

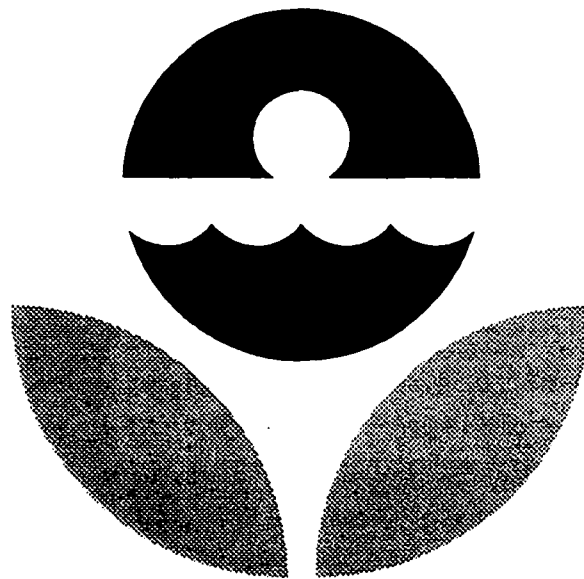


# Strontium in Water Intercomparison Study

## A Statistical Evaluation of the September 11, 1992 Data



Strontium in Water  
Intercomparison Study  
September 11, 1992



Environmental Protection Agency  
Environmental Monitoring Systems Laboratory  
Las Vegas, Nevada



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
OFFICE OF RESEARCH AND DEVELOPMENT  
ENVIRONMENTAL MONITORING SYSTEMS LABORATORY-LAS VEGAS  
P.O. BOX 93478  
LAS VEGAS, NEVADA 89193-3478  
(702/798-2100)

Dear Participant,

Enclosed are the results of the Nuclear Radiation Assessment Division (EMSL-LV) Intercomparison Study for *Strontium in Water*; **September 11, 1992.**

Please take a few minutes to review this report and the analytical data your laboratory submitted to us. If there are any apparent discrepancies, please notify us immediately.

We encourage you to make use of the computer-automated data-entry system that has been in place for some time now. As the number of participants increases, and it becomes unrealistic for us to receive results by mail or FAX, the computer system will be our only avenue for accepting data.

If you have any questions or comments, please send a message via the data-entry system or contact Frank Novielli at 702/798-2159 or Patricia Honsa at 702/798-2141.

Sincerely,

A handwritten signature in cursive script that reads "Frank Novielli".

Frank Novielli  
Senior Chemist  
Radioanalysis Branch

Enclosure

#### NOTICE

This material has been funded wholly by the U.S. Environmental Protection Agency. It has been subject to the Agency's review, and it has been approved for publication as an EPA document.

The following pages consist of separate sections for each of the nuclides in this study with four parts per section. After the first, each part is separated from the next by a new page or a thick horizontal bar. The first page of each section is a statistical summary for the nuclide and starts with a statement of the known value, the control limits, and the warning limits.

The warning limits are placed at two normalized standard deviations above and below the known value and the control limits are three normalized standard deviations above and below the known value. If you keep control charts, these values will be useful for anticipating problems with the accuracy of your analytical methods.

The coin shaped pie chart at the top of the summary page shows the fate of all the samples sent out in number and percentage terms. The pie chart starts at the top and rotates clockwise. The first sector represents those participants who submitted analytical results within both the warning and control limits. The next sector represents those who are in the warning region but not out of control. The third sector represents those who are out of control, but have passed the outlier test. The fourth sector represents those who have failed the outlier test. The last sector represents those participants who have failed to respond properly. This is the case if no analytical results were returned, or less than three determinations were reported, or if the results were received too late. The reeding on the edge of the coin is spaced at one percent intervals, and the sector shading becomes darker as the data reliability decreases. Sectors with zero width are not shown.

The table in the center shows a number of statistical quantities calculated from the submitted data based on the mean and median values in relation to the known value, both before and after outlier removal. The lower pie chart uses the same construction as the upper chart and shows the distribution of properly submitted data in terms of deviation from the known value divided into sectors representing one, two, three, and greater than three normalized standard deviations.

The second part is an alphabetical listing, in lab-code order, of submitted data and several calculated quantities. An entry that is shaded has been rejected because of one of the reasons listed above or failure of the outlier test. The fifth and sixth columns are a measure of laboratory precision. The Range analysis is a normalized value that you may use to keep precision control charts. If this value is between 2.0 and 3.0, your analytical process precision is in the warning zone; if it exceeds 3.0 it is out of control. The eighth and ninth columns are the differences from the mean of all non-outliers and from the known value, respectively. A tag symbol may appear in the last column. Each page with tags has a symbol definition summary at the bottom. If there is no tag symbol, the data is within the control limits, but it may be in the warning zone.

