Accredited proficiency testing and calibrations at the service of radiation protection

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1. Background and Goal of the present work

The Council Directive 2013/59/EURATOM points out the importance of periodical calibrations, quality assurance as well as the recognition of radiation protection services and experts. Already in 2009, the RP 160 gave the basis for procedures and criteria for mutual recognition of approved dosimetry services in Europe. Nevertheless, in Italy, the European Directive has been implemented only in 2020, subsequently this recognition process has just started. Specifically, for radon measurement providers, some indications were given about the requirements for the service recognition, including the compliance with the ISO 17025:2017 standard.

In this context, the Laboratory of Radiation Metrology (LMR) of the Politecnico di Milano has organized its activities to offer accredited calibrations and accredited proficiency testing (PT) schemes compliant with the standard ISO 17043:2010, for radiation protection practitioners. Since the Italian Accreditation Body is a signatory of the ILAC MRA Agreement, the accredited calibrations and PT are recognised by the mutual recognition.

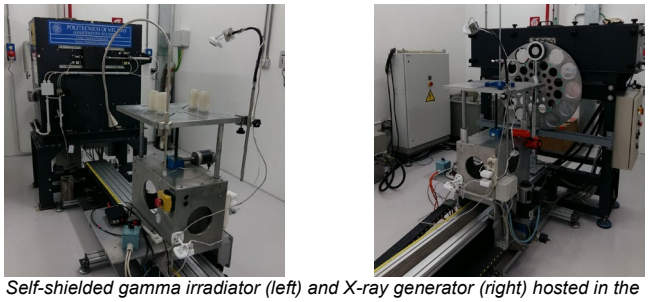
2. Calibration center of the Politecnico di Milano

The LMR hosts two calibration centers: the ionizing radiation laboratory (X and gamma beam facilities) and the radon laboratory. Both laboratories are part of the Accredited Calibration Center “LAT n° 104” of the Politecnico di Milano. More detailed information can be found on the laboratory website: https://www.metrorad.polimi.it/en/

2.1. Ionizing Radiation Laboratory

The ionizing radiation laboratory, accredited since February 1999, performs calibrations using the reference radiation qualities specified in the ISO 4037:2019 standard for the following dosimetry quantities.

The instruments calibration for the reference radiation qualities is produced via an ISOVOLT 320/10 Seifert X-ray generator and a self-shielded irradiator containing Cs-137, Am-241 and Co-60 sources. The X-ray generator is characterized by a high stability emission, particularly suitable for dosimetry uses.



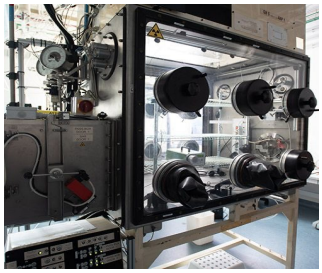
Self-shielded gamma irradiator (left) and X-ray generator (right) hosted in the Ionizing radiation laboratory of the LMR

The laboratory guarantees the metrological traceability by using graphite cavity ionization chambers as reference instruments. The ion chamber reading is done through a charge measuring system. The irradiation control is guaranteed by a transmission ionization chamber, associated with a charge measurement system identical to the one used for the reference instruments.

The accredited radiation beams are W-60, W-80, W-110, W-150, W-200, W-250, W-300, N-40, N-60, N-80, N-100, N-120, N-150, N-200, N-250, N-300, RQR3, RQR5, RQR7, RQR9, M01, M02, M03 for the X rays and S-Am, S-Cs, S- Co for gamma rays.

2.2. Radon Laboratory

The radon laboratory is equipped with a 2 m^3 radon chamber, built according to IEC 61577-4:2009, that allows carrying out active instrument calibrations and exposures of passive devices. The radon laboratory is accredited since March 2021.



