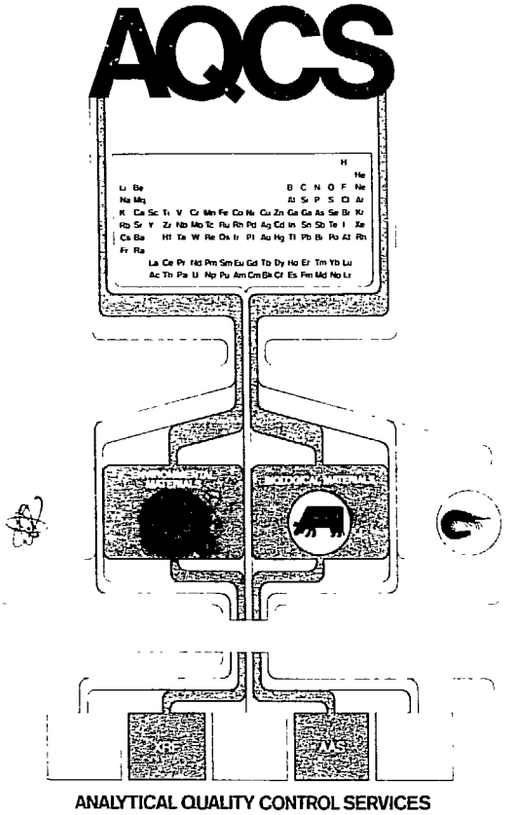
IAEA/AL/009

REPORT ON THE INTERCOMPARISON RUN

IAEA-152

RADIONUCLIDES IN MILK POWDER



ANALYTICAL QUALITY CONTROL SERVICES
INTERNATIONAL ATOMIC ENERGY AGENCY, P O BOX 100, A-1400 VIENNA, AUSTRIA

IAEA/AL/009
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Intercomparison Study IAEA-152 on the Determination of Elevated Levels of Fallout Radionuclides in Milk Powder

by

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Summary

The results of the intercomparison on milk powder (IAEA-152) for the determination of elevated levels of radioactivity are reported. The data from thirty-nine laboratories from eighteen different countries have been considered and include the determination of the following radionuclides:

^{134}Cs, ^{137}Cs, ^{40}K, ^{90}Sr.

According to a statistical evaluation sufficient data for recommended mean values and confidence intervals have been received for:

^{134}Cs:	764 Bq/kg	(722 - 802)
^{137}Cs:	2129 Bq/kg	(2053 - 2209)
^{40}K :	539 Bq/kg	(510 - 574)
^{90}Sr :	7.7 Bq/kg	(7.0 - 8.3)

Reference date: 31 August 1987

CONTENTS

1. Introduction

The increased levels of radioactive fallout which resulted from the Chernobyl reactor accident have led to increased concern about radioactivity in food. This has prompted governments to establish allowable levels of various radionuclides in food. Furthermore, in most cases the allowable levels are much higher than the levels in previously available reference materials (1). In order to assist laboratories in making these measurements, the IAEA's Analytical Quality Control Services (AQCS) collected a variety of food and environmental materials which had been contaminated by the fallout debris and reference materials are currently being prepared from these materials.

Radioactivity levels in milk are of particular concern since milk is an important component of human nutrition, especially for children, and radionuclide levels in milk can rise very quickly after radioactive contamination is released to the environment. Earlier (2), AQCS prepared a milk powder reference material, A-14 containing levels of artificial radionuclides in the Bq/kg range which was representative of previous levels due to weapons fallout. However, A-14 is not very suitable as a reference material for analyses at the current allowable levels. The milk powder used in the present intercomparison contains ^{137}Cs and ^{134}Cs at concentrations which are several times higher than most current allowable levels.

2. Scope of the study

Participating laboratories were requested to determine the following radionuclides: ^{40}K, ^{90}Sr, ^{134}Cs and ^{137}Cs. Data on other radionuclides were also welcomed. The analysts were requested to make at least three but preferably six independent measurements for each radionuclide. Each laboratory received two bottles labelled A and B as well as a bottle of A-14 which was re-evaluated at the same time.

The results listed in the tables are from thirty-nine laboratories in eighteen different countries. The evaluation was based on 119 laboratory means for each of the A and B samples. The total number of individual determinations for A and B combined was 842. Thirty-six laboratories determined ^{134}Cs, 37 determined ^{137}Cs, 30 determined ^{40}K and 14 determined ^{90}Sr. Since only very limited data were received for other radionuclides, these have not been included in the report.

3. Description of the material

A bulk sample of approximately 500 kg (20 sacks of about 25 kg each) of milk powder with elevated radioactivity was collected from a processing plant. These twenty sacks were all from the same batch process. Thus, they were assumed to be as homogeneous as possible. Nevertheless, a preliminary homogeneity testing of every two sacks for ^{134}Cs and ^{137}Cs was performed before bottling in approximate portions of 250 grams. In order to assure long-term stability of the material, all bottles were sterilized by gamma-ray irradiation of about 2.5×10^4 Gy using a ^{60}Co source.

The final homogeneity testing (after bottling) was performed on 12 bottles from different sacks as follows:

bottles A and B - six measurements each of 250 grams
bottles C and D - three measurements each of 250 grams
bottles E to L - one measurement each of 250 grams

Considering the results of ^{134}Cs and ^{137}Cs from the above and employing the Student's t-test it was found that they did not differ by more than 3% of the mean value and thus this material can be considered homogeneous for these components for a sample size of greater or equal to 250 grams.

4. Evaluation of results

The original data received from the participating laboratories were edited (converted to the same units and format), before being typed in a computer data file. This data file was processed by a computer program especially written for evaluating intercomparison results. Observations which deviated significantly after rigorous statistical evaluation from the population of the other results, were considered to be outliers and rejected if they failed either one of the following statistical tests at the significance level of $\alpha = 0.05$:

1) Dixon's,
2) Grubb's,
3) coefficient of skewness, and
4) coefficient of kurtosis.

Some further information can be found in reference (3).

Separate evaluations were run for the A and B bottles so that the final results could be compared in order to check the consistency of the results and the homogeneity of the material. Separate sets of tables and figures are included for IAEA-152 (A) and IAEA-152 (B).

4.1 Explanation of tables

4.1.1 Data tables

The laboratory mean values for a specific radionuclide for which at least two laboratory means were supplied are presented in Tables 1 to 4 for both the A and B bottles of IAEA-152.

LAB. CODE NO.: Each laboratory was assigned a code number, which is the same throughout the whole report. These do not correspond to the sequence of the laboratories in the list of participants given at the end of the report and thus anonymity is secured.

METHOD CODE: The analytical techniques employed by the participating laboratories are represented in the form of codes (a letter and number). The key to the different analytical techniques is given in Table A.

NO. OF DETERM.: The number of individual results for a given radionuclide supplied by the participating laboratory.

LAB. MEAN: The arithmetic mean computed from all the individual results supplied by the participating laboratory. An asterisk (*) after the lab mean denotes that it was detected and rejected as an outlier. Outliers were not used to compute the overall mean for this radionuclide.

LAB. STANDARD DEV: The absolute and relative standard deviations were calculated if at least three results were reported by the participating laboratory.

4.1.2 Summary of results tables

The summary of the results for IAEA-152 (A) is given in Table B, while the summary for IAEA-152 (B) is given in Table C. Most of the terms used in the summary tables have been already defined. The standard error (S.E.) is defined as the standard deviation of the mean values divided by the square root of the number of laboratory means.

4.2 Description of figures

A figure was plotted for each radionuclide when at least five laboratory means were reported. The laboratory means are plotted by ascending concentration values (Bq/kg) on the y-axis with their respective laboratory code noted along the x-axis.

