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IAEA-RML-2015-01 Proficiency Test for Determination of Radionuclides in Sea Water

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IAEA-RML-2015-01 PROFICIENCY TEST FOR DETERMINATION OF RADIONUCLIDES IN SEA WATER

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IAEA-RML-2015-01 PROFICIENCY TEST FOR DETERMINATION OF RADIONUCLIDES IN SEA WATER

INTERNATIONAL ATOMIC ENERGY AGENCY
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FOREWORD

The Radiometrics Laboratory of the IAEA Environment Laboratories has provided quality support services and products to laboratories in Member States for over 50 years. They include the organization of proficiency test exercises and laboratory intercomparisons, and the production of certified reference materials with a wide range of marine sample matrices and radionuclide levels.

As part of these activities, a follow-up proficiency test exercise was organized in 2015 at the request of the Nuclear Regulation Authority of Japan to continue testing the performance of participating laboratories in an analysis of radionuclides in a seawater sample. The exercise was designed to support laboratories in seawater analyses of ^{3}H, ^{134}Cs, ^{137}Cs and ^{90}Sr relating to the accident at the Fukushima Daiichi nuclear power plant, in March 2011, and the subsequent contamination of the marine environment. The results of the exercise, which are described in this publication, allow the participating laboratories to evaluate and compare their performance in the analysis of these radionuclides for this sample type. A total of 43 laboratories from 29 Member States participated from August to October 2015. Earlier exercises are described in IAEA Analytical Quality in Nuclear Applications Series Nos 40–43.

The IAEA is grateful to the Government of Monaco for its support and wishes to thank the participants and laboratories who took part in this proficiency test exercise. The IAEA officers responsible for this publication were A.V. Harms, I. Osvath and D. Osborn of the IAEA Environment Laboratories.

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CONTENTS

1. INTRODUCTION

The IAEA Environment Laboratories (IAEA-EL) in Monaco and Seibersdorf regularly organize proficiency tests (PT) for radionuclides in environmental samples to support laboratories in IAEA Member States. The organization and the results of a second PT organized in cooperation with the Nuclear Regulation Authority (NRA) in Japan are described in this publication. Nine laboratories associated with the IAEA Technical Cooperation project RCA RAS/7/021 entitled 'Marine Benchmark Study on the Possible Impact of the Fukushima Radioactive Releases in the Asia-Pacific Region' also took part in the exercise.

2. MATERIAL AND METHODS

2.1. PROFICIENCY TEST OBJECTIVES

This proficiency test was initiated to support laboratories in seawater analyses of ^{3}H, ^{90}Sr, ^{134}Cs and ^{137}Cs. The results of this exercise allowed the participating laboratories to evaluate their performance in the analysis of these radionuclides for this sample type.

2.2. PARTICIPANTS

A total of 43 laboratories from 29 countries participated in this exercise during the period August – October 2015. This included 10 laboratories from Japan and 33 laboratories from other IAEA Member States, including nine laboratories taking part in the IAEA Technical Cooperation project RCA RAS/7/021. The 10 Japanese laboratories are indicated with the symbol * following their participation code (i.e. Participants 1* to 10*). The 9 laboratories associated with the RCA RAS/7/021 project are indicated with the symbol # following their participation code (i.e. Participants 27# to 35#). The full list of participants is given on pages 55–60.

2.3. MATERIAL DISTRIBUTION AND REPORTING REQUIREMENTS

A sample containing 5 L of filtered and acidified Mediterranean seawater spiked by the IAEA with the radionuclides ^{3}H, ^{90}Sr, ^{134}Cs and ^{137}Cs was distributed to the participants, with the massic activities only known to the IAEA. The massic activities were traceable to a standard provided by Czech Metrology Institute ČMI. The combined massic activities in the exercise samples were lower than the natural activity level of ^{40}K in seawater (which is approximately 12 Bq kg^{-1}). The ^{3}H, ^{90}Sr, ^{134}Cs and ^{137}Cs massic activities for the samples were approximately 3.2, 0.10, 0.15 and 0.20 Bq kg^{-1}, respectively. The sample also contained a non-active Cs-carrier at 10 mg kg^{-1} in order to stabilize the solution and to avoid adsorption of Cs to the container walls. No Sr was added to the sample as non-active Sr present naturally in seawater will act as a carrier for ^{90}Sr.

The participants were required to report to the IAEA the ^{3}H, ^{90}Sr, ^{134}Cs and ^{137}Cs massic activities (in Bq kg^{-1}) of the proficiency test sample combined with the associated uncertainties (also in Bq kg^{-1}). Additionally, the participants were asked to submit the following:

- A short description of the analytical method used for the sample analysis. The Information Sheet sent to the participants suggested for ^{3}H distillation followed by liquid scintillation counting. For ^{90}Sr precipitation ^{90}Sr precipitation from seawater as mixed Ca/Sr oxalate or carbonate follow by a standard ^{90}Sr procedure (e.g. a radiochemical procedure such as precipitation with fuming nitric acid, liquid-liquid extraction or extraction chromatography followed by a measurement technique such as gas-flow proportional counting or liquid scintillation counting). For ^{134}Cs and ^{137}Cs three methods were suggested: (i) direct gamma spectrometry, (ii) adsorption on AMP (ammonium molybdophosphate, $(NH_4)_3PO_4Mo_{12}O_{36}$) and subsequent gamma spectrometry or (iii) adsorption on copper hexacyanoferrate ($Cu_2[Fe(CN)_6]$) and subsequent gamma spectrometry;
- Type of calibration and software used for gamma ray spectrometry;
- Nuclear data used;
- An uncertainty budget for the measurement results.

The reference date for reporting massic activities was set at 1 September 2015. At this date, the ranges for the traceable massic activities in the proficiency test exercise samples sent to the participants were 3.13–3.22 Bq kg^{-1} ^{3}H, 0.0996–0.1027 Bq kg^{-1} ^{90}Sr, 0.1523–0.1571 Bq kg^{-1} ^{134}Cs and 0.2017–0.2080 Bq kg^{-1} ^{137}Cs, respectively (see Table 1).

TABLE 1. IAEA ASSIGNED VALUES

Participant	^{3}H massic activity (Bq kg^{-1})	^{90}Sr massic activity (Bq kg^{-1})	^{134}Cs massic activity (Bq kg^{-1})	^{137}Cs massic activity (Bq kg^{-1})
1*	3.17 ± 0.06	0.1009 ± 0.0007	0.1543 ± 0.0006	0.2043 ± 0.0013
2*	3.19 ± 0.06	0.1016 ± 0.0007	0.1555 ± 0.0006	0.2058 ± 0.0013
3*	3.16 ± 0.06	0.1007 ± 0.0007	0.1541 ± 0.0006	0.2040 ± 0.0013
4*	3.14 ± 0.06	0.1001 ± 0.0007	0.1531 ± 0.0006	0.2027 ± 0.0013
5*	3.19 ± 0.06	0.1017 ± 0.0007	0.1555 ± 0.0006	0.2059 ± 0.0013
6*	3.14 ± 0.06	0.1001 ± 0.0007	0.1531 ± 0.0006	0.2027 ± 0.0013
7*	3.17 ± 0.06	0.1011 ± 0.0007	0.1547 ± 0.0006	0.2047 ± 0.0013
8*	3.17 ± 0.06	0.1008 ± 0.0007	0.1542 ± 0.0006	0.2041 ± 0.0013
9*	3.18 ± 0.06	0.1014 ± 0.0007	0.1551 ± 0.0006	0.2053 ± 0.0013
10*	3.18 ± 0.06	0.1015 ± 0.0007	0.1552 ± 0.0006	0.2055 ± 0.0013
11	3.15 ± 0.06	0.1002 ± 0.0007	0.1533 ± 0.0006	0.2030 ± 0.0013
12	3.15 ± 0.06	0.1002 ± 0.0007	0.1532 ± 0.0006	0.2029 ± 0.0013
13	3.18 ± 0.06	0.1012 ± 0.0007	0.1548 ± 0.0006	0.2050 ± 0.0013
14	3.15 ± 0.06	0.1004 ± 0.0007	0.1536 ± 0.0006	0.2034 ± 0.0013
15	3.18 ± 0.06	0.1013 ± 0.0007	0.1549 ± 0.0006	0.2051 ± 0.0013
16	3.18 ± 0.06	0.1013 ± 0.0007	0.1550 ± 0.0006	0.2052 ± 0.0013
17	3.22 ± 0.07	0.1027 ± 0.0007	0.1571 ± 0.0006	0.2080 ± 0.0013
18	3.21 ± 0.06	0.1022 ± 0.0007	0.1563 ± 0.0006	0.2069 ± 0.0013
19	3.22 ± 0.07	0.1026 ± 0.0007	0.1570 ± 0.0006	0.2078 ± 0.0013
20	3.17 ± 0.06	0.1010 ± 0.0007	0.1546 ± 0.0006	0.2046 ± 0.0013
21	3.18 ± 0.06	0.1012 ± 0.0007	0.1549 ± 0.0006	0.2051 ± 0.0013
22	3.17 ± 0.06	0.1010 ± 0.0007	0.1545 ± 0.0006	0.2045 ± 0.0013
23	3.19 ± 0.06	0.1015 ± 0.0007	0.1552 ± 0.0006	0.2055 ± 0.0013
24	3.17 ± 0.06	0.1010 ± 0.0007	0.1545 ± 0.0006	0.2045 ± 0.0013
25	3.18 ± 0.06	0.1013 ± 0.0007	0.1550 ± 0.0006	0.2052 ± 0.0013
26	3.17 ± 0.06	0.1009 ± 0.0007	0.1544 ± 0.0006	0.2044 ± 0.0013
27#	3.17 ± 0.06	0.1009 ± 0.0007	0.1544 ± 0.0006	0.2044 ± 0.0013
28#	3.18 ± 0.06	0.1014 ± 0.0007	0.1551 ± 0.0006	0.2054 ± 0.0013
29#	3.17 ± 0.06	0.1010 ± 0.0007	0.1544 ± 0.0006	0.2045 ± 0.0013
30#	3.16 ± 0.06	0.1007 ± 0.0007	0.1540 ± 0.0006	0.2039 ± 0.0013
31#	3.16 ± 0.06	0.1007 ± 0.0007	0.1540 ± 0.0006	0.2039 ± 0.0013
32#	3.17 ± 0.06	0.1008 ± 0.0007	0.1542 ± 0.0006	0.2041 ± 0.0013
33#	3.18 ± 0.06	0.1014 ± 0.0007	0.1552 ± 0.0006	0.2054 ± 0.0013
34#	3.17 ± 0.06	0.1010 ± 0.0007	0.1545 ± 0.0006	0.2046 ± 0.0013
35#	3.13 ± 0.06	0.0996 ± 0.0007	0.1523 ± 0.0006	0.2017 ± 0.0013
36	3.18 ± 0.06	0.1014 ± 0.0007	0.1552 ± 0.0006	0.2054 ± 0.0013

TABLE 1. IAEA ASSIGNED VALUES (cont.)

Participant	^{3}H massic activity (Bq kg^{-1})	^{90}Sr massic activity (Bq kg^{-1})	^{134}Cs massic activity (Bq kg^{-1})	^{137}Cs massic activity (Bq kg^{-1})
37	3.17 ± 0.06	0.1009 ± 0.0007	0.1543 ± 0.0006	0.2043 ± 0.0013
38	3.16 ± 0.06	0.1006 ± 0.0007	0.1539 ± 0.0006	0.2038 ± 0.0013
39	3.19 ± 0.06	0.1015 ± 0.0007	0.1553 ± 0.0006	0.2056 ± 0.0013
40	3.15 ± 0.06	0.1003 ± 0.0007	0.1535 ± 0.0006	0.2032 ± 0.0013
41	3.14 ± 0.06	0.1000 ± 0.0007	0.1530 ± 0.0006	0.2025 ± 0.0013
42	3.18 ± 0.06	0.1014 ± 0.0007	0.1551 ± 0.0006	0.2053 ± 0.0013
43	3.15 ± 0.06	0.1004 ± 0.0007	0.1535 ± 0.0006	0.2032 ± 0.0013

* Participant from Japan
# Participant from RCA RAS/7/021

3. PERFORMANCE CRITERIA

The methodology adopted for this exercise was slightly updated from the existing IAEA methodology. The scoring system took into account the accuracy, precision and trueness of the reported data and included in the evaluation both the combined standard uncertainty of the IAEA value and the combined standard uncertainty reported by the participating laboratories. The IAEA values, which were used for the data evaluation, were the certified values of radionuclides at the reference date. A result must pass three tests to be assigned the status 'Accepted', otherwise it was assigned the status 'Warning' or 'Not accepted'.

3.1. ACCURACY

The first step in producing a score for a result $Value_{Analyst}$ was the estimation of the bias. The relative bias between the Analyst's value and the IAEA target value was calculated as follows and expressed as a percentage:

$$Bias_{\text{relative}} = \frac{Value_{\text{Analyst}} - Value_{\text{IAEA}}}{Value_{\text{IAEA}}} \times 100\% \quad (1)$$

The absolute value of the relative bias was compared to the Maximal Accepted Relative Bias (MARB). Participants' results were scored as 'Pass' for accuracy when:

$$|Bias_{\text{relative}}| \leq \text{MARB} \quad (2)$$

The MARB values used in this evaluation were 20% for both ^{134}Cs and ^{137}Cs and 25% for both ^{3}H and ^{90}Sr.

3.2. PRECISION AND TRUENESS

The precision *P* for each result was calculated according to the following equation:

$$P = \sqrt{\left(\frac{unc_{\text{IAEA}}}{Value_{\text{IAEA}}}\right)^2 + \left(\frac{unc_{\text{Analyst}}}{Value_{\text{Analyst}}}\right)^2} \times 100\% \quad (3)$$

The precision *P* was compared to the Limit of Accepted Precision (LAP). The participants' results were scored as 'Pass' for precision when:

$$P \leq \text{LAP} \quad (4)$$

The LAP values used in this evaluation were 20% for both ^{134}Cs and ^{137}Cs and 25% for both ^{3}H and ^{90}Sr.

