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#6-247 Inter-laboratory comparison within the RESORAD Italian network on the natural occurring radioactive materials (NORMs)

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Environmental radioactivity monitoring is of fundamental importance not only in routine situations but also in the event of accidental occurrences, such as the Fukushima incident in 2011, and extraordinary situations, such as those currently experienced in war-torn countries with nuclear facilities. In Italy, the National Network for Environmental Radioactivity Surveillance –RESORAD is operational, and it is technically coordinated by the National Inspectorate for Nuclear Safety and Radiation Protection (ISIN). The network is constituted by the laboratories of 21 Regional and Autonomous Provinces Agencies for Environmental Protection (ARPA/APPA) and 3 Experimental zoo-prophylactic Institutes. The quality of the data provided by the laboratories within this network and the efficiency of the measurement systems are highly important requirements for fulfilling the various tasks that ISIN is entrusted within the country, in terms of radiation protection and nuclear safety. ISIN promotes, under RESORAD technical coordination, national programs for the reliability of the measurements from its laboratories. At the same time, the National Institute of Ionizing Radiation Metrology (INMRI) of ENEA has the legal duty to develop standards and disseminate units of measurement in the field of radioactivity through inter-laboratory comparisons (ILCs), calibration campaigns, and performance evaluation tests. In the two-year period 2020-2022, an agreement has been signed between ISIN and ENEA, which allowed the realization of an ILC for the RESORAD laboratories, called NORM-2021, focusing on the measurements of naturally occurring radioactive materials (NORMs). Specifically, the ILC was focused on determining NORMs present in natural sand of volcanic origin. To create the solid reference material (MRS) for the ILC, samples of sand were collected from seven distinct volcanic lake sites in the Lazio region; different samples, each with a volume of 1 L, were collected and measured through gamma spectrometry at INMRI, limiting the analyses to the gamma emissions of K-40 and the radioactive series of uranium and thorium. Among the sampled sands, the one from the site with the highest concentration of NORMs, particularly from the thorium series, was chosen. The MRS was then produced using sand from the selected lake site, sampled near the shoreline, where the grain size is more uniform. To test the measurement capabilities of the participating laboratories, the organizers of the ILC decided to introduce an artificial imbalance in the uranium radioactive series by adding a known quantity (approximately 400 Bq/kg) of Ra-226 to the sampled sand at the INMRI laboratories, thus increasing the natural activity concentration of this radionuclide by a factor of 3. A series of samples was then produced from the MRS, with each sample sent to each participant after ensuring sample homogeneity. The participants were then provided with instructions for performing measurements with their high-resolution gamma spectrometers and a sheet to record the results of their analyses. In addition to identifying the radionuclides present in the sand matrix and quantifying the activity concentration (by measurement), each participant was also asked to determine the minimum detectable activity concentration (M.D.A.) under the measuring conditions used and for some radionuclides not necessarily present in the sample matrix received. The analysis of the results provided by each participant was carried out in terms of indicators commonly used in performance evaluations and inter-laboratory comparisons [ISO, 2010; ISO, 2016], including: the percentage deviation R between the measured value, M, provided by the participant and the reference value, Mrv, provided by INMRI; the normalized error or compatibility index En defined in terms of extended uncertainty (coverage factor k=2), U, associated to M, the extended uncertainty Urv associated to Mrv and the uncertainty component, Ucp, in common to both the participant and the reference value provided by INRMI, whose value

should be between ±1 for acceptable results.
The final data analysis highlighted false positives (radionuclides incorrectly detected and not present in the MRS) from some laboratories and false negatives (radionuclides present but incorrectly not reported) from others. Given the low level of radioactivity, all participating laboratories performed measurements at a distance of the sample with the detector of less than 5 cm, which required the use of corrections for summing effect both during the calibration of the spectrometers used by the participants and during the measurement phase. The results obtained showed an En value between ±1 for 87% of the participants. In order to provide explanations for possible sources of error in the measurements performed, INMRI invited the laboratories for bilateral discussions as the final phase of the inter-laboratory comparison.

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