The respective error bars (standard deviation of the mean) are also shown. The code above the error bar is the laboratory method code, while the value below the error bar is the number of individual determinations. Finally, the points marked with an x in the circle were detected and rejected as outliers and have not been used for the calculation of the overall laboratory mean.

4.3 Criteria for recommended values and confidence intervals

* Please note that these criteria are designed especially for this report and do not apply in general.

The overall mean values (excluding data detected and rejected as outliers) were considered as the recommended values when

1) more than ten laboratory means were available
2) the percentage of outliers was less than 20% and
3) the results of the A and B intercomparisons are mutually consistent (i.e. the mean value for A falls within the confidence interval for B and vice versa).

5. Results and Conclusions

The means and confidence interval obtained for A and B are summarized in rounded form in Table D. It is apparent that the data obtained for the A and B intercomparison are consistent since the two means for each radionuclide differ only by a few percent or less. In order to generate an overall mean the average of the A and B means was calculated. The overall confidence intervals correspond to the outermost values of the individual A and B confidence intervals.

The fact that the means of the A and B intercomparison are quite close suggests that the material is homogeneous; however, it must be realized that this is referred to averages taken over up to 35 bottles. Hence, it can only be stated that the material is homogeneous over a sample size of ~8.8 kg (35 x 0.25kg) for ^{137}Cs or ~4.0 kg (16 x 0.25kg) for ^{90}Sr on the basis of the A and B means. In order to determine whether the material is homogeneous down to the single bottle level, the A and B results must be compared on a laboratory by laboratory basis. A Student's t-test which took into account the standard deviations in the results of individual laboratories was used to compare the A and B results. In order to ensure that the standard deviations were reasonably well defined the results from a subset of the laboratories were selected on the basis that:

a) the laboratory had submitted at least 4 results for both A and B, and
b) the laboratory means had not been identified as outliers.

Although the Student's t-test took into account the standard deviations in the results from individual laboratories, it could not account for any biases which the laboratories have introduced between their A and B results. Thus, biases such as simple weighing errors or using a different spectrometer for the A and B samples could introduce a significant difference in the A and B results even though the material itself is homogeneous.

The results of the Student's t-test indicate that the data from the majority of the laboratories which met the selection criteria and which produced results for a given radionuclide are consistent with homogeneity in the samples. The percentage of the results which are consistent with homogeneity are: 72% for ^{134}Cs, 67% for ^{137}Cs, 81% for ^{40}K and 100% for ^{90}Sr. On this basis it can be concluded that IAEA-152 milk powder is homogeneous.

The recommended values for the concentrations of ^{134}Cs, ^{137}Cs, ^{40}K and ^{90}Sr in IAEA-152 are summarized in Table E.

6. Ackowledgements

The authors of this report are thankful to Ms. Katalin Lewis-Goettler of the IAEA Computer Section for computation of the results and to the Oesterreichische Forschungszentrum for its cost-free ^{60}Co irradiation of these intercomparison samples. Finally, we also like to acknowledge all the participating laboratories as listed at the end of this report.

References

(1) AQCS-Analytical Quality Control Services Programme: Intercomparison Runs, Certified Reference Materials and Reference Materials 1988 IAEA, Vienna, Austria (1987)

(2) Report on Intercomparison A-14 of the Determination of Some Mineral Components and Radionuclides in Milk powder, L. Pszonicki, A.N. Hanna, O. Suschny, IAEA, Laboratory Seibersdorf, IAEA/RL/108, January 1984

(3) R. Dybczynski, A. Tugsavul, O. Suschny, Analyst 103 (1978) 733

Table A

Laboratory Method Codes Used in the IAEA-152 Intercomparison

Method Code	Method
B1	Beta counting following radiochemical separation
G2	Direct high resolution gamma spectrometry without sample pre-treatment, except for drying
G3	High resolution gamma spectrometry with sample pre-treatment
G4	Direct low resolution gamma spectrometry without sample pre-treatment, except for drying
S1	Spectrophotometric determination of potassium and calculation of ^{40}K content

RESULTS OF INTERCOMPARISON FOR CS-134 IN IAEA-152(A), 1987

UNIT: BQ/KG

NO.	LAB. CODE NO.	METHOD CODE	NO.OF DETERM.	MEAN	STANDARD DEV. ABS	STANDARD DEV. REL %	LAB. LOD
1	1	G2	2	831.50	2.12	0.3	
2	2	G2	6	820.67	12.55	1.5	
3	3	G2	2	933.00	48.08	5.2	
4	4	G2	5	608.80	5.07	0.8	
5	5	G3	6	544.15	30.51	5.6	
6	6	G2	6	708.83	4.62	0.7	
7	8	G2	2	702.50	0.71	0.1	
8	9	G2	1	754.00			
9	10	G2	3	693.33	25.17	3.6	
10	11	G2	3	831.67	31.01	3.7	
11	12	G2	5	782.20	18.31	2.3	
12	13	G2	1	600.00			
13	14	G2	4	750.50	8.89	1.2	
14	15	G2	4	857.00	63.89	7.5	
15	16	G2	4	612.50	9.57	1.6	
16	17	G2	6	757.00	11.03	1.5	
17	18A	G2	3	804.33	18.15	2.3	
18	19	G2	4	967.23	21.84	2.3	
19	20	G2	2	797.50	2.12	0.3	
20	21	G2	2	798.00	2.83	0.4	
21	22	G2	2	900.95	39.24	4.4	
22	23	G2	5	1024.80	15.96	1.6	
23	25	G2	4	845.00	12.03	1.4	
24	26	G2	4	854.75	37.49	4.4	
25	27	G3	6	799.67	7.15	0.9	
26	28	G2	6	709.48	17.23	2.4	
27	29	G2	6	173.47*	5.44	3.1	
28	30	G2	3	700.00	34.64	4.9	
29	31	G2	6	678.33	52.31	7.7	
30	32	G2	6	724.00	35.03	4.8	
31	33	G2	2	769.00	12.73	1.7	
32	34	G2	3	588.33	65.61	11.2	
33	35	G2	1	760.00			
34	36	G4	1	91.00*			
35	39A	G2	6	708.67	45.67	6.4	
36	39B	G2	6	627.33	31.93	5.1	

TABLE NO. 2 SIGNIFICANCE LEVEL 0.05

RESULTS OF INTERCOMPARISON FOR CS-137 IN IAEA-152(A), 1987

UNIT: BQ/KG

NO.	LAB. CODE NO.	METHOD CODE	NO.OF DETERM.	MEAN	STANDARD DEV. ABS	STANDARD DEV. REL %	LAB. LOD
1	1	G2	2	2280.00	84.85	3.7	
2	2	G2	6	2227.00	51.68	2.3	
3	3	G2	2	2543.50	3.54	0.1	
4	4	G2	5	1778.00	10.95	0.6	
5	5	G3	6	1676.12	28.26	1.7	
6	6	G2	6	2094.33	11.34	0.5	
7	8	G2	2	1963.00	11.31	0.6	
8	9	G2	1	2290.00			
9	10	G2	3	1990.00	43.59	2.2	
10	11	G2	3	2278.67	17.62	0.8	
11	12	G2	5	2063.20	30.41	1.5	
12	13	G2	1	1840.00			
13	14	G2	4	2080.00	16.33	0.8	
14	15	G2	2	2453.00	189.50	7.7	
15	16	G2	4	1737.50	5.00	0.3	
16	17	G2	6	2176.17	33.52	1.5	
17	18A	G2	3	2381.67	19.55	0.8	
18	19	G2	4	2569.14	70.78	2.8	
19	20	G2	2	2169.00	19.80	0.9	
20	21	G2	2	2184.50	12.02	0.6	
21	22	G2	2	2495.65	117.73	4.7	
22	23	G2	5	2368.40	91.92	3.9	
23	25	G2	4	2206.00	29.17	1.3	
24	26	G2	4	2167.75	42.25	1.9	
25	27	G3	6	2124.83	15.25	0.7	
26	28	G2	6	2053.17	47.29	2.3	
27	29	G2	6	524.15*	3.23	0.6	
28	30	G2	3	2100.00	100.00	4.8	
29	31	G2	6	2205.00	150.96	6.8	
30	32	G2	6	2148.33	40.21	1.9	
31	33	G2	2	2100.00	56.57	2.7	
32	34	G2	3	1946.67	56.86	2.9	
33	35	G2	1	2073.00			
34	36	G4	1	484.00*			
35	37	G3	4	1726.75	21.79	1.3	
36	39A	G2	6	2251.83	139.08	6.2	
37	39B	G2	6	1843.67	101.70	5.5	