The participants' results for trueness were scored as 'Pass' when:

$$|Bias_{\text{relative}}| \leq \frac{Value_{\text{Analyst}}}{Value_{\text{IAEA}}} 2.58\, P \quad (5)$$

3.3. FINAL EVALUATION

For the final evaluation, all three scores were combined (see Table 2). The result was considered as 'Accepted' if it passed all three tests. If the accuracy test was failed, the result was considered as 'Not accepted'. If the accuracy test was passed but one of the other two tests was failed, the result was assigned the 'Warning' status. The 'Warning' status will reflect cases in which the reported result was close enough to the assigned property value, but its associated uncertainty was deemed to be either too small or too large.

TABLE 2. PERFORMANCE EVALUATION CRITERIA

Accuracy	Precision	Trueness	Final evaluation
Pass	Pass	Pass	Accepted
Pass	Fail	Pass	Warning
Pass	Pass	Fail	Warning
Fail	Pass/Fail	Pass/Fail	Not accepted

These evaluation criteria can also be illustrated by plotting the relative bias against the relative uncertainty of the participants' result (see Figure 1). In the illustrated case, a relative uncertainty of 1% for the IAEA value is assumed with MARB and LAP limits of 20%.

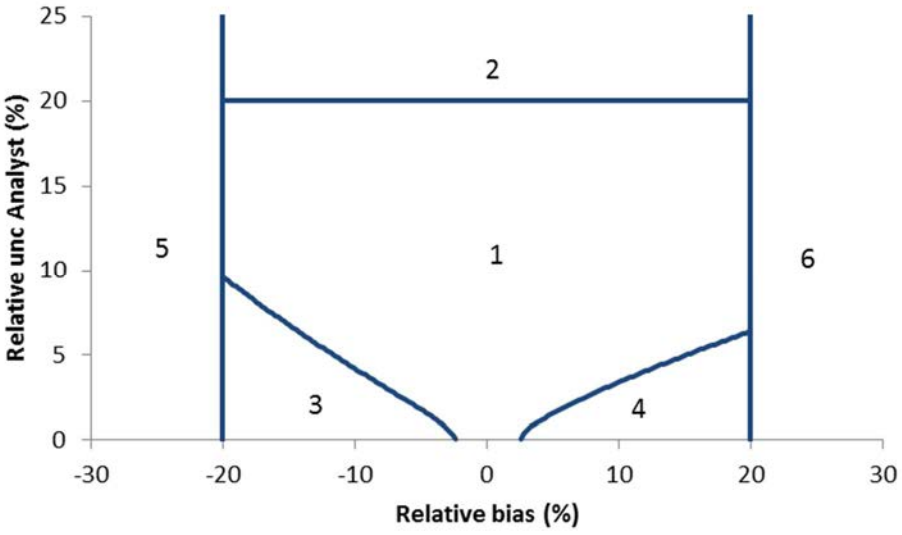

FIG. 1. Visualization of performance evaluation criteria.

The plot consists of six zones (Zone 1 'Accepted'; Zones 2, 3 and 4 'Warning'; Zones 5 and 6 'Not accepted'), whose areas are defined by the three tests used above to evaluate the data. The areas of Zones 1, 3 and 4 are finite, while the areas of Zones 2, 5 and 6 are infinite. A result located in Zone 1 passes all three tests (evaluation 'Accepted'). A result located in Zone 2 fails only the precision test as its associated uncertainty is deemed to be too large (evaluation: 'Warning'). A result located in Zones 3 and 4 fails only the trueness test as its associated uncertainty is deemed to be too small (evaluation: 'Warning'). A result located in Zones 5 and 6 fails (at least) the accuracy test as its relative bias is larger than the MARB (evaluation: 'Not accepted').

3.4. COMPARISON OF PARTICIPANTS' VALUES WITH THE IAEA VALUES

The means and the uncertainties for the combined participants' results were calculated according to a method developed by Cox (i.e. the weighted mean of the largest consistent subset containing p results)[1] and subsequently compared with the IAEA values. The mean of the combined participants' results, $Value_{Combined}$, was tested against the IAEA value, $Value_{IAEA}$, using this equation:

$$t = \frac{Value_{\text{Combined}} - Value_{\text{IAEA}}}{\sqrt{(unc_{\text{Combined}})^2 + (unc_{\text{IAEA}})^2}} \quad (6)$$

The effective degrees of freedom v_{eff} were determined with the Welch-Satterthwaite equation. The effective degrees of freedom v_{eff} were rounded and the critical value t_{crit} for this value was identified.

The criterion for passing the t test was:

$$|t| < t_{\text{crit}} \quad (7)$$

If the absolute value of t was greater than the critical value t_{crit}, this indicates there was a significant difference between the combined participants' results and the IAEA value.

4. RESULTS AND DISCUSSION

In total 131 measurement results were reported by 43 laboratories from 29 countries for ^{3}H, ^{90}Sr, ^{134}Cs and ^{137}Cs. The evaluation of these results showed that 69% of all reported results were 'Accepted', while 21% of the individual measurement results were "Not accepted" with the remaining 9% having the 'Warning' status. The performance evaluation for ^{3}H, ^{90}Sr, ^{134}Cs and ^{137}Cs is summarized in Table 3. The subset of the results of the 10 Japanese participants showed that 87% of all reported results were 'Accepted', while 7% of the results were 'Not accepted', with the remaining 7% having the 'Warning' status. The subset of the results of the 9 RCA RAS/7/021 participants showed that 68% of all reported results were 'Accepted', while 21% of the results were 'Not accepted', with the remaining 11% having the 'Warning' status.

TABLE 3. SUMMARY EVALUATION OF THE RADIONUCLIDES REPORTED

Radionuclide	Number of submitted results	Accepted	Warning	Not accepted
^{3}H	23 (7) [3]	15 (7) [2]	2 (0) [0]	6 (0) [1]
^{90}Sr	23 (5) [6]	18 (5) [4]	2 (0) [1]	3 (0) [1]
^{134}Cs	43 (9) [10]	26 (6) [7]	5 (2) [0]	12 (1) [3]
^{137}Cs	42 (9) [9]	32 (8) [6]	3 (0) [2]	7 (1) [1]

NOTE: The numbers in round brackets represent the subset of Japanese results, while the numbers in square brackets represent the subset of RCA RAS/7/021 results

There was no significant bias of the combined participants' results for ^{3}H (–3.2%), ^{90}Sr (0.3%), ^{134}Cs (–2.3%) and ^{137}Cs (1.0%) (see Table 4). For ^{3}H, ^{90}Sr, ^{134}Cs and ^{137}Cs about half of the participants' results showed a negative bias (52%, 57%, 57% and 48% of the results, respectively). Coincidence

[1] Cox, M.G., 2007. The evaluation of key comparison data: determining the largest consistent subset. Metrologia 44 187-200

summing is a problem for ^{134}Cs as it leads to signal loss and hence underestimation of the activity levels for this radionuclide. The results suggest that a small minority of the participants did not make a sufficient correction for coincidence summing. For the combined Japanese results, there were no significant relative differences with the IAEA values for all four radionuclides as well. There was a significant negative bias of the combined RCA RAS/7/021 participants' results for ^{137}Cs. Table 5 summarizes the data evaluation sorted by laboratory code.

TABLE 4. COMPARISON OF THE COMBINED PARTICIPANTS' RESULTS WITH THE IAEA VALUE

Nuclide	Combined participants' result (Bq kg^{-1})	IAEA value (Bq kg^{-1})	Size of the LCS* (%)	*t*-value	Critical *t*-value	Bias (%)
^{3}H	3.08 ± 0.05	3.18 ± 0.06	19 (83%)	–1.27	2.05	–3.2
^{90}Sr	0.1013 ± 0.0014	0.1011 ± 0.0008	20 (87%)	0.17	2.04	0.3
^{134}Cs	0.1510 ± 0.0023	0.1545 ± 0.0010	36 (84%)	–1.41	2.01	–2.3
^{137}Cs	0.207 ± 0.003	0.2046 ± 0.0013	35 (83%)	0.69	2.01	1.0

*Size of the LCS (largest consistent subset) denotes the percentage of the returned results contributing to combined participants' results

TABLE 5. SUMMARY EVALUATION

Lab code	^{3}H	^{90}Sr	^{134}Cs	^{137}Cs
1*	A	A	A	A
2*	A	A	A	A
3*			A	A
4*			W	NA
5*	A	A	NA	A
6*	A	A	W	A
7*			A	A
8*	A	A	A	A
9*	A			
10*	A		A	A
11		A	A	A
12			A	A
13	A		A	A
14			A	A
15			NA	NA
16		A	A	A
17	A	A	W	A
18	NA	A	W	A
19	A	A	NA	A
20	A	NA	A	A
21	NA	A	NA	A
22	NA		A	A

TABLE 5. SUMMARY EVALUATION (cont.)

Lab code	^{3}H	^{90}Sr	^{134}Cs	^{137}Cs
23	NA		A	NA
24			A	A
25	W	A	A	A
26			NA	A
27#		NA	A	A
28#	A	A	A	A
29#	A	A	A	NA
30#		A	A	A
31#			NA	
32#		A	A	A
33#			NA	A
34#			NA	W
35#	NA	W	A	A
36			NA	A
37			NA	NA
38	W	W	A	NA
39	A	A	W	W
40		NA	A	A
41	A	A		
42	NA		NA	A
43			NA	NA

* Participant from Japan
# Participant from RCA RAS/7/021

The performance evaluation sorted by radionuclide and the bias plots are presented in Appendix I (see Tables 6–9 and Figures 2–13). In the bias plots, the 'Accepted' results are represented by dark blue points. 'Warning' and 'Not accepted' results are represented by the yellow and red points, respectively. The error bars represent the standard uncertainties of the bias (with a coverage factor of $k = 1$). The dotted lines represent a relative bias of ± 25% or ± 20% (Maximum Accepted Bias for ^{3}H/^{90}Sr and ^{134}Cs/^{137}Cs, respectively). The performance evaluation sorted by laboratory code is presented in Appendix II. All laboratories reported their values with standard uncertainties ($k = 1$). However, a large spread in the submitted uncertainties was observed with relative uncertainties (at $k = 1$) ranging from 1.8% to 39% for ^{3}H, from 2.2% to 34% for ^{90}Sr, from 4.8% to 40% for ^{134}Cs and from 2.3% to 26% for ^{137}Cs. However, most reported relative uncertainties were in the range of 5% – 15%.

For ^{3}H, practically all participants (except Participant 18) performed a distillation of the seawater samples, followed by liquid scintillation counting (LSC). Four participants (9*, 13, 39 and 41) performed electrolytic enrichment after distillation (and obtained excellent results with small uncertainties of less than 9% at $k = 1$). The direct measurements after distillation yielded slightly larger uncertainties generally between 5% and 39%. For ^{90}Sr, most participants used gas-flow proportional counting (GPC) of chemically separated ^{90}Y as the analysis technique, except Participants 17, 18, 25, 30#, 32# and 38 who used LSC/Cherenkov counting. Chemical separation techniques used included precipitations of Sr-oxalate or Sr-carbonate, barium chromate precipitations, nitric acid precipitations, cation-exchange chromatography, Sr-extraction chromatography and direct liquid-

liquid extraction of ^{90}Y with HDEHP. No significant difference between the performances of the chemical separation techniques is apparent. For ^{134}Cs and ^{137}Cs, a majority of the participants measured the seawater samples directly with gamma spectrometry, while a minority of laboratories either used a pre-concentration technique (i.e. adsorption on ammonium molybdophosphate) to separate the caesium radionuclides from the seawater matrix followed by gamma spectrometry (Participants 1*, 4*, 10*, 12b, 15, 27#, 28#, 32#b and 35#) or they used a combination of the two techniques (Participants 26, 30# and 36). Two participants (37 and 39) evaporated the sample before measurement. No significant difference in the performance between the two techniques is apparent.

APPENDIX I. PERFORMANCE EVALUATION TABLES SORTED BY RADIONUCLIDE

TABLE 6. EVALUATION RESULTS FOR ^{3}H

Lab code	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
1*	2.85	0.18	3.17	0.06	–10	6.7	16	Pass	Pass	Pass	Accepted
2*	3.33	0.24	3.19	0.06	4.4	7.5	20	Pass	Pass	Pass	Accepted
3*	–	–	3.16	0.06	–	–	–	–	–	–	Not reported
4*	–	–	3.14	0.06	–	–	–	–	–	–	Not reported
5*	3.00	0.20	3.19	0.06	–6.0	7.0	17	Pass	Pass	Pass	Accepted
6*	3.08	0.24	3.14	0.06	–2.0	8.1	20	Pass	Pass	Pass	Accepted
7*	–	–	3.17	0.06	–	–	–	–	–	–	Not reported
8*	2.97	0.17	3.17	0.06	–6.2	6.1	15	Pass	Pass	Pass	Accepted
9*	3.12	0.15	3.18	0.06	–2.0	5.2	13	Pass	Pass	Pass	Accepted
10*	3.46	0.24	3.18	0.06	8.7	7.1	20	Pass	Pass	Pass	Accepted
11	–	–	3.15	0.06	–	–	–	–	–	–	Not reported
12	<5.7	–	3.15	0.06	–	–	–	–	–	–	Not evaluated
13	3.05	0.06	3.18	0.06	–4.0	2.7	6.9	Pass	Pass	Pass	Accepted
14	–	–	3.15	0.06	–	–	–	–	–	–	Not reported
15	–	–	3.18	0.06	–	–	–	–	–	–	Not reported
16	–	–	3.18	0.06	–	–	–	–	–	–	Not reported
17	3.4	0.3	3.22	0.07	4.9	10	28	Pass	Pass	Pass	Accepted

TABLE 6. EVALUATION RESULTS FOR ^{3}H (cont.)

Lab code	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
18	5.5	1.0	3.21	0.06	70	19	84	Fail	Pass	Pass	Not Accepted
19	2.7	0.4	3.22	0.07	–16	14	31	Pass	Pass	Pass	Accepted
20	3.21	0.11	3.17	0.06	1.2	4.0	10	Pass	Pass	Pass	Accepted
21	6.9	1.6	3.18	0.06	117	23	130	Fail	Pass	Pass	Not Accepted
22	4.0	0.5	3.17	0.06	26	12	38	Fail	Pass	Pass	Not Accepted
23	5.61	0.20	3.19	0.06	76	4.1	17	Fail	Pass	Fail	Not Accepted
24	–	–	3.17	0.06	–	–	–	–	–	–	Not reported
25	2.9	0.9	3.18	0.06	–10	33	76	Pass	Fail	Pass	Warning
26	–	–	3.17	0.06	–	–	–	–	–	–	Not reported
27#	–	–	3.17	0.06	–	–	–	–	–	–	Not reported
28#	3.60	0.20	3.18	0.06	13	5.9	17	Pass	Pass	Pass	Accepted
29#	3.5	0.4	3.17	0.06	10	11	30	Pass	Pass	Pass	Accepted
30#	–	–	3.16	0.06	–	–	–	–	–	–	Not reported
31#	–	–	3.16	0.06	–	–	–	–	–	–	Not reported
32#	–	–	3.17	0.06	–	–	–	–	–	–	Not reported
33#	–	–	3.18	0.06	–	–	–	–	–	–	Not reported
34#	–	–	3.17	0.06	–	–	–	–	–	–	Not reported
35#	5.4	0.4	3.13	0.06	73	7.7	33	Fail	Pass	Fail	Not Accepted
36	–	–	3.18	0.06	–	–	–	–	–	–	Not reported

TABLE 6. EVALUATION RESULTS FOR ^{3}H (cont.)

