The IAEA-TEL-2019-03 world wide open proficiency test on the determination of anthropogenic and natural radionuclides in water, shrimp and simulated aerosol filter samples

Laboratory's Individual Evaluation Report
Laboratory Code: 5 (CuNo: 13949)
Total Pages (with cover): 15

IAEA-TEL-2019-03 World Wide Open Proficiency Test Exercise, Individual Evaluation Report Part I

October 4, 2019

Abstract

This report describes the evaluation method for the proficiency test conducted within the IAEA-TEL-2019-03 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	Cs-134	9.30	0.30	20.00
1	Cs-137	8.92	0.25	20.00
1	Tl-208	0.29	0.07	75.00
1	Bi-212	0.80	0.20	75.00
1	Pb-212	0.80	0.20	75.00
1	Pb-214	7.50	0.25	25.00
1	Bi-214	7.50	0.25	25.00
1	Ac-228	22.08	1.00	20.00

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	Sr-90	9.40	0.31	30.00
1	Ra-224	0.80	0.20	75.00
1	Ra-226	7.50	0.25	25.00
1	Ra-228	22.08	1.00	20.00
1	Th-228	0.80	0.20	75.00

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	Cs-134	5.05	0.15	40.00
2	Cs-137	4.19	0.12	40.00
2	Tl-208	0.04	0.01	100.00
2	Bi-212	0.10	0.03	100.00
2	Pb-212	0.10	0.03	100.00
2	Pb-214	1.40	0.07	50.00
2	Bi-214	1.40	0.07	50.00
2	Ac-228	3.98	0.12	40.00

Target Values for Alpha/Beta Spectrometry Analysis in Sample 2

TABLE 4. Target values

Sample	Analyte	Massic Activity, [Bq/kg]	Uncertainty, [Bq/kg]	Maximum Acceptable Relative Bias, [%]
2	Sr-90	2.70	0.13	60.00
2	Ra-224	0.10	0.03	100.00
2	Ra-226	1.40	0.07	40.00
2	Ra-228	3.98	0.12	40.00
2	Th-228	0.10	0.03	100.00

Target Values for Gamma Spectrometry Analysis in Sample 4

TABLE 5. Target values

Sample	Analyte	Massic Activity, [Bq/kg]	Uncertainty, [Bq/kg]	Maximum Acceptable Relative Bias, [%]
4	K-40	335.00	12.00	15.00
4	Cs-137	0.21	0.04	60.00
4	Tl-208	2.40	0.14	60.00
4	Bi-212	6.70	0.40	30.00
4	Pb-212	6.70	0.40	30.00
4	Pb-214	6.00	0.60	40.00
4	Bi-214	6.00	0.60	40.00
4	Ac-228	17.70	0.90	25.00

Target Values for Alpha/Beta Spectrometry Analysis in Sample 4

TABLE 6. Target values

Sample	Analyte	Massic Activity, [Bq/kg]	Uncertainty, [Bq/kg]	Maximum Acceptable Relative Bias, [%]
4	Po-210	57.80	1.10	25.00
4	Pb-210	1.60	0.10	40.00
4	Ra-224	6.70	0.40	30.00
4	Ra-226	6.00	0.60	40.00
4	Th-228	6.70	0.40	30.00
4	Ra-228	17.70	0.90	25.00
4	Th-230	0.55	0.03	40.00
4	Th-232	0.38	0.02	40.00
4	U-234	0.81	0.03	30.00
4	U-235	0.05	0.01	60.00
4	U-238	0.67	0.03	30.00

Target Values for Gamma Spectrometry Analysis in Sample 5

TABLE 7. Target values

Sample	Analyte	Massic Activity, [Bq/filter]	Uncertainty, [Bq/filter]	Maximum Acceptable Relative Bias, [%]
5	Cs-134	10.71	0.32	20.00
5	Cs-137	13.25	0.40	20.00

Target Values for Gamma Spectrometry Analysis in Sample 6

TABLE 8. Target values

Sample	Analyte	Massic Activity, [Bq/filter]	Uncertainty, [Bq/filter]	Maximum Acceptable Relative Bias, [%]
6	Cs-134	20.28	0.61	20.00
6	Cs-137	13.02	0.40	20.00

Target Values for Gamma Spectrometry Analysis in Sample 7

TABLE 9. Target values

Sample	Analyte	Massic Activity, [Bq/filter]	Uncertainty, [Bq/filter]	Maximum Acceptable Relative Bias, [%]
7	Cs-134	6.37	0.25	25.00
7	Cs-137	24.93	0.75	20.00