TABLE NO. 3 SIGNIFICANCE LEVEL 0.05

RESULTS OF INTERCOMPARISON FOR K-40 IN IAEA-152(A), 1987

UNIT: BQ/KG

NO.	LAB. CODE NO.	METHOD CODE	NO.OF DETERM.	MEAN	STANDARD DEV. ABS	STANDARD DEV. REL %	LAB. LOD
1	1	G4	1	3650.00*			
2	2	G2	6	533.50	16.16	3.0	
3	3	G2	2	693.00	49.50	7.1	
4	4	G2	5	452.40	41.17	9.1	
5	5	G3	6	406.20	49.31	12.1	
6	6	G2	6	567.33	9.48	1.7	
7	8	G2	2	652.50	86.97	13.3	
8	9	S1	4	498.31	10.94	2.2	
9	10	G2	3	480.00	40.00	8.3	
10	12	G2	5	425.80	95.00	22.3	
11	13	G2	1	490.00			
12	14	G2	4	545.50	12.87	2.4	
13	15	G2	2	554.00	69.30	12.5	
14	16	G2	4	597.50	32.02	5.4	
15	17	G2	6	588.33	36.57	6.2	
16	18A	G2	3	626.67	22.85	3.6	
17	19	G2	4	585.02	24.91	4.3	
18	20	G2	2	549.50	20.51	3.7	
19	21	G2	2	553.50	21.92	4.0	
20	22	G2	2	662.30	41.86	6.3	
21	25	G2	4	484.50	66.28	13.7	
22	26	G2	4	434.25	97.12	22.4	
23	27	G3	6	535.33	16.06	3.0	
24	28	G2	6	501.85	54.11	10.8	
25	29	G2	6	103.62*	16.73	16.1	
26	30	G2	3	557.00	58.03	10.4	
27	31	G2	6	635.00	65.35	10.3	
28	35	G2	1	577.00			
29	39A	G2	6	625.83	153.59	24.5	
30	39B	G2	6	411.67	123.96	30.1	

TABLE NO. 4 SIGNIFICANCE LEVEL 0.05

RESULTS OF INTERCOMPARISON FOR SR-90 IN IAEA-152(A), 1987

UNIT: BQ/KG

NO.	LAB. CODE NO.	METHOD CODE	NO.OF DETERM.	MEAN	STANDARD DEV. ABS	STANDARD DEV. REL %	LAB. LOD
1	7	B1	1	7.90			
2	9	B1	3	7.24	0.88	12.2	
3	13	B1	4	6.30	0.72	11.4	
4	16	B1	3	7.60	0.36	4.7	
5	18A	B1	1	8.81			
6	18B	B1	1	8.80			
7	19	B1	4	7.66	0.29	3.8	
8	24	B1	2	8.25	0.35	4.3	
9	25	B1	2	7.80	0.25	3.2	
10	26	B1	4	8.52	0.58	6.8	
11	29	B1	3	7.87	6.70	85.0	
12	30	B1	2	5.70	0.14	2.5	
13	32	B1	6	8.06	0.43	5.3	
14	33	B1	2	8.60	0.85	9.9	
15	35	B1	2	6.65	0.35	5.3	
16	38	B1	3	7.77	0.49	6.4	

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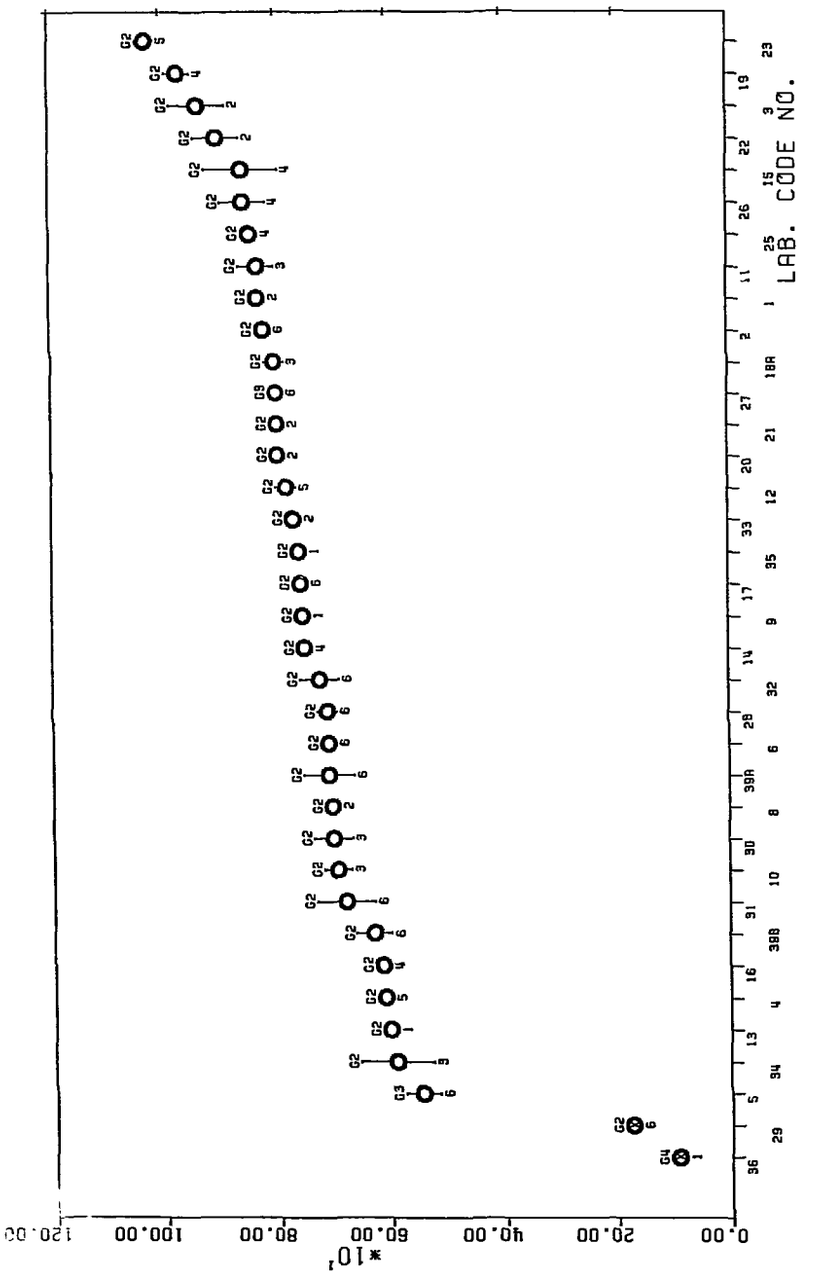
Table B

