United States
Environmental Protection
Agency

Environmental Monitoring
Systems Laboratory
P.O. Box 93478
Las Vegas NV 89193-3478

EPA/600/R-92/190
September 1992

Research and Development

EPA

Uranium in Water Intercomparison Study

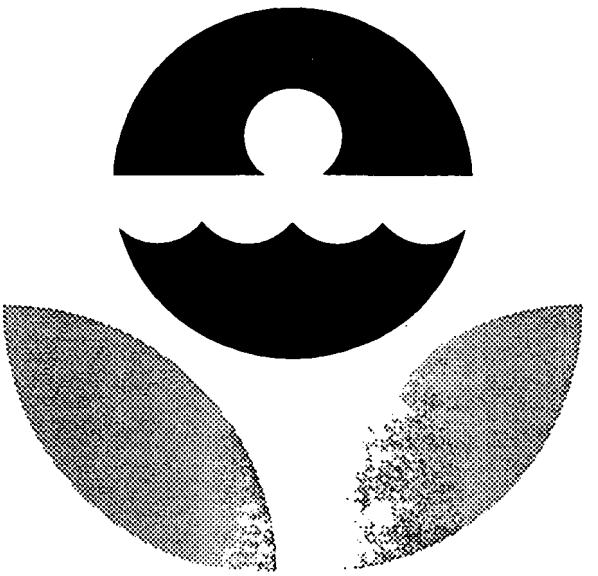
A Statistical Evaluation of the July 24, 1992 Data

5168GR92NRD-17

Uranium in Water

Intercomparison Study

July 24, 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 ***Uranium in Water; July 24, 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,

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.

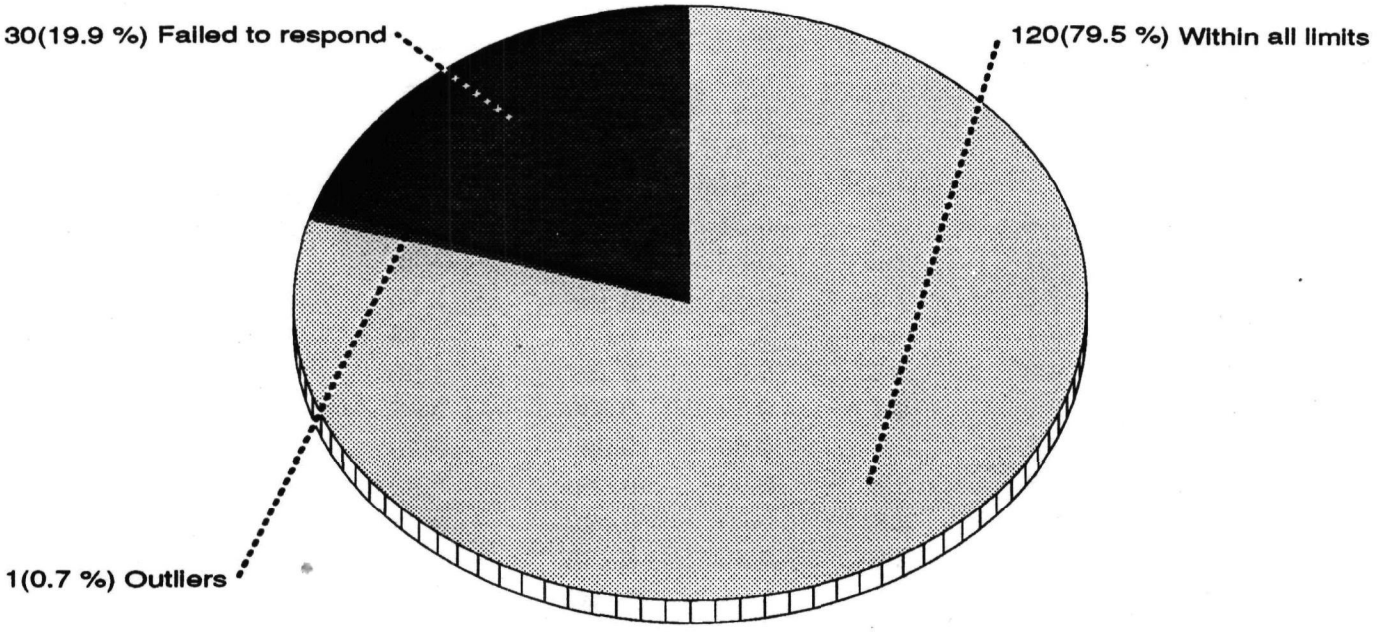
The second part is an alphabetical listing, in lab-code order, of submitted data and several calculated quantities. An entry that is shaded has been rejected because of one of the reasons listed above or failure of the outlier test. The fifth and sixth columns are a measure of laboratory precision. The 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.

