The IAEA-TEL-2020-03 world wide open proficiency test on the determination of anthropogenic and natural radionuclides in water, fish and simulated aerosol filter samples

Laboratory's Individual Evaluation Report
Laboratory Code: 5 (CuNo: 13949)
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IAEA-TEL-2020-03 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-2020-03 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	Na-22	76.80	1.20	20.00
1	Cs-134	33.50	0.50	20.00
1	Cs-137	64.40	0.90	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	23.90	0.30	30.00

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	Tl-208	2.20	0.20	40.00
2	Pb-212	6.00	0.50	35.00
2	Bi-212	6.00	0.50	60.00
2	Ac-228	24.70	1.00	25.00

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	Ra-228	24.70	1.00	25.00
2	Th-228	6.00	0.50	30.00

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	369.00	18.00	25.00
4	Cs-134	119.40	5.00	20.00
4	Cs-137	18.90	1.00	25.00
4	Tl-208	4.10	0.30	40.00
4	Pb-210	95.80	5.00	30.00
4	Pb-212	11.50	0.80	30.00
4	Bi-212	11.50	0.80	60.00
4	Bi-214	13.50	0.80	30.00
4	Pb-214	13.50	0.80	30.00
4	Ac-228	34.90	2.00	30.00

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	97.40	5.00	30.00
4	Ra-224	11.50	0.80	30.00
4	Ra-226	13.50	0.80	30.00
4	Ra-228	34.90	2.00	30.00
4	Th-228	11.50	0.80	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	Se-75	18.10	1.00	25.00
5	Ag-110m	55.10	4.00	30.00

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	Se-75	31.30	1.50	25.00
6	Ag-110m	35.10	3.00	30.00

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	Se-75	113.40	2.00	25.00
7	Ag-110m	19.20	1.40	30.00

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_beta	170.00	27.00	50.00

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	40.00	14.00	50.00
2	gross_beta	38.00	7.00	50.00

Robust Statistic Parameters for Intercomparison Parameters in Sample 4

TABLE 12. Intercomparison values

Sample	Analyte	Robust Mean, Bq/kg	Robust SD, Bq/kg	MARB, %
4	gross_alpha	169.00	126.00	50.00
4	gross_beta	597.00	186.00	50.00

Robust Statistic Parameters for Intercomparison Parameters in Sample 5

TABLE 13. Intercomparison values

Sample	Analyte	Robust Mean, Bq/filter	Robust SD, Bq/filter	MARB, %
5	gross_beta	12.40	3.50	50.00

Robust Statistic Parameters for Intercomparison Parameters in Sample 6

TABLE 14. Intercomparison values

Sample	Analyte	Robust Mean, Bq/filter	Robust SD, Bq/filter	MARB, %
6	gross_beta	8.60	2.50	50.00

Robust Statistic Parameters for Intercomparison Parameters in Sample 7

TABLE 15. Intercomparison values

Sample	Analyte	Robust Mean, Bq/filter	Robust SD, Bq/filter	MARB, %
7	gross_beta	7.60	2.50	50.00

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
Laboratory Nr. 5

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Proficiency Test IAEA-TEL-2020-03 Evaluation Report Part II

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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	Cs-134	33.5	0.5	20 %	33.9	2.4	1.19 %	1.4	0.29	A	7.24	A	A
1	Cs-137	64.4	0.9	20 %	67.2	4.5	4.35 %	1.7	1.65	A	6.84	A	A
1	Na-22	76.8	1.2	20 %	74.7	5.1	-2.73 %	5	0.42	A	7.00	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	Ac-228	24.7	1	25 %	22.3	3.2	-9.72 %	1.9	1.26	A	14.91	A	A
2	Pb-212	6	0.5	35 %	5.9	1.6	-1.67 %	2.9	0.03	A	28.37	A	A
2	Ra-224	6	0.5	30 %	5.9	1.6	-1.67 %	3.1	0.03	A	28.37	A	A
2	Ra-228	24.7	1	25 %	22.3	3.2	-9.72 %	1.9	1.26	A	14.91	A	A
2	Th-228	6	0.5	30 %	5.9	1.6	-1.67 %	2.5	0.04	A	28.37	A	A

Proficiency Test IAEA-TEL-2020-03 Evaluation Report Part II

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Values and uncertainties expressed in Bq/kg

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	34.9	2	30 %	39.9	4.8	14.33 %	3.6	1.39	A	13.33	A	A
4	Cs-134	119.4	5	20 %	123.2	7.1	3.18 %	8.8	0.43	A	7.12	A	A
4	Cs-137	18.9	1	25 %	19.2	1.8	1.59 %	1.3	0.23	A	10.77	A	A
4	K-40	369	18	25 %	434	52	17.62 %	26.2	2.48	A	12.94	A	A
4	Pb-210	95.8	5	30 %	98.0	9.9	2.30 %	16.2	0.14	A	11.37	A	A
4	Ra-228	34.9	2	30 %	39.9	4.8	14.33 %	3.6	1.39	A	13.33	A	A

Proficiency Test IAEA-TEL-2020-03 Evaluation Report Part II

Created on 2021-08-25

Values and uncertainties for sample 5,6,7 expressed in Bq/filter

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	Ag-110m	55.1	4	30 %	54.9	2.9	-0.36 %	8.9	0.02	A	8.98	A	A
5	Se-75	18.1	1	25 %	17.06	0.94	-5.75 %	1.4	0.74	A	7.80	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	Ag-110m	35.1	3	30 %	34.2	1.8	-2.56 %	5.9	0.15	A	10.04	A	A
6	Se-75	31.3	1.5	25 %	30.3	1.7	-3.19 %	3.4	0.29	A	7.38	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	Ag-110m	19.2	1.4	30 %	19.0	1.0	-1.04 %	3.2	0.06	A	8.99	A	A
7	Se-75	113.4	2	25 %	111.7	6.0	-1.50 %	12.8	0.13	A	5.65	A	A

Proficiency Test IAEA-TEL-2020-03 Evaluation Report Part II

Created on 2021-08-25

Intercomparison Parameter Evaluation: (Values for sample 1,2,4 in Bq/kg, sample 5,6,7 in Bq/filter)

Sample Code	Analyte	Robust Mean	Robust SD	Rep. Value	Rep. Unc	Z-Score	Z-Score Evaluation
1	gross_beta	170	27			n.a.	n.a.
2	gross_alpha	40	14			n.a.	n.a.
2	gross_beta	38	7			n.a.	n.a.
4	gross_alpha	169	126			n.a.	n.a.
4	gross_beta	597	186			n.a.	n.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