SUMMARY OF RESULTS OF THE INTERCOMPARISON IAEA-152(A), 1987

RADIONUCLIDE DETERMINED		CS-134	CS-137	K-40	SR-90				
UNIT		BQ/KG	BQ/KG	BQ/KG	BQ/KG				
NUMBER OF REPORTED RESULTS	LABORATORY AVERAGES	36	37	30	16				
	INDIVIDUAL DETERMINATIONS	138	140	118	43				
NUMBER OF ACCEPTED RESULTS	LABORATORY AVERAGES	34	35	28	16				
	INDIVIDUAL DETERMINATIONS	131	133	111	43				
TOTAL RANGE OF LABORATORY AVERAGES		91.00 - 1024.80	484.00 - 2569.14	103.62 - 3650.00	5.70 - 8.81				
RANGE OF ACCEPTED LABORATORY AVERAGES		544.15 - 1024.80	1676.12 - 2569.14	406.20 - 693.00	5.70 - 8.81				
PERCENTAGE OF OUTLYING LABORATORIES		6	5	7	0				
OVERALL MEAN OF ACCEPTED LABORATORY AVERAGES		760.15	2131.02	543.71	7.72				
STANDARD DEVIATION (S.D.)	ABS	110.16	226.82	77.89	0.88				
	REL%	14.5	10.6	14.3	11.5				
STANDARD ERROR (S.E.)	ABS	18.89	38.34	14.72	0.22				
	REL%	2.5	1.8	2.7	2.9				
CONFIDENCE LIMITS FOR THE MEAN OF POPULATION FOR PROBABILITY LEVEL .95		721.69 - 798.61	2053.05 - 2208.99	513.50 - 573.91	7.25 - 8.19				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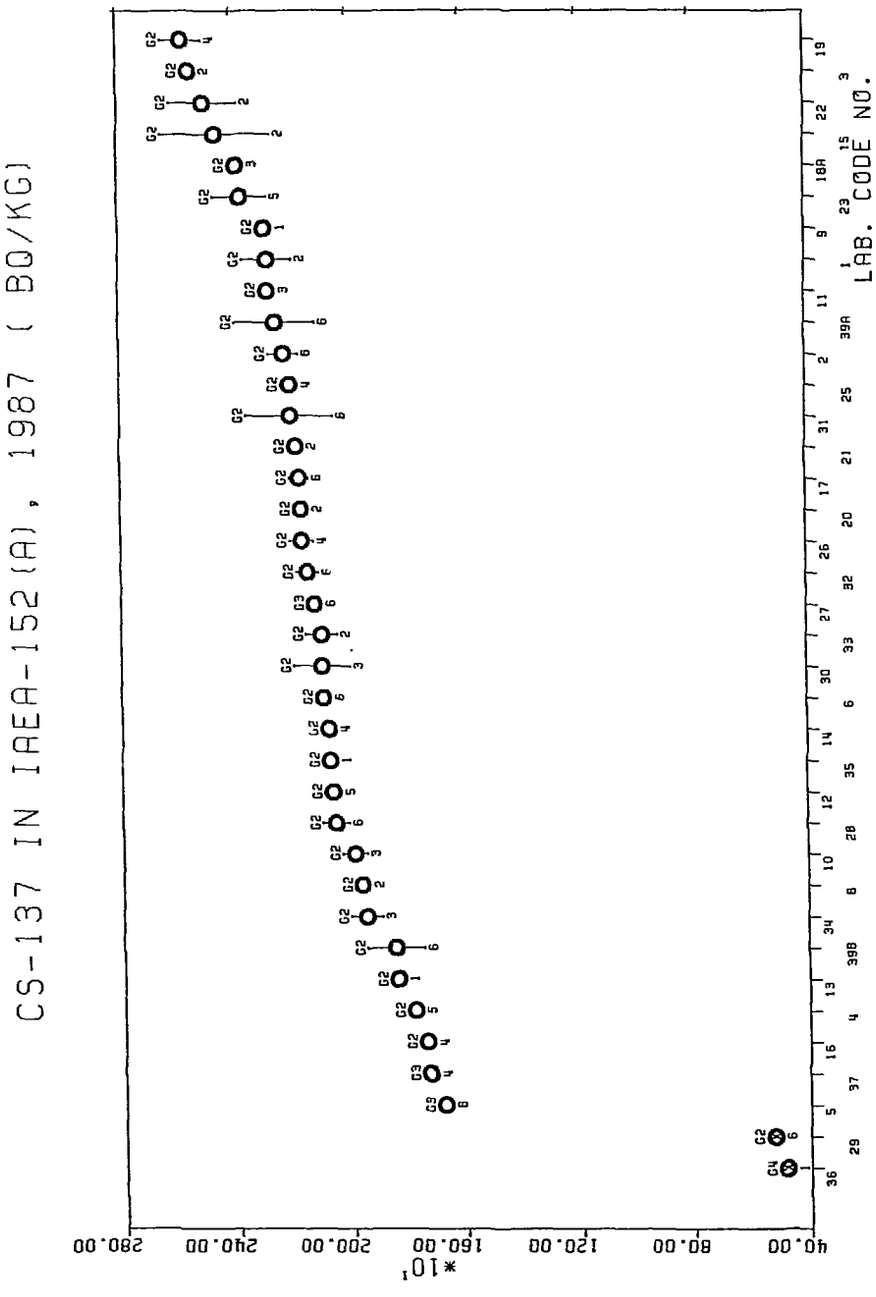
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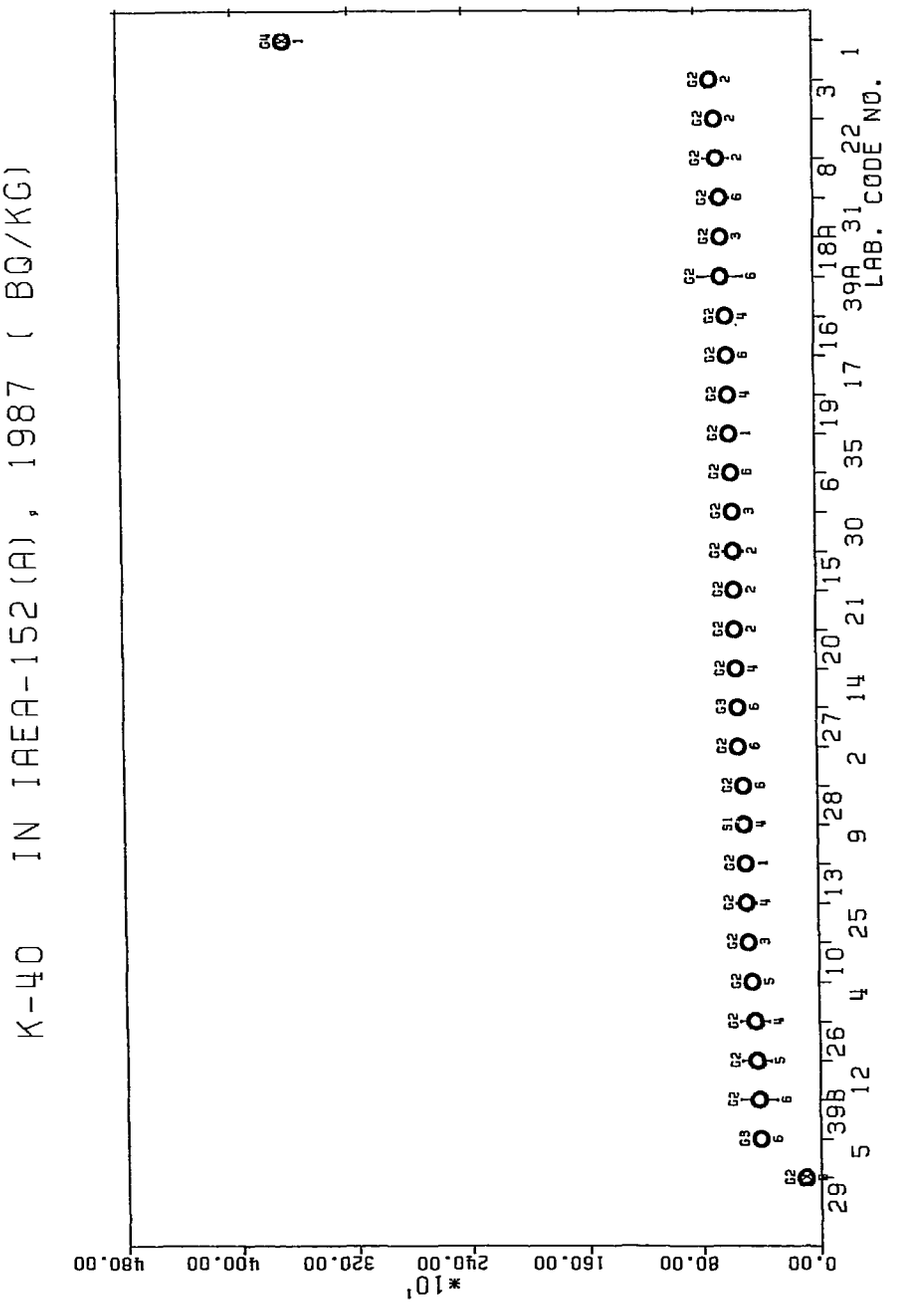
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*10¹
0.00
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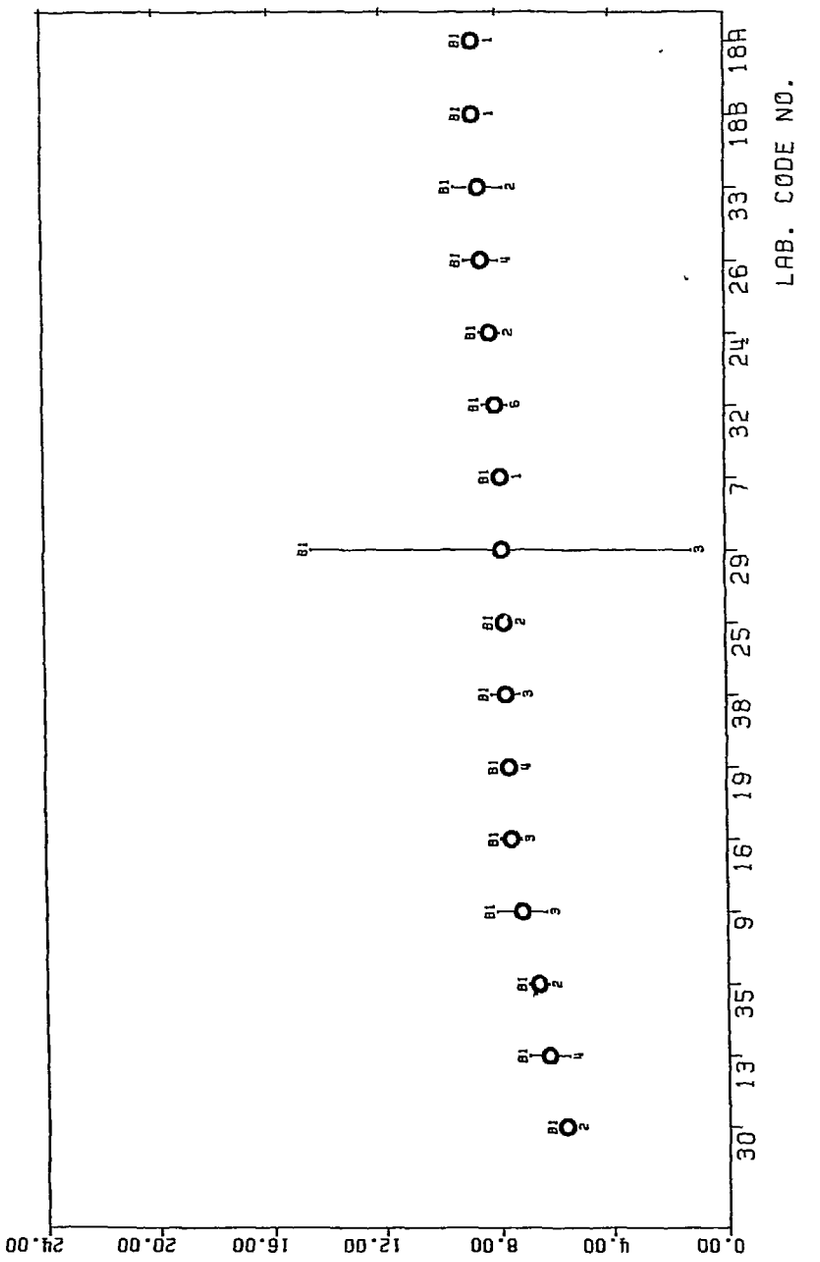
SR-90 IN IAEA-152(A), 1987 (BQ/KG)
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16.00
20.00
24.00
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30
13
35
9
16
19
38
25
29
7
32
24
26
33
18B
18A