37	–	–	3.17	0.06	–	–	–	–	–	–	Not reported
38	2.6	1.0	3.16	0.06	–17	39	84	Pass	Fail	Pass	Warning
39	2.90	0.12	3.19	0.06	–9.0	4.6	11	Pass	Pass	Pass	Accepted
40	–	–	3.15	0.06	–	–	–	–	–	–	Not reported
41	3.00	0.25	3.14	0.06	–4.5	8.6	21	Pass	Pass	Pass	Accepted
42	1.38	0.15	3.18	0.06	–57	11	13	Fail	Pass	Fail	Not Accepted
43	–	–	3.15	0.06	–	–	–	–	–	–	Not reported

TABLE 7. EVALUATION RESULTS FOR ^{90}Sr

Lab code	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
1*	0.118	0.009	0.1009	0.0007	17	7.7	23	Pass	Pass	Pass	Accepted
2*	0.116	0.006	0.1016	0.0007	14	5.2	15	Pass	Pass	Pass	Accepted
3*	–	–	0.1007	0.0007	–	–	–	–	–	–	Not reported
4*	–	–	0.1001	0.0007	–	–	–	–	–	–	Not reported
5*	0.0990	0.0022	0.1017	0.0007	–2.6	2.3	5.9	Pass	Pass	Pass	Accepted
6*	0.105	0.013	0.1001	0.0007	4.9	12	34	Pass	Pass	Pass	Accepted
7*	–	–	0.1011	0.0007	–	–	–	–	–	–	Not reported
8*	0.092	0.012	0.1008	0.0007	–8.7	13	31	Pass	Pass	Pass	Accepted
9*	–	–	0.1014	0.0007	–	–	–	–	–	–	Not reported
10*	–	–	0.1015	0.0007	–	–	–	–	–	–	Not reported
11	0.103	0.003	0.1002	0.0007	2.7	3.0	7.9	Pass	Pass	Pass	Accepted
12	<0.03	–	0.1002	0.0007	–	–	–	–	–	–	Not evaluated
13	–	–	0.1012	0.0007	–	–	–	–	–	–	Not reported
14	–	–	0.1004	0.0007	–	–	–	–	–	–	Not reported
15	–	–	0.1013	0.0007	–	–	–	–	–	–	Not reported
16	0.108	0.006	0.1013	0.0007	6.6	5.6	15	Pass	Pass	Pass	Accepted
17	0.101	0.005	0.1027	0.0007	–1.7	5.0	13	Pass	Pass	Pass	Accepted
18	0.102	0.006	0.1022	0.0007	–0.2	5.9	15	Pass	Pass	Pass	Accepted
19	0.102	0.003	0.1026	0.0007	–0.6	2.7	6.9	Pass	Pass	Pass	Accepted

TABLE 7. EVALUATION RESULTS FOR ^{90}Sr (cont.)

Lab code	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
20	0.132	0.014	0.1010	0.0007	31	10	35	Fail	Pass	Pass	Not Accepted
21	0.082	0.016	0.1012	0.0007	–19	20	41	Pass	Pass	Pass	Accepted
22	–	–	0.1010	0.0007	–	–	–	–	–	–	Not reported
23	–	–	0.1015	0.0007	–	–	–	–	–	–	Not reported
24	–	–	0.1010	0.0007	–	–	–	–	–	–	Not reported
25	0.098	0.012	0.1013	0.0007	–3.7	12	31	Pass	Pass	Pass	Accepted
26	–	–	0.1009	0.0007	–	–	–	–	–	–	Not reported
27#	0.84	0.11	0.1009	0.0007	730	14	291	Fail	Pass	Fail	Not Accepted
28#	0.091	0.013	0.1014	0.0007	–10	14	33	Pass	Pass	Pass	Accepted
29#	0.102	0.013	0.1010	0.0007	1.0	12	32	Pass	Pass	Pass	Accepted
30#	0.094	0.006	0.1007	0.0007	–6.5	6.3	15	Pass	Pass	Pass	Accepted
31#	–	–	0.1007	0.0007	–	–	–	–	–	–	Not reported
32#	0.094	0.013	0.1008	0.0007	–6.7	14	33	Pass	Pass	Pass	Accepted
33#	–	–	0.1014	0.0007	–	–	–	–	–	–	Not reported
34#	–	–	0.1010	0.0007	–	–	–	–	–	–	Not reported
35#	0.124	0.007	0.0996	0.0007	25	5.7	18	Pass	Pass	Fail	Warning
36	–	–	0.1014	0.0007	–	–	–	–	–	–	Not reported
37	–	–	0.1009	0.0007	–	–	–	–	–	–	Not reported
38	0.11	0.04	0.1006	0.0007	6.3	34	92	Pass	Fail	Pass	Warning

TABLE 7. EVALUATION RESULTS FOR ^{90}Sr (cont.)

Lab code	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
39	0.090	0.007	0.1015	0.0007	–11	7.8	18	Pass	Pass	Pass	Accepted
40	0.017	0.003	0.1003	0.0007	–83	19	8.4	Fail	Pass	Fail	Not Accepted
41	0.097	0.007	0.1000	0.0007	–3.0	7.3	18	Pass	Pass	Pass	Accepted
42	–	–	0.1014	0.0007	–	–	–	–	–	–	Not reported
43	–	–	0.1004	0.0007	–	–	–	–	–	–	Not reported

TABLE 8. EVALUATION RESULTS FOR ^{134}Cs

Lab code	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
1*	0.143	0.007	0.1543	0.0006	–7.3	4.9	12	Pass	Pass	Pass	Accepted
2*	0.156	0.010	0.1555	0.0006	0.3	6.4	17	Pass	Pass	Pass	Accepted
3*	0.157	0.011	0.1541	0.0006	1.9	7.2	19	Pass	Pass	Pass	Accepted
4*	0.175	0.008	0.1531	0.0006	14	4.8	14	Pass	Pass	Fail	Warning
5*	0.110	0.024	0.1555	0.0006	–29	22	40	Fail	Fail	Pass	Not Accepted
6*	0.13	0.03	0.1531	0.0006	–18	23	49	Pass	Fail	Pass	Warning
7*	0.155	0.019	0.1547	0.0006	0.2	12	32	Pass	Pass	Pass	Accepted
8*	0.148	0.017	0.1542	0.0006	–4.0	11	28	Pass	Pass	Pass	Accepted
9*	–	–	0.1551	0.0006	–	–	–	–	–	–	Not reported
10*	0.151	0.009	0.1552	0.0006	–2.7	6.0	15	Pass	Pass	Pass	Accepted
11	0.166	0.012	0.1533	0.0006	8.3	7.2	20	Pass	Pass	Pass	Accepted
12a	0.131	0.016	0.1532	0.0006	–15	12	27	Pass	Pass	Pass	Accepted
12b	0.155	0.018	0.1532	0.0006	1.2	12	30	Pass	Pass	Pass	Accepted
13	0.144	0.009	0.1548	0.0006	–7.0	6.3	15	Pass	Pass	Pass	Accepted
14	0.147	0.010	0.1536	0.0006	–4.3	6.8	17	Pass	Pass	Pass	Accepted
15	0.189	0.021	0.1549	0.0006	22	11	35	Fail	Pass	Pass	Not Accepted
16	0.152	0.011	0.1550	0.0006	–2.2	7.1	18	Pass	Pass	Pass	Accepted
17	0.183	0.009	0.1571	0.0006	16	4.9	15	Pass	Pass	Fail	Warning
18	0.128	0.008	0.1563	0.0006	–18	6.3	13	Pass	Pass	Fail	Warning

TABLE 8. EVALUATION RESULTS FOR ^{134}Cs (cont.)

Lab code	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
19	0.100	0.009	0.1570	0.0006	–36	8.8	14	Fail	Pass	Fail	Not Accepted
20	0.144	0.009	0.1546	0.0006	–6.8	6.3	15	Pass	Pass	Pass	Accepted
21	0.091	0.014	0.1549	0.0006	–41	15	23	Fail	Pass	Fail	Not Accepted
22	0.153	0.011	0.1545	0.0006	–1.0	7.2	18	Pass	Pass	Pass	Accepted
23	0.140	0.010	0.1552	0.0006	–9.8	7.2	17	Pass	Pass	Pass	Accepted
24	0.152	0.011	0.1545	0.0006	–1.6	7.2	18	Pass	Pass	Pass	Accepted
25	0.139	0.018	0.1550	0.0006	–10	13	29	Pass	Pass	Pass	Accepted
26	0.121	0.007	0.1544	0.0006	–22	5.8	12	Fail	Pass	Fail	Not Accepted
27#	0.160	0.008	0.1544	0.0006	3.4	4.9	13	Pass	Pass	Pass	Accepted
28#	0.160	0.014	0.1551	0.0006	3.1	8.8	23	Pass	Pass	Pass	Accepted
29#	0.18	0.03	0.1544	0.0006	16	16	48	Pass	Pass	Pass	Accepted
30#	0.162	0.018	0.1540	0.0006	5.2	11	30	Pass	Pass	Pass	Accepted
31#	0.19	0.07	0.1540	0.0006	21	40	124	Fail	Fail	Pass	Not Accepted
32#a	0.153	0.010	0.1542	0.0006	–0.8	6.5	17	Pass	Pass	Pass	Accepted
32#b	0.146	0.017	0.1542	0.0006	–5.3	12	28	Pass	Pass	Pass	Accepted
33#	0.19	0.03	0.1552	0.0006	22	16	50	Fail	Pass	Pass	Not Accepted
34#	0.121	0.009	0.1545	0.0006	–22	7.4	15	Fail	Pass	Fail	Not Accepted
35#	0.160	0.017	0.1523	0.0006	5.1	11	29	Pass	Pass	Pass	Accepted
36	0.096	0.012	0.1552	0.0006	–38	12	19	Fail	Pass	Fail	Not Accepted

TABLE 8. EVALUATION RESULTS FOR ^{134}Cs (cont.)

Lab code	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
37	0.60	0.03	0.1543	0.0006	290	5.0	50	Fail	Pass	Fail	Not Accepted
38	0.165	0.019	0.1539	0.0006	7.2	12	32	Pass	Pass	Pass	Accepted
39	0.15	0.05	0.1553	0.0006	–3.4	33	83	Pass	Fail	Pass	Warning
40	0.157	0.009	0.1535	0.0006	2.2	6.1	16	Pass	Pass	Pass	Accepted
41	–	–	0.1530	0.0006	–	–	–	–	–	–	Not reported
42	0.194	0.024	0.1551	0.0006	25	12	40	Fail	Pass	Pass	Not Accepted
43	0.117	0.016	0.1535	0.0006	–24	14	28	Fail	Pass	Pass	Not Accepted

TABLE 9. EVALUATION RESULTS FOR ^{137}Cs

Lab code	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
1*	0.194	0.007	0.2043	0.0013	–5.0	3.7	9.0	Pass	Pass	Pass	Accepted
2*	0.236	0.012	0.2058	0.0013	15	5.1	15	Pass	Pass	Pass	Accepted
3*	0.212	0.012	0.2040	0.0013	3.9	5.7	15	Pass	Pass	Pass	Accepted
4*	0.263	0.012	0.2027	0.0013	30	4.4	15	Fail	Pass	Fail	Not Accepted
5*	0.210	0.019	0.2059	0.0013	2.0	9.1	24	Pass	Pass	Pass	Accepted
6*	0.21	0.03	0.2027	0.0013	5.1	13	34	Pass	Pass	Pass	Accepted
7*	0.213	0.021	0.2047	0.0013	4.0	9.9	26	Pass	Pass	Pass	Accepted
8*	0.215	0.019	0.2041	0.0013	5.3	8.9	24	Pass	Pass	Pass	Accepted
9*	–	–	0.2053	0.0013	–	–	–	–	–	–	Not reported
10*	0.193	0.010	0.2055	0.0013	–6.1	5.2	13	Pass	Pass	Pass	Accepted
11	0.230	0.020	0.2030	0.0013	13	8.7	25	Pass	Pass	Pass	Accepted
12a	0.210	0.025	0.2029	0.0013	3.5	12	32	Pass	Pass	Pass	Accepted
12b	0.202	0.018	0.2029	0.0013	–0.4	8.9	23	Pass	Pass	Pass	Accepted
13	0.188	0.021	0.2050	0.0013	–8.3	11	26	Pass	Pass	Pass	Accepted
14	0.210	0.016	0.2034	0.0013	3.2	7.6	20	Pass	Pass	Pass	Accepted
15	0.25	0.03	0.2051	0.0013	20	11	34	Fail	Pass	Pass	Not Accepted
16	0.211	0.011	0.2052	0.0013	2.6	5.5	14	Pass	Pass	Pass	Accepted
17	0.224	0.011	0.2080	0.0013	7.7	5.0	14	Pass	Pass	Pass	Accepted
18	0.206	0.015	0.2069	0.0013	–0.4	7.3	19	Pass	Pass	Pass	Accepted

TABLE 9. EVALUATION RESULTS FOR ^{137}Cs (cont.)

