Asia-Pacific ALMERA Group Proficiency Test and Intercomparison Exercise on the Determination of Gross-Alpha and –Beta and Gamma Radionuclides

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1. Introduction

The KINS, as an ALMERA regional coordinator in the Asia-Pacific area since 2011, has been actively involved in the IAEA ALMERA activities [1]. In the regional group meeting, many Asia-Pacific members expressed their interest in the regional proficiency test (PT) or inter-comparison exercise like as IAEA PT campaign. The KINS organized from sample preparation except for soil to evaluation report.

The main task of the participating laboratories was to quantify the activity levels of ^{40}K, ^{134}Cs and ^{137}Cs in the soil and gross-alpha in the Styrofoam and gross-beta in the glass fiber filter. 14 laboratories from 11 countries participated in this campaign and reported to the KINS their results.

2. Sample Preparation

2.1 Gross-alpha (GA) sample (Styrofoam)

About Styrofoam was selected as bedding material for the alpha radiation source. ^{241}Am standard solution (NIST4332C) used as spiking solution on the surface of Styrofoam. The spiked solution was dried in the desiccator for 1 day, and then it was dried again under the IR ramp at a mild temperature. The homogeneity was tested and gave a satisfactory result.

Additional blank labelled GA-blank Styrofoam was prepared and delivered for background and efficiency.

2.2 Gross-beta (GB) sample (GF filter)

A diluted ^{90}Sr standard solution was spiked on the 47 mm diameter glass fiber (GF) filter which was fixed on a stainless steel planchette used for alpha beta counting. The ^{90}Sr solution was spiked on the surface of GF filter with a similar method used in the preparation of GA sample. Additional blank filter can be used for background and efficiency measurement.

2.3 Preparation of the natural soil

The raw material was collected and pretreated by the JCAC, and then it was transferred to the KINS. The homogeneity was tested by the KINS using the ANOVA method. The packing unit contains about 125 g of dried soil.

2.4 Homogeneity testing

A total of 8 sample bottles at 30 g sample intake for homogeneity test were selected randomly of the 25 bottles. In the ANOVA evaluation, the observed F values are less than the critical F values in both table, so we accept the null hypothesis and homogeneity in the soil sample [2].

3. Performance Criteria

The PT and inter-comparison testing scoring system applied were based on the IAEA evaluation method used in the ALMERA-PT-2015, which takes into consideration the trueness and the precision of the reported data, and it includes in the evaluation both the total combined uncertainty associated with the target value of PT testing samples and the total uncertainty reported by the participating laboratories.

4. Results and Discussion

4.1 Overall Evaluation

58 measurement results were reported to the KINS in this PT from 14 laboratories. The overall evaluation (Table 1) showed that 81% of all reported results were “Accepted” and 17 were “Not acceptable”.

Table 1. Data evaluation of Gross-alpha in spiked Styrofoam

	Gross-alpha	Gross-beta	K-40	Cs-134	Cs-137
Number of reported results	9	10	13	13	13
Acceptable (%)	67	50	92	85	100
Warning (%)	0	0	8	0	0
Not Acceptable (%)	33	50	0	15	0

4.2 Proficiency test

Tables 2 and 3 show that the distribution of results scored for Gross-alpha and Gross-beta. In the case of Gross-alpha, 3 reported results are deviated to the higher value from the target. For Gross-beta measurement, many laboratories showed a poor performance worse than gross-alpha measurement. 68% of the participant laboratories gave a "Not Acceptable" results. The main reason for these "Not Acceptable" results could be attributed to the underestimation of detector efficiency or unclarified problem in the calibration of the detector.

