IAEA / AL / 169

Report on the IAEA-CU-2006-11 Proficiency Test on the Determination of Gamma Emitting Radionuclides in Air Filters

TC Project RER-8-009
Seibersdorf, October 2006

IAEA / AL /169

Department of Nuclear Sciences and Applications

Physics, Chemistry and Instrumentation Laboratory

Chemistry Unit

REPORT ON THE IAEA-CU-2006-11 PROFICIENCY TEST ON THE DETERMINATION OF GAMMA EMITTING RADIONUCLIDES IN AIR FILTERS

Within the frame of TC project RER-8-009
"Air Pollution Monitoring in the Mediterranean Region"

Abdulghani Shakhashiro[1], Marta Ferrari[2], Chang-Kyu Kim[1], Umberto Sansone[1], David Sill[3]

[1]*IAEA Department of Nuclear Sciences and Applications*
Physics, Chemistry and Instrumentation Laboratory
Chemistry Unit

[2]*IAEA Department of Technical Cooperation*
Division for Europe

[3]*Radiological and Environmental Sciences Laboratory*
Department of Energy, United States of America

Seibersdorf, Austria, October 2006

Contact information

Abdulghani Shakhashiro
International Atomic Energy Agency (IAEA)
Department of Nuclear Sciences and Applications
Physics, Chemistry and Instrumentation Laboratory
Chemistry Unit
Agency's Laboratories Seibersdorf
A-2444 Seibersdorf, Austria

Tel. : *+431 2600 282226*
Fax : *+431 2600 7282226*
E-mail : *a.shakhashiro@iaea.org*

http://www.iaea.org/programmes/aqcs/

Legal Notice
Neither the IAEA nor any person acting on behalf of the IAEA is responsible for the use which might be made of the following information.

© International Atomic Energy Agency
Reproduction is authorised provided the source is acknowledged

Printed in Austria

Contents

Executive summary

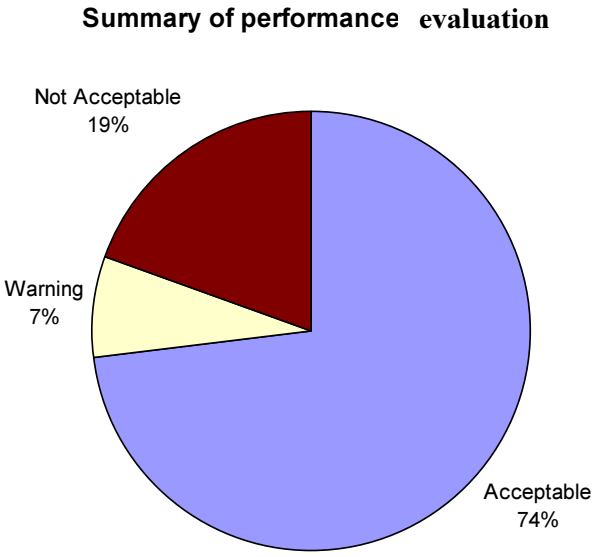
This report summarises the results of the IAEA-CU-2006-11 proficiency test on the determination of gamma emitting radionuclides in air filters, organised within the frame of the IAEA Technical Cooperation project RER/8/009 “Air Pollution Monitoring in the Mediterranean Region”. The proficiency test was conducted by the Reference Materials Group of the Chemistry Unit (Physics, Chemistry and Instrumentation Laboratory) of the IAEA's analytical laboratories located in Seibersdorf (Austria) in cooperation with the Radiological and Environmental Sciences Laboratory, Department of Energy in the United States of America.

The objective of TC project RER/8/009 is to contribute to air quality improvement through the establishment of a network for air monitoring and the design of a remedial strategy where the monitoring shows poor air quality.

A spiked air filter with known activities of gamma emitting radionuclides prepared by the Department of Energy of the United States of America was used in this proficiency test.

14 spiked filters were distributed to the participating laboratories in April 2006. The deadline for receiving the results from the participants was set at 31 July 2006. The participating laboratories were requested to analyse the samples employing the methods used in their routine work, so that their performance on the test samples could be directly related to the real performance of the laboratory. Each laboratory was given a confidential code to assure the anonymity of the evaluation results. From the 14 initially registered, 11 laboratories reported their results back to the IAEA. The analytical results of the participating laboratories were evaluated against the reference values assigned to the reference air filter, and a rating system was applied.

The following picture reports a summary of performance evaluation of this proficiency test, whereby 74 % of the reported results for all analytes obtained "Acceptable" score.



Acknowledgements

The participants and laboratories that responded to this proficiency test and contributed their efforts to the present work are highly appreciated and acknowledged.

1. Introduction

The activity concentration of the radionuclides in the air is a critical factor in assessing the environmental quality and the potential impact of possible pollutants. Air is in fact one of the main pathways for human exposure to pollutants. Radioactive airborne may be released into the atmosphere as a consequence of a nuclear or radiological incident. In addition, their malevolent dispersal in a "dirty bomb" is a possibility that cannot be totally excluded. If this kind of incident occurs, a rapid and accurate determination of radioactive contamination in the air is needed.

Within the frame of the IAEA Technical Cooperation project RER/8/009 "Air Pollution Monitoring in the Mediterranean Region", several Member States expressed their interest in establishing close cooperation among Mediterranean countries[1] in the field of harmonization of air pollution monitoring systems and creation of a common database, since they share geographical position and mutual interest in the environmental conditions of the Mediterranean region. Such cooperation will also promote and enhance the exchange of experience/information.

To fulfil the objective of the TC project, a set of systematic measurements is needed for establishing a baseline level for radionuclide and activity concentration in air. The baseline results are important for health-effect evaluation as well as for detection of the increased level of the pollutants resulting from the intentional or accidental release into the environment. Consequently it is rather important to assure that the conclusions of air monitoring studies are based on reliable and validated analytical results and to ensure the comparability of the results of different countries. Hence, this proficiency test was organized to evaluate the analytical performance of the participating laboratories.

2. Proficiency test objectives

Four distinct aims of the proficiency test can be formulated:

- to check the trueness and precision of the analytical results produced by the participating laboratories for the determination of gamma emitting radionuclides in air filters.
- to encourage the participating laboratories to find remedial actions where shortcomings in analytical performance are detected;
- to encourage the use of proper routine quality control measures within individual laboratories;
- to provide general evaluation and comments on the overall performance of participating laboratories.

3. Proficiency test materials

The PT materials used in this exercise were prepared by the Department of Energy's (DOE) Radiological and Environmental Sciences Laboratory (RESL) in the United States of America according to the following methodology:
All radionuclides standard solutions used in the preparation of the air filter samples for this PT study are traceable to the National Institute of Standards and Technology (NIST). The target values for each of the radionuclides contained in the air filters were calculated from the certified values obtained from the certificate. The combined uncertainties were calculated by propagating all random uncertainties incurred anywhere in the preparation process including uncertainties associated with weight and volumetric dilutions. The target values and

associated uncertainties are listed in Table 1. It should be noted that the known values are directly traceable to SI (Système International d'unités) through NIST by means of an unbroken chain of calculations and are not experimentally determined by analysis.

General Preparation:

1. Each individual solution of the specific radionuclide of interest was diluted to an appropriate total weight in 10% (v/v) nitric acid.

2. A master solution was prepared by combining specific amounts of each of the individual solutions containing the nuclides of interest and diluting to an appropriate final weight.

3. The master solution containing the radionuclides of interest at known activities was used to spike the individual filter papers samples.

4. Two filter papers were place on a plastic weighing dish and a known amount of the master solution was volumetrically transferred to the filter paper. The weight, as well as the volume dispensed were compared for calculation and QC purposes.

The solution weighed onto each filter package, was verified and found not to vary by more than about 0.2 % between filter sets, therefore all samples can be considered statistically identical to each other within the uncertainties given for the known values.

5. The filters were dried for 45 minutes under an IR lamp and the third filter was placed on top and the entire package was sealed.

Nuclides	Target value [Bq/filter]	Uncertainty (±1σ) [Bq/filter]	Uncertainty(±1σ) [%]
^{241}Am	0.158	0.003	2.11
^{57}Co	3.89	0.11	2.86
^{60}Co	2.66	0.07	2.78
^{134}Cs	3.26	0.07	2.27
^{137}Cs	3.18	0.07	2.33
^{54}Mn	2.89	0.07	2.56
^{65}Zn	2.57	0.07	2.59

Table 1: Target values and associated uncertainties (u) of the proficiency test sample, the uncertainty is expressed as 1 σ (k=1).

4. Performance criteria

Currently most laboratories produce test results accompanied, at best, with an indication of their repeatability only and provide no indication of their analytical uncertainty. However, new requirements coming into force (ISO/IEC 17025:2005)[2] require that laboratories have to express their measurement uncertainty.

Several rating systems have been developed for determining a laboratory's performance and the meaning of the results of the different scoring systems are not always comparable. Among various statistics, z-scores and u-scores are most often used. The drawback of z-scores is that the uncertainty of the participant's measurement result is not taken into account for the

evaluation of performance. In the case of u-scores, the evaluation includes uncertainties of the participant measurements and the uncertainty of the assigned value. Laboratories performing well in classical proficiency testing (z-scores) will not necessarily exhibit the same level of performance when their analytical uncertainties are considered in the evaluation.