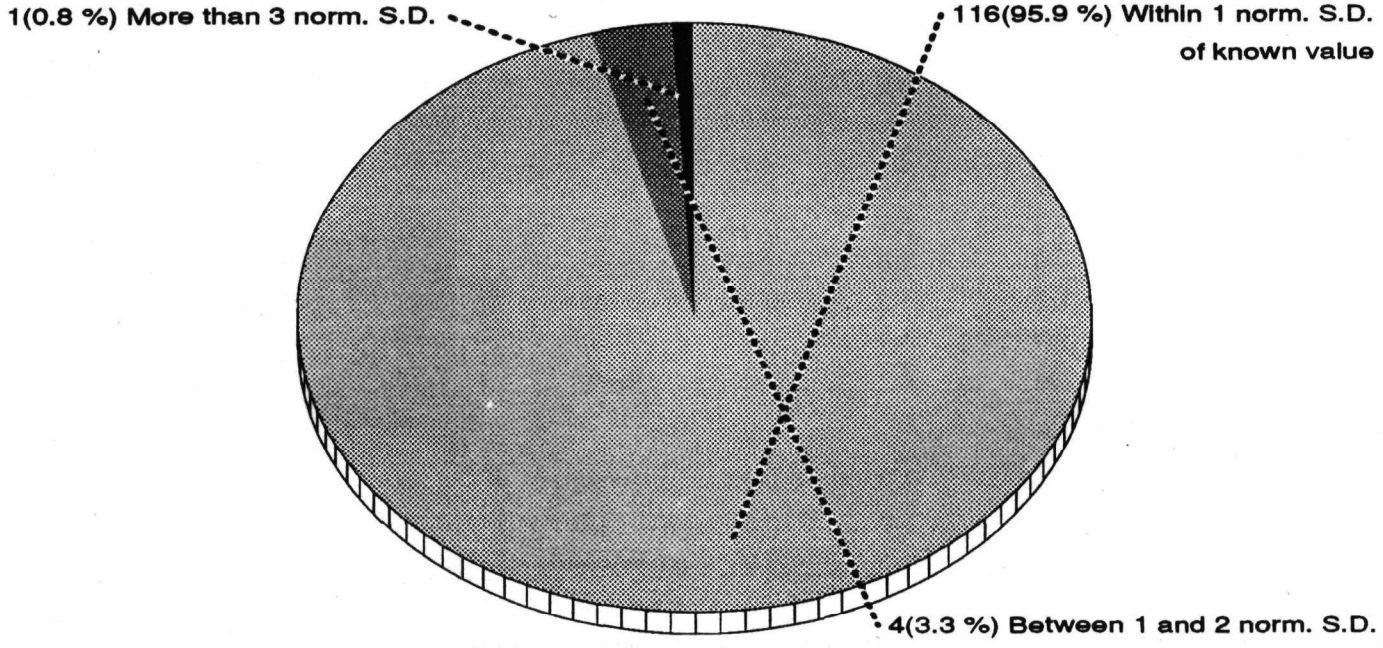
The last part is two bar chart displays showing frequency distributions of responding participants. The first chart places the known value at the center and a bar at each 0.2 unit of expected precision. The second chart places the mean of the reported measurements at the center and a bar at each 0.2 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.