3   Tables of Robust Statistic Parameters for Intercomparison Parameters

Robust Statistic Parameters for Intercomparison Parameters in Sample 1

TABLE 10. Intercomparison values

Sample	Analyte	Robust Mean, Bq/kg	Robust SD, Bq/kg	MARB, %
1	gross alpha	21.06	8.33	30.00
1	gross beta	59.45	10.54	30.00

Robust Statistic Parameters for Intercomparison Parameters in Sample 2

TABLE 11. Intercomparison values

Sample	Analyte	Robust Mean, Bq/kg	Robust SD, Bq/kg	MARB, %
2	gross alpha	4.20	1.58	30.00
2	gross beta	17.32	4.15	30.00

Robust Statistic Parameters for Intercomparison Parameters in Sample 5

TABLE 12. Intercomparison values

Sample	Analyte	Robust Mean, Bq/filter	Robust SD, Bq/filter	MARB, %
5	gross beta	24.00	3.89	30.00

Robust Statistic Parameters for Intercomparison Parameters in Sample 6

TABLE 13. Intercomparison values

Sample	Analyte	Robust Mean, Bq/filter	Robust SD, Bq/filter	MARB, %
6	gross beta	33.00	5.04	30.00

Robust Statistic Parameters for Intercomparison Parameters in Sample 7

TABLE 14. Intercomparison values

Sample	Analyte	Robust Mean, Bq/filter	Robust SD, Bq/filter	MARB, %
7	gross beta	31.00	5.41	30.00