The third part is a three-column listing of result average, tag symbol, and lab-code in average order excluding those labs not responding properly. In this order, all outliers and out-of-control results appear at the top or bottom of the list.

The last part is two bar chart displays showing frequency distributions of responding participants. The first chart places the known value at the center and a bar at each 0.2 unit of expected precision. The second chart places the mean of the reported measurements at the center and a bar at each 0.2 unit of standard deviation. In both cases, a bar includes those results within 0.1 unit up to the maximum of six. Any results more than six units from the center value are shown cumulatively by a shaded bar one past the sixth unit. If the central tendency of the known value distribution falls away from the center, an error in accuracy is indicated. If the distribution is broad, poor precision is indicated. The mean value distribution is similar but uses the average and standard deviation of reported results as its basis.

**Strontium-89**

**Statistical Summary**

**85 Participants**

The known value of this nuclide is **20.0 pCi/l** with an expected precision of **5.0**; the control limits are 11.3 to 28.7; the warning regions are 11.3 to 14.2 and 25.8 to 28.7

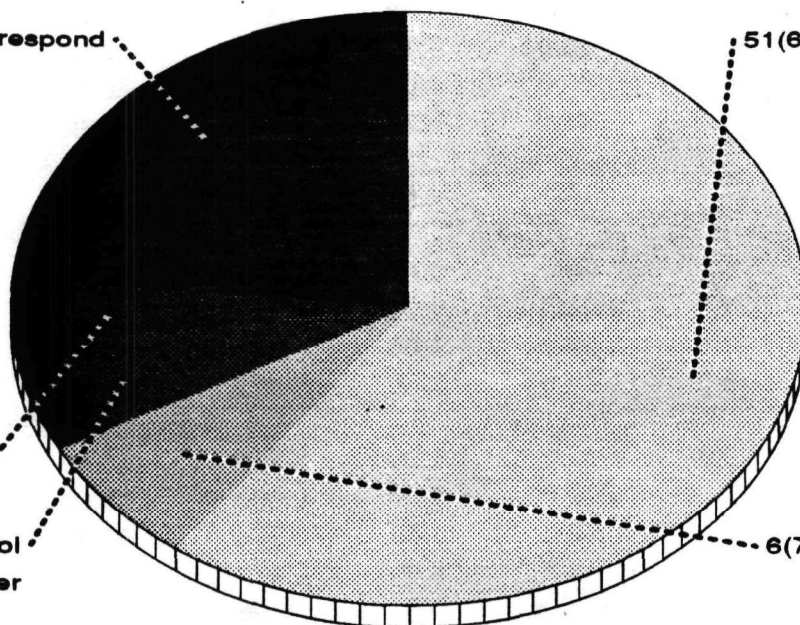
20(23.5 %) Failed to respond

51(60.0 %) Within all limits

3(3.5 %) Outliers

5(5.9 %) Out of control  
but not an outlier

6(7.1 %) In warning zone  
but within control



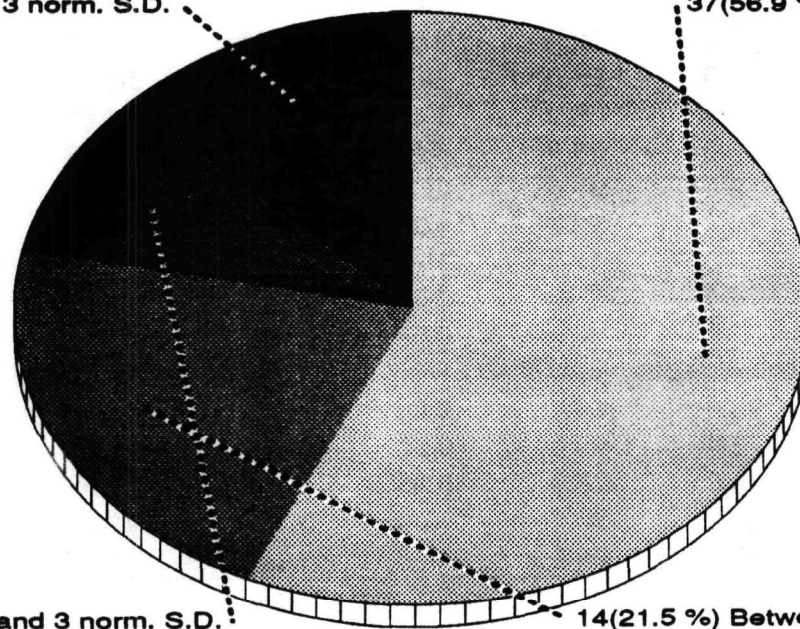
Statistic	Respondents	Non-outliers
Mean	23.68	<b>Grand Avg 20.04</b>
Std. Dev.	30.13	4.84
Variance	907.79	23.41
% Coef. of Var.	127.23	24.15
% deviation of mean from known value	18.41	0.19
Norm. dev. of mean from known value	0.12	0.01
Median	19.00	19.00
% deviation of median from known value	-5.00	-5.00
Norm. dev. of median from known value	-0.03	-0.21

8(12.3 %) More than 3 norm. S.D.