The proficiency testing scoring system applied by the Chemistry Unit in the Agency's laboratories 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 proficiency testing samples and the total uncertainty reported by the participating laboratories. According to the newly adopted approach, the reported results are evaluated against the acceptance criteria for accuracy and precision and assigned the status "acceptable" or "not acceptable" accordingly. A result must pass both criteria to be assigned the final status of "acceptable". The advantage of this approach is that it checks the credibility of uncertainty statement given by the participating laboratories, and results are no longer compared against fixed criteria but participants establish their individual acceptance range on the basis of the uncertainties assigned to the values. Such an approach highlights not only methodological problems affecting the accuracy of the reported data but also identifies shortcomings in uncertainty estimation.

In addition, three other statistical parameters namely: z-score, IAEA/Laboratory result ratio and relative bias are calculated as complementary information for the participating laboratories.

4.1 Relative bias

The first stage in producing a score for a result $Value_{Analyst}$ (a single measurement of analyte concentration in a test material) is obtaining the estimate of the bias. To evaluate the bias of the reported results, the relative bias between the Analyst's value and the IAEA value is calculated and expressed as a percentage:

$$Relative \quad bias = \frac{Value_{Analyst} - Value_{IAEA}}{Value_{IAEA}} \times 100\% \qquad (1)$$

4.2 The z-score value

The z-score is calculated from the laboratory results, the assigned value and a standard deviation in accordance with the following equation:

$$z_{Score} = \frac{Value_{Analyst} - Value_{IAEA}}{\sigma} \qquad (2)$$

On the basis of the "fitness for purpose" principle, the target value for the standard deviation (σ) is:

$$0.10 \text{ x } Value_{IAEA}$$

The laboratory performance is evaluated as satisfactory if $|z_{Score}| \leq 2$; questionable for $2<|z_{Score}|<3$, and unsatisfactory for $|z_{Score}| \geq 3$.

4.3 The u-score value

The value of the u_{test} was calculated according to the following equation [3]

$$u_{test} = \frac{\left|Value_{IAEA} - Value_{Analyst}\right|}{\sqrt{Unc._{IAEA}^2 + Unc._{Analyst}^2}} \qquad (3)$$

This value is compared with the critical value listed in the t-statistic tables to determine if the reported result differs significantly from the expected value at a given level of probability. The advantage of the u_{test} is that it takes into consideration the propagation of measurement uncertainties when defining the normalised error. This is especially useful when evaluating results, which uncertainty may overlap with the reference interval.

It should be noted that the choice of the significance level is subjective. For this proficiency test we have set the limiting value for the u-test parameter to 2.58 for a level of probability at 99% to determine if a result passes the test ($u < 2.58$).

4.4 Evaluation criteria

The proficiency test results were evaluated against the acceptance criteria for trueness and precision and assigned the status “Acceptable”, “Warning” or “Not Acceptable” accordingly[4].

4.4.1 Trueness

The participant result is assigned “Acceptable” status for trueness if:

$$A1 \leq A2$$

where:

$$A1 = \left|Value_{IAEA} - Value_{Analyst}\right|$$

$$A2 = 2.58 \times \sqrt{Unc_{IAEA}^2 + Unc_{Analyst}^2}$$

4.4.2 Precision

For evaluation of precision an estimator P is calculated for each participant, according to the following formula:

$$P = \sqrt{\left(\frac{Unc_{IAEA}}{Value_{IAEA}}\right)^2 + \left(\frac{Unc_{Analyst}}{Value_{Analyst}}\right)^2} \times 100\%$$

P directly depends on the measurement uncertainty claimed by the participant. The Limit of Acceptable Precision (LAP) for each analyte respectively is defined for the respective proficiency test in advance, including any adjustment due to the concentration or activity level of the analytes concerned and the complexity of the analytical problem. Participants' results are scored as "acceptable" for precision when $P \leq LAP$. The LAP value used in the evaluation of all radionuclides is 15%.
In the final evaluation, both scores for trueness and precision are combined. A result must obtain an "acceptable" score in both criteria to be assigned the final score "acceptable". Obviously, if a score of "not acceptable" was obtained for both trueness and precision, the final score will also be "not acceptable". In cases where either precision or trueness is "not acceptable", a further check is applied. The reported result relative bias (R. Bias) is compared with the maximum acceptable bias (MAB). If R. Bias ≤ MAB, the final score will be "warning". "warning" will reflect mainly two situations. The first situation will be a result with small measurement uncertainty; however its bias is still within MAB. The second situation will appear when result close to the assigned property value are reported, but the associated uncertainty is large. If R. Bias > MAB, the result will be "Not Acceptable". The MAB value used in the evaluation of all radionuclides is 15%.

5. Results and discussions

5.1 General

Of the 14 initially registered 11 laboratories reported their results to the IAEA. The participants' data along with the performance evaluation criteria and evaluation scores were compiled and presented in tables which constitute an integral part of this report.

The results submitted by the laboratories were evaluated against the reference values; the uncertainties claimed by the laboratories were revised and taken into consideration during the evaluation.

Performance evaluation sorted by analyte is reported in Appendix A, while the performance evaluation sorted by laboratory code is presented in Appendix B.

The performance evaluation results showed that 74% of all reported results obtained "Acceptable" score. Table 2 presents the number of reported results and evaluation scores for each radionuclide.

Radionuclides	Number of reported results	Acceptable score (%)	Warning score (%)	Not Acceptable score (%)
^{241}Am	9	67	0	33
^{57}Co	10	90	0	10
^{60}Co	11	73	18	9
^{134}Cs	11	73	0	27
^{137}Cs	11	82	0	18
^{54}Mn	11	91	0	9
^{65}Zn	11	55	27	18

Table 2: Number of reported results and evaluation scores for each radionuclide.

5.2 Observations on the performance and reported results

Due to the limited technical information provided by the participants about the details of their analytical procedures, it was not possible to define the detailed root causes of discrepancies. Based on the results of this proficiency test, analysts could investigate their problems and take necessary remedial actions. Upon a request for assistance on a specific issue, the proficiency test organiser could give a technical advice which might help in resolving remaining issues. Therefore, it is recommended, later on, to confirm whether the participating laboratories have resolved the problem through another proficiency test.
However, it was decided to list some observations and comments which may help the participating laboratories to consider sources of problems, uncertainty calculation, calibration, validation and use of RMs. These points are mostly of general nature and should not be taken as an exhaustive list.

5.2.1 Uncertainty

Many laboratory reports stated that they were following the international guides[5,6] for expression of uncertainties and/or were combining 'all sources' of uncertainty. Some participating laboratories gave detailed formulas and uncertainty data.

It is worthy mentioning that uncertainty calculation is not an easy task even for laboratories with some experience in this field. This can be seen from the fact that the approaches are still very different even for the same analytical technique.

Some possible reasons for different uncertainty estimations/calculations are:
- different and/or incomplete evaluation of uncertainty sources, e.g. limiting uncertainties to counting statistics, weighing, dilution and used nuclear data;
- not considering possible uncertainty components due to e.g. matrix-density effects, physical properties of samples and standards, sample geometry;
- the calibration procedure used.

Often, laboratories which overestimated the uncertainty account all possible uncertainty sources (worst case scenario) or sometimes double count uncertainties, e.g. when including an uncertainty due to a bias to the reference value of the RM, the calibration uncertainty is included in the RM **and** in the sample result.

This overestimation can cause a not acceptable score for the precision, since the limit of acceptable precision is easily reached. An unrealistic increase of the uncertainty to get an acceptable scoring for the accuracy should be avoided.

5.2.2 Calibration

In most cases the information on how the efficiency calibration was performed was not clearly specified. Few laboratories reported how the coincidence summing was ascertained for.
The following calibration methods were mentioned:
- Calibration using multi gamma standard source;
- Calibration using single gamma standard sources;

- Calibration using computational model;
- Calibration using a spiked filter;

According to the QA requirements each laboratory should have readily available information on the calibration method containing at least the following:
- Details of the calibration method;
- Description of the traceability of calibration standards to SI;
- Uncertainty associated with the activity concentration values of the calibration standards;
- The use of RMs and CRMs to validate the calibration and/or any used computational model;
- Applied corrections to overcome the differences in physical properties between the calibration standards and analysed samples and their effect on the calibration function.

It was noticed that few laboratories' results had a systematic negative or positive bias, which might indicate a calibration problem.

5.2.3 Recommendations to participating laboratories

Laboratory 02

Laboratory 02 performed the efficiency calibration by means of multi gamma standard. The laboratory did not report any quality control mechanism or any use of reference materials (RM) to validate the calibration.

Laboratory 02 did not report a result for Am-241. For all the analytes, a negative bias was observed, which might indicate a calibration problem. It is recommended that the analyst review the efficiency calibration and check it with appropriate RM

Laboratory 04

Laboratory 04 reported that the geometry used for measurements was filter paper diameter 5 cm. A sample was placed on top of the detector in its own plastic bag. Measurements were performed using EG&G ORTEC Ge(Li) coaxial detector.

Energy and efficiency calibrations were performed using standards (Am-241, Cd-109, Ce-139, Co-57, Co-60, Cs-137, Hg-203, Sn-113, Sr-85 and Y-88) from a metrological institute.

Laboratory 04 did not report a result for Am-241. Reported results were acceptable for all radionuclides except for Zn-65 which had a "warning" due to overestimated uncertainty (18%), it is recommended to revise the uncertainty estimation for this analyte.

