



PROFICIENCY TESTING FOR THE MEASUREMENT OF INTEGRATED RADON-222 ACTIVITY CONCENTRATION IN AIR

General information

LMR/DOC.21.006 - agg. 5 del 2025-03-12

PROFICIENCY TEST PROVIDER	Politecnico di Milano Energy Department Laboratory of Radiation Metrology (LMR) Via la Masa, 34 – Building B18 20156 Milano (Italy)
ACCREDITATION	Proficiency testing accredited based on UNI CEI EN ISO/IEC 17043:2024 (PTP n. 00140)
ACTIVITIES TO BE SUBCONTRACTED	Exposure of the devices performed at: Cento di Taratura accreditato n. 00140 - Politecnico di Milano – Settore Radon Via la Masa, 34 – Building B18 – 20156 Milano (Italy)
REFERENCE STANDARDS	ISO/IEC 17043:2023 “Conformity assessment – General requirements for proficiency testing” (Italian version UNI CEI EN ISO/IEC 17043:2024) JCGM 100:2008/Amd.1:2026 “Guide to the expression of uncertainty in measurement” ISO 13528:2026 “Statistical methods for use in proficiency testing for interlaboratory comparisons” ISO 11665-4:2021 “Measurement of radioactivity in the environment — Air: radon-222 — Part 4: Integrated measurement method for determining average activity concentration using passive sampling and delayed analysis”

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Agg.	Modifica
0	Prima stesura
1	Modifiche al paragrafo 9 con inserimento della dicitura corretta “valore centrale” al posto di “mediana”
2	Modifiche al paragrafo 9 circa dati non trasmessi o dati relativi a esposizioni errate
3	Modifiche ai paragrafi 1, 2 e 9 in seguito all’analisi documentale di Accredia (2022/05/16)
4	Modifiche al paragrafo 9 circa l’analisi statistica, in seguito ad audit su campo di Accredia (2022/06/28)
5	Modifiche ai paragrafi 10,11,12 in seguito ad aggiornamento della norma UNI EN ISO/IEC 17043:2024

1. Proficiency testing scheme

This document applies to any device capable of measuring the exposure, i.e. integrated radon concentration in air over time. The proficiency testing schemes for these devices are: a) simultaneous (i.e. several participants in parallel) b) quantitative (i.e. comparison vs a reference value).

The scheme has the identification code RNE.VV.XX.YY.ZZ, where:

- VV indicates the type of device (CR = plastic CR-39; EL = electret; TD = generic trace detectors; AL = all types of devices);
- XX indicates the aspect to be highlighted in the test (DL = different levels in a short time; AF = aging and fading;);
- YY indicates the last two digits of the year of the start of the evaluation test;
- ZZ indicates the scheme number proposed in the year.

Each proficiency testing consists of a variable number of exposures, established in the details of the proficiency testing (EN_LMR/MOD.21.003 "Proficiency testing scheme").

2. Proficiency testing scope

The scope is to offer each participant lab an evaluation test to verify their capability of measuring the radon exposure. The participating laboratory can use the proficiency testing results to demonstrate its capabilities to customers, accreditation and regulation bodies.

Furthermore, the test allows participants to comply with the provisions of § 8.3 in the ISO 11665-4 standard, regarding the maintenance over time of the measurement capabilities:

8.3 Calibration

[...]

In addition to calibration, consideration should be given to regular testing to ensure measurements remain suitable for use. These should include internal blind tests and external proficiency, validation or interlaboratory comparisons.

The LMR reserves the right of using statistical data from the tests, for scientific purposes (including peer review publications), or benchmarking of measuring systems, ensuring the anonymity of the participants.

3. Management system

The management of each test is the responsibility of a Coordinator, appointed by the LMR according to UNI CEI EN ISO/IEC 17043:2024.

The Coordinator is supported by a group of experts, appointed by him, and by one or more Italian secondary standard calibration labs (LAT) or foreign laboratories accredited to ISO 17025:2017 for the exposure of devices in radon atmospheres (subcontractors).

The LMR assumes responsibility towards the laboratories participating in the evaluation tests with regard to the activities carried out by the subcontractors in charge.

4. Proficiency testing time schedule

The schedule of the proficiency testing and documents specifying the organization are on the website <https://www.metrorad.polimi.it/en/>.