37(56.9 %) Within 1 norm. S.D.  
of known value

6(9.2 %) Between 2 and 3 norm. S.D.

14(21.5 %) Between 1 and 2 norm. S.D.



## Strontium-89

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg) (known)		Tag
	0.0	0.0	0.0	0.00	0.000	0.00	-6.94	-6.93	x
AE	24.0	21.0	23.0	1.53	0.354	22.67	0.91	0.92	
AF	20.0	22.0	20.0	1.15	0.236	20.67	0.22	0.23	
AK	19.0	21.0	20.0	1.00	0.236	20.00	-0.01	0.00	
AL	13.0	21.0	14.0	4.36	0.945	16.00	-1.40	-1.39	
AU									•
AW	15.0	14.0	15.0	0.58	0.118	14.67	-1.86	-1.85	
AY									•
BA	14.0	15.0	13.0	1.00	0.236	14.00	-2.09	-2.08	
BO	21.0	24.0	21.0	1.73	0.354	22.00	0.68	0.69	
C	22.0	21.0	23.0	1.00	0.236	22.00	0.68	0.69	
CA	16.0	18.0	14.0	2.00	0.473	16.00	-1.40	-1.39	
CE									•
CJ	16.0	15.0	17.0	1.00	0.236	16.00	-1.40	-1.39	
CK	19.0	19.0	19.0	0.00	0.000	19.00	-0.36	-0.35	
CQ	18.0	17.0	20.0	1.53	0.354	18.33	-0.59	-0.58	
CS	16.0	12.0	14.0	2.00	0.473	14.00	-2.09	-2.08	
CX	258.0	228.0	259.0	30.01	12.596	258.33	82.55	82.56	x
D	19.0	18.0	19.0	0.58	0.118	18.67	-0.47	-0.46	
DE	18.0	18.0	19.0	0.58	0.118	18.33	-0.59	-0.58	
DG	21.0	23.0	18.0	2.52	0.591	20.67	0.22	0.23	
DO	19.0	20.0	18.0	1.00	0.236	19.00	-0.36	-0.35	
DT	18.0	16.0	20.0	2.00	0.473	18.00	-0.71	-0.69	
DZ	31.0	33.0	33.0	1.15	0.236	32.33	4.26	4.27	↑
E	19.0	21.0	17.0	2.00	0.473	19.00	-0.36	-0.35	
EB	18.0	23.0	23.0	2.89	0.591	21.33	0.45	0.46	
EH	16.0	15.0	16.0	0.58	0.118	15.67	-1.51	-1.50	
EL	15.0	18.0	15.0	1.73	0.354	16.00	-1.40	-1.39	
FE	18.0	17.0	17.0	0.58	0.118	17.33	-0.94	-0.92	
HK	19.0	18.0	18.0	0.58	0.118	18.33	-0.59	-0.58	
HU	11.0	12.0	12.0	0.58	0.118	11.67	-2.90	-2.89	
IC	20.0	22.0	21.0	1.00	0.236	21.00	0.33	0.35	
J	20.0	20.0	22.0	1.15	0.236	20.67	0.22	0.23	
JE	38.0	27.0	38.0	6.35	1.570	34.33	4.95	4.97	↑
JS	23.0	19.0	21.0	2.00	0.473	21.00	0.33	0.35	
JY	24.0	16.0	22.0	4.16	0.945	20.67	0.22	0.23	
K	17.0	15.0	17.0	1.15	0.236	16.33	-1.28	-1.27	
KX	22.0	19.0	21.0	1.53	0.354	20.67	0.22	0.23	
L	21.0	22.0	21.0	0.58	0.118	21.33	0.45	0.46	
LM									•
LT	34.0	34.0	34.0	0.00	0.000	34.00	4.84	4.85	↑
M	23.0	23.0	22.0	0.58	0.118	22.67	0.91	0.92	
ME	30.0	20.0	26.0	5.03	1.345	25.33	1.83	1.85	
MQ	18.0	19.0	20.0	1.00	0.236	19.00	-0.36	-0.35	
MS	23.0	22.0	23.0	0.58	0.118	22.67	0.91	0.92	

