United States
Environmental Protection
Agency

Office of Research and
Development
Washington, DC 20460

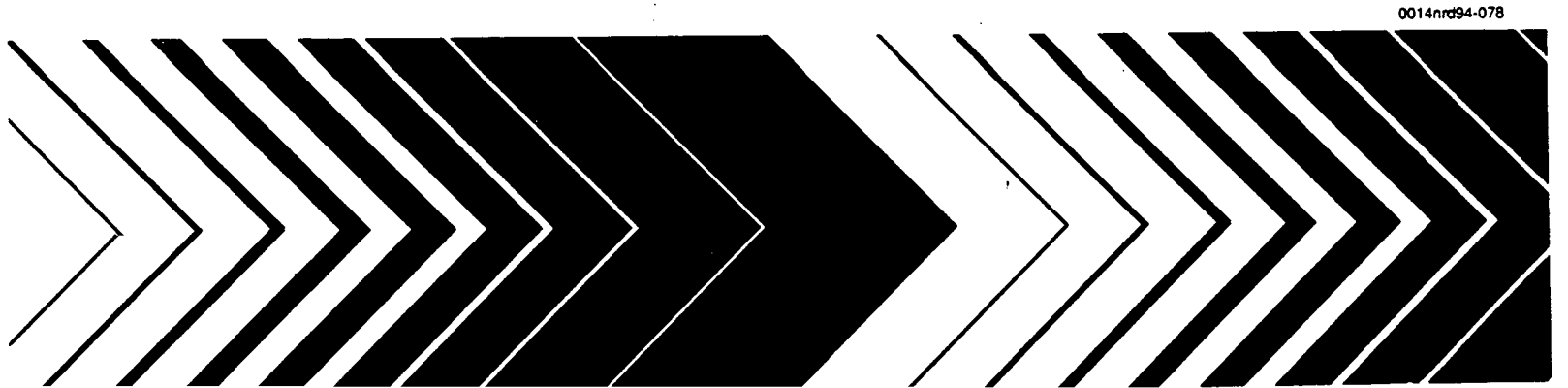
EPA/600/R-94/078
February 1994

EPA

Uranium-Radium in Water Performance Evaluation Study

A Statistical Evaluation of the February 11, 1994 Data

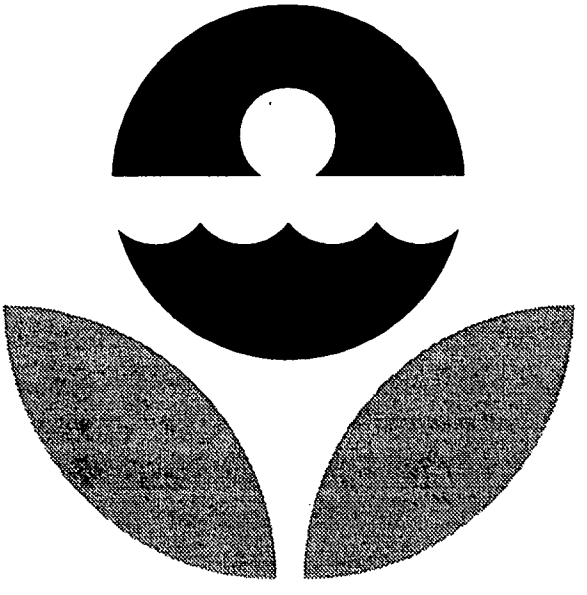
0014nrd94-078



Uranium-Radium in Water

Performance Evaluation Study

February 11, 1994



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) Performance Evaluation Study for ***Uranium-Radium in Water; February 11, 1994.***

The known value for each analysis was determined by gravimetric methods, checked by chemical analyses performed by EMSL-LV's Radiochemistry Laboratory, and compared to the participating laboratories' grand average.

The expected precision, determined by the known value, was taken from "Table 3. Laboratory Precision: One Standard Deviation Values and Control Limits for Various Analyses", which is based on data accumulated over the years by the Performance Evaluation Program, and can be found in the Environmental Radioactivity Performance Evaluation Studies Program and Radioactive Standards Distribution Program information brochure.

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 George Dilbeck at 702/798-2104 or Patricia Honsa at 702/798-2141.

Sincerely,

George Dilbeck

George Dilbeck
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 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.