Laboratory 06

Laboratory 06 performed energy calibration using a 6 points standard source containing: Co-57, Co-60, Y-88, Ba-133, Cs-137 and Eu-152, produced by a metrological institute. Radionuclide activity concentration was determined using an absolute method with comparison to well-documented standard sources.

Laboratory 06 obtained 4 "Not Acceptable" scores due to 8-40 % systematic negative bias, while for Am-241 at 60 keV in the low energy part, the bias was positive up to 27 %. The

analyst did not give enough details on the efficiency calibration and which corrections were applied. From the reported information it was not clear which RM were used to validate the method and to control the quality of the produced data.

Revision of the calibration factors for each radionuclide and validation of the calibration method with RM is recommended.

Laboratory 08

Laboratory 08 used air filters with known activities from previous proficiency tests to perform efficiency calibration. All results were acceptable except Am-241 which had a negative bias up to 25 %. Probable cause is the calibration in the low energy part of the calibration curve or the self attenuation factor. The analyst could investigate more and find the exact root cause.

The analyst should be aware that the traceability of the measurement results is not easily defined, since the efficiency calibration is performed using PT materials and not a traceable certified standard.

Laboratory 09

Laboratory 09 obtained an acceptable score for all reported radionuclides including Am-241.

The laboratory did not report any technical information on the calibration method applied, which could be of interest to many other laboratories especially, from such a well performing laboratory.

Laboratory 10

Laboratory 10 reported that the filter was transferred from the plastic bag to a Polystyrol vial (Fig. 1) and measured on the endcap of the detector. The detector was characterized by the producer. The efficiency for sample geometry was calculated with ISOCS/LABSOCS software.

The laboratory 10 obtained Acceptable results for all radionuclides

Figure 1: Polystyrol vial used in laboratory 10

Laboratory 10A

Laboratory 10A reported that the sample was mounted on the sample holder for aerosol filters and measured directly on the detectors; only two protective foils (capton 0.003 mm) and polyethylene (0.01 mm) were used for protection.

The efficiency calibration curves were calculated from the detector data base for the actual sample properties and position.

Laboratory 10A also obtained an acceptable results for all radionuclides.

Laboratory 11

Laboratory 11 stated that the efficiency calibration was performed by means of a filter with the same geometry. The filter contained the following nuclides:
Mn-54, Co-60, Cs-137, Am-241. For Am-241 computational efficiency calibration was applied.

The energy calibration was performed with different measurement geometry. The standard source consisted following nuclides: Co-57, Co-60, Cd-109, Ba-133, Cs-137 and Am-241.

Laboratory 11 obtained Acceptable results for all radionuclides except for the Zn-65, which scored a "Warning" due to underestimated uncertainty (5.8 %) while the relative bias is 14.8 %.

Laboratory 13

Laboratory 13 reported that the efficiency calibration was performed with filter with similar geometry. The filter contained the following nuclides:
Pb-210, Am-241, Cd-109, Co-57, Tc-123m, Sn-113, Sr-85, Cs-137, Y-88, Co-60.

A positive bias was observed in Zn-65 result which could be caused by the wrong correction of the interference from Bi-214.

Laboratory 13 obtained Acceptable results for all radionuclides.

Laboratory 14

Laboratory 14 reported that the energy calibration was performed by means of Cs-137 and Co-60 sources. The efficiency calibration curve was constructed as a weighted sum of two functions generated by the fit on the points measured for Ra-226, Am-241, Cs-137, Co-60.

There was neither indication of any validation of the efficiency calibration nor any use of reference materials to check the trueness of the results. The laboratory obtained four "Not Acceptable" and one "Warning "score. This could be correlated to a calibration problem.

A positive bias was observed in Zn-65 result which could be caused by the wrong correction of the interference from Bi-214.

Laboratory 14A

Laboratory 14A did not report any information on its analytical procedure. The laboratory had "Acceptable" scores for five radionuclides and two "Not Acceptable" for Cs-134 and Zn-65. The root cause of the problem should be investigated.

A positive bias was observed in the Zn-65 result which could be caused by the wrong correction of the interference from Bi-214.

6. Conclusions

The performance of most of the laboratories for this PT was acceptable, whereas 74 % of all reported results fulfilled PT criteria. Nevertheless the participants are requested to critically review their method, find the root cause of any discrepancy and introduce the needed corrective actions based on the results of this PT.

More care should be given to the determination of Zn-65, where the largest scatter and lowest acceptable score were observed due to an interference problem with Bi-214.

In addition, it could be seen that the awareness among participating laboratories for the importance of QA/QC procedures and method validation is increasing. Also, laboratories which are not planning for a formal accreditation are performing additional activities to control and/or improve their analytical quality. The knowledge on uncertainty budget and method validation is growing.

This PT has demonstrated that the participating laboratories are producing analytical results fit for the purpose of air pollution monitoring and investigations, if they are applied by experienced laboratories.

Nevertheless, a few laboratories still reported not acceptable results and need additional training in gamma spectrometry and probably need to be provided them with reference materials in order to produce more accurate results.

7. References

1. The IAEA Technical Cooperation project RER/8/009 "Air Pollution Monitoring in the Mediterranean Region", TC, IAEA, Vienna, Austria 2005.
2. ISO/IEC 17025:2005, General Requirements for the Competence of Testing and Calibration Laboratories, ISO, Geneva, Switzerland.
3. Brookes, C.J., Betteley, I.G., Loxton, S.M.; Fundamentals of Mathematics and Statistics, Wiley 1979.
4. A. Shakhashiro, A. Fajgelj, U. Sansone, Comparison of Different Approaches To Evaluate Proficiency Test Data. Presented and accepted in the publications of the International Workshop on Combining and Reporting Analytical Results. The Role of (metrological) Traceability and (measurement) Uncertainty for Comparing Analytical Results, Rome 6-8 March, 2006.
5. Quantifying Uncertainty in Nuclear Analytical Measurements, IAEA TECDOC-1401, IAEA Vienna, Austria, 2004.
6. Quantifying uncertainties in analytical measurements, Eurachem/Citac Guide, 2000.