5. Proficiency testing registration

The eligibility rule is described in the document EN_LMR/MOD.21.003. Participants can apply on the website <https://www.metrorad.polimi.it/en/>.

6. Design of proficiency testing scheme

For each proficiency testing scheme, the document EN_LMR/MOD.21.003, contains the following information: type of devices and quantity under test; type of radionuclide, range and conditions of the exposure; test scheme; operating instructions and registration fee; name of the Coordinator;

information about the participants selection criteria; measures taken to guarantee the confidentiality of the test results.

7. Shipping of proficiency testing devices

Instructions for shipment of the devices, to and from the organizer laboratory, will be provided to each participant in an ad hoc document, in agreement with the proficiency testing schedule.

8. Transmission of proficiency testing results

According to the deadlines defined in the proficiency testing schedule, the participants must send the results to the organizing laboratory. Participants must pay particular attention to the instructions for submission of results, double checking the numerical format and the units of measurement.

Transmitted results are considered definitive and unchangeable. This means that errors in the transmission of the results cannot be corrected upon request, even if this would result in the exclusion from data processing made by the organization.

9. Data analysis and evaluation of proficiency testing results

Participants will send the results in terms of $\text{kBq} \cdot \text{h} \cdot \text{m}^{-3}$ for each sample set, corresponding to different exposures. The correction for transits devices, if any, must be done by the participant.

For each set, the organizer calculates the following quantities: mean value and standard deviation, according to the standard JCGM 100:2008/Amd.1:2026.

For each exposure the following statistical indicators are calculated:

- *z score of the mean value (z_j)*, defined by equation (1)

$$z_j = \frac{\bar{x}_j - X_j}{\hat{\sigma}} \quad (1)$$

where $\bar{x}_j$ is the mean value of the results of devices belonging to one set, $\hat{\sigma}$ (and $\hat{\sigma}_{rel}$, if used the percentage) the standard deviation used to assess the capability of the participant (it is defined by the organizer in the module EN_LMR/MOD.21.003) and X_j is the reference value with uncertainty $\sigma_{rel} < \hat{\sigma}_{rel}$. This indicator z_j assesses the deviation from the reference value with respect to a $\hat{\sigma}$ defined a priori, based on the value of the reference quantity, international standard of other kind of regulation.

- *z score of the mid-range value (z_M)*, defined by equation (2)

$$z_{Mj} = \frac{M_j - X_j}{\hat{\sigma}} \quad (2)$$

where M_j is the mid-range value of the results of devices belonging to one set (it is the arithmetic mean of the maximum and minimum values of the data set), X_j and $\hat{\sigma}$ are the same quantities defined for equation (1). This indicator assesses the presence of anomalous results.

- *Relative standard deviation $s_{rel}(x)$* , defined by equation (3)

$$s_{rel}(x)_j = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x}_j)^2}{n-1}} / \bar{x}_j \quad (3)$$

This indicator assesses the precision of the results given by the participant.

The reference value X is supplied by the secondary standard calibration labs in charge of the exposures, with the corresponding uncertainty. $\hat{\sigma}$ cannot be lower than the uncertainty associated to the reference value (typically less than 10% as expanded uncertainty).

To give the same weight to the three indicators, $s_{rel}(x)$ is corrected by a multiplicative coefficient p defined in equation (4):

$$p = 1/\hat{\sigma}_{rel} \quad (4)$$

where $\hat{\sigma}_{rel}$ is the standard deviation used in equations (1) and (2), expressed in a relative way.

Thus, the total score T for a single exposure and single set is given by the sum of the three indicators (absolute value), defined in equation (5):

$$T_j = |z_j| + |z_{Mj}| + p \cdot s_{rel}(x)_j \quad (5)$$

The value lower than 1 for each of the three indicators means a very good performance; the value lower than 2 for each of the three indicators means an acceptable performance, while values of the indicators in the range 2 to 3 are representative of a critical performance (important scattering of the results, calibration problems or presence of outliers). Values higher than 3 indicate not acceptable results.

The T indicator does not allow for systematic underestimation or overestimation of the reference value to be highlighted: for this reason, the z -score is shown in the final report.

A procedure to reject outliers is not used. This is because the test is on a set of at least 10 devices, while experimental campaigns in the field typically involve only one device.

The presence of outliers is managed by introducing the indicator z_{Mj} , sensitive to a single data that deviates significantly from the average.

