

INTERCOMPARISON EXERCISE ON THE CHARACTERIZATION OF NORM SAMPLES BY GAMMA SPECTROMETRY

Manjola Shyti¹, Hermes Plaku², Erjon Spahiu³

¹Department of Radiometry and Radiochemistry, Institute of Applied Nuclear Physics, University of Tirana, Albania

²Office of Radiation Protection, Radiation Protection Commission, Institute of Public Health, Albania

³Department of Physics, Faculty of Natural Sciences, University of Tirana, Albania

INTRODUCTION

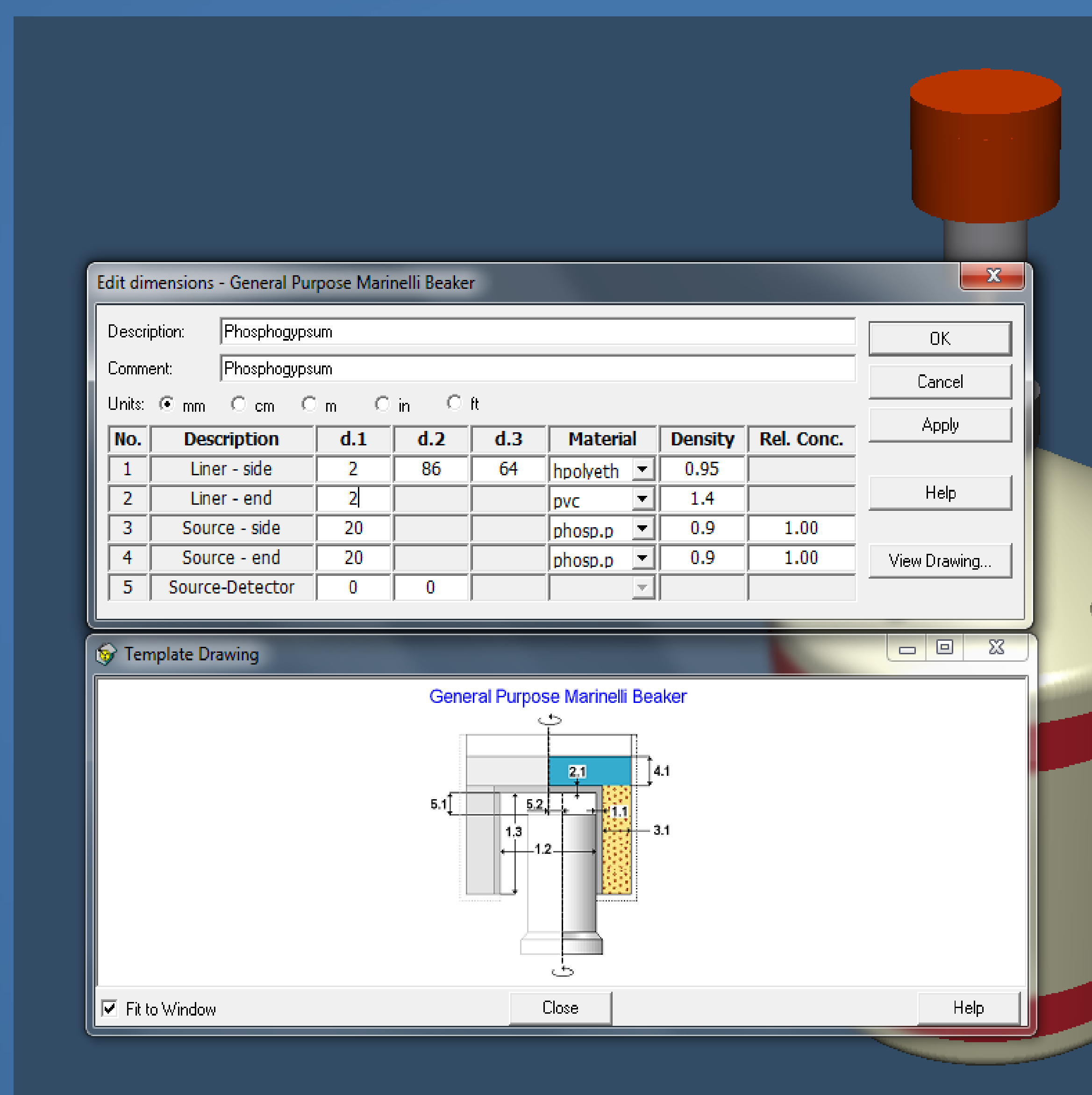
This paper describes the results of an intercomparison exercise on determination of natural radionuclides samples received by an industry involving NORM. Within the framework of IAEA RER 9155 project two NORM samples of phosphate ore and phosphogypsum were analyzed. The main radionuclides contributing to gamma exposure are ²¹⁴Pb and ²¹⁴Bi from the ²³⁸U decay series and ²²⁸Ac, ²¹²Pb and ²⁰⁸Tl from the ²³²Th decay series. In the phosphate industry, exposure to gamma radiation from radionuclides in the ²³⁸U decay series is the main concern for radiation protection and, as in many other industries involving NORM industries, arises mainly from accumulations of mineral concentrates or residues.