The Range Analysis(R + SR) is calculated from the range, mean range and standard error of the range values. The range is the difference between the maximum and minimum results for the laboratory. The mean range is calculated by multiplying the expected precision by 1.693(for three results). The standard error of the range is calculated by multiplying the mean range by 2.575(for three results), subtracting the mean range from this product, and dividing the result by 3. If the range is greater than the mean range, then the range analysis is calculated by subtracting the mean range from the range, dividing the result by the standard error of the range and adding 1. If the mean range is greater than or equal to the range, then the range analysis is calculated by dividing the range by the mean range.

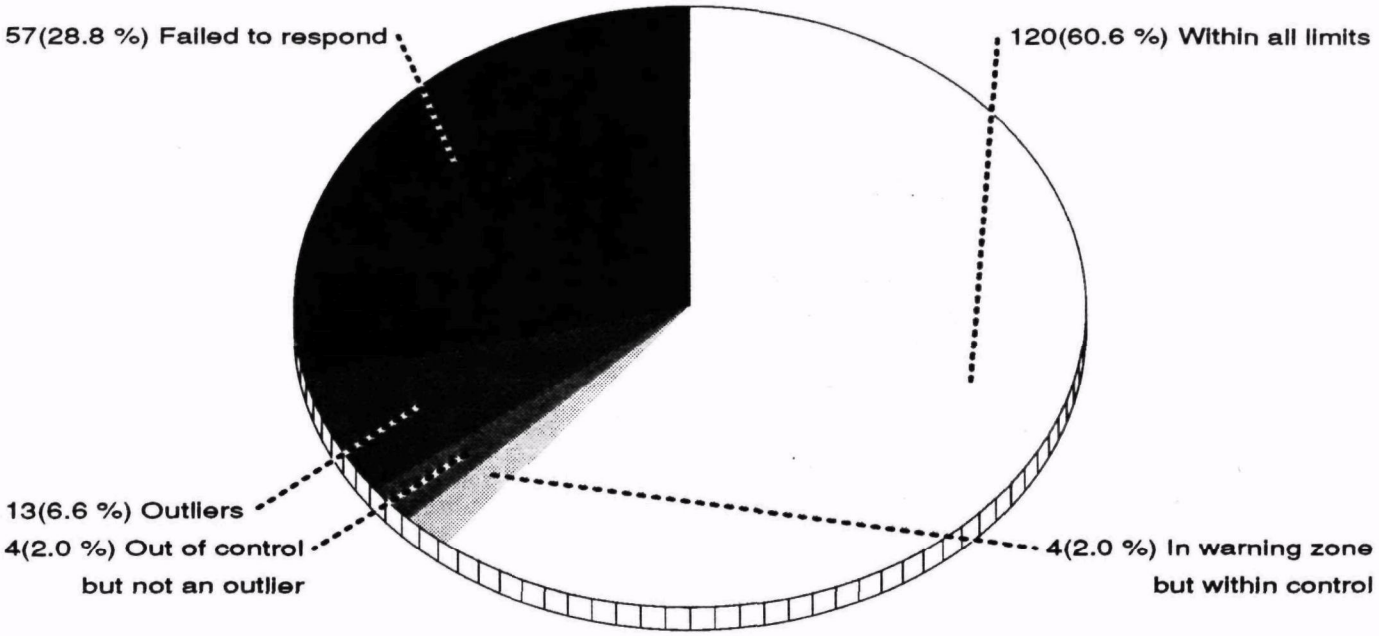
The normalized deviation of the mean from the grand average is calculated from the deviation of the mean from the grand average and the standard error of the mean values. The deviation of the mean from the grand average is calculated by subtracting the grand average from the average of the laboratory's three results. The standard error of the mean is calculated by dividing the expected precision by the square root of 3(the number of results). The normalized deviation of the mean from the grand average is calculated by dividing the deviation of the mean from the grand average by the standard error of the mean.

The normalized deviation of the mean from the known value is calculated from the deviation of the mean from the known value and the standard error of the mean values. The deviation of the mean from the known value is calculated by subtracting the known value from the average of the laboratory's three results. The standard error of the mean is calculated by dividing the expected precision by the square root of 3(the number of results). The normalized deviation of the mean from the known value is calculated by dividing the deviation of the mean from the known value by the standard error of the mean.