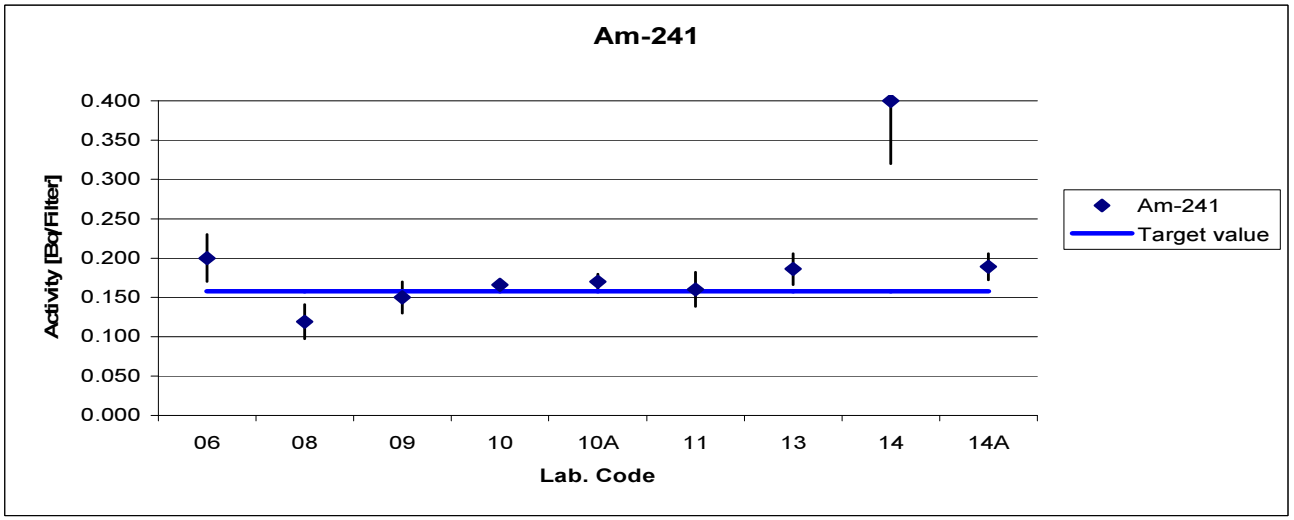
List of Appendixes

APPENDIX A: Performance evaluation sorted by Analyte

Data evaluation of Am-241 in air filter

Target value: 0.158 **[Bq/filter]**
Uncertainty: 0.003

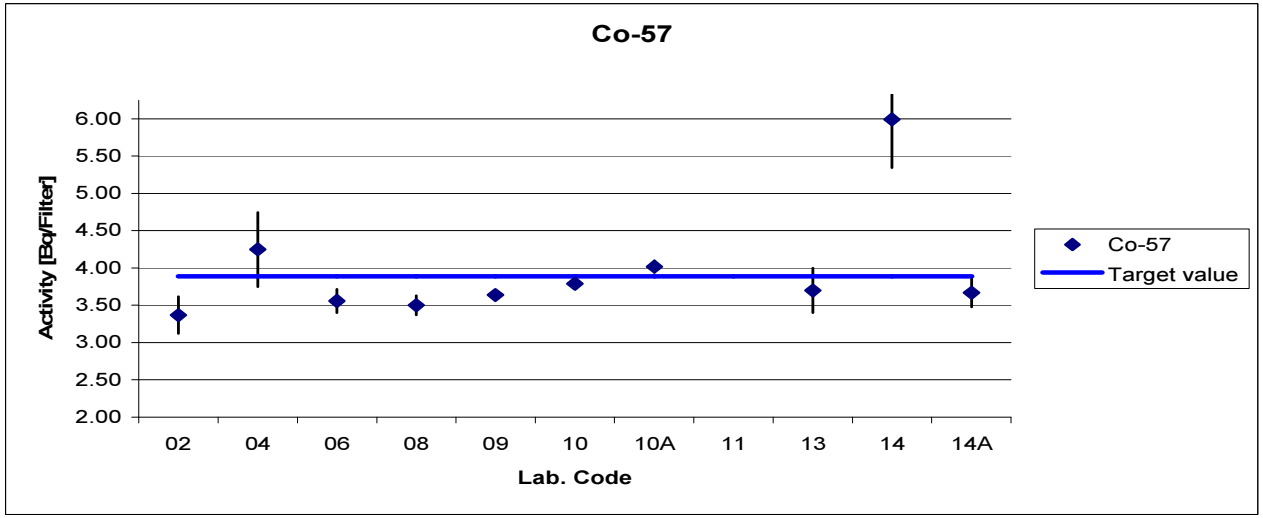
Lab. Code	Laboratories Results Value [Bq/filter]	Unc. [Bq/filter]	Unc. %	Bias(%)	Z-Score	U-Score	Lab/IAEA	Acceptance criteria Trueness A1	Trueness A2	Trueness Score	Precision P	Precision Score	Final Score
02	-	-											
04	-	-											
06	0.200	0.030	15.00	26.58	2.66	1.39	1.27	0.04	0.08	A	15.12	N	N
08	0.119	0.022	18.49	-24.68	-2.47	-1.76	0.75	0.04	0.06	A	18.58	N	N
09	0.150	0.020	13.33	-5.06	-0.51	-0.40	0.95	0.01	0.05	A	13.47	A	A
10	0.166	0.005	3.01	5.06	0.51	1.37	1.05	0.01	0.02	A	3.56	A	A
10A	0.170	0.010	5.88	7.59	0.76	1.15	1.08	0.01	0.03	A	6.18	A	A
11	0.160	0.022	13.75	1.27	0.13	0.09	1.01	0.00	0.06	A	13.88	A	A
13	0.186	0.020	10.75	17.72	1.77	1.38	1.18	0.03	0.05	A	10.92	A	A
14	0.400	0.080	20.00	153.16	15.32	3.02	2.53	0.24	0.21	N	20.09	N	N
14A	0.189	0.017	8.99	19.62	1.96	1.80	1.20	0.03	0.04	A	9.19	A	A



Data evaluation of Co-57 in air filter

Target value: 3.89 **[Bq/filter]**
Uncertainty: 0.11

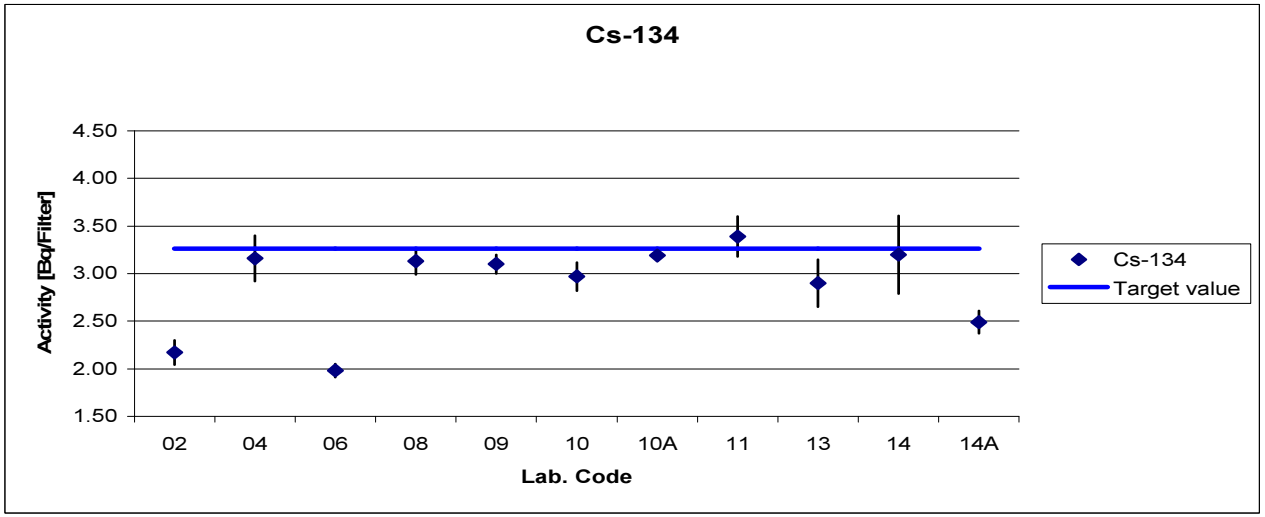
Lab. Code	Laboratories Results Value [Bq/filter]	Unc. [Bq/filter]	Unc. %	Bias(%)	Z-Score	U-Score	Lab/IAEA	Acceptance criteria Trueness A1	Trueness A2	Trueness Score	Precision P	Precision Score	Final Score
02	3.37	0.25	7.42	-13.37	-1.34	-1.90	0.87	0.52	0.70	A	7.94	A	A
04	4.25	0.50	11.76	9.25	0.93	0.70	1.09	0.36	1.32	A	12.10	A	A
06	3.56	0.16	4.49	-8.48	-0.85	-1.70	0.92	0.33	0.50	A	5.31	A	A
08	3.50	0.13	3.71	-10.03	-1.00	-2.29	0.90	0.39	0.44	A	4.67	A	A
09	3.64	0.04	1.10	-6.43	-0.64	-2.14	0.94	0.25	0.30	A	3.03	A	A
10	3.79	0.03	0.79	-2.57	-0.26	-0.88	0.97	0.10	0.29	A	2.94	A	A
10A	4.02	0.08	1.99	3.34	0.33	0.96	1.03	0.13	0.35	A	3.46	A	A
11	-	-											
13	3.70	0.30	8.11	-4.88	-0.49	-0.59	0.95	0.19	0.82	A	8.59	A	A
14	5.99	0.65	10.85	53.98	5.40	3.19	1.54	2.10	1.70	N	11.21	A	N
14A	3.67	0.19	5.18	-5.66	-0.57	-1.00	0.94	0.22	0.57	A	5.90	A	A



Data evaluation of Cs-134 in air filter

Target value: 3.26 **[Bq/filter]**
Uncertainty: 0.07

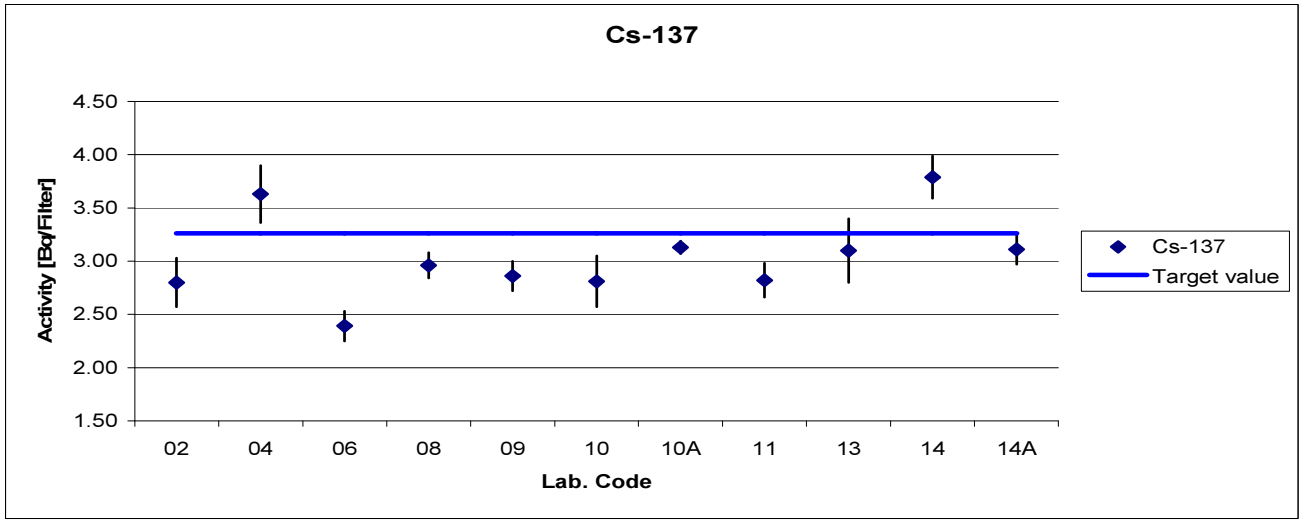
Lab. Code	Laboratories Results Value [Bq/filter]	Unc. [Bq/filter]	Unc. %	Bias(%)	Z-Score	U-Score	Lab/IAEA	Acceptance criteria Trueness A1	Trueness A2	Trueness Score	Precision P	Precision Score	Final Score
02	2.17	0.13	5.99	-33.44	-3.34	-7.38	0.67	1.09	0.38	**N**	6.36	**A**	**N**
04	3.16	0.24	7.59	-3.07	-0.31	-0.40	0.97	0.10	0.65	**A**	7.89	**A**	**A**
06	1.98	0.07	3.54	-39.26	-3.93	-12.93	0.61	1.28	0.26	**N**	4.14	**A**	**N**
08	3.13	0.14	4.47	-3.99	-0.40	-0.83	0.96	0.13	0.40	**A**	4.96	**A**	**A**
09	3.10	0.10	3.23	-4.91	-0.49	-1.31	0.95	0.16	0.31	**A**	3.88	**A**	**A**
10	2.97	0.15	5.05	-8.90	-0.89	-1.75	0.91	0.29	0.43	**A**	5.49	**A**	**A**
10A	3.19	0.06	1.88	-2.15	-0.21	-0.76	0.98	0.07	0.24	**A**	2.85	**A**	**A**
11	3.39	0.21	6.28	3.99	0.40	0.58	1.04	0.13	0.58	**A**	6.64	**A**	**A**
13	2.90	0.25	8.62	-11.04	-1.10	-1.39	0.89	0.36	0.67	**A**	8.88	**A**	**A**
14	3.20	0.41	12.81	-1.84	-0.18	-0.14	0.98	0.06	1.07	**A**	12.99	**A**	**A**
14A	2.49	0.12	4.82	-23.62	-2.36	-5.54	0.76	0.77	0.36	**N**	5.28	**A**	**N**



