uncertainty in measurement) [3] were requested.

Fig. 2: Average Rn-222 concentration (reference measuring instruments) during the exposition periods



4. Discussion

The participant's results were discussed based on two criteria. The measured value should be in an interval from: {mean value of the reference measuring instrument ± 20%} [2]. The second criterion was a direct comparison of the measured value with the reference value [4]. With this method the difference between reference value and measured value from the participant is compared with the combined uncertainty of the measured value and the reference value.

$$\Delta_m = \left| c_m - c_{CRM} \right|$$

Δ_m .... absolute difference between mean measured value and reference value

c_m .... mean measured value

c_{CRM} .... reference value

$$u_\Delta = \sqrt{u_m^2 + u_{CRM}^2}$$

u_Δ .... combined uncertainty of measured value and reference value

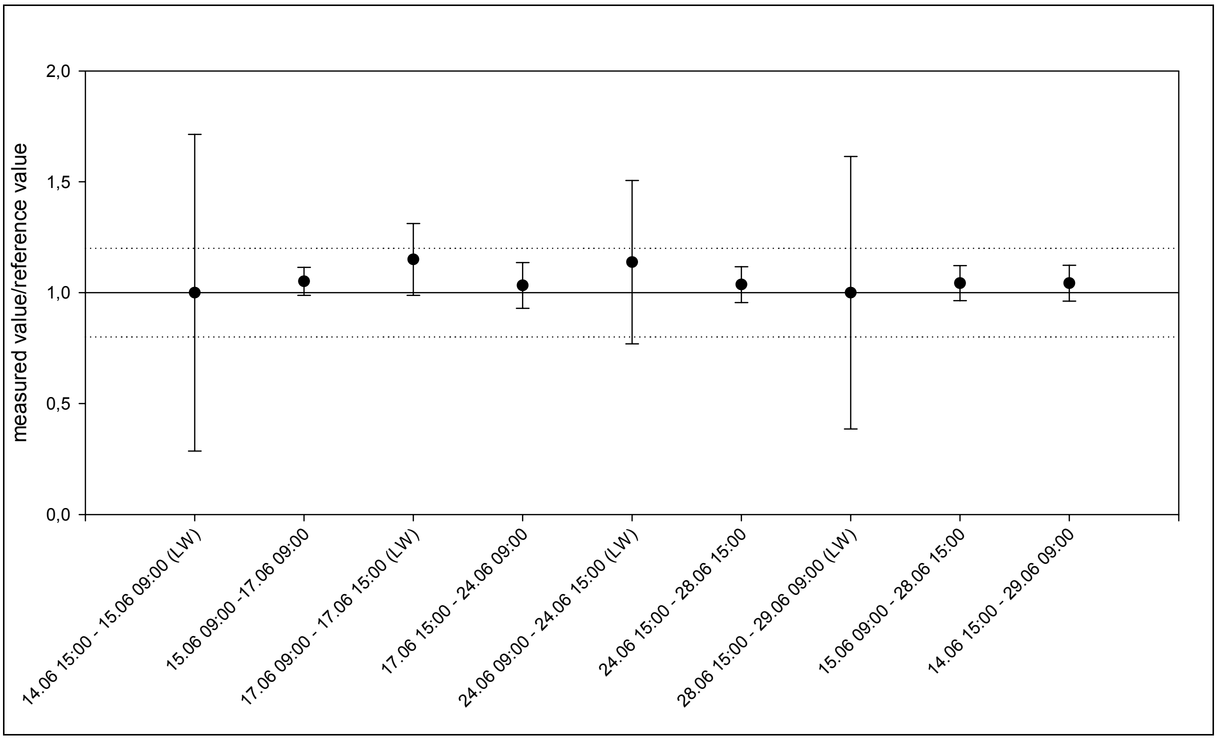
u_m .... uncertainty of the measured value

u_{CRM} .... uncertainty of the reference value

In case of this intercomparison exercise Δ_m is compared with an extended uncertainty U_Δ. U_Δ is related to a 95 % confidence interval and determined by multiplication of u_Δ with an uncertainty extension factor of $k = 2$. In case of $\Delta_m \leq U_\Delta$ there is no significant difference between measured value and reference value. If a measured value was not in the 20 % interval of the mean value and the absolute difference between measured value and reference value is bigger than the combined uncertainty the value was disqualified. To reach qualification, each instrument or detector system have to be in compliance with the criteria in all three exposition intervals.

An example for the evaluation of the results from the participating measuring institutions shows Fig. 3. In this graph the relation between measured value and reference value in case of an active radon measuring instrument during all the arranged exposition intervals is documented.

Fig. 3: Evaluation of an active measuring instrument



Eventually 17 out of 22 active measuring instruments and 6 out of 8 detector types used in passive radon detection methods were compliance to the given criteria. The results and evaluation are given in detail in the final report of the intercomparison exercise [14] (in German, requestable via: andreas.baumgartner@bev.gv.at).

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