Lab code	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
19	0.200	0.019	0.2078	0.0013	–3.7	9.4	23	Pass	Pass	Pass	Accepted
20	0.218	0.007	0.2046	0.0013	6.5	3.0	8.3	Pass	Pass	Pass	Accepted
21	0.18	0.03	0.2051	0.0013	–12	15	34	Pass	Pass	Pass	Accepted
22	0.202	0.017	0.2045	0.0013	–1.2	8.4	21	Pass	Pass	Pass	Accepted
23	0.160	0.010	0.2055	0.0013	–22	6.3	13	Fail	Pass	Fail	Not Accepted
24	0.189	0.012	0.2045	0.0013	–7.6	6.4	15	Pass	Pass	Pass	Accepted
25	0.242	0.019	0.2052	0.0013	18	7.8	24	Pass	Pass	Pass	Accepted
26	0.195	0.009	0.2044	0.0013	–4.6	4.7	11	Pass	Pass	Pass	Accepted
27#	0.202	0.009	0.2044	0.0013	–1.0	4.5	12	Pass	Pass	Pass	Accepted
28#	0.192	0.021	0.2054	0.0013	–6.5	11	26	Pass	Pass	Pass	Accepted
29#	0.27	0.05	0.2045	0.0013	32	18	62	Fail	Pass	Pass	Not Accepted
30#	0.204	0.023	0.2039	0.0013	0.0	11	29	Pass	Pass	Pass	Accepted
31#	<0.15	–	0.2039	0.0013	–	–	–	–	–	–	Not evaluated
32#a	0.177	0.010	0.2041	0.0013	–13	5.6	12	Pass	Pass	Fail	Warning
32#b	0.188	0.024	0.2041	0.0013	–7.9	13	30	Pass	Pass	Pass	Accepted
33#	0.24	0.04	0.2054	0.0013	17	17	50	Pass	Pass	Pass	Accepted
34#	0.187	0.005	0.2046	0.0013	–8.6	2.7	6.5	Pass	Pass	Fail	Warning
35#	0.212	0.019	0.2017	0.0013	5.1	9.0	24	Pass	Pass	Pass	Accepted
36	0.167	0.017	0.2054	0.0013	–19	10	21	Pass	Pass	Pass	Accepted

TABLE 9. EVALUATION RESULTS FOR ^{137}Cs (cont.)

Lab code	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
37	0.865	0.020	0.2043	0.0013	323	2.4	25	Fail	Pass	Fail	Not Accepted
38	0.351	0.023	0.2038	0.0013	72	6.6	29	Fail	Pass	Fail	Not Accepted
39	0.19	0.05	0.2056	0.0013	–7.6	26	63	Pass	Fail	Pass	Warning
40	0.202	0.011	0.2032	0.0013	–0.6	5.5	14	Pass	Pass	Pass	Accepted
41	–	–	0.2025	0.0013	–	–	–	–	–	–	Not reported
42	0.246	0.025	0.2053	0.0013	20	10	31	Pass	Pass	Pass	Accepted
43	0.142	0.018	0.2032	0.0013	–30	12	22	Fail	Pass	Fail	Not Accepted

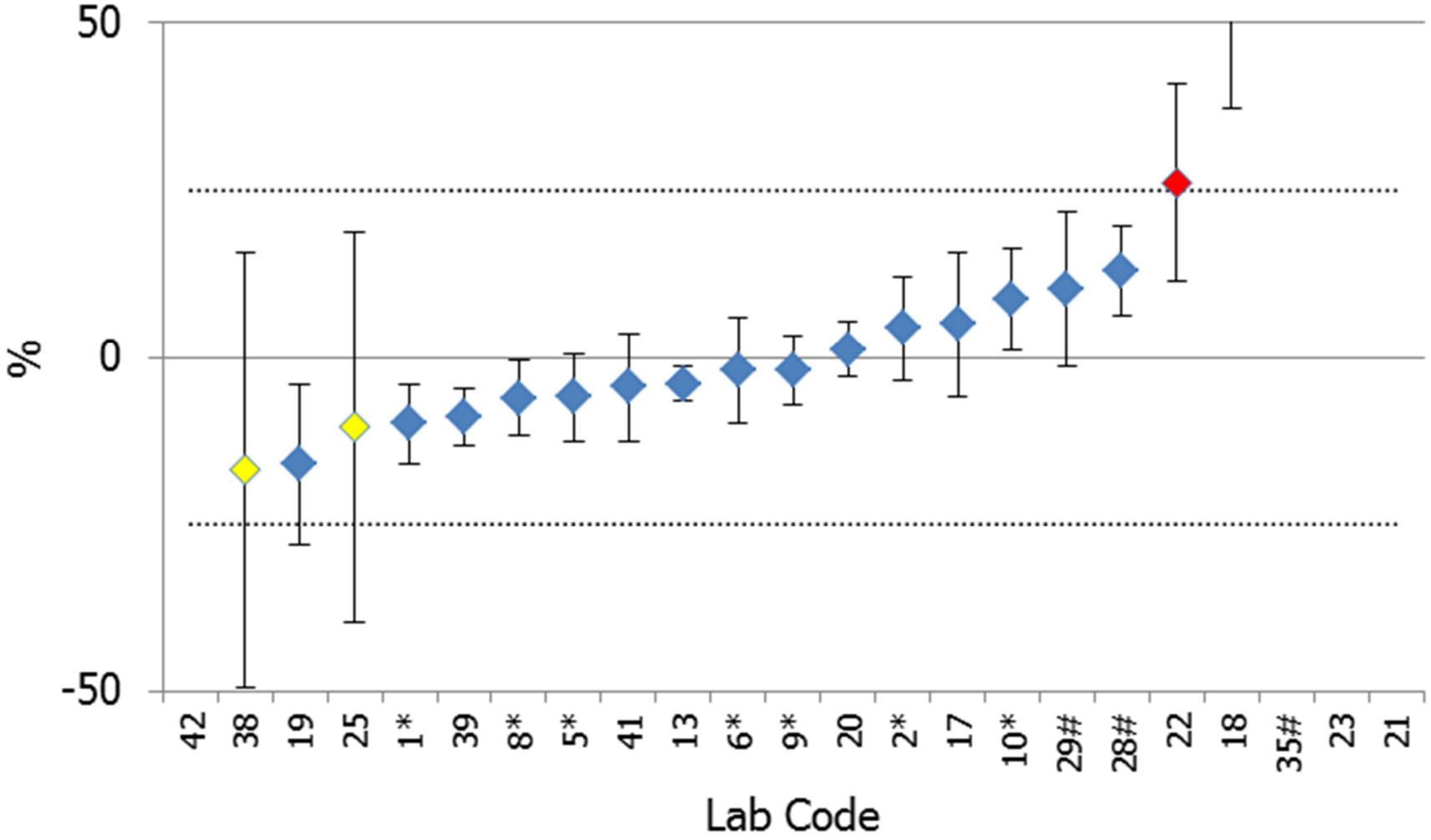
50
0
-50
%
42
38
19
25
1*
39
8*
5*
41
13
6*
9*
20
2*
17
10*
29#
28#
22
18
35#
23
21
Lab Code

FIG. 2. H-3 bias.

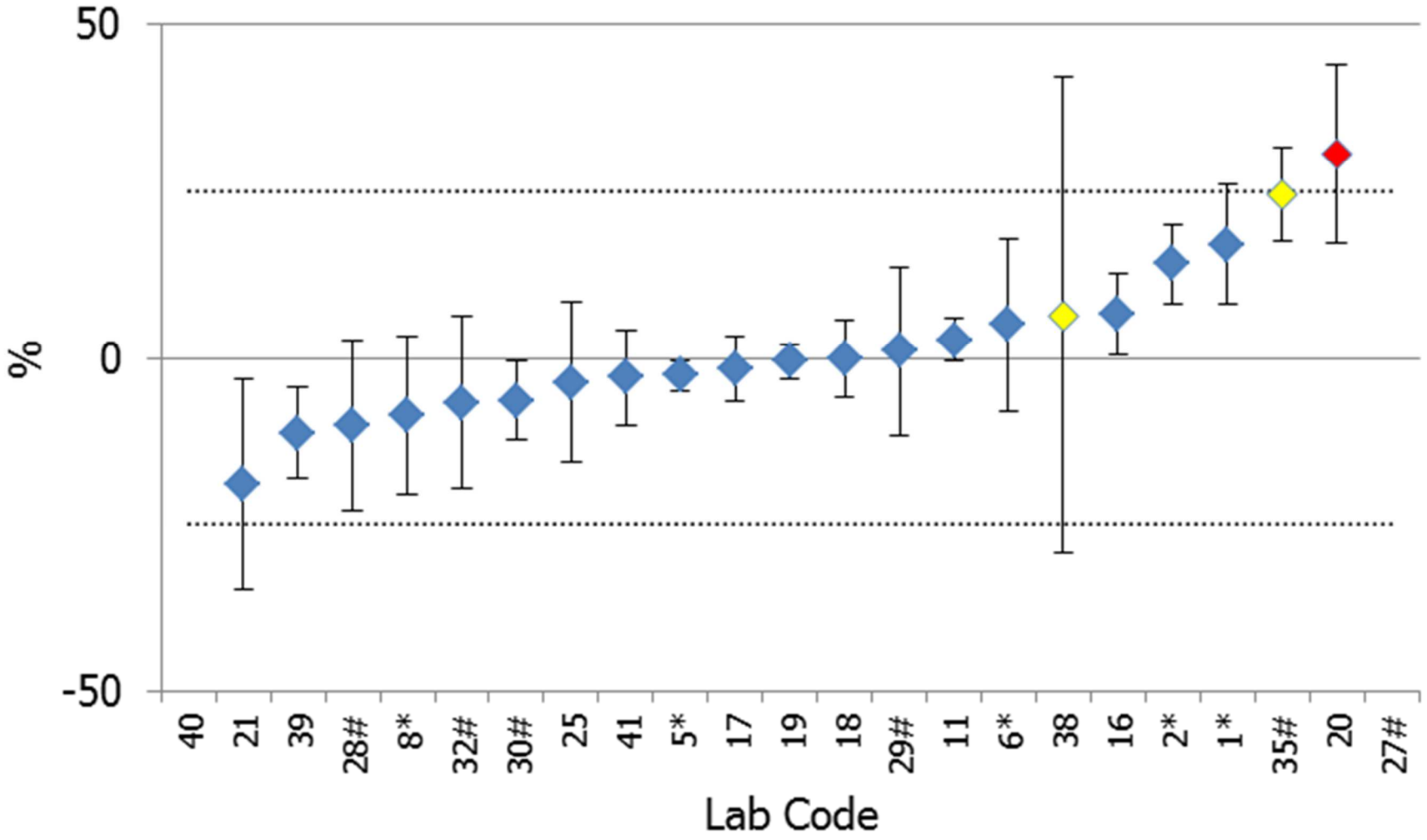

FIG. 3. Sr-90 bias.

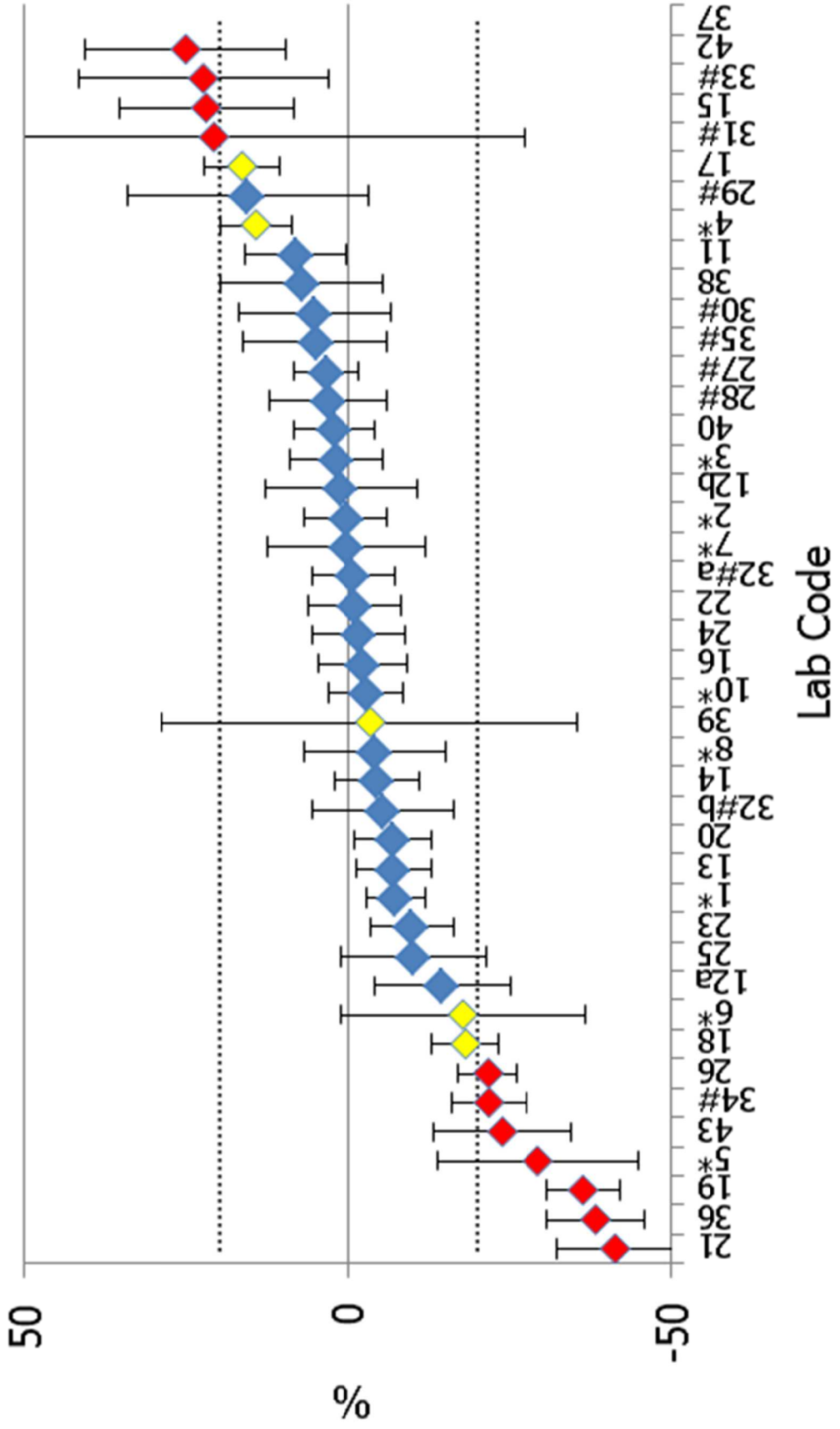

FIG. 4. Cs-134 bias.