Data evaluation of Cs-137 in air filter

Target value: 3.18 **[Bq/filter]**
Uncertainty: 0.07

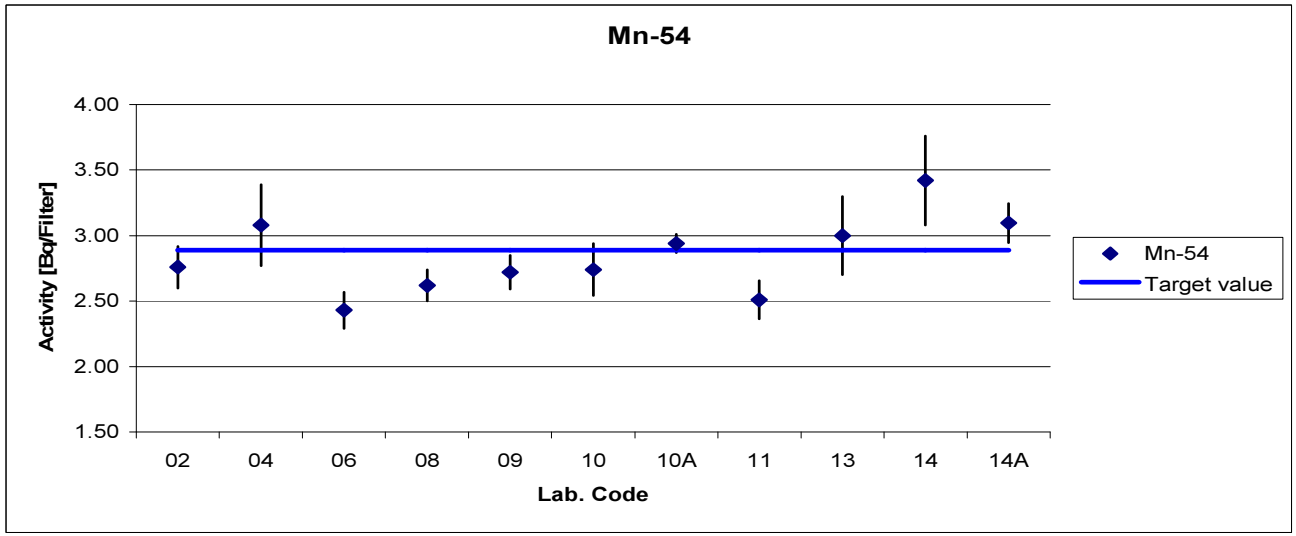
Lab. Code	Laboratories Results Value [Bq/filter]	Unc. [Bq/filter]	Unc. %	Bias(%)	Z-Score	U-Score	Lab/IAEA	Acceptance criteria Trueness A1	Trueness A2	Trueness Score	Precision P	Precision Score	Final Score
02	2.80	0.23	8.21	-11.95	-1.19	-1.58	0.88	0.38	0.62	**A**	8.50	**A**	**A**
04	3.63	0.27	7.44	14.15	1.42	1.61	1.14	0.45	0.72	**A**	7.76	**A**	**A**
06	2.39	0.14	5.86	-24.84	-2.48	-5.05	0.75	0.79	0.40	**N**	6.26	**A**	**N**
08	2.96	0.12	4.05	-6.92	-0.69	-1.58	0.93	0.22	0.36	**A**	4.61	**A**	**A**
09	2.86	0.14	4.90	-10.06	-1.01	-2.04	0.90	0.32	0.40	**A**	5.37	**A**	**A**
10	2.81	0.24	8.54	-11.64	-1.16	-1.48	0.88	0.37	0.65	**A**	8.82	**A**	**A**
10A	3.13	0.06	1.92	-1.57	-0.16	-0.54	0.98	0.05	0.24	**A**	2.92	**A**	**A**
11	2.82	0.16	5.67	-11.32	-1.13	-2.06	0.89	0.36	0.45	**A**	6.09	**A**	**A**
13	3.10	0.30	9.68	-2.52	-0.25	-0.26	0.97	0.08	0.79	**A**	9.92	**A**	**A**
14	3.79	0.20	5.28	19.18	1.92	2.88	1.19	0.61	0.55	**N**	5.72	**A**	**N**
14A	3.11	0.14	4.50	-2.20	-0.22	-0.45	0.98	0.07	0.40	**A**	5.01	**A**	**A**



Data evaluation of Mn-54 in air filter

Target value: 2.89 **[Bq/filter]**
Uncertainty: 0.07

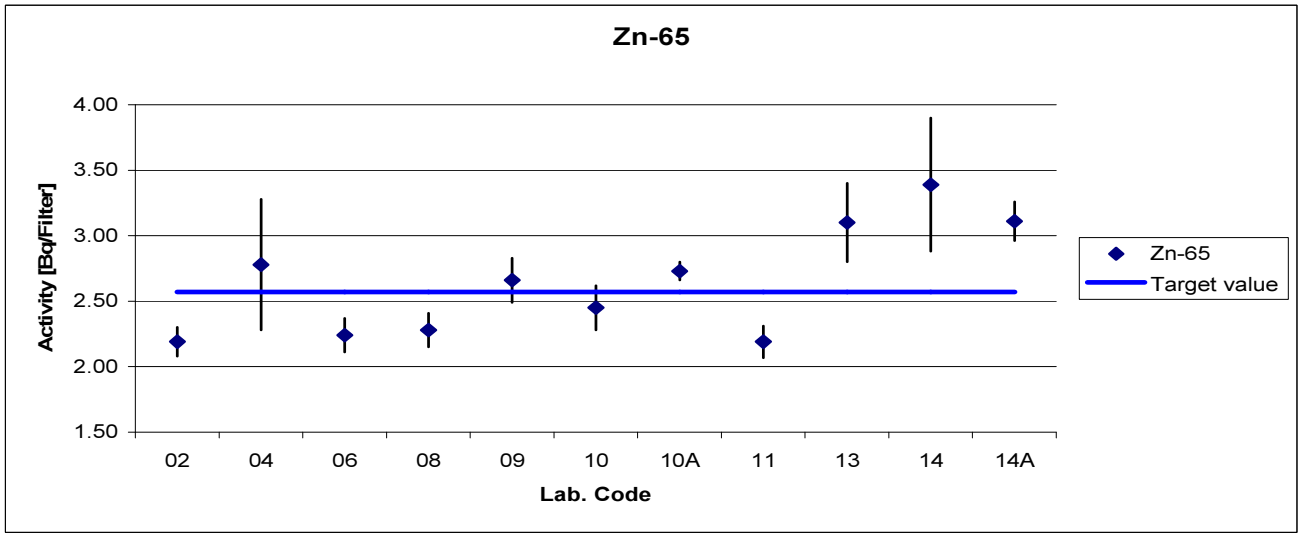
Lab. Code	Laboratories Results Value [Bq/filter]	Unc. [Bq/filter]	Unc. %	Bias(%)	Z-Score	U-Score Lab/IAEA		Acceptance criteria Trueness A1	Trueness A2	Trueness Score	Precision P	Precision Score	Final Score
02	2.76	0.16	5.80	-4.50	-0.45	-0.74	0.96	0.13	0.45	A	6.28	A	A
04	3.08	0.31	10.06	6.57	0.66	0.60	1.07	0.19	0.82	A	10.35	A	A
06	2.43	0.14	5.76	-15.92	-1.59	-2.94	0.84	0.46	0.40	N	6.25	A	N
08	2.62	0.12	4.58	-9.34	-0.93	-1.94	0.91	0.27	0.36	A	5.18	A	A
09	2.72	0.13	4.78	-5.88	-0.59	-1.15	0.94	0.17	0.38	A	5.36	A	A
10	2.74	0.20	7.30	-5.19	-0.52	-0.71	0.95	0.15	0.55	A	7.69	A	A
10A	2.94	0.07	2.38	1.73	0.17	0.51	1.02	0.05	0.26	A	3.40	A	A
11	2.51	0.15	5.82	-13.15	-1.31	-2.35	0.87	0.38	0.42	A	6.30	A	A
13	3.00	0.30	10.00	3.81	0.38	0.36	1.04	0.11	0.79	A	10.29	A	A
14	3.42	0.34	9.94	18.34	1.83	1.53	1.18	0.53	0.90	A	10.23	A	A
14A	3.10	0.15	4.84	7.13	0.71	1.24	1.07	0.21	0.43	A	5.42	A	A



