The IAEA-TEL-2018-03 world wide open proficiency test on the determination of anthropogenic and natural radionuclides in water, soil sample and surface contamination measurement

Laboratory's Individual Evaluation Report
Laboratory Code: 27 (CuNo: 13949)
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IAEA-TEL-2018-03 World Wide Open Proficiency Test Exercise, Individual Evaluation Report Part I

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Abstract

This report describes the evaluation method for the proficiency test conducted within the IAEA-TEL-2018-03 world wide open proficiency test exercise. The data is evaluated by the Terrestrial Environment Laboratory (TEL) of the NA Environment Laboratories using its standard approach for proficiency test evaluations.

1 Evaluation criteria

The data is evaluated according to the following steps:

The relative bias between the reported and the target value (the best estimation of the true value) is expressed by the following equation:

$$Bias_{relative} = \frac{Value_{reported} - Value_{target}}{Value_{target}} * 100\%$$

The relative bias is compared to the Maximum Acceptable Relative Bias (MARB) which has been determined for each measurand considering the physical background of radio-analytical methods including the level of radioactivity and the complexity of the task.

If the $|Bias_{relative}| \leq MARB$, the result will be "Accepted" for accuracy.

Based on fit for purpose and the good laboratory practice principles, the expanded relative combined uncertainty should cover the relative bias:

$$P = \sqrt{\left(\frac{u_{target}}{A_{target}}\right)^2 + \left(\frac{u_{reported}}{A_{reported}}\right)^2} * 100$$

$$|Bias_{relative}| \leq k * P$$

where k is the coverage factor, for the 99% confidential level, $k = 2.58$. If the result is between the $\pm MARB$ values, but it is not overlapping with the target value within their uncertainties, this equation helps to decide whether they are significantly different or not.

The P value is compared to the MARB also. If both the:

$$P \leq MARB$$

and

$$|Bias_{relative}| \leq k * P$$

are fulfilled, the reported results will be "Accepted" for the precision. If one of them is insufficient, the result will be assigned the "Not accepted" status for precision.

The final score according to the above detailed evaluation:

- "Accepted" when both, accuracy and precision achieved "Accepted" status
- "Not Accepted" when the accuracy is "Not accepted"
- "Warning" when accuracy is "Accepted" but the precision is "Not accepted"

As additional information a z-score parameter is shown in the evaluation tables that calculates by using the robust standard deviation described in [2] as:

$$z = \left| \frac{Value_{reported} - Value_{target}}{robustsd} \right|$$

If the analyte is included in the proficiency test evaluation schema, the stated target value is used to calculate the z-score. For those analytes, which are subject of an intercomparison only, the robust mean of the values reported is used instead.

2 Tables of Target Values and Evaluation Criteria Parameters for Proficiency Test Parameters

Target Values for Gamma Spectrometry Analysis in Sample 1

TABLE 1. Target values

Sample	Analyte	Massic Activity, [Bq/kg]	Uncertainty, [Bq/kg]	Maximum Acceptable Relative Bias, [%]
1	Co-60	97.6	0.8	15
1	Sr-89	93.8	1.4	25
1	Sr-90	9.7	0.1	25
1	Ba-133	28.6	0.2	15
1	Cs-134	58.2	0.3	15
1	Cs-137	29.0	0.2	15
1	Pb-210	95.6	0.9	15
1	Am-241	29.3	0.2	15

Target Values for Alpha/Beta Spectrometry Analysis in Sample 1

TABLE 2. Target values

Sample	Analyte	Massic Activity, [Bq/kg]	Uncertainty, [Bq/kg]	Maximum Acceptable Relative Bias, [%]
1	Po-210	86.6	4.0	30

Target Values for Gamma Spectrometry Analysis in Sample 2

TABLE 3. Target values

Sample	Analyte	Massic Activity, [Bq/kg]	Uncertainty, [Bq/kg]	Maximum Acceptable Relative Bias, [%]
2	Be-7	440	12	15
2	Na-24	21900	600	25
2	K-42	444000	17000	25
2	Mn-54	61.3	1.4	20
2	Co-58	15.5	1.2	30
2	Co-60	14.3	0.6	30
2	Br-82	224	8	30
2	Rb-86	240	7	30
2	Mo-99(Tc-99m)	470	15	30
2	Sb-124	33.5	0.7	30
2	I-131	241	7	20
2	I-133	2760	70	30
2	Cs-134	3010	60	15
2	Cs-136	29.2	0.7	30
2	Cs-137	2010	40	15
2	W-187	425	23	20