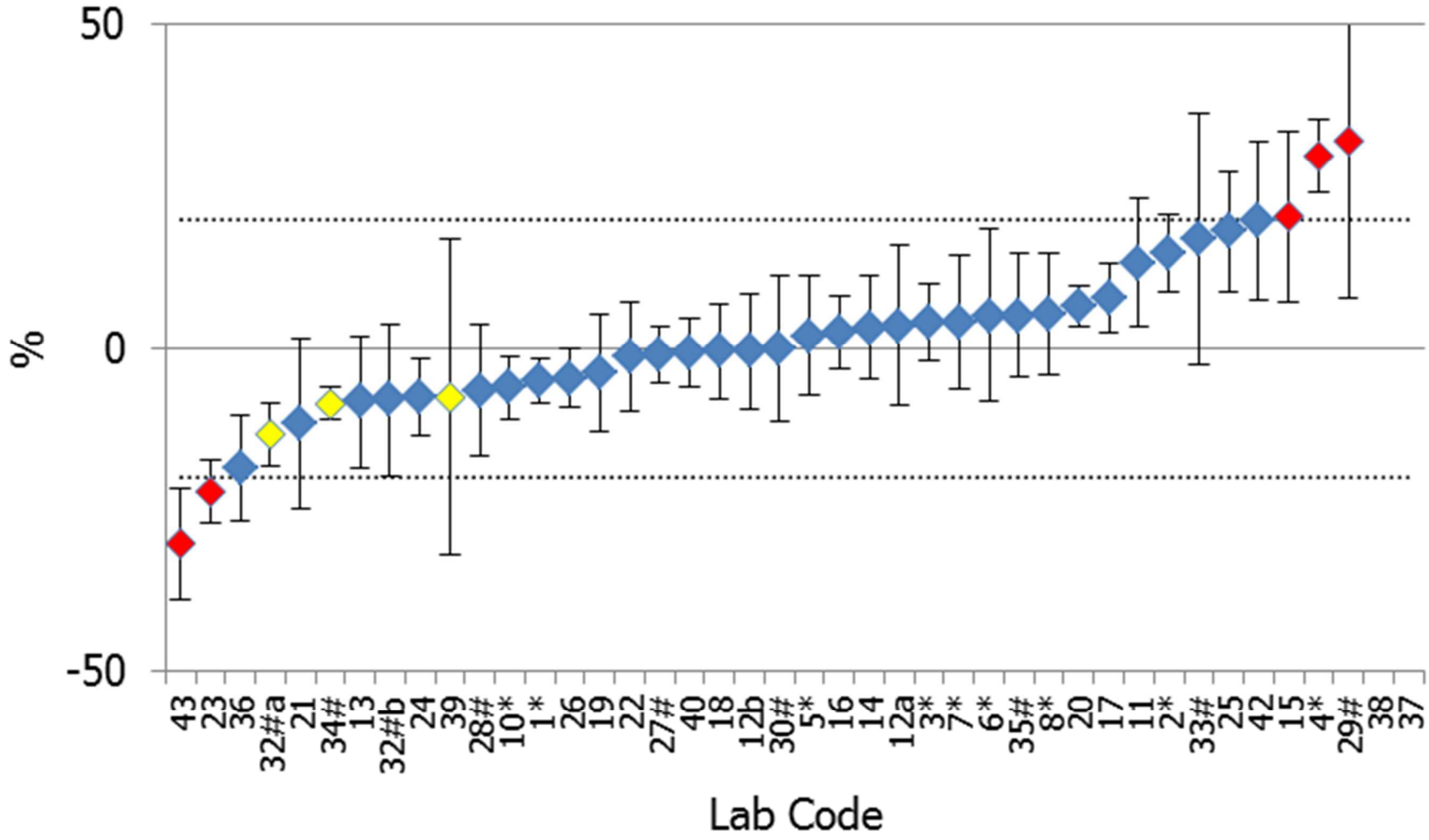

FIG. 5. Cs-137 bias.

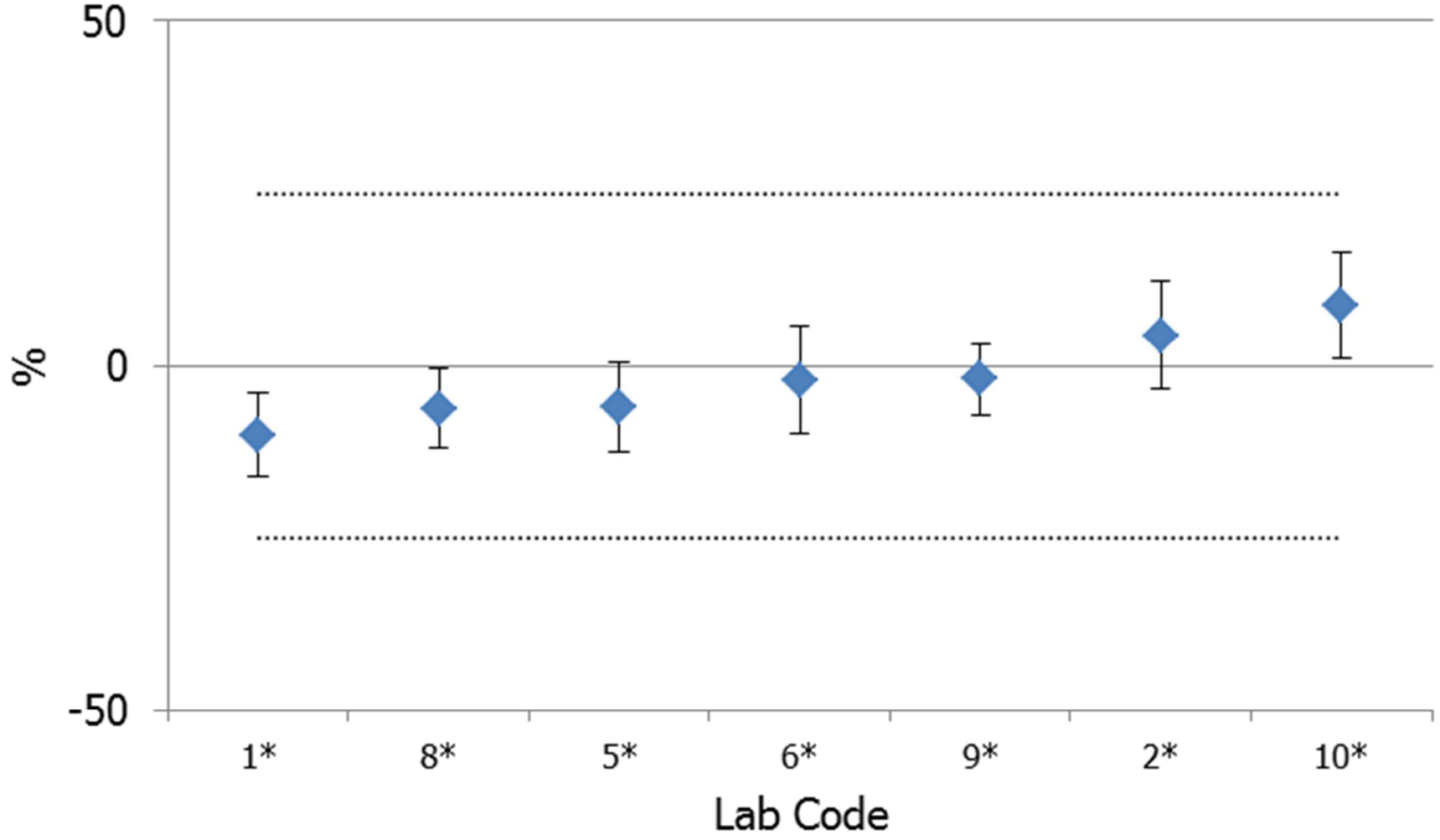

FIG. 6. H-3 bias Japanese participants.

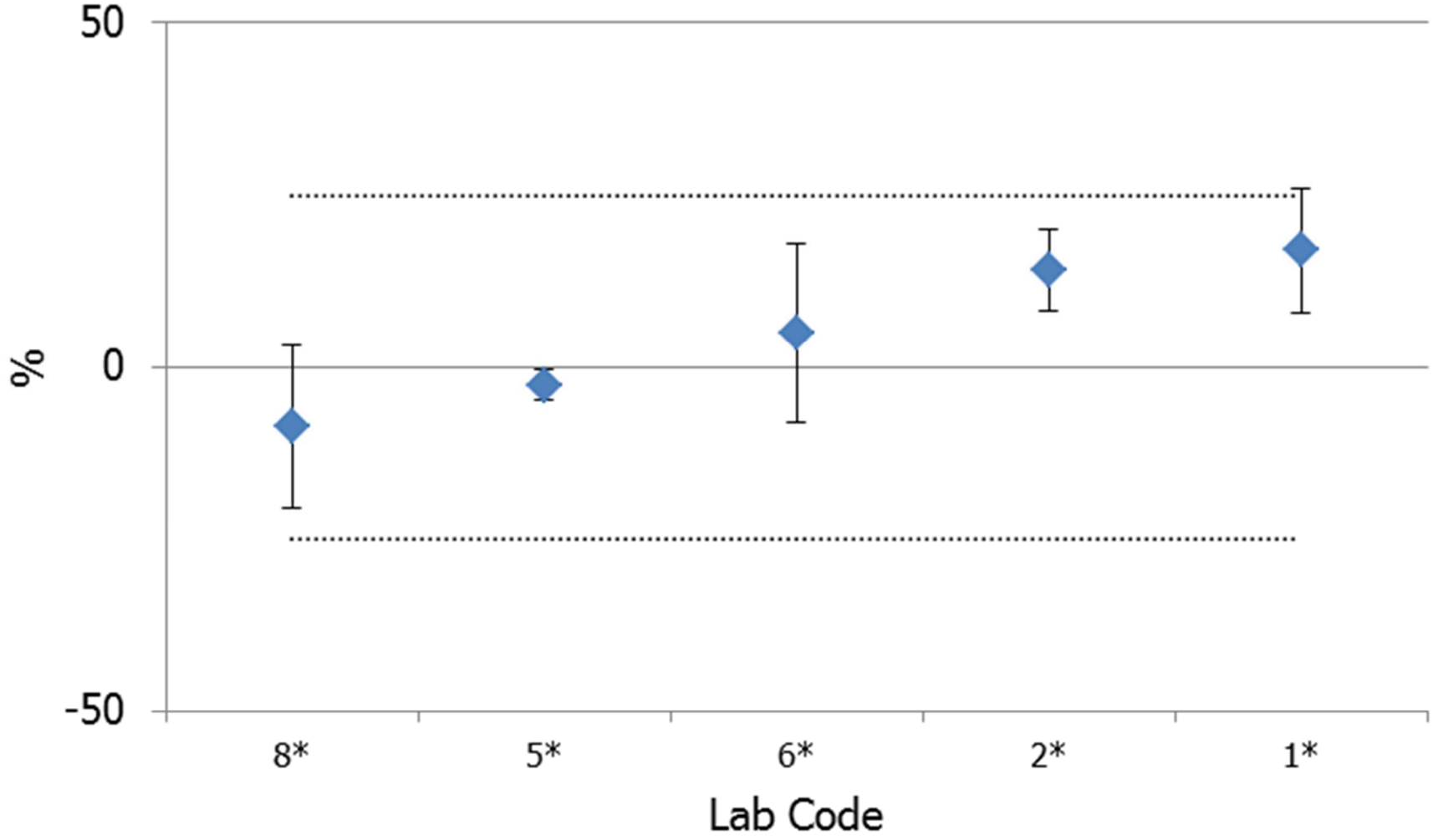

FIG. 7. Sr-90 bias Japanese participants.

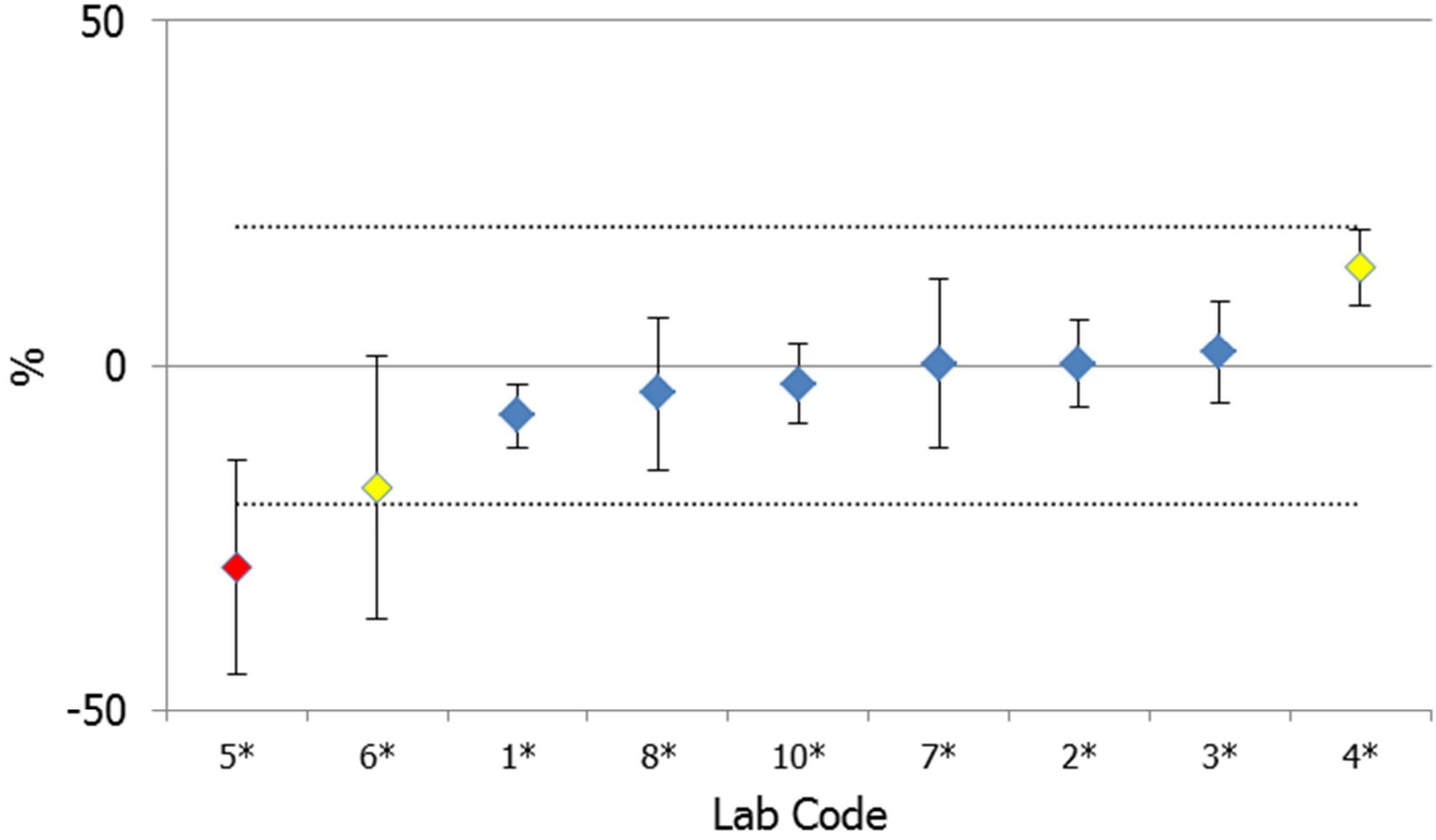

FIG. 8. Cs-134 bias Japanese participants.