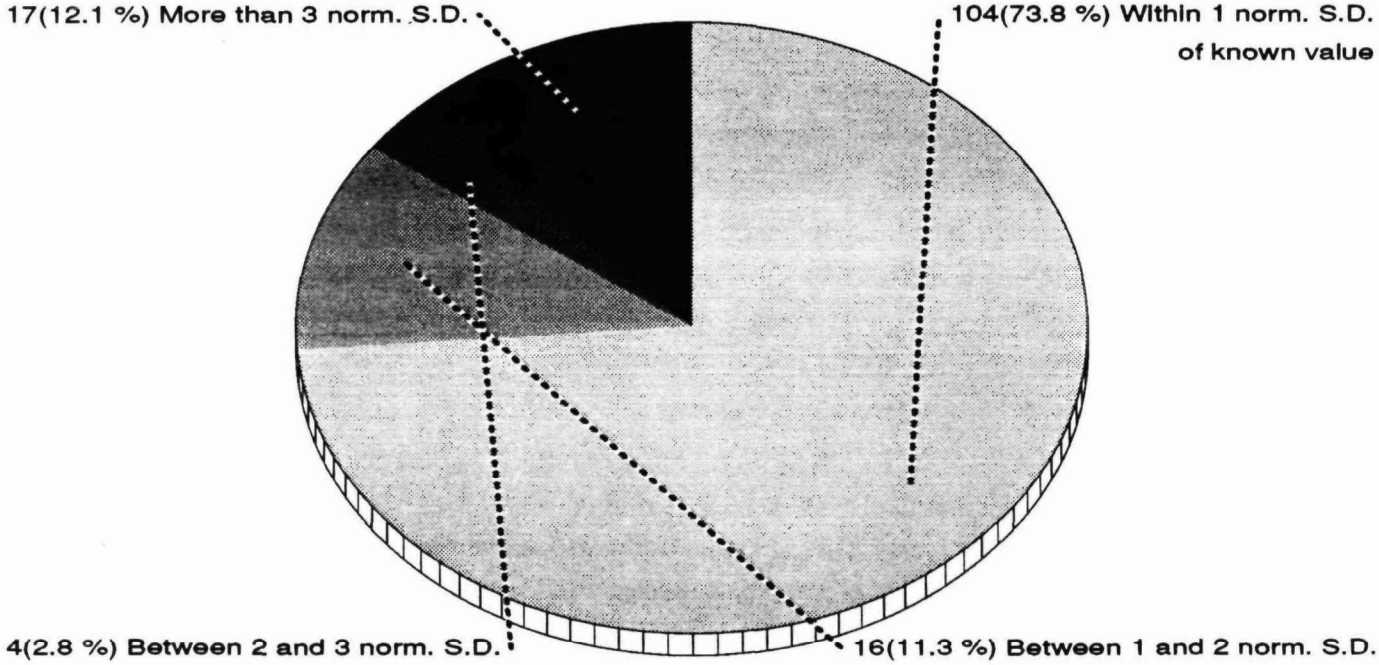
A complete explanation of the statistical calculations involved in the report may be found in the Environmental Radioactivity Performance Evaluation Studies Program information brochure [Draft Revision of EPA-600/4-81-004], available from George Dilbeck, EMSL-LV, 702/798-2104.

Uranium (Natural) Statistical Summary 198 Participants

The known value of this nuclide is **10.1 pCi/l** with an expected precision of **3.0**; the control limits are 4.9 to 15.3; the warning regions are 4.9 to 6.6 and 13.6 to 15.3



Statistic	Respondents	Non-outliers
Mean	9.92	**Grand Avg 9.64**
Std. Dev.	3.75	1.70
Variance	14.09	2.90
% Coef. of Var.	37.85	17.65
% deviation of mean from known value	-1.80	-4.54
Norm. dev. of mean from known value	-0.05	-0.27
Median	9.90	9.88
% deviation of median from known value	-1.98	-2.15
Norm. dev. of median from known value	-0.05	-0.13



Uranium (Natural)