Table 2. Data evaluation of Gross-alpha in spiked Styrofoam

Lab. Code	Rep. Value	Rep. Unc.	Rel. Bias(%)	Accuracy	P	Precision	Final Score
12	5.68	0.29	1.61	A	7.94	A	A
14	5.45	0.06	2.50	A	6.18	A	A
15	6.8	0.4	21.65	NA	8.46	A	NA
16	4.77	0.16	14.67	A	6.95	A	A
18	5.2	0.14	6.98	A	6.65	A	A
20	6.9	0.02	23.43	NA	6.09	NA	NA
22	5.42	0.63	3.04	A	13.12	A	A
23	5.01	0.1	10.38	A	6.40	A	A
24	6.77	0.1	21.11	NA	6.26	NA	NA

* Target value: 5.59 ± 0.34, MARB: 15%

Table 3. Data evaluation of Gross-beta in spiked glass filter

Lab. Code	Rep. Value	Rep. Unc.	Rel. Bias(%)	Accuracy	P	Precision	Final Score
12	2.21	0.11	-3.07	A	7.90	A	A
14	2.19	0.04	-3.95	A	6.41	A	A
15	1.7	0.1	-25.44	NA	8.50	A	NA
16	2.36	0.08	3.51	A	7.01	A	A
18	1.15	0.05	-49.56	NA	7.52	A	NA
20	2.3	0.015	0.88	A	6.17	A	A
21	1.113	0.023	-51.18	NA	6.48	A	NA
22	1.02	0.18	-55.26	NA	18.68	NA	NA
23	2.3	0.08	0.88	A	7.06	A	A
24	1.49	0.03	-34.65	NA	6.46	A	NA

* Target value: 2.28 ± 0.14, MARB: 15%

4.3 Inter-Comparison exercise (Gamma radionuclides)

Fig. 1 shows the z-score evaluation results sorted by the laboratories code. Comparing to the PT test, these three gamma radionuclides results are mostly | z- Score | < 2. The ^{40}K results' evaluation demonstrated that just one laboratory is "Warning" and others are "Acceptable". While the evaluation of ^{134}Cs is a little worse than ^{40}K with one extremely low value, a mistake in the calculation procedure is suspected. The result for ^{137}Cs are all located within 2 in z-score without failure in performance.

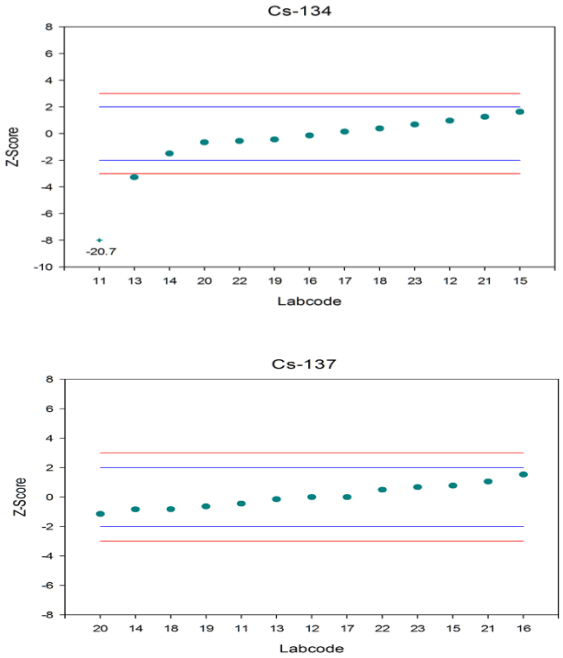

Fig. 1. z-scores in ^{134}Cs and ^{137}Cs in soil.

5. Conclusion

Overall, this exercise provided that the level of analytical performance of the Asia-Pacific ALMERA network members is good enough in the determination of three above gamma emitting radionuclides (for ^{40}K, ^{134}Cs and ^{137}Cs) in environmental soil. It is recommended, however, that a repeat of this exercise for the Gross-alpha and Gross-beta analysis be conducted at some time in the near future to provide an opportunity for laboratories to introduce proper corrective actions in the filter type of samples.

REFERENCES

[1] A. Shakhashiro, Z. Radecki, A. Trinkl, U. Sansone and T. Benesch, "Final Report on the Proficiency Test of the Analytical Laboratories for the Measurement of Environmental Radioactivity (ALMERA) Network", IAEA/AL/152, p.242, August 2005.

[2] Pagano, R. R. (2004). Understanding Statistics in the Behavioral Sciences (7th ed.) Belmont, CA: Thomson/Wadsworth.