Incorrectly exposed devices and non-transmitted data lead to a reduction in the dataset on which the statistical analysis is made. If up to 50% of the elements of the dataset are missing (only 5 data available), the analysis is still carried out as described above. If less than half of the dataset is available, no analysis is performed.

The statistical indicators and the proposed ranking procedure maintain their validity independently of the number of participants. Thus, the statistical analysis does not require a minimum of participants

The performance of the participant is assessed per single exposure through the total score T_j (equation (5)). Six ranking levels are identified, according to the following table:

T value	Level	Indications
$T \leq 3$	A	Very good results for all the indicators
$3 < T \leq 4$	B	At least one indicator > 1 Good results, no action suggested
$4 < T \leq 5$	C	One or more indicators > 1 Fair results, double check of data is suggested
$5 < T \leq 6$	D	One or more indicators $>> 1$ Acceptable results, detailed data revision is suggested
$6 < T \leq 7$	E	One or more indicators $>> 1$ Critical results, a review of the whole process is suggested
$T > 7$	F	Not acceptable results Identify reasons and take countermeasure

For each exposure, the final report will include a summary table with data sorted by increasing T_j and reporting the value of the three indicators.

A benchmark among participants, highlighting the deviation from the reference value, will also be included in the final report.

For comparative purposes, the index R_j is calculated, defined as the ratio between the average of the values of the devices of the j -th exposure $\bar{x}_j$ and the reference value X_j , as indicated in the equation (6):

$$R_j = \frac{\bar{x}_j}{X_j} \quad (6)$$

10. Proficiency testing document

Each proficiency testing is characterized by a unique code, reported in all the documents of the specific test and in the announcement on the website <https://www.metro-rad.polimi.it/en/>.

More detailed information is sent to the registered participants, according to the time schedule.

The results from each participant, including the statistical and performance analysis will be described in a Test Report, written in compliance with the standard UNI CEI EN ISO/IEC 17043:2024. Each participant will receive the test report, together with a Certificate of Participation, certifying the participation of the laboratory to the proficiency test and the performances obtained.

Participants may use the Test Report, provided it is in its entirety, for their own purposes, but may not make it public via websites or social media. The Certificate of Participation is the property of the participant and may be distributed and published in its entirety at their discretion.

11. Confidentiality

All personnel of the PTP is trained not to disseminate information about the participants of the different PT; before the publication of the corresponding Test Reports, no information about the proficiency testing schemes and proficiency testing results may be disseminated.

In the exceptional case that the PT provider is required by law to release the proficiency testing results, participants are notified via an explicit declaration in the forms EN_LMR/MOD.21.003 "Proficiency testing scheme" and EN_LMR/MOD.21.005 "Participation rules"

For confidentiality assurance, a specific identification code (CI) is assigned to the participants. An additional code (CS) is given to each device group/set; this code is used also for documents transmission, both to the participant and to the laboratory performing the exposures. A third code (CP) is used for anonymous presentation of the results in the final report. To further guarantee the confidentiality with respect to the personnel involved in the proficiency test, whether belonging to the Politecnico di Milano - Department of Energy, or to external structures, the pairing between CP and CS is known only by the coordinator,

Participants must not disclose these codes to third parties. Politecnico di Milano - LMR is bound to keep confidentiality as well.

The participant must not share information about test results with other participants.

In case of evident collusion (agreement) between/among participants or falsification of the results, the Politecnico di Milano - LMR has the right to exclude from the test the responsible parties for such behavior. All the staff of the Politecnico di Milano are required to respect the Code of Ethics adopted by the Politecnico di Milano; impartiality is one of the values of this Code of Ethics. Therefore, all personnel of the PTP is required not to commit favoritism and to treat all participants the exact same way

12. Communication with participants

The mailbox ptp-deng@polimi.it is the only communication channel between the organizer, the coordinator and the participants. Participants can use this box to send warnings or complaints (damage or tampering of the devices; problems related to compliance with the test schedule time; clarifications or appeals regarding the evaluation of their data). The coordinator, after consulting the organizer, evaluates if it is necessary to open a complaint, promptly informing the participant.

Any appeals must necessarily be sent in writing to mailbox ptp-deng@polimi.it. The CPT is responsible for recording and handling appeals. He must promptly notify the RL. CPT and RL must open a complaint, constantly keeping the participant updated on its handling.