Materials and methods

These two NORM samples were opened in the air for drying on trays for 2 days and then in the oven were dried at a temperature of about 80°C for 8 hours until a constant mass was obtained. Each sample was put in a 250 and 500 ml Marinelli beaker, then stored in tight plastic containers for about 30 days to allow radioactive equilibrium to be reached between parents and their daughter, concretely to parents ²²⁶Ra and ²³²Th and their daughters, before the measurements to have been performed. An empty Marinelli beaker similar to others was also counted under the same conditions to determine the background. An empty Marinelli beaker similar to others was also counted under the same conditions to determine the background. The measurements were performed by using the High Purity Germanium (HPGe) detector and the activity concentration was determined by gamma-ray spectrometry method (Genie 2000 software). The detector has an energy resolution (FWHM) of 1.8 keV for 1.33 MeV γ -energy of ⁶⁰Co and 40% relative efficiency on the peak. To avoid radiation from outside and other fluctuations, the detector was shielded by three layers of lead, copper and cadmium. The counting time interval was 24 h for each sample, to have a better statistical of counts. The energy calibration was performed in the range from 30 keV to 2000 keV by a mathematical model Software of LabSOCS. The range of absolute efficiency uncertainties was calculated on each peak, however, these varies from 10% at low energies to 4% at high energies.

Results

The values of activity concentration of radionuclides ²²⁶Ra, ²³²Th and ⁴⁰K for both samples and uncertainty ($\pm 1\sigma$) are presented in Tables A and B. For this intercomparison we use efficiency calibration curve generated by Labsocs. In figure below is presented as example the case of phosphogypsum. From the results shown in table A, final score in the phosphate ore sample has been for three natural radionuclides taken in consideration Acceptable. In the case of phosphogypsum for ²²⁶Ra and ²³²Th the final scores has been Acceptable, whereas ⁴⁰K has been Warning. **Z-score has been Acceptable in both cases.**



A. Evaluation results for phosphate ore sample (Bq kg⁻¹)

Isotope	Lab. Value	Lab. Unc.	Bias Relative	Max. Acceptable Relative Bias	Reference Value	Unc. Ref. Value	P	Final Score	Z-Score
K-40	28	1.8	-7 %	20 %	30	1.5	8 % A	A	-0.35 A
Ra-226	442	27	-17 %	20 %	530	20	7 % A	A	-0.85 A
Th-232	42	3	-4 %	20 %	44	1.9	8 % A	A	-0.20 A

B. Evaluation results for phosphogypsum sample (Bq kg⁻¹)

Isotope	Lab. Value	Lab. Unc.	Bias Relative	Max. Acceptable Relative Bias	Reference Value	Unc. Ref. Value	P	Final Score	Z-Score
K-40	11	2	29 %	20 %	15	1.7	8 % A	W	-1.46 A
Ra-226	315	14	-6 %	20 %	340	15	7 % A	A	-0.31 A
Th-232	30	1.8	0 %	20 %	30	3.0	0 % A	A	0.00 A

Conclusions

The results of Z-score in this exercise for characterization of NORM samples have all been accepted and clearly showed that the calibration procedure as well as the detector type, geometry used, and laboratory staff skills play a major role in the laboratory performance.

References

- [1] International Organization for Standardization (ISO). (2022). Statistical methods for use in proficiency testing by interlaboratory comparison, ISO 13528:2022.
- [2] International Atomic Energy Agency, Safety Standard Series No. GSG-7, Occupational Radiation Protection, Vienna 2018.
- [3] International Atomic Energy Agency, Safety Reports Series (SRS) No. 78, Radiation Protection and Management of NORM Residues in the phosphate industry, Vienna 2013.
- [4] M. Shyti, "Calibration and performance of HPGe detector for environmental radioactivity measurements using LabSOCS," AIP Conf. Proc., vol. 2075, no. 1, 130012, February 2019. <https://doi.org/10.1063/1.5091297>.

RAD
CONFERENCE

CONTACT

Manjola Shyti

Institute of Applied Nuclear Physics, University of Tirana
manjola.Shyti@unitir.edu.al
manjolashyti@yahoo.com
www.unitir.edu.al

THIRTEENTH INTERNATIONAL CONFERENCE ON RADIATION,
NATURAL SCIENCES, MEDICINE, ENGINEERING, TECHNOLOGY AND ECOLOGY

JUNE 16-20, 2025
HUNGUEST HOTEL SUN RESORT, HERCEG NOVI, MONTENEGRO