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
A	4.4	4.0	4.0	0.23	0.079	4.13	-3.18	-3.44	⇓
AA									•
AE	9.3	9.7	9.5	0.20	0.079	9.50	-0.08	-0.35	
AF	11.8	11.9	10.8	0.61	0.217	11.50	1.07	0.81	
AI	1.0	1.0	1.0	0.00	0.000	1.00	-4.99	-5.25	×
AJ	10.5	10.9	10.3	0.31	0.118	10.57	0.53	0.27	
AK									•
AL	11.3	10.5	12.6	1.06	0.413	11.47	1.05	0.79	
AP	10.4	10.2	10.0	0.20	0.079	10.20	0.32	0.06	
AU									•
AW	10.4	10.5	10.4	0.06	0.020	10.43	0.46	0.19	
AZ	9.8	9.7	9.5	0.15	0.059	9.67	0.01	-0.25	
BA	9.3	7.0	8.0	1.15	0.453	8.10	-0.89	-1.15	
BC	8.4	9.9	8.6	0.81	0.295	8.97	-0.39	-0.65	
BG	8.8	9.6	8.7	0.49	0.177	9.03	-0.35	-0.62	
BG	10.1	9.6	9.7	0.26	0.098	9.80	0.09	-0.17	
BG	10.0	10.0	10.0	0.00	0.000	10.00	0.21	-0.06	
BH	12.1	11.1	10.6	0.76	0.295	11.27	0.94	0.67	
BK	11.6	10.8	10.7	0.49	0.177	11.03	0.80	0.54	
BL									•
BM	9.3	9.9	9.5	0.31	0.118	9.57	-0.04	-0.31	
BN	8.2	8.7	9.6	0.71	0.276	8.83	-0.47	-0.73	
BO	8.9	8.1	7.1	0.90	0.354	8.03	-0.93	-1.19	
C	9.9	9.3	9.4	0.32	0.118	9.53	-0.06	-0.33	
CA	10.1	9.8	9.3	0.40	0.158	9.73	0.05	-0.21	
CE	8.5	8.2	7.5	0.51	0.197	8.07	-0.91	-1.17	
CG	10.3	9.4	9.7	0.46	0.177	9.80	0.09	-0.17	
CJ	9.8	9.8	9.6	0.12	0.039	9.73	0.05	-0.21	
CK	10.0	9.2	8.8	0.61	0.236	9.33	-0.18	-0.44	
CM	10.2	10.1	9.9	0.15	0.059	10.07	0.25	-0.02	
CO	9.4	10.1	11.7	1.18	0.453	10.40	0.44	0.17	
CQ									•
CS	10.7	10.7	10.7	0.00	0.000	10.70	0.61	0.35	
CX	9.8	10.1	9.9	0.15	0.059	9.93	0.17	-0.10	
D	9.8	9.9	9.9	0.06	0.020	9.87	0.13	-0.13	
DB	10.3	9.8	9.8	0.29	0.098	9.97	0.19	-0.08	
DE	10.2	10.2	10.3	0.06	0.020	10.23	0.34	0.08	
DI									•
DO	10.7	10.6	10.2	0.26	0.098	10.50	0.50	0.23	
DP									•
DT	6.3	6.8	8.8	1.32	0.492	7.30	-1.35	-1.62	
DZ	9.5	10.0	10.7	0.60	0.236	10.07	0.25	-0.02	
E	9.4	9.3	9.8	0.26	0.098	9.50	-0.08	-0.35	
EB	9.1	8.4	8.4	0.40	0.138	8.63	-0.58	-0.85	
EH									•