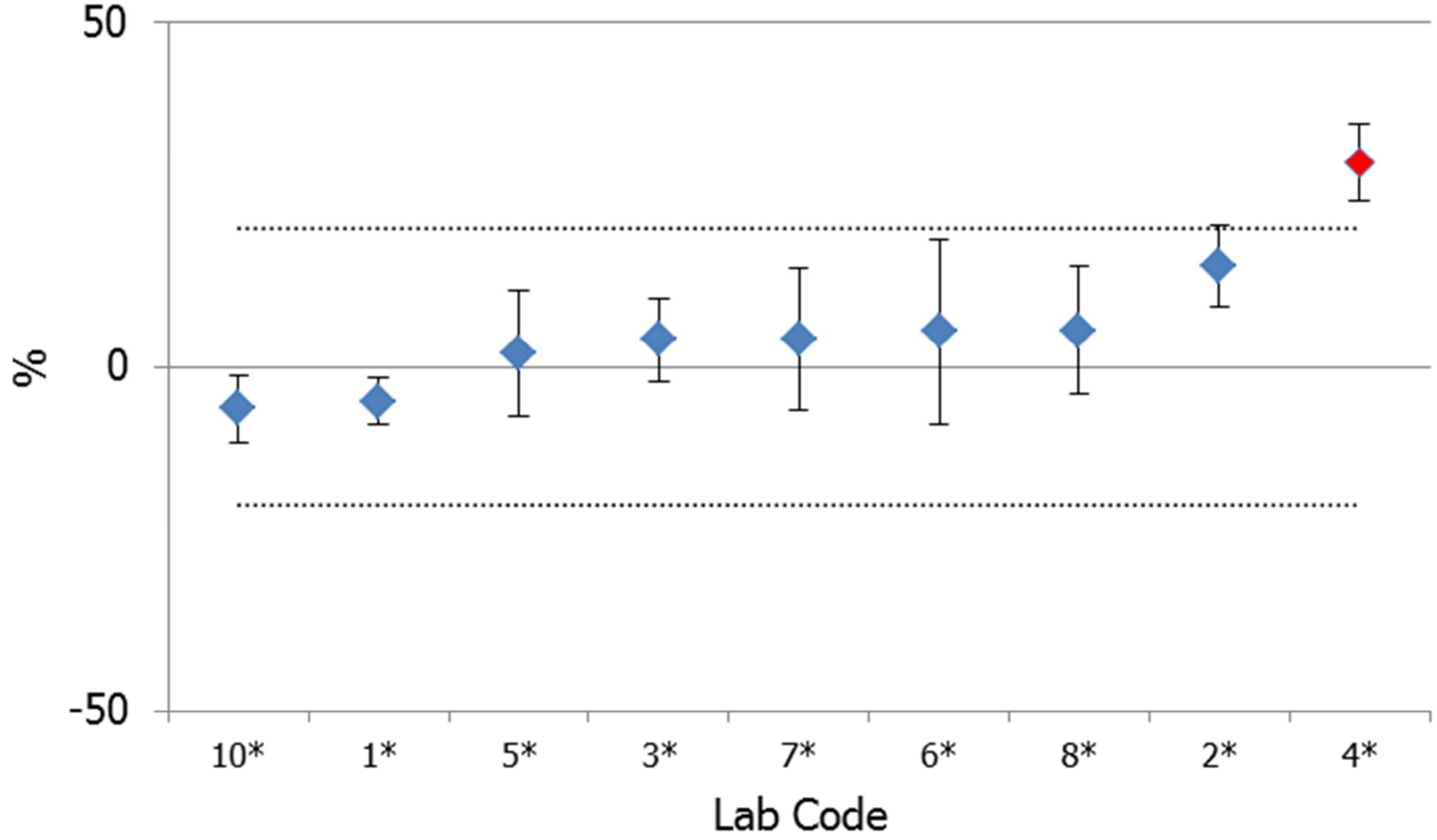

FIG. 9. Cs-137 bias Japanese participants.

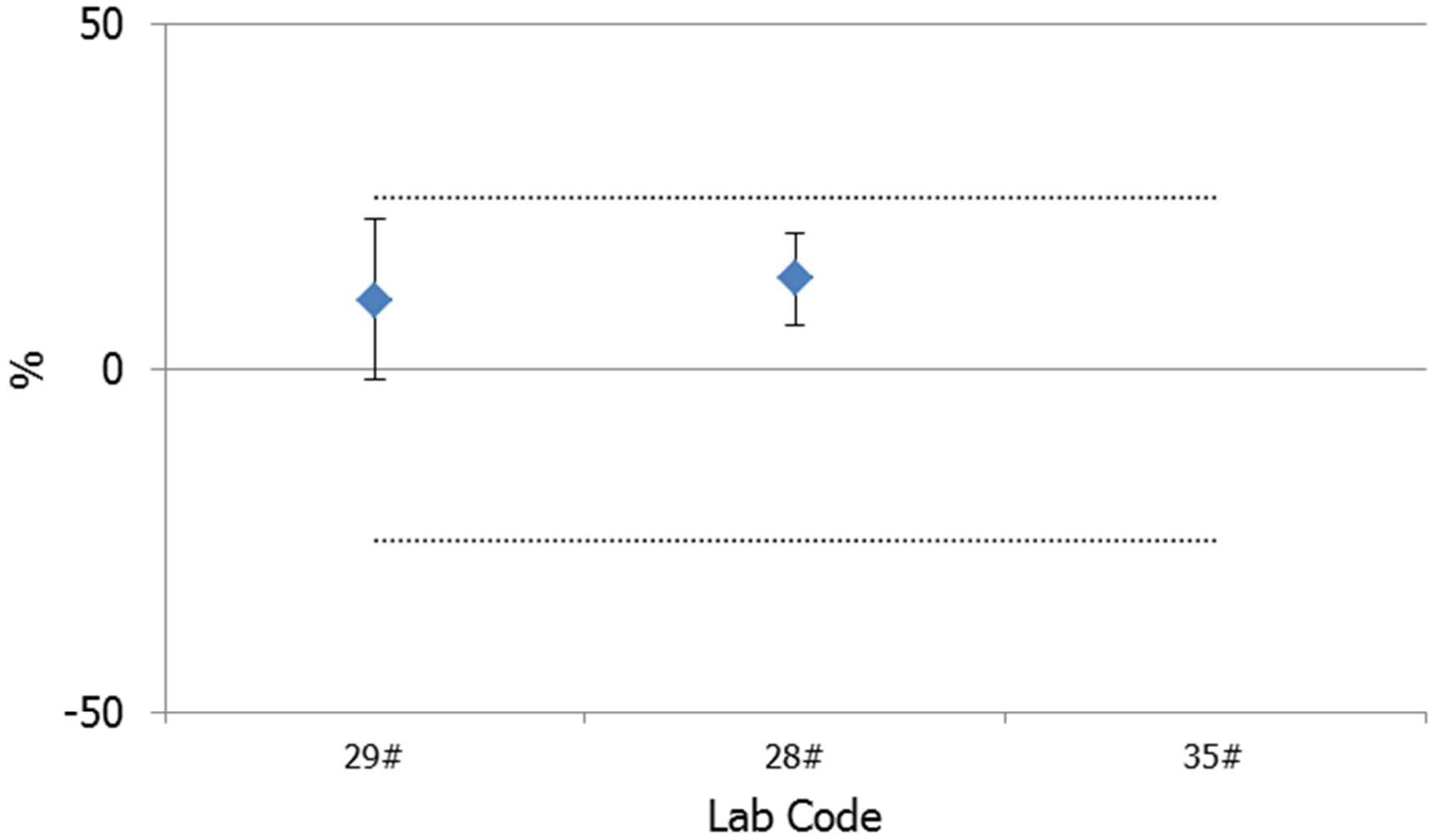

FIG. 10. H-3 bias RCA RAS/7/021 participants.

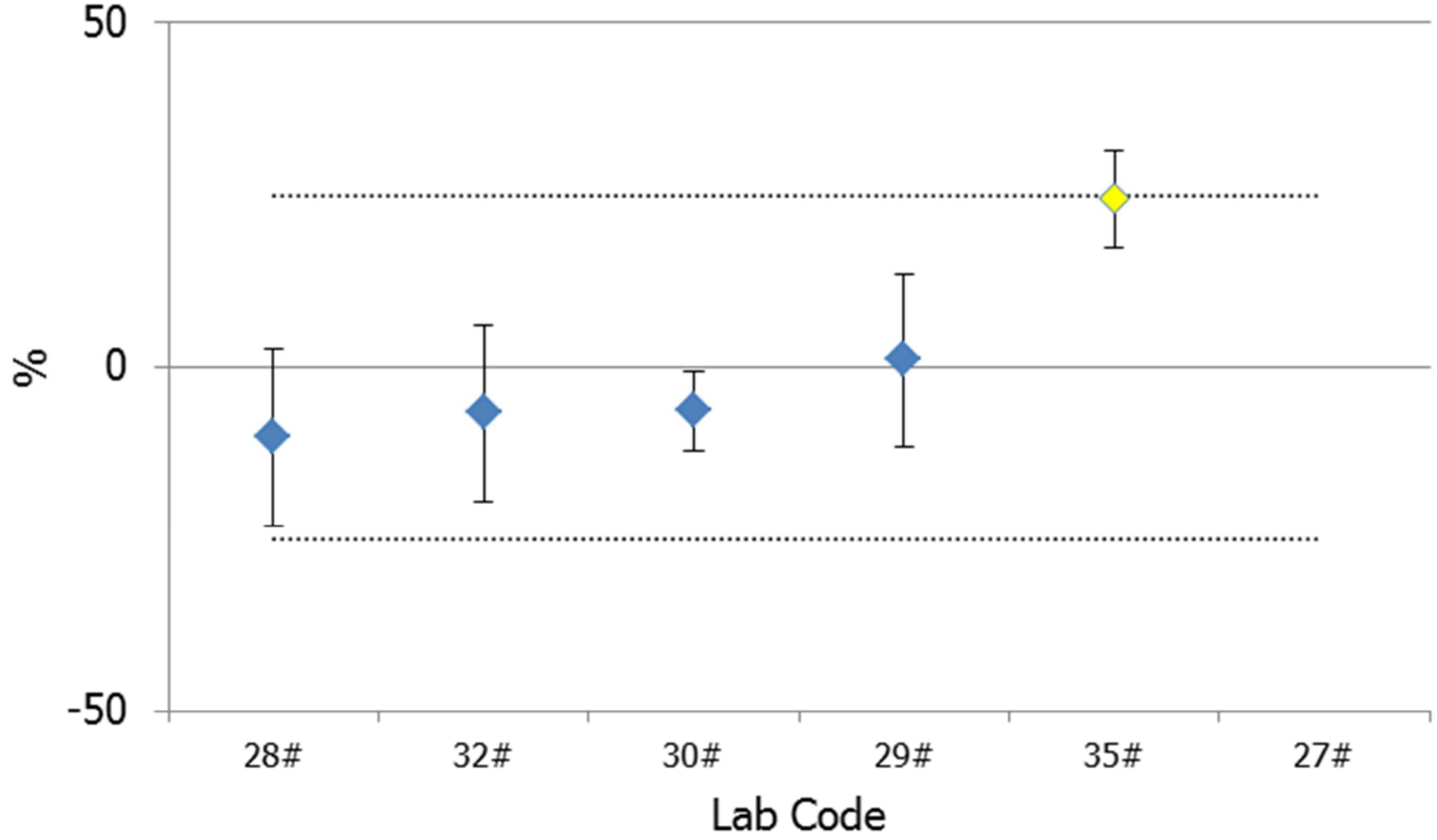

FIG. 11. Sr-90 bias RCA RAS/7/021 participants.