• = No data submitted

## TAG SYMBOLS

↑ = Above control limit

∅ = Insufficient data

x = Determined to be an outlier

↓ = Below control limit

## Strontium-89

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg) (known)		Tag
N									•
NB	31.0	31.0	30.0	0.58	0.118	30.67	3.68	3.70	↑
NJ	18.0	19.0	19.0	0.58	0.118	18.67	-0.47	-0.46	
NT	23.0	22.0	22.0	0.58	0.118	22.33	0.80	0.81	
OA	27.0	24.0	26.0	1.53	0.354	25.67	1.95	1.96	
OL									•
PB	20.0	20.0	20.0	0.00	0.000	20.00	-0.01	0.00	
PC									•
PE									•
PP									•
PU									•
PV	19.0	17.0	20.0	1.53	0.354	18.67	-0.47	-0.46	
QU	30.0	29.0	30.0	0.58	0.118	29.67	3.34	3.35	↑
QW	27.0	26.0	28.0	1.00	0.236	27.00	2.41	2.42	
QZ	22.0	21.0	20.0	1.00	0.236	21.00	0.33	0.35	
R	13.0	15.0	15.0	1.15	0.236	14.33	-1.98	-1.96	
RC									•
RK	18.0	17.0	18.0	0.58	0.118	17.67	-0.82	-0.81	
RM	22.0	19.0	26.0	3.51	0.827	22.33	0.80	0.81	
RN	14.0	16.0	13.0	1.53	0.354	14.33	-1.98	-1.96	
RR									•
RU									•
S	17.0	18.0	19.0	1.00	0.236	18.00	-0.71	-0.69	
SC	18.0	18.0	21.0	1.73	0.354	19.00	-0.36	-0.35	
SD	16.0	17.0	18.0	1.00	0.236	17.00	-1.05	-1.04	
SI	16.0	11.0	13.0	2.52	0.591	13.33	-2.32	-2.31	
SS	19.0	20.0	21.0	1.00	0.236	20.00	-0.01	0.00	
ST	25.0	26.0	25.0	0.58	0.118	25.33	1.83	1.85	
SY									•
SZ	17.0	17.0	17.0	0.00	0.000	17.00	-1.05	-1.04	
TA									•
TB									•
TE									•
TG									•
TI	16.0	13.0	13.0	1.73	0.354	14.00	-2.09	-2.08	
TL	24.0	17.0	12.0	6.03	1.795	17.67	-0.82	-0.81	
TM									•
TP	38.0	40.0	38.0	1.15	0.236	38.67	6.45	6.47	×
TW									•
U	17.0	16.0	19.0	1.53	0.354	17.33	-0.94	-0.92	

## Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
0.00	×		13.33		SI	14.00		CS
11.67		HU	14.00		TI	14.00		BA

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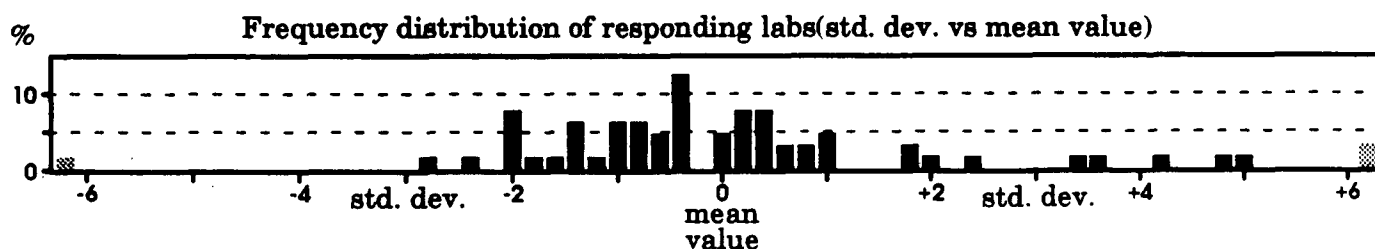
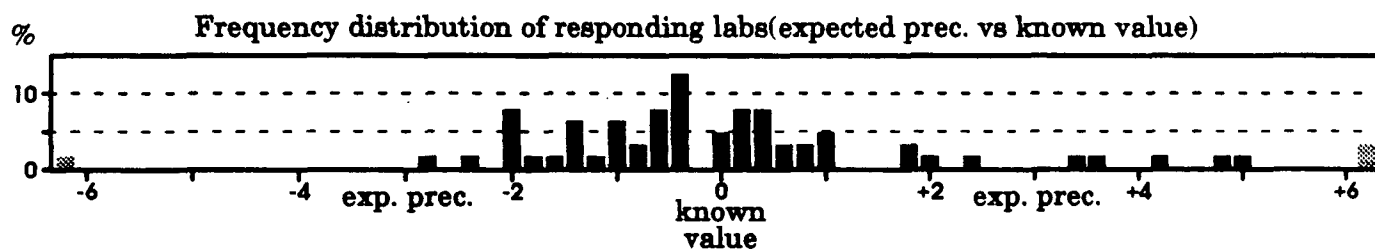
↓ = Below control limit