Uranium (Natural) Statistical Summary 151 Participants

The known value of this nuclide is **4.0 pCi/l** with an expected precision of **3.0**; the control limits are 0.0 to 9.2; the warning regions are 0.0 to 0.5 and 7.5 to 9.2



Statistic	Respondents	Non-outliers
Mean	4.03	**Grand Avg 3.97**
Std. Dev.	0.93	0.72
Variance	0.87	0.52
% Coef. of Var.	23.10	18.24
% deviation of mean from known value	0.67	-0.67
Norm. dev. of mean from known value	0.03	-0.04
Median	4.00	3.98
% deviation of median from known value	0.00	-0.42
Norm. dev. of median from known value	0.00	-0.02



EMSL-LV Intercomparison Study: Uranium in Water, 24-Jul-1992

Uranium (Natural)

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	Normalized deviation (known)	Tag
A	4.9	4.8	4.8	0.06	0.020	4.83	0.50	0.48	
AA	4.0	4.3	3.9	0.21	0.079	4.07	0.05	0.04	
AE	2.8	2.6	2.7	0.10	0.039	2.70	-0.74	-0.75	
AF	4.0	4.1	4.3	0.15	0.059	4.13	0.09	0.08	
AI	4.1	4.2	4.0	0.10	0.039	4.10	0.07	0.06	
AJ	4.7	4.6	4.5	0.10	0.039	4.60	0.36	0.35	
AK	4.0	3.1	4.3	0.62	0.236	3.80	-0.10	-0.12	
AL	2.3	1.6	2.0	0.35	0.138	1.97	-1.16	-1.17	
AP	4.0	4.7	4.6	0.38	0.138	4.43	0.27	0.25	
AW	2.9	3.0	2.2	0.44	0.158	2.70	-0.74	-0.75	
AZ	3.2	3.1	3.4	0.15	0.059	3.23	-0.43	-0.44	
BA	3.8	4.8	4.3	0.50	0.197	4.30	0.19	0.17	
BB	3.9	3.9	4.1	0.12	0.039	3.97	0.00	-0.02	
BC	3.8	3.7	3.7	0.06	0.020	3.73	-0.14	-0.15	
BG	3.8	3.8	3.8	0.00	0.000	3.80	-0.10	-0.12	
BG	3.9	4.0	3.9	0.06	0.020	3.93	-0.02	-0.04	
BH	3.2	2.7	2.5	0.36	0.138	2.80	-0.68	-0.69	
BK	4.1	4.0	4.0	0.06	0.020	4.03	0.03	0.02	
BL									•
BM	4.7	4.7	4.3	0.23	0.079	4.57	0.34	0.33	
BN	4.5	3.7	4.1	0.40	0.158	4.10	0.07	0.06	
BO	4.3	4.2	4.6	0.21	0.079	4.37	0.23	0.21	
C	4.1	3.7	4.5	0.40	0.158	4.10	0.07	0.06	
CA	3.4	3.7	3.6	0.15	0.059	3.57	-0.23	-0.25	
CE	3.6	3.6	3.5	0.06	0.020	3.57	-0.23	-0.25	
CG	3.6	4.0	4.1	0.26	0.098	3.90	-0.04	-0.06	
CJ	3.9	3.9	4.0	0.06	0.020	3.93	-0.02	-0.04	
CK	4.2	4.8	4.5	0.30	0.118	4.50	0.30	0.29	
CM									•
CO	4.1	3.9	4.3	0.20	0.079	4.10	0.07	0.06	
CS	4.0	3.9	4.0	0.06	0.020	3.97	0.00	-0.02	
D	4.1	4.0	4.0	0.06	0.020	4.03	0.03	0.02	
DB	3.0	3.0	2.0	0.58	0.197	2.67	-0.75	-0.77	
DE	4.4	4.5	4.7	0.15	0.059	4.53	0.32	0.31	
DO	4.4	4.5	4.5	0.06	0.020	4.47	0.28	0.27	
DP	2.9	3.1	3.2	0.15	0.059	3.07	-0.52	-0.54	
DT	6.1	3.1	3.5	1.63	0.591	4.23	0.15	0.13	
DZ	3.0	2.9	3.0	0.06	0.020	2.97	-0.58	-0.60	
E	3.9	3.9	4.8	0.52	0.177	4.20	0.13	0.12	
EB	3.2	3.2	2.4	0.46	0.158	2.93	-0.60	-0.62	
EH									•
EO									•
ER	4.0	3.5	4.0	0.29	0.098	3.83	-0.08	-0.10	
FE	3.5	3.7	3.5	0.12	0.039	3.57	-0.23	-0.25	
FJ	2.8	2.9	2.8	0.06	0.020	2.83	-0.66	-0.67	