Data evaluation of Zn-65 in air filter

Target value: 2.57 **[Bq/filter]**
Uncertainty: 0.07

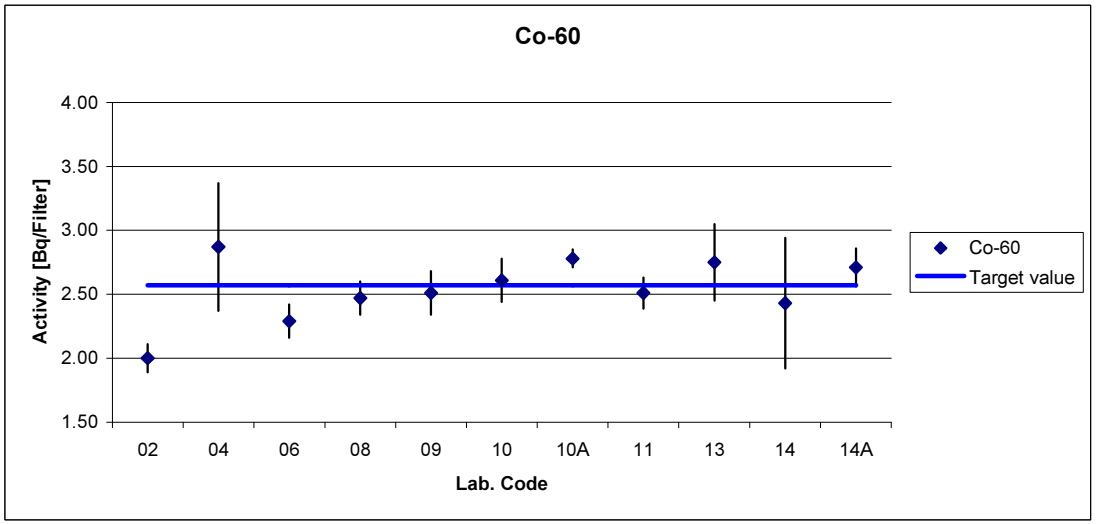
Lab. Code	Laboratories Results Value [Bq/filter]	Unc. [Bq/filter]	Unc. %	Bias(%)	Z-Score	U-Score	Lab/IAEA	Acceptance criteria Trueness A1	Trueness A2	Trueness Score	Precision P	Precision Score	Final Score
02	2.19	0.11	5.02	-14.79	-1.48	-2.91	0.85	0.38	0.34	N	5.71	A	W
04	2.78	0.50	17.99	8.17	0.82	0.42	1.08	0.21	1.30	A	18.19	N	W
06	2.24	0.13	5.80	-12.84	-1.28	-2.24	0.87	0.33	0.38	A	6.41	A	A
08	2.28	0.13	5.70	-11.28	-1.13	-1.96	0.89	0.29	0.38	A	6.32	A	A
09	2.66	0.17	6.39	3.50	0.35	0.49	1.04	0.09	0.47	A	6.95	A	A
10	2.45	0.17	6.94	-4.67	-0.47	-0.65	0.95	0.12	0.47	A	7.45	A	A
10A	2.73	0.07	2.56	6.23	0.62	1.62	1.06	0.16	0.26	A	3.74	A	A
11	2.19	0.12	5.57	-14.79	-1.48	-2.70	0.85	0.38	0.36	N	6.20	A	W
13	3.10	0.30	9.68	20.62	2.06	1.72	1.21	0.53	0.79	A	10.05	A	A
14	3.39	0.51	15.04	31.91	3.19	1.59	1.32	0.82	1.33	A	15.29	N	N
14A	3.11	0.15	4.82	21.01	2.10	3.26	1.21	0.54	0.43	N	5.54	A	N



Data evaluation of Co-60 in air filter

Target value: 2.66 **[Bq/filter]**
Uncertainty: 0.07

Lab. Code	Laboratories Results Value [Bq/filter]	Unc. [Bq/filter]	Unc. %	Bias(%)	Z-Score	U-Score	Lab/IAEA	Acceptance criteria Trueness A1	Trueness A2	Trueness Score	Precision P	Precision Score	Final Score
02	2.00	0.12	6.00	-24.81	-2.48	-4.75	0.75	0.66	0.36	**N**	6.55	**A**	**N**
04	2.87	0.31	10.80	7.89	0.79	0.66	1.08	0.21	0.82	**A**	11.12	**A**	**A**
06	2.29	0.10	4.37	-13.91	-1.39	-3.03	0.86	0.37	0.31	**N**	5.10	**A**	**W**
08	2.47	0.13	5.26	-7.14	-0.71	-1.29	0.93	0.19	0.38	**A**	5.88	**A**	**A**
09	2.51	0.09	3.59	-5.64	-0.56	-1.32	0.94	0.15	0.29	**A**	4.45	**A**	**A**
10	2.61	0.13	4.98	-1.88	-0.19	-0.34	0.98	0.05	0.38	**A**	5.63	**A**	**A**
10A	2.78	0.06	2.16	4.51	0.45	1.30	1.05	0.12	0.24	**A**	3.40	**A**	**A**
11	2.51	0.16	6.49	-5.64	-0.56	-0.85	0.94	0.15	0.46	**A**	7.01	**A**	**A**
13	2.75	0.23	8.36	3.38	0.03	0.37	1.03	0.09	0.62	**A**	8.77	**A**	**A**
14	2.43	0.60	24.69	-8.65	-0.86	-0.38	0.91	0.23	1.56	**A**	24.83	**N**	**W**
14A	2.71	0.12	4.43	1.88	0.19	0.36	1.02	0.05	0.36	**A**	5.15	**A**	**A**



APPENDIX B: Performance evaluation sorted by laboratory code

Analytical Performance Evaluation of Laboratory 02
Radionuclides in air filters

Reference date: 1 - 01- 2006

	IAEA		Laboratory							Acceptance criteria					
Analyte	**Value**	**Unc.**	**Value**	**Unc.**		**R. bias**	**Z-score**	**U-score**	**Lab./IAEA**	**Trueness**			**Precision**		**Final score**
	[Bq/filter]	**[Bq/filter]**	**[Bq/filter]**	**[Bq/filter]**	**[%]**	**[%]**				A1	A2	Score	P	Score	
Am-241	0.158	0.003	-	-											
Co-57	3.89	0.11	3.37	0.25	7.42	-13.37	-1.34	-1.90	0.87	0.52	0.70	**A**	7.94	**A**	**A**
Cs-134	3.26	0.07	2.17	0.13	5.99	-33.44	-3.34	-7.38	0.67	1.09	0.38	**N**	6.36	**A**	**N**
Cs-137	3.18	0.07	2.80	0.23	8.21	-11.95	-1.19	-1.58	0.88	0.38	0.62	**A**	8.50	**A**	**A**
Mn-54	2.89	0.07	2.76	0.16	5.80	-4.50	-0.45	-0.74	0.96	0.13	0.45	**A**	6.28	**A**	**A**
Zn-65	2.57	0.07	2.19	0.11	5.02	-14.79	-1.48	-2.91	0.85	0.38	0.34	**N**	5.71	**A**	**W**
Co-60	2.66	0.07	2.00	0.12	6.00	-24.81	-2.48	-4.75	0.75	0.66	0.36	**N**	6.55	**A**	**N**

A : Acceptable
W: Warning
N : Not Acceptable

Analytical Performance Evaluation of Laboratory 04
Radionuclides in air filters

Reference date: 1 - 01- 2006

Analyte	IAEA		Laboratory			R. bias	Z-score	U-score	Lab./IAEA	Acceptance criteria					
	Value	Unc.	Value	Unc.						Trueness			Precision		Final score
	[Bq/filter]	[Bq/filter]	[Bq/filter]	[Bq/filter]	[%]	[%]				A1	A2	Score	P	Score	
Am-241	0.158	0.003	-	-											
Co-57	3.89	0.11	4.25	0.50	11.76	9.25	0.93	0.70	1.09	0.36	1.32	**A**	12.10	**A**	**A**
Cs-134	3.26	0.07	3.16	0.24	7.59	-3.07	-0.31	-0.40	0.97	0.10	0.65	**A**	7.89	**A**	**A**
Cs-137	3.18	0.07	3.63	0.27	7.44	14.15	1.42	1.61	1.14	0.45	0.72	**A**	7.76	**A**	**A**
Mn-54	2.89	0.07	3.08	0.31	10.06	6.57	0.66	0.60	1.07	0.19	0.82	**A**	10.35	**A**	**A**
Zn-65	2.57	0.07	2.78	0.50	17.99	8.17	0.82	0.42	1.08	0.21	1.30	**A**	18.19	**N**	**W**
Co-60	2.66	0.07	2.87	0.31	10.80	7.89	0.79	0.66	1.08	0.21	0.82	**A**	11.12	**A**	**A**