TABLE NO. 1 SIGNIFICANCE LEVEL 0.05

RESULTS OF INTERCOMPARISON FOR CS-134 IN IAEA-152(B), 1987

UNIT: BQ/KG

NO.	LAB. CODE NO.	METHOD CODE	NO.OF DETERM.	MEAN	STANDARD DEV. ABS	STANDARD DEV. REL %	LAB. LOD
1	1	G2	2	848.50	2.12	0.3	
2	2	G2	6	773.50	5.86	0.8	
3	3	G2	2	957.50	54.45	5.7	
4	4	G2	5	718.60	10.01	1.4	
5	5	G3	6	586.10	27.51	4.7	
6	6	G2	6	707.33	4.50	0.6	
7	8	G2	4	*697.00*	*13.37*	*1.9*	
8	9	G2	1	758.00			
9	10	G2	3	766.67	75.06	9.8	
10	11	G2	3	822.33	7.64	0.9	
11	12	G2	5	776.60	19.27	2.5	
12	13	G2	1	620.00			
13	14	G2	3	695.67	2.08	0.3	
14	15	G2	4	828.25	41.53	5.0	
15	16	G2	4	637.50	5.00	0.8	
16	17	G2	6	731.50	4.51	0.6	
17	18A	G2	3	823.67	5.51	0.7	
18	19	G2	4	929.70	26.47	2.8	
19	20	G2	2	791.50	7.78	1.0	
20	21	G2	2	806.00	2.83	0.4	
21	22	G2	2	804.75	49.71	6.2	
22	23	G2	5	1033.82	14.88	1.4	
23	25	G2	4	840.00	11.17	1.3	
24	26	G2	4	877.25	9.07	1.0	
25	27	G3	6	797.67	4.68	0.6	
26	28	G2	6	727.37	25.60	3.5	
27	29	G2	6	189.27*	4.59	2.4	
28	30	G2	3	700.00	34.64	4.9	
29	31	G2	6	660.00	52.54	8.0	
30	32	G2	6	729.17	36.35	5.0	
31	33	G2	2	811.00	21.21	2.6	
32	34	G2	3	574.33	9.29	1.6	
33	35	G2	2	774.50	2.12	0.3	
34	36	G4	1	89.00*			
35	39A	G2	6	737.50	52.97	7.2	
36	39B	G2	6	739.33	20.47	2.8	