• ≡ No data submitted

∅ ≡ Insufficient data

TAG SYMBOLS

× ≡ Determined to be an outlier

⇑ ≡ Above control limit

⇓ ≡ Below control limit

Uranium (Natural)

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	Normalized deviation (known)	Tag
FN	4.0	3.8	3.9	0.10	0.039	3.90	-0.04	-0.06	
FZ	3.1	3.3	4.2	0.59	0.217	3.53	-0.25	-0.27	
GG									•
GN	5.4	5.4	5.1	0.17	0.059	5.30	0.77	0.75	
GO									•
GQ	4.8	4.7	4.4	0.21	0.079	4.63	0.38	0.37	
GZ	4.4	4.1	3.7	0.35	0.138	4.07	0.05	0.04	
HE	3.6	3.6	3.6	0.00	0.000	3.60	-0.22	-0.23	
HK	4.0	4.0	4.0	0.00	0.000	4.00	0.02	0.00	
HL	3.8	3.8	3.7	0.06	0.020	3.77	-0.12	-0.13	
HP	3.8	3.9	3.9	0.06	0.020	3.87	-0.06	-0.08	
HU									•
HY	3.6	3.4	3.1	0.25	0.098	3.37	-0.35	-0.37	
I	3.9	4.2	4.3	0.21	0.079	4.13	0.09	0.08	
ID	6.2	6.2	6.2	0.00	0.000	6.20	1.29	1.27	
IE	4.9	4.5	5.1	0.31	0.118	4.83	0.50	0.48	
J	4.1	4.3	4.3	0.12	0.039	4.23	0.15	0.13	
JE	5.8	6.8	5.2	0.81	0.315	5.93	1.13	1.12	
JG									•
JK	4.5	3.2	3.9	0.65	0.256	3.87	-0.06	-0.08	
JP	3.8	3.9	4.0	0.10	0.039	3.90	-0.04	-0.06	
JS	3.7	3.7	3.7	0.00	0.000	3.70	-0.16	-0.17	
JU	3.7	3.9	4.2	0.25	0.098	3.93	-0.02	-0.04	
JY	2.0	2.7	2.6	0.38	0.138	2.43	-0.89	-0.90	
K	4.1	4.3	4.3	0.12	0.039	4.23	0.15	0.13	
KH	3.9	3.9	3.8	0.06	0.020	3.87	-0.06	-0.08	
L	3.6	3.6	3.7	0.06	0.020	3.63	-0.20	-0.21	
LB									•
LH	4.0	4.0	4.0	0.00	0.000	4.00	0.02	0.00	
LM	3.1	3.2	3.8	0.38	0.138	3.37	-0.35	-0.37	
LS									•
LT	4.2	4.3	4.2	0.06	0.020	4.23	0.15	0.13	
LZ	3.9	3.8	3.8	0.06	0.020	3.83	-0.08	-0.10	
ME	3.4	3.4	3.5	0.06	0.020	3.43	-0.31	-0.33	
MN									•
MS	3.7	3.7	3.8	0.06	0.020	3.73	-0.14	-0.15	
N	3.1	3.4	4.7	0.85	0.315	3.73	-0.14	-0.15	
NA	4.9	4.6	4.1	0.40	0.158	4.53	0.32	0.31	
NH	4.1	5.4	5.5	0.78	0.276	5.00	0.59	0.58	
NK	2.5	3.2	3.0	0.36	0.138	2.90	-0.62	-0.64	
NO									•
NT	3.3	3.0	2.7	0.30	0.118	3.00	-0.56	-0.58	
OA									•
OB	4.1	4.1	4.2	0.06	0.020	4.13	0.09	0.08	
OF	3.9	4.4	6.1	1.15	0.433	4.80	0.48	0.46	