Target Values for Gamma Spectrometry Analysis in Sample 4

TABLE 4. Target values

Sample	Analyte	Massic Activity, [Bq/kg]	Uncertainty, [Bq/kg]	Maximum Acceptable Relative Bias, [%]
4	K-40	374	15	20
4	Co-60	141.8	2.7	20
4	Ba-133	56.8	0.9	20
4	Cs-134	112.2	1.6	20
4	Cs-137	64.9	1.2	20
4	Tl-208	11.7	0.4	25
4	Pb-210	485	11.6	20
4	Pb-212	32.6	1.3	25
4	Pb-214	31.2	1.5	20
4	Bi-214	31.2	1.5	20
4	Ra-226	31.2	1.5	20
4	Ra-228	32.6	1.3	25
4	Ra-228	32.6	1.3	25
4	Ac-228	32.6	1.3	25
4	Th-228	32.6	1.3	25
4	Pa-234m	25	1.7	20
4	Th-234	25	1.7	20
4	U-235	1.0	0.1	30
4	Am-241	53.1	0.9	20

Target Values for Alpha/Beta Spectrometry Analysis in Sample 4

TABLE 5. Target values

Sample	Analyte	Massic Activity, [Bq/kg]	Uncertainty, [Bq/kg]	Maximum Acceptable Relative Bias, [%]
4	Po-210	482	24	20
4	Ra-226	31.2	1.5	20
4	Th-228	32.6	1.3	25
4	U-234	25.0	1.7	20
4	U-235	1.0	0.1	30
4	U-238	25.0	1.7	20

3 Tables of Robust Statistic Parameters for Intercomparison Parameters

Robust Statistic Parameters for gross alpha and gross beta measurement in Sample 1

TABLE 6. Intercomparison values

Sample	Analyte	Robust Mean, Bq/kg	Robust SD, Bq/kg	MARB, %
1	gross_alpha	104.5	34.1	50
1	gross_beta	242	76	50

Robust Statistic Parameters for Xe-133 determination in Sample 2

TABLE 7. Intercomparison values

Sample	Analyte	Robust Mean, Bq/kg	Robust SD, Bq/kg	MARB, %
2	Xe-133	180	40	40

Robust Statistic Parameters for Th-232 determination in Sample 4

TABLE 8. Intercomparison values

Sample	Analyte	Robust Mean, Bq/kg	Robust SD, Bq/kg	MARB, %
4	Th-232	33.6	3.3	25

Robust Statistic Parameters for the measurement of the beta emission rate in Sample 5

TABLE 9. Intercomparison values

Sample	Analyte	Robust Mean, particle/cm2/s	Robust SD, particle/cm2/s	MARB, %
5	beta	1.1	0.5	50

Robust Statistic Parameters for the measurement of the alpha emission rate in Sample 6

TABLE 10. Intercomparison values

Sample	Analyte	Robust Mean, particle/cm2/s	Robust SD, particle/cm2/s	MARB, %
6	alpha	0.3	0.2	50

Robust Statistic Parameters for the measurement of emission rates in Sample 7

TABLE 11. Intercomparison values

Sample	Analyte	Robust Mean, particle/cm2/s	Robust SD, particle/cm2/s	MARB, %
7	alpha	0.2	0.1	50
7	beta	2.0	0.9	50

4 References

References

[1] International Organization for Standardization (ISO). (2010). Conformity assessment - General requirements for proficiency testing, ISO/IEC 17043:2010. Geneva: Switzerland.

[2] International Organization for Standardization (ISO). (2015). Statistical methods for use in proficiency testing by interlaboratory comparison, ISO 13528:2015. Geneva: Switzerland.

for the World-Wide Open Proficiency Test IAEA-TEL-2018-03 Part II

Individual Evaluation Report
for
Laboratory Nr. 27

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Evaluation Tables for Labcode 27. (Values and uncertainties expressed in Bq/kg)

Evaluation Result Table for Sample 1

Sample Code	Analyte	Target Value	Target Unc.	MARB	Rep. Value	Rep. Unc	Rel. Bias	Robust SD	Z-Score	Accuracy	P	Precision	Final Score
1	Am-241	29.3	0.2	15 %	28.1	2.5	-4.10 %	1.9	0.63	A	8.92	A	A
1	Ba-133	28.6	0.2	15 %	28.7	2.2	0.35 %	1.9	0.05	A	7.70	A	A
1	Co-60	97.6	0.8	15 %	94.5	6.3	-3.18 %	4	0.77	A	6.72	A	A
1	Cs-134	58.2	0.3	15 %	54.2	3.8	-6.87 %	2.6	1.54	A	7.03	A	A
1	Cs-137	29	0.2	15 %	25.5	1.9	-12.07 %	1.1	3.18	A	7.48	A	A
1	Pb-210	95.6	0.9	15 %	89	11	-6.90 %	8.7	0.76	A	12.40	A	A