TABLE NO. 2 SIGNIFICANCE LEVEL 0.05

RESULTS OF INTERCOMPARISON FOR CS-137 IN IAEA-152(B), 1987

UNIT: BQ/KG

NO.	LAB. CODE NO.	METHOD CODE	NO.OF DETERM.	MEAN	STANDARD DEV. ABS	STANDARD DEV. REL %	LAB. LOD
1	1	G2	2	2290.00	28.28	1.2	
2	2	G2	6	2069.00	4.94	0.2	
3	3	G2	2	2612.50	43.13	1.7	
4	4	G2	5	2026.00	23.02	1.1	
5	5	G3	6	1735.75	30.47	1.8	
6	6	G2	6	2087.17	7.47	0.4	
7	8	G2	4	1988.50	13.53	0.7	
8	9	G2	1	2060.00			
9	10	G2	3	2056.67	166.53	8.1	
10	11	G2	3	2244.67	52.00	2.3	
11	12	G2	5	2050.40	31.07	1.5	
12	13	G2	1	1810.00			
13	14	G2	3	1916.67	11.55	0.6	
14	15	G2	2	2390.50	120.92	5.1	
15	16	G2	4	1802.50	20.62	1.1	
16	17	G2	6	2098.83	4.45	0.2	
17	18A	G2	3	2390.67	23.67	1.0	
18	19	G2	4	2457.17	85.48	3.5	
19	20	G2	2	2184.50	30.41	1.4	
20	21	G2	2	2207.50	27.58	1.2	
21	22	G2	2	2240.35	86.34	3.9	
22	23	G2	5	2411.12	9.00	0.4	
23	25	G2	4	2196.00	25.21	1.1	
24	26	G2	4	2174.25	50.97	2.3	
25	27	G3	6	2125.33	3.67	0.2	
26	28	G2	6	2129.83	57.23	2.7	
27	29	G2	6	548.50*	7.84	1.4	
28	30	G2	3	2066.67	57.74	2.8	
29	31	G2	6	2188.33	106.29	4.9	
30	32	G2	6	2156.67	41.31	1.9	
31	33	G2	2	2125.00	77.78	3.7	
32	34	G2	3	1793.33	40.41	2.3	
33	35	G2	2	2094.50	3.54	0.2	
34	36	G4	1	376.00*			
35	37	G3	4	1741.75	40.74	2.3	
36	39A	G2	6	2302.33	116.80	5.1	
37	39B	G2	6	2211.67	64.44	2.9	

TABLE NO. 3 SIGNIFICANCE LEVEL 0.05

RESULTS OF INTERCOMPARISON FOR K-40 IN IAEA-152(B), 1987

UNIT: BQ/KG

NO.	LAB. CODE NO.	METHOD CODE	NO.OF DETERM.	MEAN	STANDARD DEV. ABS	STANDARD DEV. REL %	LAB. LOD
1	1	G4	1	3740.00*			
2	2	G2	6	517.83	8.64	1.7	
3	3	G2	2	645.50	28.99	4.5	
4	4	G2	5	494.60	34.53	7.0	
5	5	G3	6	435.50	31.65	7.3	
6	6	G2	6	571.83	12.25	2.1	
7	8	G2	4	523.75	141.97	27.1	
8	9	S1	4	458.99	3.65	0.8	
9	10	G2	3	456.67	25.17	5.5	
10	12	G2	5	517.20	109.31	21.1	
11	13	G2	1	460.00			
12	14	G2	3	532.00	11.79	2.2	
13	15	G2	2	582.50	70.00	12.0	
14	16	G2	4	532.50	52.52	9.9	
15	17	G2	6	513.00	41.74	8.1	
16	18A	G2	3	585.33	23.16	4.0	
17	19	G2	4	691.76	25.60	3.7	
18	20	G2	2	560.00	8.49	1.5	
19	21	G2	2	566.00	7.07	1.2	
20	22	G2	2	616.05	23.55	3.8	
21	25	G2	4	476.00	33.71	7.1	
22	26	G2	4	487.50	110.24	22.6	
23	27	G3	6	522.17	20.87	4.0	
24	28	G2	6	521.27	61.42	11.8	
25	29	G2	6	111.50*	15.51	13.9	
26	30	G2	3	556.67	5.77	1.0	
27	31	G2	6	616.67	92.45	15.0	
28	35	G2	2	583.00	0.00	0.0	
29	39A	G2	3	442.00	81.46	18.4	
30	39B	G2	6	496.33	144.30	29.1	

TABLE NO. 4 SIGNIFICANCE LEVEL 0.05

RESULTS OF INTERCOMPARISON FOR SR-90 IN IAEA-152(B), 1987

UNIT: BQ/KG

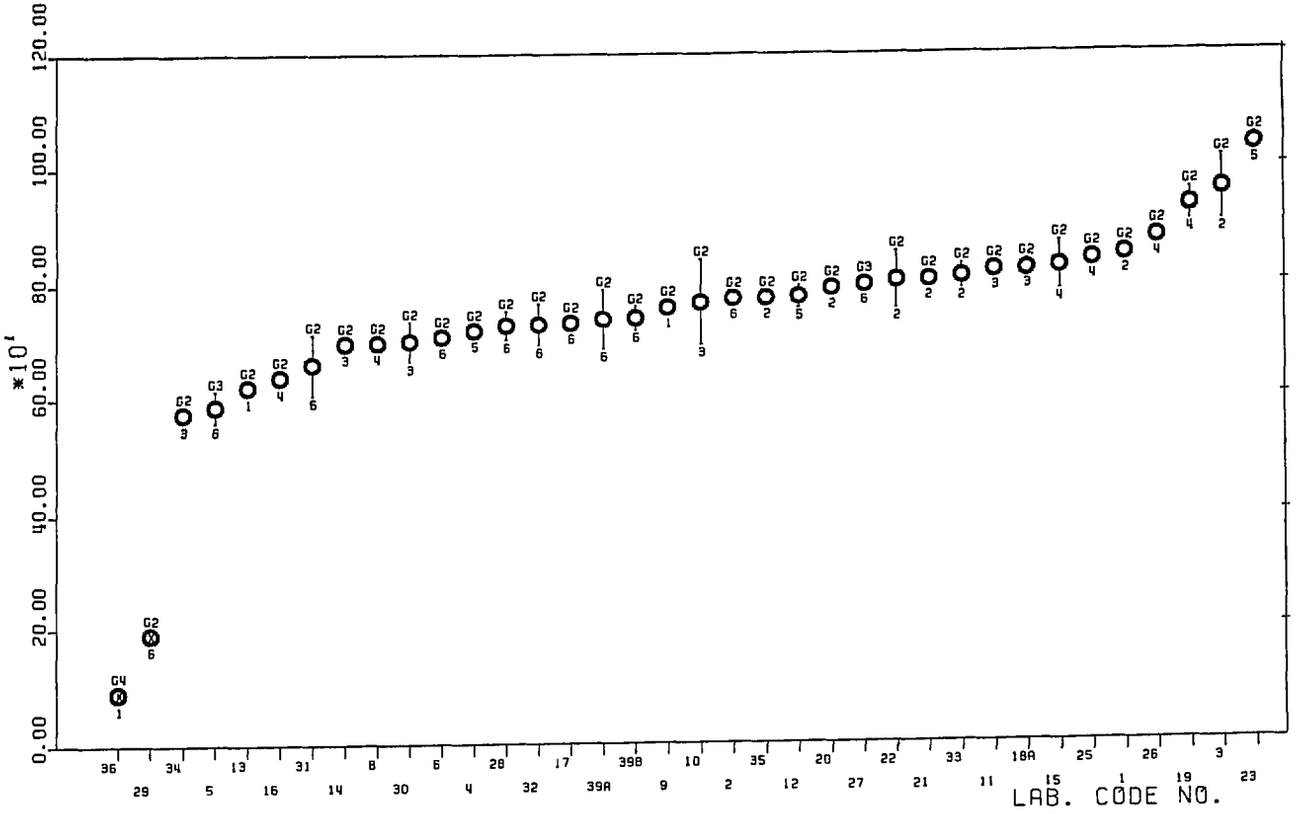
NO.	LAB. CODE NO.	METHOD CODE	NO.OF DETERM.	MEAN	STANDARD DEV. ABS	STANDARD DEV. REL %	LAB. LOD
1	7	B1	1	7.80			
2	9	B1	3	9.80	1.72	17.6	
3	13	B1	4	6.25	0.47	7.4	
4	16	B1	3	7.40	0.30	4.1	
5	18A	B1	1	6.33			
6	18B	B1	1	6.37			
7	19	B1	4	7.70	0.23	3.0	
8	24	B1	2	8.65	0.35	4.1	
9	25	B1	1	8.02			
10	26	B1	4	8.02	0.29	3.6	
11	29	B1	3	5.57	0.79	14.2	
12	30	B1	5	6.76	2.03	30.1	
13	32	B1	6	8.65	0.76	8.8	
14	33	B1	2	8.55	0.07	0.8	
15	35	B1	3	9.27	0.25	2.7	
16	38	B1	3	6.87	0.12	1.7	