• ≡ 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
EO									•
EP									•
ER	9.1	9.2	9.2	0.06	0.020	9.17	-0.27	-0.54	
FE	9.5	9.2	9.5	0.17	0.059	9.40	-0.14	-0.40	
FJ	3.0	2.9	2.9	0.06	0.020	2.93	-3.87	-4.14	×
FK									•
FN	10.1	9.6	8.8	0.66	0.256	9.50	-0.08	-0.35	
FP									•
FZ	10.4	11.1	10.9	0.36	0.138	10.80	0.67	0.40	
GG									•
GN	7.5	7.7	7.9	0.20	0.079	7.70	-1.12	-1.39	
GO	10.4	10.3	10.8	0.26	0.098	10.50	0.50	0.23	
GQ	10.4	9.8	10.1	0.30	0.118	10.10	0.26	0.00	
HE	21.7	20.0	20.9	0.85	0.335	20.87	6.48	6.22	×
HK	9.3	9.2	10.6	0.78	0.276	9.70	0.03	-0.23	
HL	9.3	10.4	11.7	1.20	0.473	10.47	0.48	0.21	
HP	10.2	9.6	11.1	0.75	0.295	10.30	0.38	0.12	
HU	4.7	4.8	4.9	0.10	0.039	4.80	-2.80	-3.06	⇓
I	12.6	10.9	9.6	1.50	0.591	11.03	0.80	0.54	
IA									•
ID	9.2	9.8	9.9	0.38	0.138	9.63	0.00	-0.27	
IE	10.4	11.1	10.6	0.36	0.138	10.70	0.61	0.35	
J	10.4	9.9	10.1	0.25	0.098	10.13	0.28	0.02	
JE									•
JG									•
JK	9.6	10.3	10.1	0.36	0.138	10.00	0.21	-0.06	
JN	8.8	9.2	10.5	0.89	0.335	9.50	-0.08	-0.35	
JP	10.0	9.8	10.1	0.15	0.059	9.97	0.19	-0.08	
JS	8.1	8.1	8.1	0.00	0.000	8.10	-0.89	-1.15	
JU									•
JX									•
JY	12.6	13.2	12.9	0.30	0.118	12.90	1.88	1.62	
K	9.6	11.5	10.5	0.95	0.374	10.53	0.51	0.25	
KF									•
KH	10.0	9.7	9.9	0.15	0.059	9.87	0.13	-0.13	
KL									•
L	10.1	10.3	10.5	0.20	0.079	10.30	0.38	0.12	
LA									•
LB									•
LG	3.0	3.0	3.0	0.00	0.000	3.00	-3.83	-4.10	×
LH	11.5	12.1	11.2	0.46	0.177	11.60	1.13	0.87	
LM									•
LS									•
LT	8.5	11.7	9.8	1.61	0.630	10.00	0.21	-0.06	
LZ	19.9	19.8	19.7	0.10	0.039	19.80	5.87	5.60	×

• ≡ No data submitted

∅ ≡ Insufficient data

TAG SYMBOLS

× ≡ Determined to be an outlier

⇑ ≡ Above control limit

⇓ ≡ Below control limit

EMSL-LV Performance Evaluation: Uranium-Radium in Water, 11-Feb-1994

Uranium (Natural)

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
M									•
MN									•
MS	10.0	9.9	10.2	0.15	0.059	10.03	0.23	-0.04	
MY									•
N	9.4	9.0	9.7	0.35	0.138	9.37	-0.16	-0.42	
NA	8.6	9.4	8.3	0.57	0.217	8.77	-0.51	-0.77	
NC									•
NG	13.8	15.1	14.8	0.68	0.256	14.57	2.84	2.58	
NH	10.0	10.2	10.5	0.25	0.098	10.23	0.34	0.08	
NJ	10.0	10.0	10.0	0.00	0.000	10.00	0.21	-0.06	
NK	10.4	9.3	10.2	0.59	0.217	9.97	0.19	-0.08	
NO	8.9	10.0	11.1	1.10	0.433	10.00	0.21	-0.06	
NT	7.2	7.1	7.0	0.10	0.039	7.10	-1.47	-1.73	
OB	9.2	9.0	9.0	0.12	0.039	9.07	-0.33	-0.60	
OF	8.8	8.6	8.3	0.25	0.098	8.57	-0.62	-0.89	
OK									•
OS	8.8	10.2	8.2	1.03	0.394	9.07	-0.33	-0.60	
OX	7.1	6.6	6.3	0.40	0.158	6.67	-1.72	-1.98	
OY	11.4	10.6	11.8	0.61	0.236	11.27	0.94	0.67	
OZ	8.6	8.6	9.3	0.40	0.138	8.83	-0.47	-0.73	
P	12.1	12.6	14.5	1.27	0.473	13.07	1.98	1.71	
PB	10.2	10.2	10.4	0.12	0.039	10.27	0.36	0.10	
PC	32.2	34.1	36.1	1.95	0.768	34.13	14.14	13.88	×
PE									•
PG									•
PP	22.4	22.4	22.5	0.06	0.020	22.43	7.39	7.12	×
PQ	10.2	10.1	9.9	0.15	0.059	10.07	0.25	-0.02	
PT	6.7	6.8	7.2	0.26	0.098	6.90	-1.58	-1.85	
PV	5.1	5.3	5.5	0.20	0.079	5.30	-2.51	-2.77	
PW	13.3	12.8	13.1	0.25	0.098	13.07	1.98	1.71	
PX	22.7	21.7	22.3	0.50	0.197	22.23	7.27	7.01	×
PY									•
Q	3.8	5.3	3.6	0.93	0.335	4.23	-3.12	-3.39	⇓
QB	2.2	2.3	1.9	0.21	0.079	2.13	-4.33	-4.60	×
QJ	9.5	7.5	8.5	1.00	0.394	8.50	-0.66	-0.92	
QM	10.1	11.1	11.3	0.64	0.236	10.83	0.69	0.42	
QQ	5.0	5.1	5.6	0.32	0.118	5.23	-2.55	-2.81	
QU	7.7	9.4	12.5	2.43	0.945	9.87	0.13	-0.13	
QX	8.5	8.4	8.3	0.10	0.039	8.40	-0.72	-0.98	
QZ	10.5	10.4	10.3	0.10	0.039	10.40	0.44	0.17	
R	9.7	6.5	8.1	1.60	0.630	8.10	-0.89	-1.15	
RC	10.8	11.3	13.3	1.32	0.492	11.80	1.25	0.98	
RD									•
RF									•
RG	11.7	11.3	12.2	0.45	0.177	11.73	1.21	0.94	

