CHARACTERIZATION AND CALIBRATION OF A BATCH OF FIVE THOUSAND SSNTD COLUMBIA RESIN 39 DETECTORS

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INTRODUCTION

The sampling of radon 222 (Rn-222) in confined environments can be performed using solid-state nuclear track detectors (SSNTD) of the Columbia Resin 39 (CR-39) type.
In 2022, the National Inspectorate for Nuclear Safety and Radiation Protection (ISIN) carried out the characterization and calibration of a batch of 5054 CR39 detectors supplied by a British manufacturer and divided into 3 different production lots. The characterization was conducted at the ISIN radon laboratory, while the calibration was performed at the National Institute for Ionizing Radiation Metrology of ENEA (INMRI-ENEA).
The batch was characterized and calibrated using 106 detectors, corresponding to 2%, and 255 detectors, corresponding to 5% of the total detectors, respectively.

MATERIALS AND METHODS

CR39 Tastrak detectors and RADOSURE measurement chambers from TASL were used. Chemical etching of the CR39 detectors using 25% P/V NaOH solution. The instrumentations used: automated TASLImage reader and DL 22 Mettler titrator.

The detectors used in this study were:

- 54 control samples consisting of CR39 detectors exposed to an 241Am source with known activity;
- 50 CR39 samples for determination of background track level;
- 3 calibration group of 85 detectors each;
- 5 exposures in the Radon Chamber of ENEA, within a range of 136±3 kBqhm-3 to 4651±93 kBqhm-3;
- transit detectors were also prepared for each calibration group.

Statistical parameter used:

- mean,
- standard deviation,
- coefficient of variation,
- variance.

Statistical test applied:

- Shapiro-Wilk test for normal data distribution verification;
- Outlier elimination using Dixon's test, Grubbs' criterion for 1 and 2 data points, and Huber's rejection rule;
- Variance verification was carried out using Hartley's Criterion for comparing groups of results with different sample sizes;
- The sensitivity of the 3 supply lots was measured as the ratio of the radon tracks read by the TASL reader (after background subtraction) to the reference exposure, while the calibration factor was defined as the ratio 1/Sensitivity.

RESULTS

The application of the Shapiro-Wilk test to all sample groups (backgrounds, 241Am controls, and calibration samples) revealed a normal distribution of data, except for one lot's exposure. The application of statistical tests for outlier elimination across all sample groups identified 9 outliers in the total dataset subjected to evaluation. After removing these outliers, the remaining samples were re-evaluated with the Shapiro-Wilk test, which indicated a normal data distribution. Variance verification using Hartley's criterion indicated that the criterion was met for the 241Am and background samples, whereas for the calibration samples, it was satisfied only after removing a divergent variance. After removing the outliers, the weighted average sensitivity of the three calibration batches was determined to be 2,388 +/- 0,055, and the Calibration Factor was calculated as 0,42 +/- 0,10. The final results, obtained after removing outliers, were used to draft Shewhart Control Charts, which can serve as a reference for future laboratory measurement control procedures.

CONCLUSIONS

Overall, the measurement results indicate the homogeneity of the measurement material, except for the exposure of one lot, which requires further analysis. The laboratory concluded that the measurement material from this batch is suitable for use in measurement campaigns and national and international intercomparison procedures.