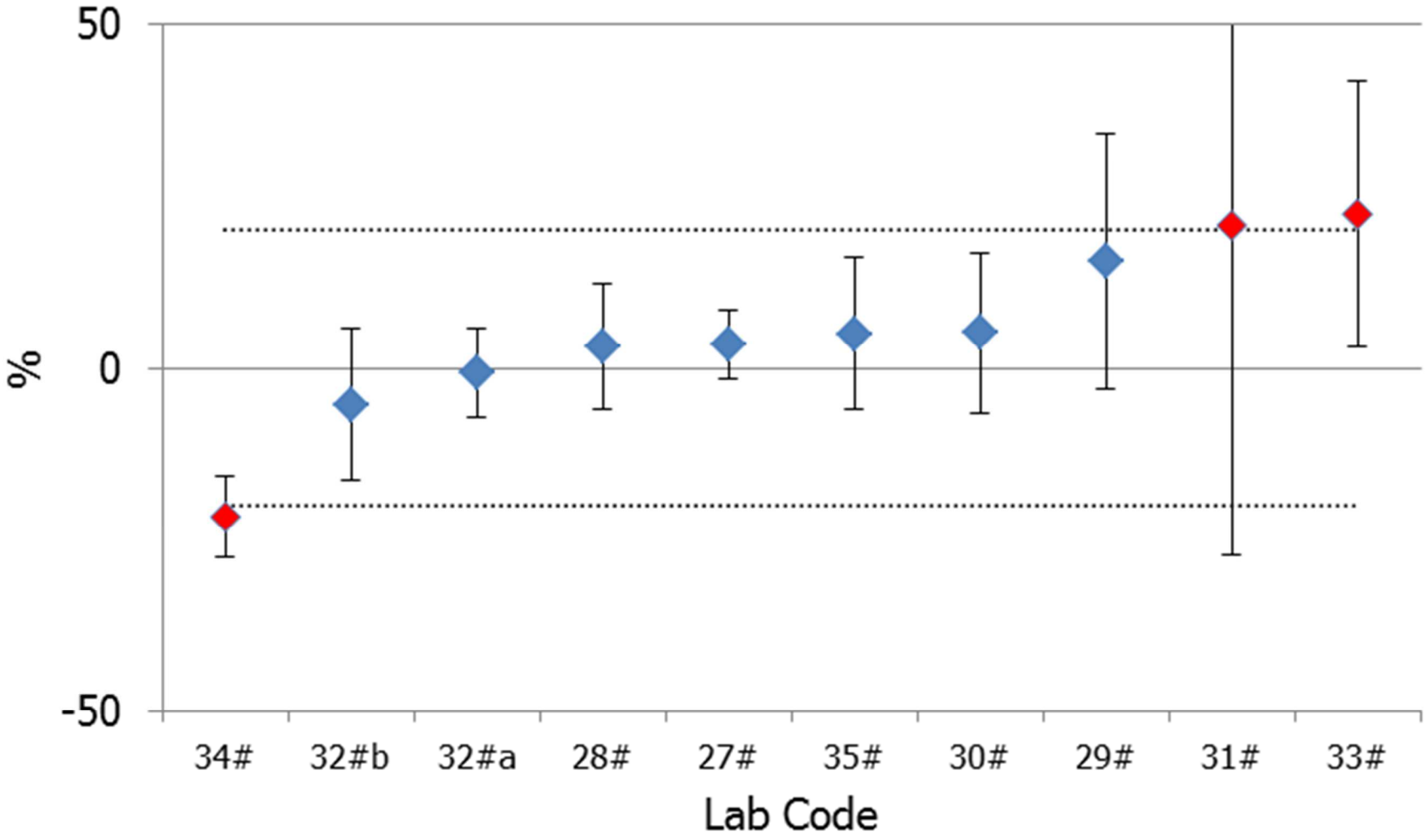

FIG. 12. Cs-134 bias RCA RAS/7/021 participants.

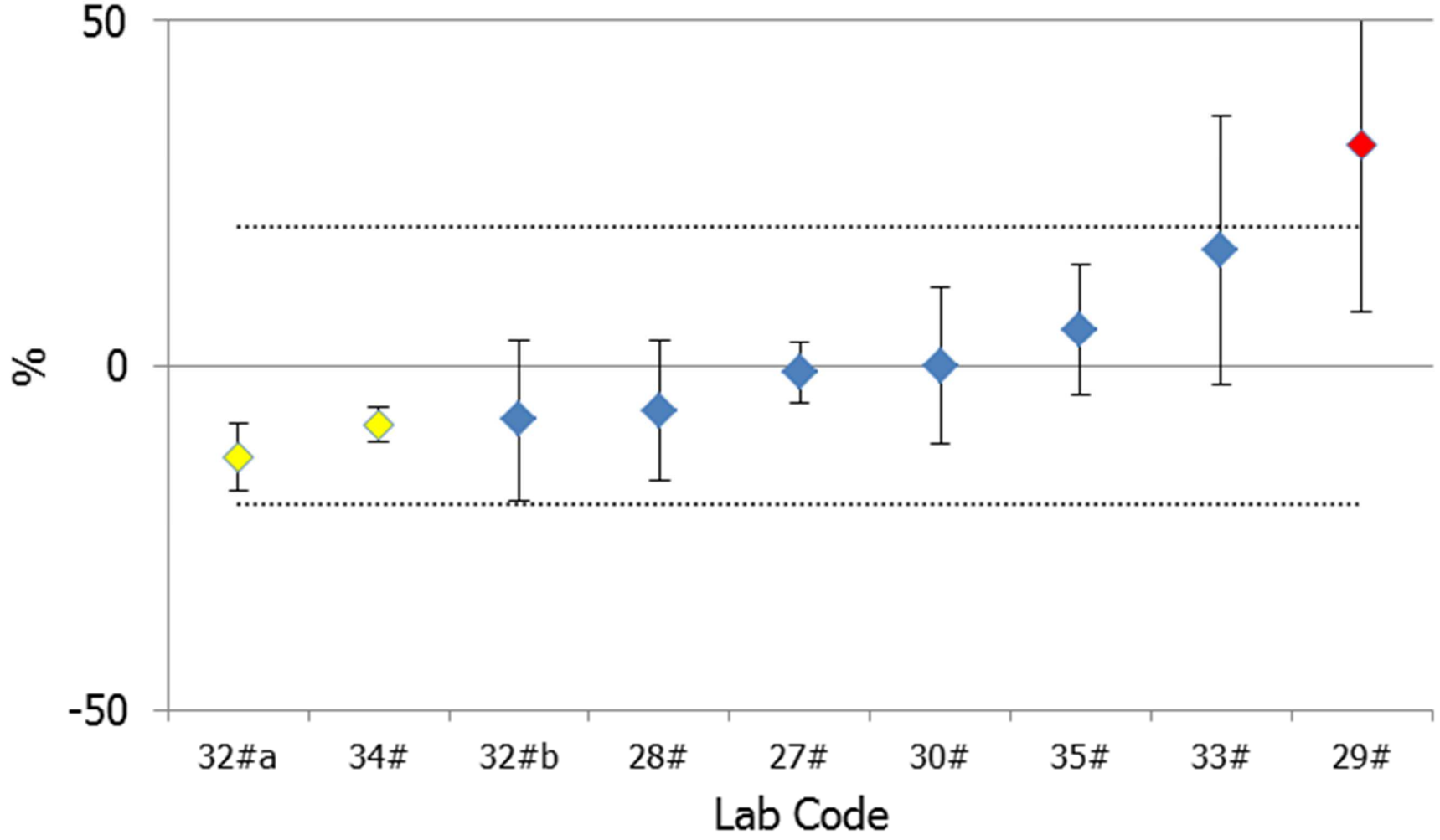

FIG. 13. Cs-137 bias RCA RAS/7/021 participants.

APPENDIX II. PERFORMANCE EVALUATION TABLES SORTED BY LABORATORY CODE

TABLE 10. LABORATORY CODE 1*

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	2.85	0.18	3.17	0.06	–10	6.7	16	Pass	Pass	Pass	Accepted
^{90}Sr	0.118	0.009	0.1009	0.0007	17	7.7	23	Pass	Pass	Pass	Accepted
^{134}Cs	0.143	0.007	0.1543	0.0006	–7.3	4.9	12	Pass	Pass	Pass	Accepted
^{137}Cs	0.194	0.007	0.2043	0.0013	–5.0	3.7	9.0	Pass	Pass	Pass	Accepted

TABLE 11. LABORATORY CODE 2*

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	3.33	0.24	3.19	0.06	4.4	7.5	20	Pass	Pass	Pass	Accepted
^{90}Sr	0.116	0.006	0.1016	0.0007	14	5.2	15	Pass	Pass	Pass	Accepted
^{134}Cs	0.156	0.010	0.1555	0.0006	0.3	6.4	17	Pass	Pass	Pass	Accepted
^{137}Cs	0.236	0.012	0.2058	0.0013	15	5.1	15	Pass	Pass	Pass	Accepted

TABLE 12. LABORATORY CODE 3*.

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	–	–	3.16	0.06	–	–	–	–	–	–	Not reported
^{90}Sr	–	–	0.1007	0.0007	–	–	–	–	–	–	Not reported
^{134}Cs	0.157	0.011	0.1541	0.0006	1.9	7.2	19	Pass	Pass	Pass	Accepted
^{137}Cs	0.212	0.012	0.2040	0.0013	3.9	5.7	15	Pass	Pass	Pass	Accepted

TABLE 13. LABORATORY CODE 4*

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	–	–	3.14	0.06	–	–	–	–	–	–	Not reported
^{90}Sr	–	–	0.1001	0.0007	–	–	–	–	–	–	Not reported
^{134}Cs	0.175	0.008	0.1531	0.0006	14	4.8	14	Pass	Pass	Fail	Warning
^{137}Cs	0.263	0.012	0.2027	0.0013	30	4.4	15	Fail	Pass	Fail	Not Accepted

TABLE 14. LABORATORY CODE 5*

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	3.00	0.20	3.19	0.06	–6.0	7.0	17	Pass	Pass	Pass	Accepted
^{90}Sr	0.0990	0.0022	0.1017	0.0007	–2.6	2.3	5.9	Pass	Pass	Pass	Accepted
^{134}Cs	0.110	0.024	0.1555	0.0006	–29	22	40	Fail	Fail	Pass	Not Accepted
^{137}Cs	0.210	0.019	0.2059	0.0013	2.0	9.1	24	Pass	Pass	Pass	Accepted

TABLE 15. LABORATORY CODE 6*

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	3.08	0.24	3.14	0.06	–2.0	8.1	20	Pass	Pass	Pass	Accepted
^{90}Sr	0.105	0.013	0.1001	0.0007	4.9	12	34	Pass	Pass	Pass	Accepted
^{134}Cs	0.13	0.03	0.1531	0.0006	–18	23	49	Pass	Fail	Pass	Warning
^{137}Cs	0.21	0.03	0.2027	0.0013	5.1	13	34	Pass	Pass	Pass	Accepted

TABLE 16. LABORATORY CODE 7*

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	–	–	3.17	0.06	–	–	–	–	–	–	Not reported
^{90}Sr	–	–	0.1011	0.0007	–	–	–	–	–	–	Not reported
^{134}Cs	0.155	0.019	0.1547	0.0006	0.2	12	32	Pass	Pass	Pass	Accepted
^{137}Cs	0.213	0.021	0.2047	0.0013	4.0	9.9	26	Pass	Pass	Pass	Accepted

TABLE 17. LABORATORY CODE 8*

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	2.97	0.17	3.17	0.06	–6.2	6.1	15	Pass	Pass	Pass	Accepted
^{90}Sr	0.092	0.012	0.1008	0.0007	–8.7	13	31	Pass	Pass	Pass	Accepted
^{134}Cs	0.148	0.017	0.1542	0.0006	–4.0	11	28	Pass	Pass	Pass	Accepted
^{137}Cs	0.215	0.019	0.2041	0.0013	5.3	8.9	24	Pass	Pass	Pass	Accepted

TABLE 18. LABORATORY CODE 9*

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	3.12	0.15	3.18	0.06	–2.0	5.2	13	Pass	Pass	Pass	Accepted
^{90}Sr	–	–	0.1014	0.0007	–	–	–	–	–	–	Not reported
^{134}Cs	–	–	0.1551	0.0006	–	–	–	–	–	–	Not reported
^{137}Cs	–	–	0.2053	0.0013	–	–	–	–	–	–	Not reported

TABLE 19. LABORATORY CODE 10*

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	3.46	0.24	3.18	0.06	8.7	7.1	20	Pass	Pass	Pass	Accepted
^{90}Sr	–	–	0.1015	0.0007	–	–	–	–	–	–	Not reported
^{134}Cs	0.151	0.009	0.1552	0.0006	–2.7	6.0	15	Pass	Pass	Pass	Accepted
^{137}Cs	0.193	0.010	0.2055	0.0013	–6.1	5.2	13	Pass	Pass	Pass	Accepted

TABLE 20. LABORATORY CODE 11

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	–	–	3.15	0.06	–	–	–	–	–	–	Not reported
^{90}Sr	0.103	0.003	0.1002	0.0007	2.7	3.0	7.9	Pass	Pass	Pass	Accepted
^{134}Cs	0.166	0.012	0.1533	0.0006	8.3	7.2	20	Pass	Pass	Pass	Accepted
^{137}Cs	0.230	0.020	0.2030	0.0013	13	8.7	25	Pass	Pass	Pass	Accepted

TABLE 21. LABORATORY CODE 12

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	<5.7	–	3.15	0.06	–	–	–	–	–	–	Not evaluated
^{90}Sr	<0.03	–	0.1002	0.0007	–	–	–	–	–	–	Not evaluated
^{134}Cs	0.131	0.016	0.1532	0.0006	–15	12	27	Pass	Pass	Pass	Accepted
^{134}Cs	0.155	0.018	0.1532	0.0006	1.2	12	30	Pass	Pass	Pass	Accepted
^{137}Cs	0.210	0.025	0.2029	0.0013	3.5	12	32	Pass	Pass	Pass	Accepted
^{137}Cs	0.202	0.018	0.2029	0.0013	–0.4	8.9	23	Pass	Pass	Pass	Accepted

TABLE 22. LABORATORY CODE 13

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	3.05	0.06	3.18	0.06	–4.0	2.7	6.9	Pass	Pass	Pass	Accepted
^{90}Sr	–	–	0.1012	0.0007	–	–	–	–	–	–	Not reported
^{134}Cs	0.144	0.009	0.1548	0.0006	–7.0	6.3	15	Pass	Pass	Pass	Accepted
^{137}Cs	0.188	0.021	0.2050	0.0013	–8.3	11	26	Pass	Pass	Pass	Accepted

TABLE 23. LABORATORY CODE 14

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	–	–	3.15	0.06	–	–	–	–	–	–	Not reported
^{90}Sr	–	–	0.1004	0.0007	–	–	–	–	–	–	Not reported
^{134}Cs	0.147	0.010	0.1536	0.0006	–4.3	6.8	17	Pass	Pass	Pass	Accepted
^{137}Cs	0.210	0.016	0.2034	0.0013	3.2	7.6	20	Pass	Pass	Pass	Accepted

TABLE 24. LABORATORY CODE 15

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	–	–	3.18	0.06	–	–	–	–	–	–	Not reported
^{90}Sr	–	–	0.1013	0.0007	–	–	–	–	–	–	Not reported
^{134}Cs	0.189	0.021	0.1549	0.0006	22	11	35	Fail	Pass	Pass	Not Accepted
^{137}Cs	0.25	0.03	0.2051	0.0013	20	11	34	Fail	Pass	Pass	Not Accepted

TABLE 25. LABORATORY CODE 16

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	–	–	3.18	0.06	–	–	–	–	–	–	Not reported
^{90}Sr	0.108	0.006	0.1013	0.0007	6.6	5.6	15	Pass	Pass	Pass	Accepted
^{134}Cs	0.152	0.011	0.1550	0.0006	–2.2	7.1	18	Pass	Pass	Pass	Accepted
^{137}Cs	0.211	0.011	0.2052	0.0013	2.6	5.5	14	Pass	Pass	Pass	Accepted