A: Acceptable
W: Warning
N: Not Acceptable

Analytical Performance Evaluation of Laboratory 06
Radionuclides in air filters

Reference date: 1 - 01- 2006

Analyte	IAEA		Laboratory							Acceptance criteria					
	Value	Unc.	Value	Unc.		R. bias	Z-score	U-score	Lab./IAEA	Trueness			Precision		Final score
	[Bq/filter]	[Bq/filter]	[Bq/filter]	[Bq/filter]	[%]	[%]				A1	A2	Score	P	Score	
Am-241	0.158	0.003	0.200	0.03	15.00	26.58	2.66	1.39	1.27	0.04	0.08	**A**	15.12	**N**	**N**
Co-57	3.89	0.11	3.56	0.16	4.49	-8.48	-0.85	-1.70	0.92	0.33	0.50	**A**	5.31	**A**	**A**
Cs-134	3.26	0.07	1.98	0.07	3.54	-39.26	-3.93	-12.93	0.61	1.28	0.26	**N**	4.14	**A**	**N**
Cs-137	3.18	0.07	2.39	0.14	5.86	-24.84	-2.48	-5.05	0.75	0.79	0.40	**N**	6.26	**A**	**N**
Mn-54	2.89	0.07	2.43	0.14	5.76	-15.92	-1.59	-2.94	0.84	0.46	0.40	**N**	6.25	**A**	**N**
Zn-65	2.57	0.07	2.24	0.13	5.80	-12.84	-1.28	-2.24	0.87	0.33	0.38	**A**	6.41	**A**	**A**
Co-60	2.66	0.07	2.29	0.10	4.37	-13.91	-1.39	-3.03	0.86	0.37	0.31	**N**	5.10	**A**	**W**

A : Acceptable
W: Warning
N : Not Acceptable

Analytical Performance Evaluation of Laboratory 08
Radionuclides in air filters

Reference date: 1 - 01- 2006

Analyte	IAEA		Laboratory							Acceptance criteria					
	Value	Unc.	Value	Unc.		R. bias	Z-score	U-score	Lab./IAEA	Trueness			Precision		Final score
	[Bq/filter]	[Bq/filter]	[Bq/filter]	[Bq/filter]	[%]	[%]				A1	A2	Score	P	Score	
Am-241	0.158	0.003	0.119	0.022	18.49	-24.68	-2.47	-1.76	0.75	0.04	0.06	**A**	18.58	**N**	**N**
Co-57	3.89	0.11	3.50	0.13	3.71	-10.03	-1.00	-2.29	0.90	0.39	0.44	**A**	4.67	**A**	**A**
Cs-134	3.26	0.07	3.13	0.14	4.47	-3.99	-0.40	-0.83	0.96	0.13	0.40	**A**	4.96	**A**	**A**
Cs-137	3.18	0.07	2.96	0.12	4.05	-6.92	-0.69	-1.58	0.93	0.22	0.36	**A**	4.61	**A**	**A**
Mn-54	2.89	0.07	2.62	0.12	4.58	-9.34	-0.93	-1.94	0.91	0.27	0.36	**A**	5.18	**A**	**A**
Zn-65	2.57	0.07	2.28	0.13	5.70	-11.28	-1.13	-1.96	0.89	0.29	0.38	**A**	6.32	**A**	**A**
Co-60	2.66	0.07	2.47	0.13	5.26	-7.14	-0.71	-1.29	0.93	0.19	0.38	**A**	5.88	**A**	**A**

A : Acceptable
W: Warning
N : Not Acceptable

Analytical Performance Evaluation of Laboratory 09
Radionuclides in air filters

Reference date: 1 - 01- 2006

	IAEA		Laboratory							Acceptance criteria					
Analyte	**Value**	**Unc.**	**Value**	**Unc.**		**R. bias**	**Z-score**	**U-score**	**Lab./IAEA**	**Trueness**			**Precision**		**Final score**
	[Bq/filter]	**[Bq/filter]**	**[Bq/filter]**	**[Bq/filter]**	**[%]**	**[%]**				A1	A2	Score	P	Score	
Am-241	0.158	0.003	0.15	0.02	13.33	-5.06	-0.51	-0.40	0.95	0.01	0.05	**A**	13.47	**A**	**A**
Co-57	3.89	0.11	3.64	0.04	1.10	-6.43	-0.64	-2.14	0.94	0.25	0.30	**A**	3.03	**A**	**A**
Cs-134	3.26	0.07	3.10	0.10	3.23	-4.91	-0.49	-1.31	0.95	0.16	0.31	**A**	3.88	**A**	**A**
Cs-137	3.18	0.07	2.86	0.14	4.90	-10.06	-1.01	-2.04	0.90	0.32	0.40	**A**	5.37	**A**	**A**
Mn-54	2.89	0.07	2.72	0.13	4.78	-5.88	-0.59	-1.15	0.94	0.17	0.38	**A**	5.36	**A**	**A**
Zn-65	2.57	0.07	2.66	0.17	6.39	3.50	0.35	0.49	1.04	0.09	0.47	**A**	6.95	**A**	**A**
Co-60	2.66	0.07	2.51	0.09	3.59	-5.64	-0.56	-1.32	0.94	0.15	0.29	**A**	4.45	**A**	**A**

A: Acceptable
W: Warning
N: Not Acceptable

Analytical Performance Evaluation of Laboratory 10
Radionuclides in air filters

Reference date: 1 - 01- 2006

Analyte	IAEA		Laboratory			R. bias	Z-score	U-score	Lab./IAEA	Acceptance criteria					
	Value	Unc.	Value	Unc.						Trueness			Precision		Final score
	[Bq/filter]	[Bq/filter]	[Bq/filter]	[Bq/filter]	[%]	[%]				A1	A2	Score	P	Score	
Am-241	0.158	0.003	0.166	0.005	3.01	5.06	0.51	1.37	1.05	0.01	0.02	**A**	3.56	**A**	**A**
Co-57	3.89	0.11	3.79	0.03	0.79	-2.57	-0.26	-0.88	0.97	0.10	0.29	**A**	2.94	**A**	**A**
Cs-134	3.26	0.07	2.97	0.15	5.05	-8.90	-0.89	-1.75	0.91	0.29	0.43	**A**	5.49	**A**	**A**
Cs-137	3.18	0.07	2.81	0.24	8.54	-11.64	-1.16	-1.48	0.88	0.37	0.65	**A**	8.82	**A**	**A**
Mn-54	2.89	0.07	2.74	0.20	7.30	-5.19	-0.52	-0.71	0.95	0.15	0.55	**A**	7.69	**A**	**A**
Zn-65	2.57	0.07	2.45	0.17	6.94	-4.67	-0.47	-0.65	0.95	0.12	0.47	**A**	7.45	**A**	**A**
Co-60	2.66	0.07	2.61	0.13	4.98	-1.88	-0.19	-0.34	0.98	0.05	0.38	**A**	5.63	**A**	**A**

A : Acceptable
W: Warning
N : Not Acceptable

Analytical Performance Evaluation of Laboratory 10A
Radionuclides in air filters

Reference date: 1 - 01- 2006

	IAEA		Laboratory							Acceptance criteria					
Analyte	**Value**	**Unc.**	**Value**	**Unc.**		**R. bias**	**Z-score**	**U-score**	**Lab./IAEA**	**Trueness**			**Precision**		**Final score**
	[Bq/filter]	**[Bq/filter]**	**[Bq/filter]**	**[Bq/filter]**	**[%]**	**[%]**				A1	A2	Score	P	Score	
Am-241	0.158	0.003	0.17	0.01	5.88	7.59	0.76	1.15	1.08	0.01	0.03	**A**	6.18	**A**	**A**
Co-57	3.89	0.11	4.02	0.08	1.99	3.34	0.33	0.96	1.03	0.13	0.35	**A**	3.46	**A**	**A**
Cs-134	3.26	0.07	3.19	0.06	1.88	-2.15	-0.21	-0.76	0.98	0.07	0.24	**A**	2.85	**A**	**A**
Cs-137	3.18	0.07	3.13	0.06	1.92	-1.57	-0.16	-0.54	0.98	0.05	0.24	**A**	2.92	**A**	**A**
Mn-54	2.89	0.07	2.94	0.07	2.38	1.73	0.17	0.51	1.02	0.05	0.26	**A**	3.40	**A**	**A**
Zn-65	2.57	0.07	2.73	0.07	2.56	6.23	0.62	1.62	1.06	0.16	0.26	**A**	3.74	**A**	**A**
Co-60	2.66	0.07	2.78	0.06	2.16	4.51	0.45	1.30	1.05	0.12	0.24	**A**	3.40	**A**	**A**

A : Acceptable
W: Warning
N : Not Acceptable

Analytical Performance Evaluation of Laboratory 11
Radionuclides in air filters

Reference date: 1 - 01- 2006

	IAEA		Laboratory							Acceptance criteria					
Analyte	**Value**	**Unc.**	**Value**	**Unc.**		**R. bias**	**Z-score**	**U-score**	**Lab./IAEA**	**Trueness**			**Precision**		**Final score**
	[Bq/filter]	**[Bq/filter]**	**[Bq/filter]**	**[Bq/filter]**	**[%]**	**[%]**				A1	A2	Score	P	Score	
Am-241	0.158	0.003	0.160	0.022	13.75	1.27	0.13	0.09	1.01	0.00	0.06	**A**	13.88	**A**	**A**
Co-57	3.89	0.11	-	-											
Cs-134	3.26	0.07	3.39	0.21	6.28	3.99	0.40	0.58	1.04	0.13	0.58	**A**	6.64	**A**	**A**
Cs-137	3.18	0.07	2.82	0.16	5.67	-11.32	-1.13	-2.06	0.89	0.36	0.45	**A**	6.09	**A**	**A**
Mn-54	2.89	0.07	2.51	0.15	5.82	-13.15	-1.31	-2.35	0.87	0.38	0.42	**A**	6.30	**A**	**A**
Zn-65	2.57	0.07	2.19	0.12	5.57	-14.79	-1.48	-2.70	0.85	0.38	0.36	**N**	6.20	**A**	**W**
Co-60	2.66	0.07	2.51	0.16	6.49	-5.64	-0.56	-0.85	0.94	0.15	0.46	**A**	7.01	**A**	**A**