• ≡ No data submitted

∅ ≡ Insufficient data

TAG SYMBOLS

× ≡ Determined to be an outlier

⇑ ≡ Above control limit

⇓ ≡ Below control limit

EMSL-LV Intercomparison Study: Uranium in Water, 24-Jul-1992

Uranium (Natural)

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	Normalized deviation (known)	Tag
OK									•
OM									•
OS	2.5	2.3	2.1	0.20	0.079	2.30	-0.97	-0.98	
OY	5.0	5.2	4.9	0.15	0.059	5.03	0.61	0.60	
OZ	6.4	6.2	6.4	0.12	0.039	6.33	1.36	1.35	
P	4.4	3.7	4.4	0.40	0.138	4.17	0.11	0.10	
PB	4.5	5.0	5.0	0.29	0.098	4.83	0.50	0.48	
PC									•
PE									•
PL									•
PP	3.7	3.6	3.7	0.06	0.020	3.67	-0.18	-0.19	
PQ	3.5	3.6	3.7	0.10	0.039	3.60	-0.22	-0.23	
PV	11.0	10.8	9.5	0.81	0.295	10.43	3.73	3.71	×
PW									•
PX	5.0	5.4	4.8	0.31	0.118	5.07	0.63	0.62	
PY									•
QM	4.7	4.6	4.7	0.06	0.020	4.67	0.40	0.38	
QQ	3.4	2.2	2.6	0.61	0.236	2.73	-0.72	-0.73	
QU	4.3	4.6	4.8	0.25	0.098	4.57	0.34	0.33	
QX									•
QY	4.1	4.1	4.1	0.00	0.000	4.10	0.07	0.06	
QZ	3.8	3.7	4.0	0.15	0.059	3.83	-0.08	-0.10	
RC	4.2	3.8	4.2	0.23	0.079	4.07	0.05	0.04	
RG	4.0	3.9	4.1	0.10	0.039	4.00	0.02	0.00	
RK									•
RM	3.2	3.2	3.5	0.17	0.059	3.30	-0.39	-0.40	
RN	4.0	3.9	3.9	0.06	0.020	3.93	-0.02	-0.04	
RP	5.0	5.0	6.0	0.58	0.197	5.33	0.79	0.77	
RR	4.1	3.9	3.9	0.12	0.039	3.97	0.00	-0.02	
RV	5.6	5.3	5.8	0.25	0.098	5.57	0.92	0.90	
RW	4.9	4.8	4.8	0.06	0.020	4.83	0.50	0.48	
RZ	4.4	4.4	4.2	0.12	0.039	4.33	0.21	0.19	
S	3.4	3.5	3.7	0.15	0.059	3.53	-0.25	-0.27	
SC	3.8	3.8	3.9	0.06	0.020	3.83	-0.08	-0.10	
SD	3.6	3.4	3.4	0.12	0.039	3.47	-0.29	-0.31	
SF	4.1	4.2	4.2	0.06	0.020	4.17	0.11	0.10	
SI	2.8	2.8	2.8	0.00	0.000	2.80	-0.68	-0.69	
SM	3.8	4.1	4.2	0.21	0.079	4.03	0.03	0.02	
SO	3.6	3.4	3.9	0.25	0.098	3.63	-0.20	-0.21	
SS	3.7	3.7	3.8	0.06	0.020	3.73	-0.14	-0.15	
ST	3.8	3.9	4.1	0.15	0.059	3.93	-0.02	-0.04	
SW	3.4	3.6	3.6	0.12	0.039	3.53	-0.25	-0.27	
SY									•
SZ	4.2	3.9	4.0	0.15	0.059	4.03	0.03	0.02	
T	3.6	3.3	3.1	0.25	0.098	3.33	-0.37	-0.38	