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)	(known)	Tag
RK	11.2	11.0	11.4	0.20	0.079	11.20	0.90	0.64	
RL	2.3	2.3	2.3	0.00	0.000	2.30	-4.24	-4.50	×
RM	10.1	8.6	9.2	0.75	0.295	9.30	-0.20	-0.46	
RP	9.4	9.4	9.4	0.00	0.000	9.40	-0.14	-0.40	
RR	10.5	10.2	9.9	0.30	0.118	10.20	0.32	0.06	
RV	10.2	9.1	14.9	3.08	1.270	11.40	1.02	0.75	
RW									•
RX									•
RZ	9.7	9.5	9.8	0.15	0.059	9.67	0.01	-0.25	
S	9.3	9.3	9.2	0.06	0.020	9.27	-0.22	-0.48	
SA									•
SC	11.0	13.4	10.4	1.59	0.591	11.60	1.13	0.87	
SD	7.8	6.7	8.0	0.70	0.256	7.50	-1.24	-1.50	
SF	10.0	9.9	9.8	0.10	0.039	9.90	0.15	-0.12	
SI	9.6	10.1	9.7	0.26	0.098	9.80	0.09	-0.17	
SL									•
SM	11.1	12.4	10.9	0.81	0.295	11.47	1.05	0.79	
SO	10.1	10.8	11.2	0.56	0.217	10.70	0.61	0.35	
SS	9.3	9.5	9.5	0.12	0.039	9.43	-0.12	-0.38	
ST	9.7	10.0	9.6	0.21	0.079	9.77	0.07	-0.19	
SW	9.7	9.2	10.5	0.66	0.256	9.80	0.09	-0.17	
SX	13.2	9.0	12.0	2.16	0.827	11.40	1.02	0.75	
SZ	9.7	9.3	9.7	0.23	0.079	9.57	-0.04	-0.31	
T	11.2	10.7	11.2	0.29	0.098	11.03	0.80	0.54	
TA									•
TD	9.7	9.6	9.7	0.06	0.020	9.67	0.01	-0.25	
TE	4.5	5.2	5.6	0.56	0.217	5.10	-2.62	-2.89	
TG	9.9	10.0	10.0	0.06	0.020	9.97	0.19	-0.08	
TH									•
TI	9.9	10.1	9.7	0.20	0.079	9.90	0.15	-0.12	
TK									•
TL	10.8	9.1	9.3	0.93	0.335	9.73	0.05	-0.21	
TN									•
TQ	8.4	9.0	8.7	0.30	0.118	8.70	-0.54	-0.81	
TR									•
TS	9.3	11.9	9.0	1.59	0.571	10.07	0.25	-0.02	
TU	11.2	11.0	11.1	0.10	0.039	11.10	0.84	0.58	
TV									•
TW									•
U	0.1	0.1	0.1	0.00	0.000	0.10	-5.51	-5.77	×
UB									•
UE	9.6	9.3	10.0	0.35	0.138	9.63	0.00	-0.27	
UI	4.3	4.3	4.6	0.17	0.059	4.40	-3.03	-3.29	⇓
UL									•
UN	15.0	16.9	18.0	1.52	0.591	16.63	4.04	3.77	×