Table C

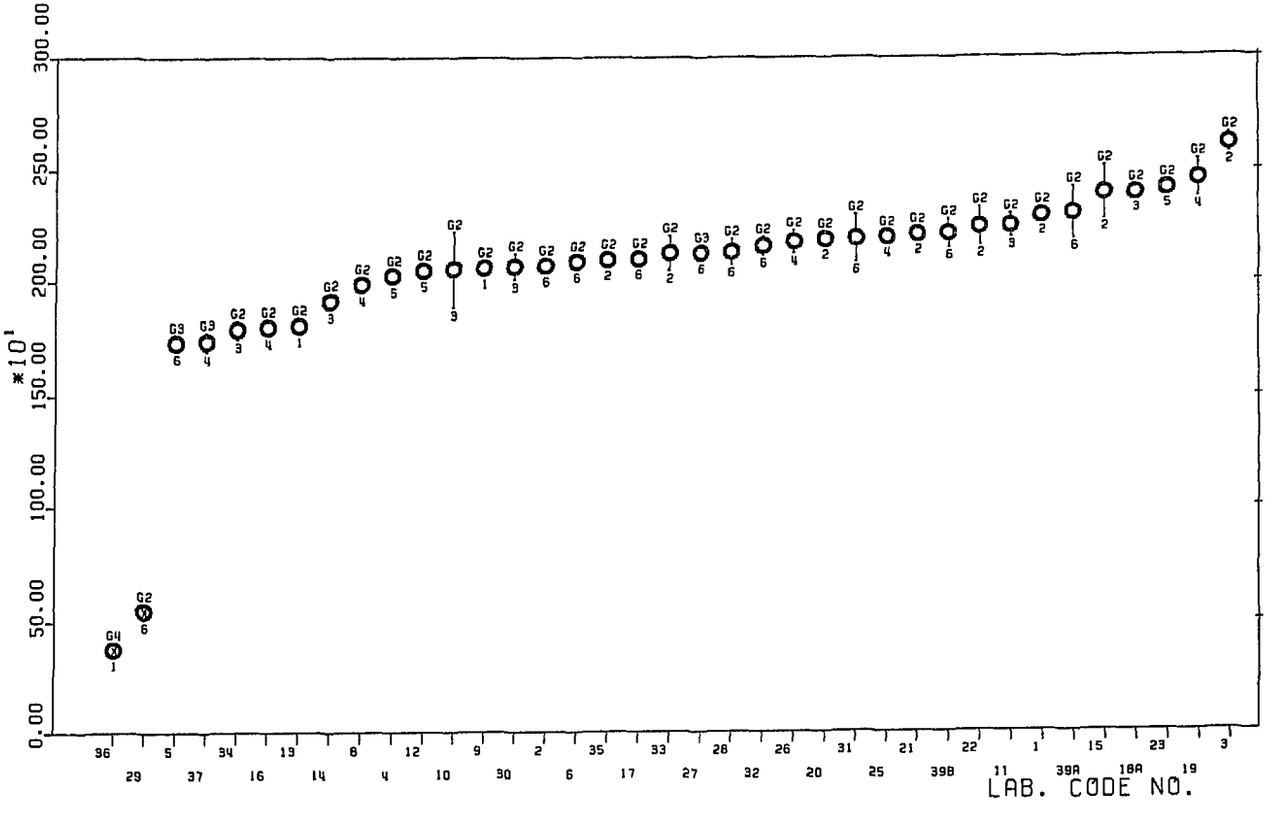
SUMMARY OF RESULTS OF THE INTERCOMPARISON IAEA-152(B), 1987

RADIONUCLIDE DETERMINED		CS-134	CS-137	K-40	SR-90				
UNIT		BQ/KG	BQ/KG	BQ/KG	BQ/KG				
NUMBER OF REPORTED RESULTS	LABORATORY AVERAGES	36	37	30	16				
	INDIVIDUAL DETERMINATIONS	140	142	117	46				
NUMBER OF ACCEPTED RESULTS	LABORATORY AVERAGES	34	35	28	16				
	INDIVIDUAL DETERMINATIONS	133	135	110	46				
TOTAL RANGE OF LABORATORY AVERAGES		89.00 - 1033.82	376.00 - 2612.50	111.50 - 3740.00	5.57 - 9.80				
RANGE OF ACCEPTED LABORATORY AVERAGES		574.33 - 1033.82	1735.75 - 2612.50	435.50 - 691.76	5.57 - 9.80				
PERCENTAGE OF OUTLYING LABORATORIES		6	5	7	0				
OVERALL MEAN OF ACCEPTED LABORATORY AVERAGES		767.13	2126.74	534.38	7.63				
STANDARD DEVIATION (S.D.)	ABS	98.59	202.56	62.97	1.20				
	REL%	12.9	9.5	11.8	15.7				
STANDARD ERROR (S.E.)	ABS	16.91	34.24	11.90	0.30				
	REL%	2.2	1.6	2.2	3.9				
CONFIDENCE LIMITS FOR THE MEAN OF POPULATION FOR PROBABILITY LEVEL .95		732.72 - 801.55	2057.11 - 2196.37	509.96 - 558.80	6.99 - 8.26				

CS-134 IN IAEA-152(B), 1987 (BQ/KG)



CS-137 IN IAEA-152(B), 1987 (BQ/KG)