Radon chamber of the Radon Laboratory of the LMR

The reference instrument, guaranteeing the metrological traceability, is an AlphaGUARD DF2000 (Bertin GmbH) and it is calibrated every two years in European institutes with ISO 17025:2017 accreditation. The exposures and the calibrations are done in decay mode following internal procedures. Temperature, pressure, and relative humidity are monitored by a periodically calibrated datalogger. The calibration table is here reported:

Object to calibrate	Measurand	Measurement field	Uncertainty*
Active instruments for measuring radon concentration in air	radon concentration in air	from 1 000 Bq m^{-3} to 2 500 Bq m^{-3}	11.0 %
		from 2 500 Bq m^{-3} to 12 000 m^{-3}	9.0 %
Passive devices	radon concentration in air integrated over time	from 200 kBq h m^{-3} to 4 000 kBq h m^{-3}	8.0 %

* Extended uncertainty (k=2 with confidence level around 95%)

3. ISO 17043:2010 accreditation

To connect the calibration activity with the increasing request of inter-laboratory comparisons, and thanks to the experience as organisers and participants in different intercomparisons, the LMR undertook the ISO 17043:2010 accreditation process to become a PT Provider (PTP) for external dosimetry and passive radon detectors.

The accreditation includes the organizational system, and one or more schemes. It is not required that the organizer has in house the experimental facility to carry out the calibration: in fact, this activity can be subcontracted.

To apply for the accreditation of one specific scheme, it is necessary to run a pilot PT and to attach the final report to the application to be sent to the Italian Accreditation Body. For this reason, the laboratory had to run two pilot PT.

Currently the LMR is an accredited PTP for both the dosimetry and the radon scheme.

The accreditation for the dosimetry field is conducted under flexible scope, according to the EA-2/15 M: 2019: this allows the LMR to assume responsibility for the management of all or part of its scope of accreditation without the necessity of a preliminary evaluation by the NAB for each new activity. In this way, the LMR can organize PT for the dosimetry scheme, using different radiation qualities and type of dosimeters.

3.1. Pilot PT Scheme for External Dosimetry

The Pilot PT for the dosimetry field started in March 2020 and focused on testing the whole body dosimeters for the operational quantities $H_p(10)$ and $H_p(0.07)$. The calibration activity was subcontracted to the Ionizing Radiation Sector of LAT n° 104. The photonic radiation used for the irradiations had these characteristics: energy from 30 keV to 1.3 MeV; dose equivalent from 0.3 to 200 mSv (assuming H_0 = 0.1 mSv); beam incidence angle: ± 60 °.

The Pilot PT, according to the ISO 14146:2018, defines a testing scheme covering the whole scope of the standard. The participants were 5, for a total of 9 dosimetric systems (2 based on filmbadge, 7 based on TLD). Also, the organizer provided OSLs for monitoring each single irradiation.

The final report was sent to the participants in October 2020.

3.2. Pilot PT Scheme for Radon Passive Devices

The pilot intercomparison for radon passive devices started in summer 2021. To not overlap with existing PT, the aim was testing how efficiently laboratories deal with the aging and fading effects on passive devices based on CR-39. The calibration activity was subcontracted to the Radon Sector of the LAT n° 104.

The PT is carried out in a Rn-222 controlled atmosphere and it consisted in 6 exposures in the range of from 200 to 3000 kBq·h·m^{-3}. The 17 attending participants, of which 10 were Italian, had to provide 6 sets of 12 devices each (10 to be exposed and 2 as transits), for a total of 72 devices. The sets were exposed and returned to the participants in different moments within a period of maximum 6 months.

3.3. Future PT organized

Currently the first accredited PT for dosimeters is taking place: it focuses on testing the dosimeters for the extremities (ring, bracelet or anklet) for the equivalent operative dose quantity $H_p(0.07)$. The final report, ending the inter-laboratory comparison, will be issued in mid-September 2022.

The LMR organizes two PT per year for the dosimetry (one for the whole body and one in rotation between extremities, area, and eye lens) and one PT per year for the radon scheme.

The dosimetry PT is currently open only for Italian participants but attendance requests from foreign laboratories can be evaluated. The Radon PT, instead, is open to everybody.

The PT are promoted on the laboratory website, the database EPTIS and LinkedIn.

4. Conclusions

- The LMR provides accredited calibrations at the service of radiation protection: in addition to offering, with 20 years of experience, X and gamma calibrations, since 2021 the LMR expanded its accreditation to provide radon calibrations. Furthermore, to connect these activities with the increasing demand of inter-laboratory comparisons, the LMR is also an accredited PTP for the same fields.