## Strontium-89

## Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
14.33		RN	18.33		CQ	21.33		L
14.33		R	18.67		PV	21.33		EB
14.67		AW	18.67		NJ	22.00		C
15.67		EH	18.67		D	22.00		BO
16.00		EL	19.00		SC	22.33		RM
16.00		CJ	19.00		MQ	22.33		NT
16.00		CA	19.00		E	22.67		MS
16.00		AL	19.00		DO	22.67		M
16.33		K	19.00		CK	22.67		AE
17.00		SZ	20.00		SS	25.33		ST
17.00		SD	20.00		PB	25.33		ME
17.33		U	20.00		AK	25.67		OA
17.33		FE	20.67		KX	27.00		QW
17.67		TL	20.67		JY	29.67	↑↑	QU
17.67		RK	20.67		J	30.67	↑↑	NB
18.00		S	20.67		DG	32.33	↑↑	DZ
18.00		DT	20.67		AF	34.00	↑↑	LT
18.33		HK	21.00		QZ	34.33	↑↑	JE
18.33		DE	21.00		JS	38.67	×	TP
			21.00		IC	258.33	×	CX



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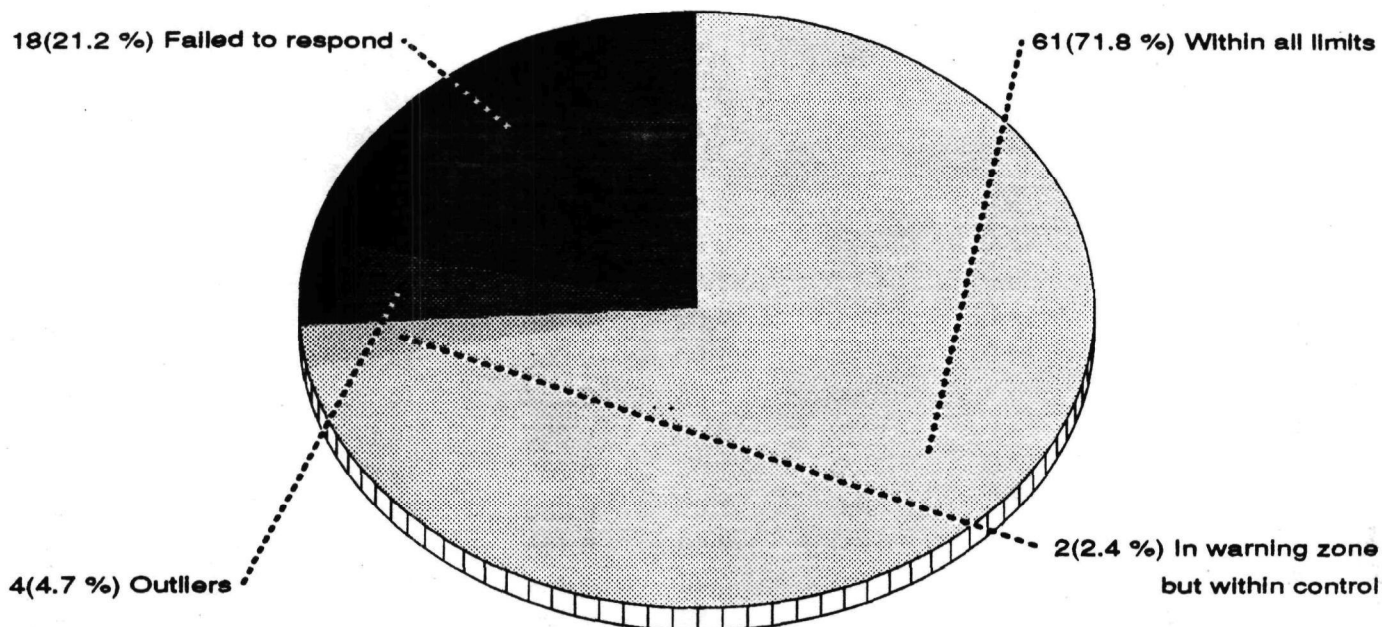
↓↓ = Below control limit