TAG SYMBOLS

• ≡ No data submitted
∅ ≡ Insufficient data
× ≡ Determined to be an outlier
⇑ ≡ Above control limit
⇓ ≡ Below control limit

Uranium (Natural)

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	Normalized deviation (known)	Tag
TA	3.8	4.2	4.1	0.21	0.079	4.03	0.03	0.02	
TD									•
TE									•
TG									•
TI	4.2	4.6	4.2	0.23	0.079	4.33	0.21	0.19	
TJ									•
TK									•
TL	4.5	4.2	4.3	0.15	0.059	4.33	0.21	0.19	
TQ									•
TS	4.3	4.2	4.3	0.06	0.020	4.27	0.17	0.15	
TU	4.8	4.7	4.5	0.15	0.059	4.67	0.40	0.38	
TV									•
U	4.0	4.2	4.5	0.25	0.098	4.23	0.15	0.13	
W	4.2	3.9	3.9	0.17	0.059	4.00	0.02	0.00	
Y	4.0	3.8	3.9	0.10	0.039	3.90	-0.04	-0.06	
Z	3.9	3.9	4.2	0.17	0.059	4.00	0.02	0.00	

Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
1.97		AL	3.57		CE	3.93		ST
2.30		OS	3.57		CA	3.93		RN
2.43		JY	3.60		PQ	3.93		JU
2.67		DB	3.60		HE	3.93		CJ
2.70		AW	3.63		L	3.93		BG
2.70		AE	3.63		SO	3.97		RR
2.73		QQ	3.67		PP	3.97		CS
2.80		SI	3.70		JS	3.97		BB
2.80		BH	3.73		SS	4.00		Z
2.83		FJ	3.73		N	4.00		W
2.90		NK	3.73		MS	4.00		RG
2.93		EB	3.73		BC	4.00		LH
2.97		DZ	3.77		HL	4.00		HK
3.00		NT	3.80		BG	4.03		TA
3.07		DP	3.80		AK	4.03		SZ
3.23		AZ	3.83		SC	4.03		SM
3.30		RM	3.83		QZ	4.03		D
3.33		T	3.83		LZ	4.03		BK
3.37		LM	3.83		ER	4.07		RC
3.37		HY	3.87		KH	4.07		GZ
3.43		ME	3.87		JK	4.07		AA
3.47		SD	3.87		HP	4.10		QY
3.53		FZ	3.90		Y	4.10		CO
3.53		SW	3.90		JP	4.10		C
3.53		S	3.90		FN	4.10		BN
3.57		FE	3.90		CG	4.10		AI