4 References
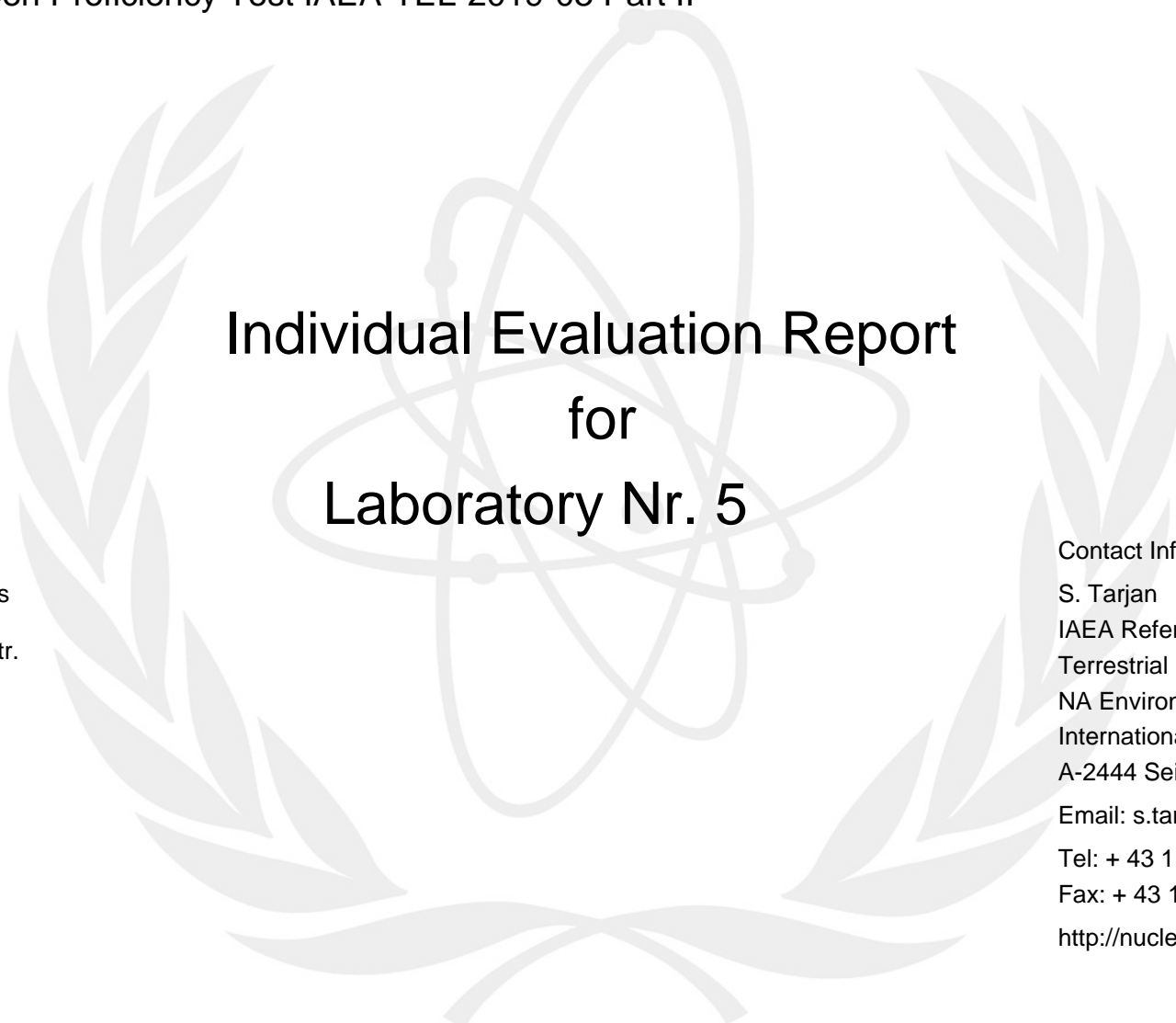
References

[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.

Individual Evaluation Report

for the World-Wide Open Proficiency Test IAEA-TEL-2019-03 Part II

Individual Evaluation Report

for

Laboratory Nr. 5

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Evaluation Tables for Labcode 5. (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	Ac-228	22.08	1	20 %	22.0	2.0	-0.36 %	1.31	0.06	A	10.16	A	A
1	Cs-134	9.3	0.3	20 %	8.95	0.60	-3.76 %	0.65	0.54	A	7.44	A	A
1	Cs-137	8.92	0.25	20 %	8.6	1.0	-3.59 %	0.4	0.80	A	11.96	A	A
1	Ra-226	7.5	0.25	25 %	7.59	0.71	1.20 %	1.5	0.06	A	9.93	A	A
1	Ra-228	22.08	1	20 %	24.4	2.3	10.51 %	1.25	1.86	A	10.46	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	Cs-134	5.05	0.15	40 %	4.49	0.40	-11.09 %	0.35	1.60	A	9.39	A	A
2	Cs-137	4.19	0.12	40 %	4.55	0.53	8.59 %	0.22	1.64	A	12.00	A	A
2	Ra-226	1.4	0.07	40 %	1.36	0.13	-2.86 %	0.56	0.07	A	10.79	A	A
2	Ra-228	3.98	0.12	40 %	4.44	0.43	11.56 %	0.36	1.28	A	10.14	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	K-40	335	12	15 %	339	42	1.19 %	33.59	0.12	A	12.90	A	A

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Evaluation Result Table for Sample 5

Sample Code	Analyte	Target Value	Target Unc.	MARB	Rep. Value	Rep. Unc	Rel. Bias	Robust SD	Z-Score	Accuracy	P	Precision	Final Score
5	Cs-134	10.71	0.32	20 %	9.92	0.79	-7.38 %	1.42	0.56	A	8.51	A	A
5	Cs-137	13.25	0.4	20 %	12.3	1.0	-7.17 %	1.49	0.64	A	8.67	A	A

Evaluation Result Table for Sample 6

Sample Code	Analyte	Target Value	Target Unc.	MARB	Rep. Value	Rep. Unc	Rel. Bias	Robust SD	Z-Score	Accuracy	P	Precision	Final Score
6	Cs-134	20.28	0.61	20 %	18.6	1.5	-8.28 %	2.52	0.67	A	8.61	A	A
6	Cs-137	13.02	0.4	20 %	11.92	0.99	-8.45 %	1.36	0.81	A	8.86	A	A

Evaluation Result Table for Sample 7

Sample Code	Analyte	Target Value	Target Unc.	MARB	Rep. Value	Rep. Unc	Rel. Bias	Robust SD	Z-Score	Accuracy	P	Precision	Final Score
7	Cs-134	6.37	0.25	25 %	5.86	0.47	-8.01 %	0.9	0.57	A	8.93	A	A
7	Cs-137	24.93	0.75	20 %	23.3	1.9	-6.54 %	2.78	0.59	A	8.69	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
1	gross_alpha	21.06	8.33	21.4	1.9	0.04	A
1	gross_beta	59.45	10.54	88	14	2.71	W
2	gross_alpha	4.2	1.58	3.74	0.37	0.29	A
2	gross_beta	17.32	4.15	23.9	4.0	1.59	A
5	gross_beta	24	3.89	20.8	7.0	0.82	A
6	gross_beta	33	5.04	25.5	8.5	1.49	A
7	gross_beta	31	5.41	30	10	0.18	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