**Strontium-90**

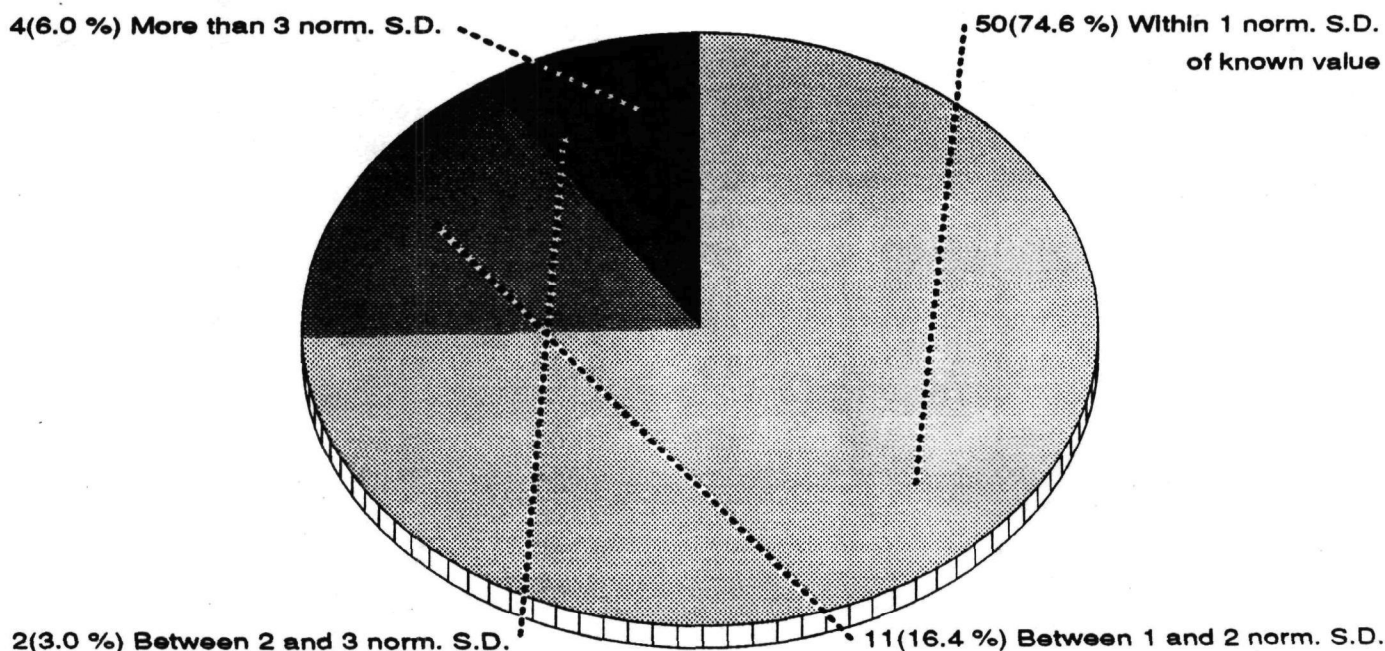
**Statistical Summary**

85 Participants

The known value of this nuclide is 15.0 pCi/l with an expected precision of 5.0; the control limits are 6.3 to 23.7; the warning regions are 6.3 to 9.2 and 20.8 to 23.7



Statistic	Respondents	Non-outliers
Mean	16.92	<b>Grand Avg 14.50</b>
Std. Dev.	18.88	2.37
Variance	356.48	5.61
% Coef. of Var.	111.59	16.34
% deviation of mean from known value	12.80	-3.32
Norm. dev. of mean from known value	0.10	-0.21
Median	14.33	14.33
% deviation of median from known value	-4.44	-4.44
Norm. dev. of median from known value	-0.04	-0.28