• ≡ No data submitted

∅ ≡ Insufficient data

TAG SYMBOLS

× ≡ Determined to be an outlier

⇑ ≡ Above control limit

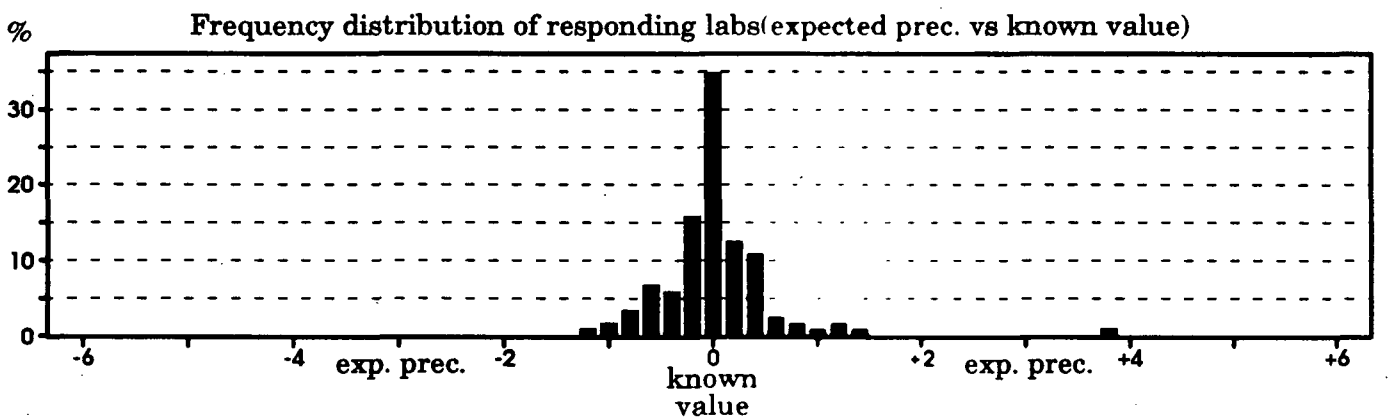
⇓ ≡ Below control limit

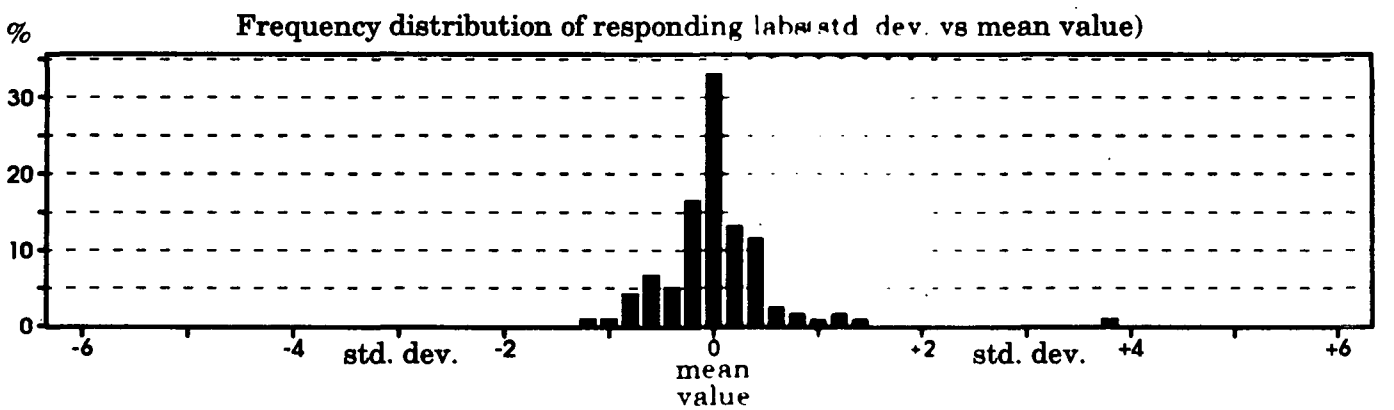
EMSL-LV Intercomparison Study: Uranium in Water, 24-Jul-1992

Uranium (Natural)

Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
4.13		OB	4.33		TI	4.80		OF
4.13		I	4.33		RZ	4.83		RW
4.13		AF	4.37		BO	4.83		PB
4.17		SF	4.43		AP	4.83		IE
4.17		P	4.47		DO	4.83		A
4.20		E	4.50		CK	5.00		NH
4.23		U	4.53		NA	5.03		OY
4.23		LT	4.53		DE	5.07		PX
4.23		DT	4.57		BM	5.30		GN
4.23		K	4.57		QU	5.33		RP
4.23		J	4.60		AJ	5.57		RV
4.27		TS	4.63		GQ	5.93		JE
4.30		BA	4.67		TU	6.20		ID
4.33		TL	4.67		QM	6.33		OZ
						10.43	×	PV





• ≡ No data submitted
∅ ≡ Insufficient data

TAG SYMBOLS

× ≡ Determined to be an outlier

⇑ ≡ Above control limit
⇓ ≡ Below control limit