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Quality assurance key point for environmental measurements using various techniques: Intercomparison

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Introduction

The intercomparison exercises and proficiency tests (PTs) are very important for the laboratories. These tests are the most used methods to assess the accuracy of the analytical data produced. At the same time, they are a requirement for the laboratories which have ISO 17025 and quality assurance systems implemented. The gross alpha-beta, gamma and radon measurements are worldwide applied techniques to measure and to analyze, both the natural and artificial isotopes. This work presents the results from few intercomparison exercises organized by the International Atomic Energy Agency (IAEA) for the gross alpha-beta, gamma in which the laboratory has participated, but also for radon within an international collaboration such as the traceRadon* project.

Experiments

An activity planned within traceRadon project was to perform the stability comparison (of at least one month) with a radon transfer standard at least at two different Atmospheric Monitoring Network Stations (AMNS), to prove consistency of the conventional true value of the transfer standard and that of the radon activity concentration monitor of each AMNS, as a quality assurance procedure. For this activity, at least five solid-state nuclear track detectors (SSNTD) were provided to determine the integral radon exposure.

The first experiment was conducted during November-December 2021 at PTB Braunschweig (Germany) were two types of SSNTDs were exposed, five detectors of each type. They were TASTRAK SSNTDs, together with the dosimetry system and optical reading TASLIMAGE (produced by Track Analysis Systems Ltd. (TASL), Bristol, UK) and RSKS from Radosys Ltd., Hungary. The second experiment was conducted between April-September 2022 at Saclay ICOS atmospheric station (France) also for both type of SSNTDs [1].

Due to the above applications, there was a need assuring the high quality radon activity concentrations measurements for these systems, thus both types of SSNTDs were checked in controlled environment, as radon chamber, at PTB, BFS and IFIN-HH [2].

Tower and shelter at Saclay ICOS station.

Conclusions

The experiments in the facility chambers showed reliable results between the measured value of the standard device and the SSNTDs, were the relative bias between the values showed from SSNTDs was up to 15%. Considering ^{222}Rn activity concentration highly dependence on the environmental factors, temperature, humidity, pressure, can be understood that the results were different, being generally higher for SSNTDs than the standard devices values. However, the SSNTDs should not be so much influenced by the environmental factors as the active monitors. Further investigations are required for SSNTDs in outdoor environment in order to providing more accurate and traceable results for these measurement methods.

Outlook

The failed results served as the basis for an analysis to apply corrections in the laboratory's measurement capabilities and to optimize the preparation and measurement procedures. By participating in intercomparison tests and PTs, the methods of evaluating the accuracy and precision of analytical data produced by laboratories are improved.

The aim

Accurate measurements of outdoor atmospheric radon activity concentrations are of interest both for radiation protection and climate research communities. Particularly, radon activities concentrations in the range of 1 to 100 Bqm^{-3} measured with uncertainties of 10% (k=1) are very important for atmospheric process modelling. The calibration and measurement capabilities of outdoor low-level radon concentrations lack robust metrological traceability chain to ensure their quality. For this purpose, the traceRadon project works towards improved traceable low-level outdoor radon measurements.

Tests at PTB

SSNTDs were also exposed to at the PTB climate chamber facility to a known an know radon concentration and subsequently, the integral radon exposure of the SSNTDs were determined, was compare to the radon activity concentration estimated from the integral values measured by active monitoring devices. In operational services, the sensitivity and accuracy of the SSNTD readings are key factors, and must be properly estimated to provide correct exposure from radon.

Site	Radon exposure value ± unc [kBqhm^{-3}] (for k=1)	Relative bias %
PTB climate chamber facility	40.7 ± 2.0	-
Radosys SSNTDs	35.4 ± 9.0	-13.0
TASTRACK SSNTDs	46.9 ± 7.0	15.2

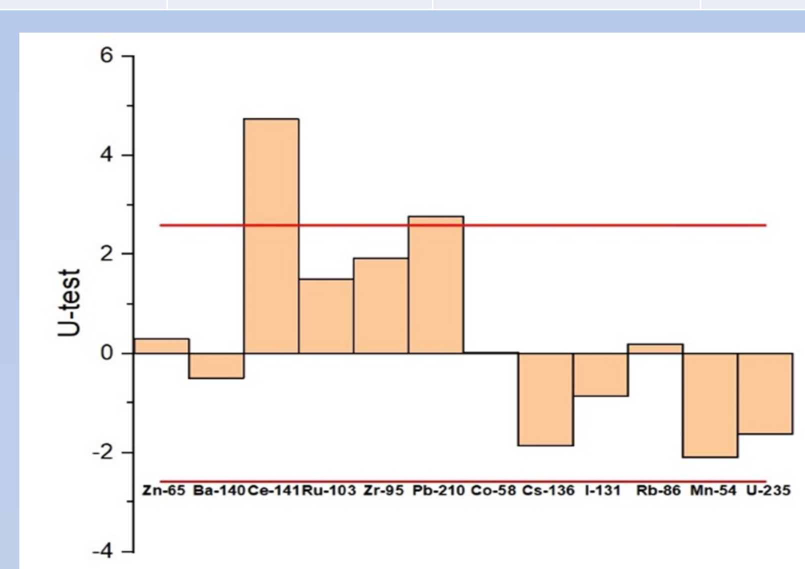
Reference site	Radon activity concentration, average value ± unc [Bq/m³]	Reference site	Radon activity concentration, average value ± unc [Bq/m³]
PTB - AMNS	5 ± 3 (for k=2)	SSNTDs at PTB	40 ± 14 (for k=1)
Saclay - ICOS station	3.5 ± 2.6 (for k=2)	SSNTDs at Saclay	37.0 ± 9.40 (for k=1)

PTs for gamma and gross alpha-beta measurements

The accuracy and precision of the laboratory have been tested also in other types of measurements such as gamma, and gross alpha-beta, in the yearly PTs organized by IAEA. In general, the feedback from the final IAEA reports demonstrated that for more than 100 reported results, 94 passed all test acceptance criteria, leading to an acceptance rate of almost 90 %. In the last years, the purpose of the laboratory was to pass the acceptance criteria for many types of the radionuclides, not only the most used ones such as ^{60}Co, ^{134}Cs, ^{137}Cs but also for ^{95}Zr, ^{103}Ru, ^{140}Ba, ^{141}Ce, radionuclides from ^{232}Th and ^{238}U series, but also ^{235}U. In case of the gross beta results these passed all acceptance criteria, but for gross alfa results some failed.

Sample	Analyte	Target Value	Target Unc.	Reported Value	Reported Unc.	Final Score
water	Ba-140	37.1	1.1	39.11	3.90	A
water	Ce-141	15.7	0.4	10.75	0.5	N
water	Ru-103	3.94	0.12	3.44	0.31	A
water	Zr-95	8.00	0.22	6.75	0.61	A
soil	Ra-226	19.0	0.8	15.9	1.2	A
soil	Th-234	15.9	0.4	14.3	1.1	A
Soil	Tl-208	4.1	0.7	3.96	0.35	A
Soil	U-235	1.1	0.5	1.96	0.17	A

Table values are reported in Bql^{-1} or Bqkg^{-1} for (k=1).



The U test. The limit value is ±2.58 and corresponds to the criterion "Accepted" for the accuracy of the laboratory result.

References

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