Strontium-90								
Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg) (known) Tag	
	0.0	0.0	0.0	0.00	0.000	0.00	-5.02	-5.20 ×
AE	14.0	15.0	16.0	1.00	0.236	15.00	0.17	0.00
AF	15.0	15.0	16.0	0.58	0.118	15.33	0.29	0.12
AK	18.0	16.0	16.0	1.15	0.236	16.67	0.75	0.58
AL	19.0	15.0	20.0	2.65	0.591	18.00	1.21	1.04
AU								•
AW	18.0	18.0	16.0	1.15	0.236	17.33	0.98	0.81
AY	13.0	12.0	13.0	0.58	0.118	12.67	-0.64	-0.81
BA	22.0	20.0	21.0	1.00	0.236	21.00	2.25	2.08
BO	14.0	12.0	13.0	1.00	0.236	13.00	-0.52	-0.69
C	14.0	14.0	14.0	0.00	0.000	14.00	-0.17	-0.35
CA	14.0	13.0	16.0	1.53	0.354	14.33	-0.06	-0.23
CE	14.0	14.0	14.0	0.00	0.000	14.00	-0.17	-0.35
CJ	14.0	13.0	12.0	1.00	0.236	13.00	-0.52	-0.69
CK	15.0	14.0	16.0	1.00	0.236	15.00	0.17	0.00
CQ	12.0	13.0	12.0	0.58	0.118	12.33	-0.75	-0.92
CS	24.0	24.0	21.0	1.73	0.354	23.00	2.94	2.77
CX	142.0	200.0	157.0	80.11	12.146	166.33	52.60	52.42 ×
D	14.0	14.0	14.0	0.00	0.000	14.00	-0.17	-0.35
DE	15.0	15.0	15.0	0.00	0.000	15.00	0.17	0.00
DG	17.0	14.0	16.0	1.53	0.354	15.67	0.40	0.23
DO	14.0	12.0	13.0	1.00	0.236	13.00	-0.52	-0.69
DT	12.0	14.0	10.0	2.00	0.473	12.00	-0.87	-1.04
DZ	20.0	20.0	20.0	0.00	0.000	20.00	1.90	1.73
E	15.0	15.0	16.0	0.58	0.118	15.33	0.29	0.12
EB	13.0	14.0	13.0	0.58	0.118	13.33	-0.41	-0.58
EH	17.0	16.0	16.0	0.58	0.118	16.33	0.63	0.46
EL	15.0	15.0	17.0	1.15	0.236	15.67	0.40	0.23
FE	14.0	13.0	13.0	0.58	0.118	13.33	-0.41	-0.58
HK	14.0	14.0	14.0	0.00	0.000	14.00	-0.17	-0.35
HU	10.0	9.0	10.0	0.58	0.118	9.67	-1.68	-1.85
IC	15.0	15.0	14.0	0.58	0.118	14.67	0.06	-0.12
J	14.0	16.0	15.0	1.00	0.236	15.00	0.17	0.00
JE	10.0	13.0	8.0	2.52	0.591	10.33	-1.44	-1.62
JS	15.0	16.0	13.0	1.53	0.354	14.67	0.06	-0.12
JY	12.0	12.0	13.0	0.58	0.118	12.33	-0.75	-0.92
K	15.0	15.0	15.0	0.00	0.000	15.00	0.17	0.00
KX	13.0	15.0	14.0	1.00	0.236	14.00	-0.17	-0.35
L	15.0	14.0	14.0	0.58	0.118	14.33	-0.06	-0.23
LM								•
LT	18.0	18.0	18.0	0.00	0.000	18.00	1.21	1.04
M	30.0	28.0	27.0	1.53	0.354	28.33	4.79	4.62 ×
ME	13.0	15.0	14.0	1.00	0.236	14.00	-0.17	-0.35
MQ	14.0	16.0	16.0	1.15	0.236	15.33	0.29	0.12
MS	15.0	15.0	15.0	0.00	0.000	15.00	0.17	0.00

• = No data submitted

## TAG SYMBOLS

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↓ = Below control limit

**Strontium-90**

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg) (known)		Tag
N									•
NB	13.0	13.0	13.0	0.00	0.000	13.00	-0.52	-0.69	
NJ	19.0	18.0	17.0	1.00	0.236	18.00	1.21	1.04	
NT	14.0	14.0	14.0	0.00	0.000	14.00	-0.17	-0.35	
OA	15.0	14.0	16.0	1.00	0.236	15.00	0.17	0.00	
OL									•
PB	14.0	15.0	14.0	0.58	0.118	14.33	-0.06	-0.23	
PC									•
PE									•
PP									•
PU									•
PV	19.0	21.0	12.0	4.73	1.120	17.33	0.98	0.81	
QU	13.0	14.0	14.0	0.58	0.118	13.67	-0.29	-0.46	
QW	14.0	15.0	13.0	1.00	0.236	14.00	-0.17	-0.35	
QZ	13.0	12.0	12.0	0.58	0.118	12.33	-0.75	-0.92	
R	10.0	11.0	11.0	0.58	0.118	10.67	-1.33	-1.50	
RC									•
RK	15.0	14.0	15.0	0.58	0.118	14.67	0.06	-0.12	
RM	11.0	14.0	13.0	1.53	0.354	12.67	-0.64	-0.81	
RN	15.0	14.0	13.0	1.00	0.236	14.00	-0.17	-0.35	
RE									•
RU									•
S	14.0	14.0	15.0	0.58	0.118	14.33	-0.06	-0.23	
SC	13.0	14.0	12.0	1.00	0.236	13.00	-0.52	-0.69	
SD	12.0	12.0	12.0	0.00	0.000	12.00	-0.87	-1.04	
SI	14.0	15.0	16.0	1.00	0.236	15.00	0.17	0.00	
SS	14.0	15.0	14.0	0.58	0.118	14.33	-0.06	-0.23	
ST	9.0	10.0	11.0	1.00	0.236	10.00	-1.56	-1.73	
SY									•
SZ	16.0	16.0	16.0	0.00	0.000	16.00	0.52	0.35	
TA									•
TD									•
TE									•
TG									•
TI	14.0	12.0	15.0	1.53	0.354	13.67	-0.29	-0.46	
TL	12.0	13.0	11.0	1.00	0.236	12.00	-0.87	-1.04	
TM									•
TP	25.0	25.0	26.0	0.58	0.118	25.33	3.75	3.58	×
TW									•
U	15.0	14.0	16.0	1.00	0.236	15.00	0.17	0.00	