TABLE 26. LABORATORY CODE 17

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	3.4	0.3	3.22	0.07	4.9	10	28	Pass	Pass	Pass	Accepted
^{90}Sr	0.101	0.005	0.1027	0.0007	–1.7	5.0	13	Pass	Pass	Pass	Accepted
^{134}Cs	0.183	0.009	0.1571	0.0006	16	4.9	15	Pass	Pass	Fail	Warning
^{137}Cs	0.224	0.011	0.2080	0.0013	7.7	5.0	14	Pass	Pass	Pass	Accepted

TABLE 27. LABORATORY CODE 18

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	5.5	1.0	3.21	0.06	70	19	84	Fail	Pass	Pass	Not Accepted
^{90}Sr	0.102	0.006	0.1022	0.0007	–0.2	5.9	15	Pass	Pass	Pass	Accepted
^{134}Cs	0.128	0.008	0.1563	0.0006	–18	6.3	13	Pass	Pass	Fail	Warning
^{137}Cs	0.206	0.015	0.2069	0.0013	–0.4	7.3	19	Pass	Pass	Pass	Accepted

TABLE 28. LABORATORY CODE 19

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	2.7	0.4	3.22	0.07	–16	14	31	Pass	Pass	Pass	Accepted
^{90}Sr	0.102	0.003	0.1026	0.0007	–0.6	2.7	6.9	Pass	Pass	Pass	Accepted
^{134}Cs	0.100	0.009	0.1570	0.0006	–36	8.8	14	Fail	Pass	Fail	Not Accepted
^{137}Cs	0.200	0.019	0.2078	0.0013	–3.7	9.4	23	Pass	Pass	Pass	Accepted

TABLE 29. LABORATORY CODE 20

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	3.21	0.11	3.17	0.06	1.2	4.0	10	Pass	Pass	Pass	Accepted
^{90}Sr	0.132	0.014	0.1010	0.0007	31	10	35	Fail	Pass	Pass	Not Accepted
^{134}Cs	0.144	0.009	0.1546	0.0006	–6.8	6.3	15	Pass	Pass	Pass	Accepted
^{137}Cs	0.218	0.007	0.2046	0.0013	6.5	3.0	8.3	Pass	Pass	Pass	Accepted

TABLE 30. LABORATORY CODE 21

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	6.9	1.6	3.18	0.06	117	23	130	Fail	Pass	Pass	Not Accepted
^{90}Sr	0.082	0.016	0.1012	0.0007	–19	20	41	Pass	Pass	Pass	Accepted
^{134}Cs	0.091	0.014	0.1549	0.0006	–41	15	23	Fail	Pass	Fail	Not Accepted
^{137}Cs	0.18	0.03	0.2051	0.0013	–12	15	34	Pass	Pass	Pass	Accepted

TABLE 31. LABORATORY CODE 22

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	4.0	0.5	3.17	0.06	26	12	38	Fail	Pass	Pass	Not Accepted
^{90}Sr	–	–	0.1010	0.0007	–	–	–	–	–	–	Not reported
^{134}Cs	0.153	0.011	0.1545	0.0006	–1.0	7.2	18	Pass	Pass	Pass	Accepted
^{137}Cs	0.202	0.017	0.2045	0.0013	–1.2	8.4	21	Pass	Pass	Pass	Accepted

TABLE 32. LABORATORY CODE 23

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	5.61	0.20	3.19	0.06	76	4.1	17	Fail	Pass	Fail	Not Accepted
^{90}Sr	–	–	0.1015	0.0007	–	–	–	–	–	–	Not reported
^{134}Cs	0.140	0.010	0.1552	0.0006	–9.8	7.2	17	Pass	Pass	Pass	Accepted
^{137}Cs	0.160	0.010	0.2055	0.0013	–22	6.3	13	Fail	Pass	Fail	Not Accepted

TABLE 33. LABORATORY CODE 24

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	–	–	3.17	0.06	–	–	–	–	–	–	Not reported
^{90}Sr	–	–	0.1010	0.0007	–	–	–	–	–	–	Not reported
^{134}Cs	0.152	0.011	0.1545	0.0006	–1.6	7.2	18	Pass	Pass	Pass	Accepted
^{137}Cs	0.189	0.012	0.2045	0.0013	–7.6	6.4	15	Pass	Pass	Pass	Accepted

TABLE 34. LABORATORY CODE 25

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	2.9	0.9	3.18	0.06	–10	33	76	Pass	Fail	Pass	Warning
^{90}Sr	0.098	0.012	0.1013	0.0007	–3.7	12	31	Pass	Pass	Pass	Accepted
^{134}Cs	0.139	0.018	0.1550	0.0006	–10	13	29	Pass	Pass	Pass	Accepted
^{137}Cs	0.242	0.019	0.2052	0.0013	18	7.8	24	Pass	Pass	Pass	Accepted

TABLE 35. LABORATORY CODE 26

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	–	–	3.17	0.06	–	–	–	–	–	–	Not reported
^{90}Sr	–	–	0.1009	0.0007	–	–	–	–	–	–	Not reported
^{134}Cs	0.121	0.007	0.1544	0.0006	–22	5.8	12	Fail	Pass	Fail	Not Accepted
^{137}Cs	0.195	0.009	0.2044	0.0013	–4.6	4.7	11	Pass	Pass	Pass	Accepted

TABLE 36. LABORATORY CODE 27#

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	–	–	3.17	0.06	–	–	–	–	–	–	Not reported
^{90}Sr	0.84	0.11	0.1009	0.0007	730	14	291	Fail	Pass	Fail	Not Accepted
^{134}Cs	0.160	0.008	0.1544	0.0006	3.4	4.9	13	Pass	Pass	Pass	Accepted
^{137}Cs	0.202	0.009	0.2044	0.0013	–1.0	4.5	12	Pass	Pass	Pass	Accepted

TABLE 37. LABORATORY CODE 28#

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	3.60	0.20	3.18	0.06	13	5.9	17	Pass	Pass	Pass	Accepted
^{90}Sr	0.091	0.013	0.1014	0.0007	–10	14	33	Pass	Pass	Pass	Accepted
^{134}Cs	0.160	0.014	0.1551	0.0006	3.1	8.8	23	Pass	Pass	Pass	Accepted
^{137}Cs	0.192	0.021	0.2054	0.0013	–6.5	11	26	Pass	Pass	Pass	Accepted

TABLE 38. LABORATORY CODE 29#

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	3.5	0.4	3.17	0.06	10	11	30	Pass	Pass	Pass	Accepted
^{90}Sr	0.102	0.013	0.1010	0.0007	1.0	12	32	Pass	Pass	Pass	Accepted
^{134}Cs	0.18	0.03	0.1544	0.0006	16	16	48	Pass	Pass	Pass	Accepted
^{137}Cs	0.27	0.05	0.2045	0.0013	32	18	62	Fail	Pass	Pass	Not Accepted

TABLE 39. LABORATORY CODE 30#

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	–	–	3.16	0.06	–	–	–	–	–	–	Not reported
^{90}Sr	0.094	0.006	0.1007	0.0007	–6.5	6.3	15	Pass	Pass	Pass	Accepted
^{134}Cs	0.162	0.018	0.1540	0.0006	5.2	11	30	Pass	Pass	Pass	Accepted
^{137}Cs	0.204	0.023	0.2039	0.0013	0.0	11	29	Pass	Pass	Pass	Accepted

TABLE 40. LABORATORY CODE 31#

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	–	–	3.16	0.06	–	–	–	–	–	–	Not reported
^{90}Sr	–	–	0.1007	0.0007	–	–	–	–	–	–	Not reported
^{134}Cs	0.19	0.07	0.1540	0.0006	21	40	124	Fail	Fail	Pass	Not Accepted
^{137}Cs	<0.15	–	0.2039	0.0013	–	–	–	–	–	–	Not evaluated

TABLE 41. LABORATORY CODE 32#

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	–	–	3.17	0.06	–	–	–	–	–	–	Not reported
^{90}Sr	0.094	0.013	0.1008	0.0007	–6.7	14	33	Pass	Pass	Pass	Accepted
^{134}Cs	0.153	0.010	0.1542	0.0006	–0.8	6.5	17	Pass	Pass	Pass	Accepted
^{134}Cs	0.146	0.017	0.1542	0.0006	–5.3	12	28	Pass	Pass	Pass	Accepted
^{137}Cs	0.177	0.010	0.2041	0.0013	–13	5.6	12	Pass	Pass	Fail	Warning
^{137}Cs	0.188	0.024	0.2041	0.0013	–7.9	13	30	Pass	Pass	Pass	Accepted

TABLE 42. LABORATORY CODE 33#

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	–	–	3.18	0.06	–	–	–	–	–	–	Not reported
^{90}Sr	–	–	0.1014	0.0007	–	–	–	–	–	–	Not reported
^{134}Cs	0.19	0.03	0.1552	0.0006	22	16	50	Fail	Pass	Pass	Not Accepted
^{137}Cs	0.24	0.04	0.2054	0.0013	17	17	50	Pass	Pass	Pass	Accepted

TABLE 43. LABORATORY CODE 34#

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	–	–	3.17	0.06	–	–	–	–	–	–	Not reported
^{90}Sr	–	–	0.1010	0.0007	–	–	–	–	–	–	Not reported
^{134}Cs	0.121	0.009	0.1545	0.0006	–22	7.4	15	Fail	Pass	Fail	Not Accepted
^{137}Cs	0.187	0.005	0.2046	0.0013	–8.6	2.7	6.5	Pass	Pass	Fail	Warning

TABLE 44. LABORATORY CODE 35#

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	5.4	0.4	3.13	0.06	73	7.7	33	Fail	Pass	Fail	Not Accepted
^{90}Sr	0.124	0.007	0.0996	0.0007	25	5.7	18	Pass	Pass	Fail	Warning
^{134}Cs	0.160	0.017	0.1523	0.0006	5.1	11	29	Pass	Pass	Pass	Accepted
^{137}Cs	0.212	0.019	0.2017	0.0013	5.1	9.0	24	Pass	Pass	Pass	Accepted

TABLE 45. LABORATORY CODE 36

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	–	–	3.18	0.06	–	–	–	–	–	–	Not reported
^{90}Sr	–	–	0.1014	0.0007	–	–	–	–	–	–	Not reported
^{134}Cs	0.096	0.012	0.1552	0.0006	–38	12	19	Fail	Pass	Fail	Not Accepted
^{137}Cs	0.167	0.017	0.2054	0.0013	–19	10	21	Pass	Pass	Pass	Accepted

TABLE 46. LABORATORY CODE 37

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	–	–	3.17	0.06	–	–	–	–	–	–	Not reported
^{90}Sr	–	–	0.1009	0.0007	–	–	–	–	–	–	Not reported
^{134}Cs	0.60	0.03	0.1543	0.0006	290	5.0	50	Fail	Pass	Fail	Not Accepted
^{137}Cs	0.865	0.020	0.2043	0.0013	323	2.4	25	Fail	Pass	Fail	Not Accepted

TABLE 47. LABORATORY CODE 38

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	2.6	1.0	3.16	0.06	–17	39	84	Pass	Fail	Pass	Warning
^{90}Sr	0.11	0.04	0.1006	0.0007	6.3	34	92	Pass	Fail	Pass	Warning
^{134}Cs	0.165	0.019	0.1539	0.0006	7.2	12	32	Pass	Pass	Pass	Accepted
^{137}Cs	0.351	0.023	0.2038	0.0013	72	6.6	29	Fail	Pass	Fail	Not Accepted

TABLE 48. LABORATORY CODE 39

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	2.90	0.12	3.19	0.06	–9.0	4.6	11	Pass	Pass	Pass	Accepted
^{90}Sr	0.090	0.007	0.1015	0.0007	–11	7.8	18	Pass	Pass	Pass	Accepted
^{134}Cs	0.15	0.05	0.1553	0.0006	–3.4	33	83	Pass	Fail	Pass	Warning
^{137}Cs	0.19	0.05	0.2056	0.0013	–7.6	26	63	Pass	Fail	Pass	Warning

TABLE 49. LABORATORY CODE 40

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	–	–	3.15	0.06	–	–	–	–	–	–	Not reported
^{90}Sr	0.017	0.003	0.1003	0.0007	–83	19	8.4	Fail	Pass	Fail	Not Accepted
^{134}Cs	0.157	0.009	0.1535	0.0006	2.2	6.1	16	Pass	Pass	Pass	Accepted
^{137}Cs	0.202	0.011	0.2032	0.0013	–0.6	5.5	14	Pass	Pass	Pass	Accepted

TABLE 50. LABORATORY CODE 41

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	3.00	0.25	3.14	0.06	–4.5	8.6	21	Pass	Pass	Pass	Accepted
^{90}Sr	0.097	0.007	0.1000	0.0007	–3.0	7.3	18	Pass	Pass	Pass	Accepted
^{134}Cs	–	–	0.1530	0.0006	–	–	–	–	–	–	Not reported
^{137}Cs	–	–	0.2025	0.0013	–	–	–	–	–	–	Not reported

TABLE 51. LABORATORY CODE 42

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	1.38	0.15	3.18	0.06	–57	11	13	Fail	Pass	Fail	Not Accepted
^{90}Sr	–	–	0.1014	0.0007	–	–	–	–	–	–	Not reported
^{134}Cs	0.194	0.024	0.1551	0.0006	25	12	40	Fail	Pass	Pass	Not Accepted
^{137}Cs	0.246	0.025	0.2053	0.0013	20	10	31	Pass	Pass	Pass	Accepted

TABLE 52. LABORATORY CODE 43

Radio-nuclide	Lab value (Bq kg^{-1})	Lab uncert. (Bq kg^{-1})	IAEA value (Bq kg^{-1})	IAEA uncert. (Bq kg^{-1})	Relative bias (%)	P (%)	Trueness limit (%)	Accuracy	Precision	Trueness	Final score
^{3}H	–	–	3.15	0.06	–	–	–	–	–	–	Not reported
^{90}Sr	–	–	0.1004	0.0007	–	–	–	–	–	–	Not reported
^{134}Cs	0.117	0.016	0.1535	0.0006	–24	14	28	Fail	Pass	Pass	Not Accepted
^{137}Cs	0.142	0.018	0.2032	0.0013	–30	12	22	Fail	Pass	Fail	Not Accepted

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