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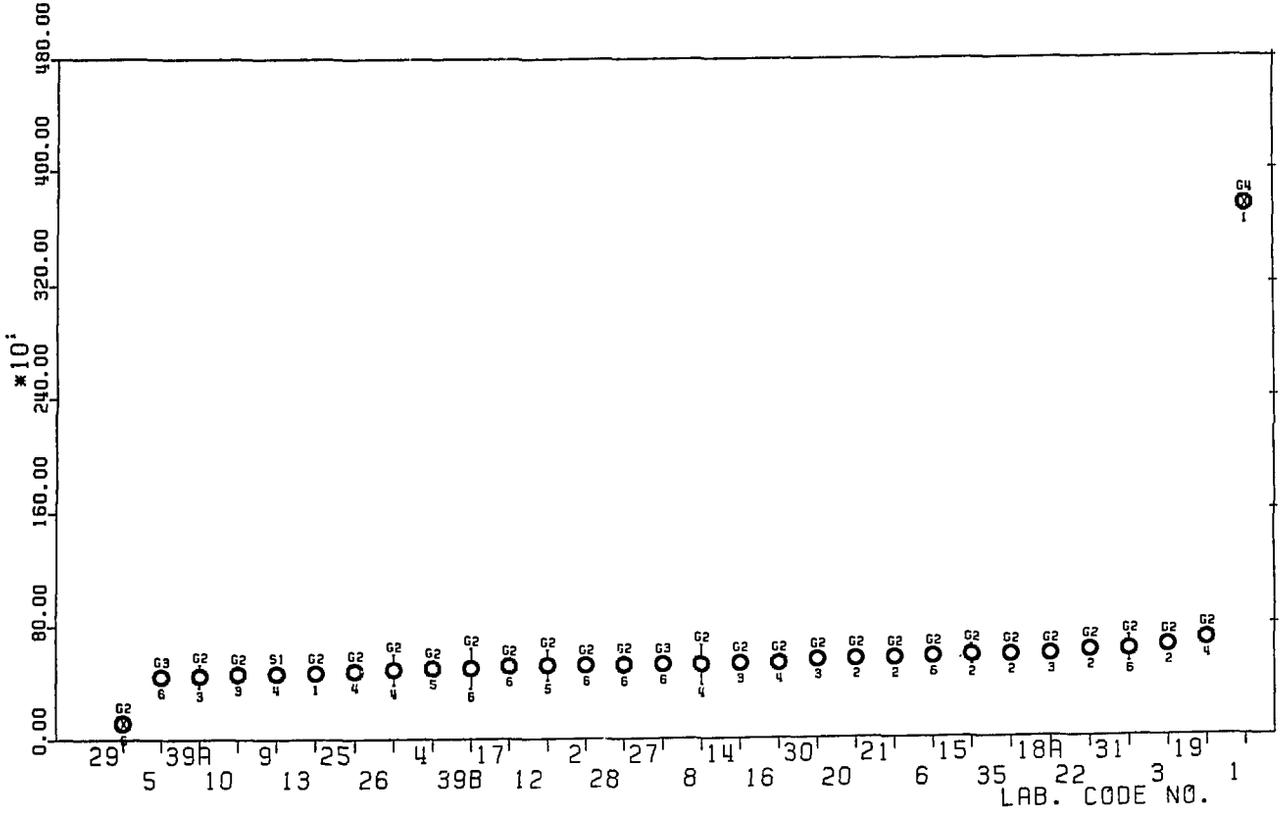
K-40 IN IAEA-152(B), 1987 (BQ/KG)



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SR-90 IN IAEA-152(B), 1987 (BQ/KG)

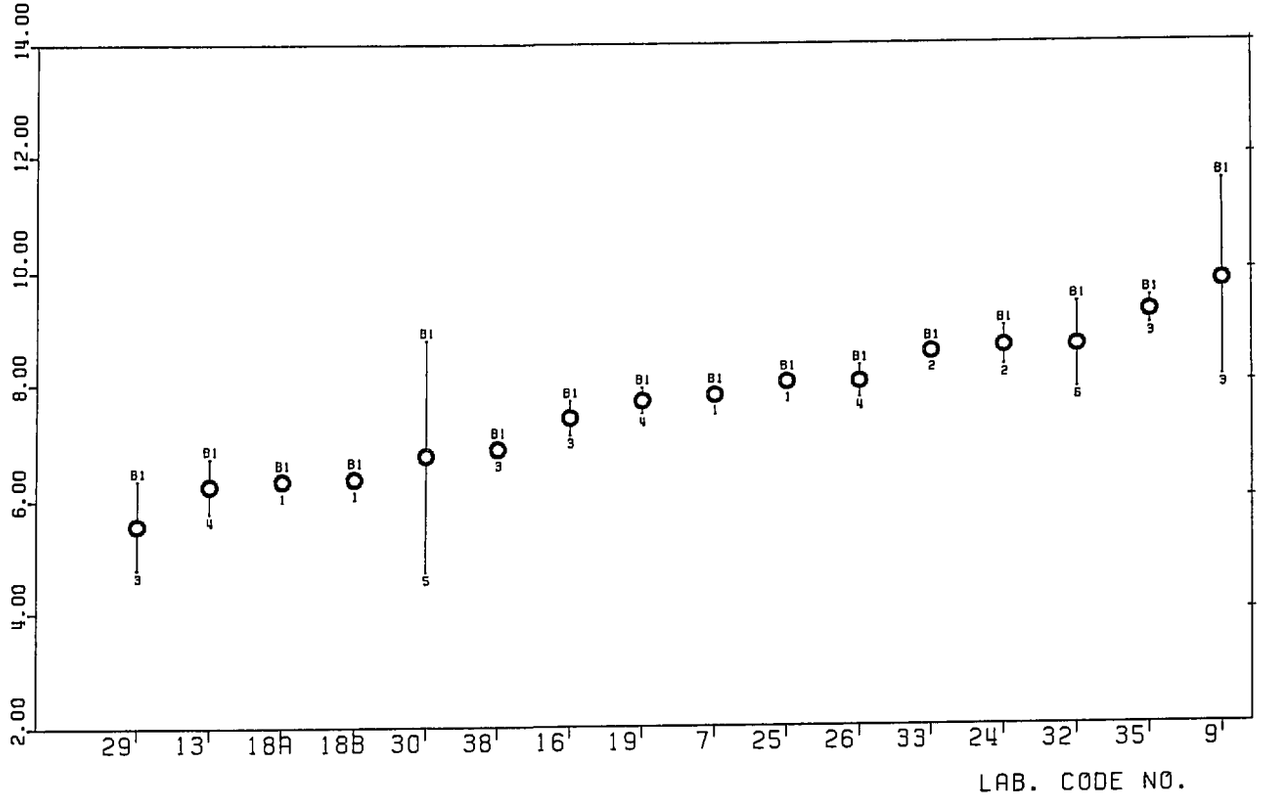

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Table D

Summary of Means and Confidence Intervals

Radionuclide	Bottle	Mean (Bq/kg)	Confidence intervals* (Bq/kg)
^{134}Cs	A	760	K-722 - 799
	B	767	733 - 802
	A + B	764	722 - 802
^{137}Cs	A	2131	2053 - 2209
	B	2127	2057 - 2196
	A + B	2129	2053 - 2209
^{40}K	A	544	514 - 574
	B	534	510 - 559
	A + B	539	510 - 574
^{90}Sr	A	7.7	7.3 - 8.2
	B	7.6	7.0 - 8.3
	A + B	7.7	7.0 - 8.3

* Confidence intervals are for significance level 0.05.

Table E

Recommended Values and Confidence Intervals for Radionuclide in IAEA-152 Milk Powder

Radionuclide	Recommended Value (Bq/kg)	Confidence Interval* (Bq/kg)
^{134}Cs	764	722 - 802
^{137}Cs	2129	2053 - 2209
^{40}K	539	510 - 574
^{90}Sr	7.7	7.0 - 8.3

* Based on the outermost confidence intervals of the A and B intercomparison for a significance level 0.05.

Reference date: 31 August 1987

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