Evaluation Result Table for Sample 2

Sample Code	Analyte	Target Value	Target Unc.	MARB	Rep. Value	Rep. Unc	Rel. Bias	Robust SD	Z-Score	Accuracy	P	Precision	Final Score
2	Be-7	440	12	15 %	437	36	-0.68 %	30.6	0.10	A	8.68	A	A
2	Co-58	15.5	1.2	30 %	13.8	2.0	-10.97 %	1.5	1.13	A	16.43	A	A
2	Co-60	14.3	0.6	30 %	13.1	1.8	-8.39 %	2	0.60	A	14.37	A	A
2	Cs-134	3010	60	15 %	2930	180	-2.66 %	152.2	0.53	A	6.46	A	A
2	Cs-136	29.2	0.7	30 %	28.6	3.0	-2.05 %	3.4	0.18	A	10.76	A	A
2	Cs-137	2010	40	15 %	1960	150	-2.49 %	71.3	0.70	A	7.91	A	A
2	I-131	241	7	20 %	247	21	2.49 %	17.1	0.35	A	8.98	A	A
2	Mn-54	61.3	1.4	20 %	60.2	4.8	-1.79 %	3	0.37	A	8.29	A	A
2	Mo-99	470	15	30 %	442	53	-5.96 %	49.8	0.56	A	12.41	A	A
2	Rb-86	240	7	30 %	214	32	-10.83 %	20.1	1.29	A	15.24	A	A
2	Sb-124	33.5	0.7	30 %	27.8	2.6	-17.01 %	3.3	1.73	A	9.58	A	A

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Evaluation Result Table for Sample 4

Sample Code	Analyte	Target Value	Target Unc.	MARB	Rep. Value	Rep. Unc	Rel. Bias	Robust SD	Z-Score	Accuracy	P	Precision	Final Score
4	Ac-228	32.6	1.3	25 %	33.2	4.9	1.84 %	2.3	0.26	A	15.29	A	A
4	Am-241	53.1	0.9	20 %	52.8	4.1	-0.56 %	6.3	0.05	A	7.95	A	A
4	Ba-133	56.8	0.9	20 %	54.2	3.8	-4.58 %	5.9	0.44	A	7.19	A	A
4	Bi-214	31.2	1.5	20 %	28.1	4.3	-9.94 %	5.8	0.53	A	16.04	A	A
4	Co-60	141.8	2.7	20 %	138.8	9.2	-2.12 %	8.3	0.36	A	6.90	A	A
4	Cs-134	112.2	1.6	20 %	110.6	7.4	-1.43 %	9.1	0.18	A	6.84	A	A
4	Cs-137	64.9	1.2	20 %	62.3	3.7	-4.01 %	4	0.65	A	6.22	A	A
4	K-40	374	15	20 %	332	51	-11.23 %	32.8	1.28	A	15.88	A	A
4	Pb-210	485	11.6	20 %	470	38	-3.09 %	82.9	0.18	A	8.43	A	A
4	Pb-212	32.6	1.3	25 %	35.8	3.3	9.82 %	3.1	1.03	A	10.04	A	A
4	Pb-214	31.2	1.5	20 %	31.4	4.0	0.64 %	3.4	0.06	A	13.62	A	A
4	Ra-226	31.2	1.5	20 %	29.8	4.6	-4.49 %	19	0.07	A	16.17	A	A
4	Th-234	25	1.7	20 %	26.7	3.1	6.80 %	4.5	0.38	A	13.46	A	A
4	Tl-208	11.7	0.4	25 %	12.2	1.5	4.27 %	1.3	0.38	A	12.76	A	A
4	U-238	25	1.7	20 %	26.7	3.1	6.80 %	5.8	0.29	A	13.46	A	A

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Intercomparison Parameter Evaluation: (Values and uncertainties for sample 1 and sample 4 are expressed in Bq/kg)

Sample Code	Analyte	Robust Mean	Robust SD	Rep. Value	Rep. Unc	Z-Score	Z-Score Evaluation
5	Beta_emission_rate	1.1	0.5	1.29	0.23	0.38	A
6	Alpha_emission_rate	0.3	0.2	0.281	0.055	0.09	A
7	Alpha_emission_rate	0.2	0.1	0.180	0.035	0.20	A
7	Beta_emission_rate	2	0.9	2.33	0.43	0.37	A

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The analytes listed in the table below have been identified but are not present in the samples (false positive):

Sample Code	Analyte	Reported Value