**Data sorted by Laboratory Average**

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
0.00	×		10.00		ST	10.67		R
9.67		HU	10.33		JE	12.00		TL

• = No data submitted

**TAG SYMBOLS**

↑ = Above control limit

∅ = Insufficient data

× = Determined to be an outlier

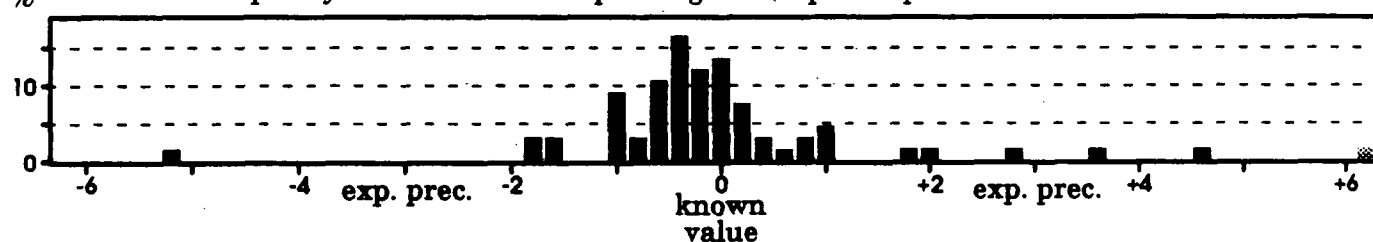
↓ = Below control limit

## Strontium-90

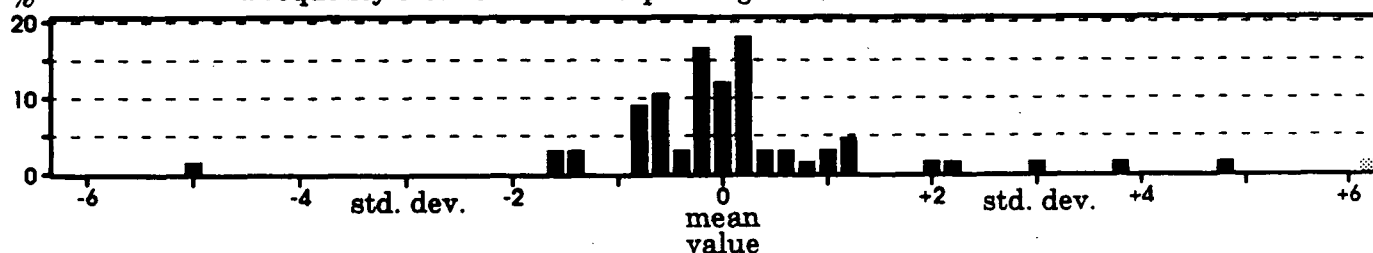
## Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
12.00		SD	14.00		KX	15.00		CK
12.00		DT	14.00		HK	15.00		AE
12.33		QZ	14.00		D	15.33		MQ
12.33		JY	14.00		CE	15.33		E
12.33		CQ	14.00		C	15.33		AF
12.67		RM	14.33		SS	15.67		EL
12.67		AY	14.33		S	15.67		DG
13.00		SC	14.33		PB	16.00		SZ
13.00		NB	14.33		L	16.33		EH
13.00		DO	14.33		CA	16.67		AK
13.00		CJ	14.67		RK	17.33		PV
13.00		BO	14.67		JS	17.33		AW
13.33		FE	14.67		IC	18.00		NJ
13.33		EB	15.00		U	18.00		LT
13.67		TI	15.00		SI	18.00		AL
13.67		QU	15.00		OA	20.00		DZ
14.00		RN	15.00		MS	21.00		BA
14.00		QW	15.00		K	23.00		CS
14.00		NT	15.00		J	25.33	×	TP
14.00		ME	15.00		DE	28.33	×	M
						166.33	×	CX

Frequency distribution of responding labs(expected prec. vs known value)



Frequency distribution of responding labs(std. dev. vs mean value)



• = No data submitted

## TAG SYMBOLS

↑ = Above control limit

∅ = Insufficient data

× = Determined to be an outlier

↓ = Below control limit