A : Acceptable
W: Warning
N : Not Acceptable

Analytical Performance Evaluation of Laboratory 13
Radionuclides in air filters

Reference date: 1 - 01- 2006

Analyte	IAEA Value [Bq/filter]	IAEA Unc. [Bq/filter]	Laboratory Value [Bq/filter]	Laboratory Unc. [Bq/filter]	Laboratory Unc. [%]	R. bias [%]	Z-score	U-score	Lab./IAEA	Acceptance criteria Trueness A1	Trueness A2	Trueness Score	Precision P	Precision Score	Final score
Am-241	0.158	0.003	0.186	0.020	10.75	17.72	1.77	1.38	1.18	0.03	0.05	**A**	10.92	**A**	**A**
Co-57	3.89	0.11	3.70	0.30	8.11	-4.88	-0.49	-0.59	0.95	0.19	0.82	**A**	8.59	**A**	**A**
Cs-134	3.26	0.07	2.90	0.25	8.62	-11.04	-1.10	-1.39	0.89	0.36	0.67	**A**	8.88	**A**	**A**
Cs-137	3.18	0.07	3.10	0.30	9.68	-2.52	-0.25	-0.26	0.97	0.08	0.79	**A**	9.92	**A**	**A**
Mn-54	2.89	0.07	3.00	0.30	10.00	3.81	0.38	0.36	1.04	0.11	0.79	**A**	10.29	**A**	**A**
Zn-65	2.57	0.07	3.10	0.30	9.68	20.62	2.06	1.72	1.21	0.53	0.79	**A**	10.05	**A**	**A**
Co-60	2.66	0.07	2.75	0.23	8.36	3.38	0.34	0.37	1.03	0.09	0.62	**A**	8.77	**A**	**A**

A : Acceptable
W: Warning
N : Not Acceptable

Analytical Performance Evaluation of Laboratory 14
Radionuclides in air filters

Reference date: 1 - 01- 2006

	IAEA		Laboratory							Acceptance criteria					
Analyte	**Value**	**Unc.**	**Value**	**Unc.**		**R. bias**	**Z-score**	**U-score**	**Lab./IAEA**	**Trueness**			**Precision**		**Final score**
	[Bq/filter]	**[Bq/filter]**	**[Bq/filter]**	**[Bq/filter]**	**[%]**	**[%]**				A1	A2	Score	P	Score	
Am-241	0.158	0.003	0.400	0.080	20.00	153.16	15.32	3.02	2.53	0.24	0.21	**N**	20.09	**N**	**N**
Co-57	3.89	0.11	5.99	0.65	10.85	53.98	5.40	3.19	1.54	2.10	1.70	**N**	11.21	**A**	**N**
Cs-134	3.26	0.07	3.20	0.41	12.81	-1.84	-0.18	-0.14	0.98	0.06	1.07	**A**	12.99	**A**	**A**
Cs-137	3.18	0.07	3.79	0.20	5.28	19.18	1.92	2.88	1.19	0.61	0.55	**N**	5.72	**A**	**N**
Mn-54	2.89	0.07	3.42	0.34	9.94	18.34	1.83	1.53	1.18	0.53	0.90	**A**	10.23	**A**	**A**
Zn-65	2.57	0.07	3.39	0.51	15.04	31.91	3.19	1.59	1.32	0.82	1.33	**A**	15.29	**N**	**N**
Co-60	2.66	0.07	2.43	0.60	24.69	-8.65	-0.86	-0.38	0.91	0.23	1.56	**A**	24.83	**N**	**W**

A : Acceptable
W: Warning
N : Not Acceptable

Analytical Performance Evaluation of Laboratory 14A
Radionuclides in air filters

Reference date: 1 - 01- 2006

Analyte	IAEA		Laboratory							Acceptance criteria					
	Value	Unc.	Value	Unc.		R. bias	Z-score	U-score	Lab./IAEA	Trueness			Precision		Final score
	[Bq/filter]	[Bq/filter]	[Bq/filter]	[Bq/filter]	[%]	[%]				A1	A2	Score	P	Score	
Am-241	0.158	0.003	0.189	0.017	8.99	19.62	1.96	1.80	1.20	0.03	0.04	**A**	9.19	**A**	**A**
Co-57	3.89	0.11	3.67	0.19	5.18	-5.66	-0.57	-1.00	0.94	0.22	0.57	**A**	5.90	**A**	**A**
Cs-134	3.26	0.07	2.49	0.12	4.82	-23.62	-2.36	-5.54	0.76	0.77	0.36	**N**	5.28	**A**	**N**
Cs-137	3.18	0.07	3.11	0.14	4.50	-2.20	-0.22	-0.45	0.98	0.07	0.40	**A**	5.01	**A**	**A**
Mn-54	2.89	0.07	3.10	0.15	4.84	7.13	0.71	1.24	1.07	0.21	0.43	**A**	5.42	**A**	**A**
Zn-65	2.57	0.07	3.11	0.15	4.82	21.01	2.10	3.26	1.21	0.54	0.43	**N**	5.54	**A**	**N**
Co-60	2.66	0.07	2.71	0.12	4.43	1.88	0.19	0.36	1.02	0.05	0.36	**A**	5.15	**A**	**A**

A : Acceptable
W: Warning
N : Not Acceptable

Appendix C: List of Participants

1.	**BOSNIA AND HERZEGOVINA**	**Ms. Delveta DELJIC** Institute for Public Health Radiation Protection Center Titova 9 71000 Sarajevo Bosnia and Herzegovina Tel.: 00387 33 268280 Fax: 00387 33 268280 Email: rpc@bih.net.ba
2.	**CROATIA**	**Mr. Branko PETRINEC** Institute for Medical Research and Occupational Health (IMI) Ksaverska cesta 2 P.O. Box 291 10001 Zagreb Croatia Tel.: 00385 1 4673188 Fax: 00385 1 4673303 Email: petrinec@imi.hr
3.	**GREECE**	**Mr. K. ELEFTHERIADIS** E.R.L./ Institute of Nuclear Technology & Radiation Protection N.C.S.R. "Demokritos" Ag. Paraskevi 15310 Greece Tel.: 0030210 6503008 Fax: 0030210 6503050 Email: eleftheri@ipta.demokritos.gr
4.	**GREECE**	**Mr. K. POTIRIADIS** Department of Environmental Radiation GAEC Ag. Paraskevi 15310 Greece Tel.: 0030210 6506779 Fax: 0030210 6506748 Email: cpot@eeae.gr

5. GREECE

Mr. Christos Ath. MARAMATHAS
Nuclear Technology & Radiation Protection
Tele DOS LTD
Apostolou Paulou / 102
Corinth / GR-20 100
Greece

Tel.: 0030697 4867477
Fax: 0030274 1084349
Email: cmaramat@otenet.gr

6. MONTENEGRO

Mr. Tomislav ANDELIČ
Montenegrian Center for Ecotoxicological Research
Radiation Protection and Monitoring Dept.
Put Radomira Ivanovica, bt.2
P.O. Box 371
81000 Podgorica
Montenegro

Tel.: 00381 81 658090
Fax: 00381 81 658092
Email: tomo.a@cg.yu

7. SERBIA

Ms. Gordana K. PANTELIC
Institute of Occupational and Radiological Health
"Dr. Dragomir Karajovic"
Deligradska 29
11000 Belgrade
Serbia

Tel.: 00381 11 3615079
Fax: 00381 11 2643675
Email: dpantelic@ptt.yu

8. SERBIA

Ms. Irena TANASKOVIĆ
Institute of Occupational and Radiological Health
"Dr. Dragomir Karajovic"
Deligradska 29
11000 Belgrade
Serbia

Tel.: 00381 11 3615079
Fax: 00381 11 2643675
Email: vtan@eunet.yu

9.	**SLOVENIA**	**Mr. Matjaz Korun** **LMR** Jozef Stefan Institute Jamova 39 1000 Ljubljana Slovenia Tel.: 00386 1 4773900 Fax: 00386 1 4773151 Email: matjaz.korun@ijs.si
10.	**SLOVENIA**	**Mr. Matjaz STEPIŠNIK** Jozef Stefan Institute Radiation Protection Unit Jamova 39 1000 Ljubljana Slovenia Tel.: 00386 1 5885254 Fax: 00386 1 5885377 Email: matjaz.stepisnik@ijs.si
11.	**REPUBLIC OF MACEDONIA**	**Ms. Zdenka STOJANOVSKA** Republic Institute of Health Protection 50 Divizija 6 P.O. Box 570 1000 Skopje Republic of Macedonia Tel.: 00389 231 24351 Fax: 00389 232 23354 Email: stojanovskazdenka@yahoo.co.uk