• ≡ No data submitted

TAG SYMBOLS

⇑ ≡ Above control limit

∅ ≡ Insufficient data

× ≡ Determined to be an outlier

⇓ ≡ Below control limit

8 / 23 EMSL-LV Performance Evaluation: Uranium-Radium in Water, 11-Feb-1994

Uranium (Natural)

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
UP	7.3	7.6	7.8	0.25	0.098	7.57	-1.20	-1.46	
UQ									•
US									•
UW	9.8	8.7	8.9	0.59	0.217	9.13	-0.29	-0.56	
UZ	12.2	16.3	21.7	4.76	2.658	16.73	4.09	3.83	×
VA									•
VG	12.4	12.9	12.8	0.26	0.098	12.70	1.77	1.50	
VH									•
VI									•
VK									•
VL									•
VN									•
VQ									•
W	10.3	10.2	9.8	0.26	0.098	10.10	0.26	0.00	
WA									•
X	10.7	10.5	10.2	0.25	0.098	10.47	0.48	0.21	
Y	10.3	10.1	9.8	0.25	0.098	10.07	0.25	-0.02	
Z	9.8	9.7	10.4	0.38	0.138	9.97	0.19	-0.08	

Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
0.10	×	U	8.10		BA	9.50		AE
1.00	×	AI	8.40		QX	9.50		FN
2.13	×	QB	8.50		QJ	9.53		C
2.30	×	RL	8.57		OF	9.57		SZ
2.93	×	FJ	8.63		EB	9.57		BM
3.00	×	LG	8.70		TQ	9.63		ID
4.13	⇓	A	8.77		NA	9.63		UE
4.23	⇓	Q	8.83		BN	9.67		TD
4.40	⇓	UI	8.83		OZ	9.67		RZ
4.80	⇓	HU	8.97		BC	9.67		AZ
5.10		TE	9.03		BG	9.70		HK
5.23		QQ	9.07		OS	9.73		TL
5.30		PV	9.07		OB	9.73		CJ
6.67		OX	9.13		UW	9.73		CA
6.90		PT	9.17		ER	9.77		ST
7.10		NT	9.27		S	9.80		SW
7.30		DT	9.30		RM	9.80		SI
7.50		SD	9.33		CK	9.80		CG
7.57		UP	9.37		N	9.80		BG
7.70		GN	9.40		RP	9.87		QU
8.03		BO	9.40		FE	9.87		KH
8.07		CE	9.43		SS	9.87		D
8.10		R	9.50		JN	9.90		TI
8.10		JS	9.50		E	9.90		SF

• ≡ No data submitted

Ø ≡ Insufficient data

TAG SYMBOLS

× ≡ Determined to be an outlier

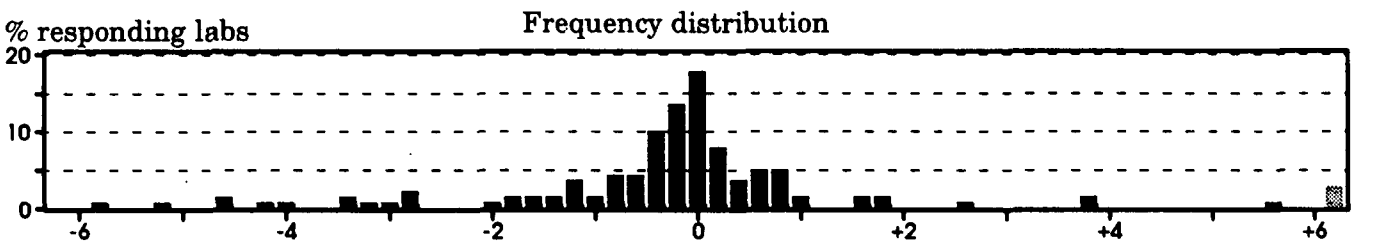
⇑ ≡ Above control limit

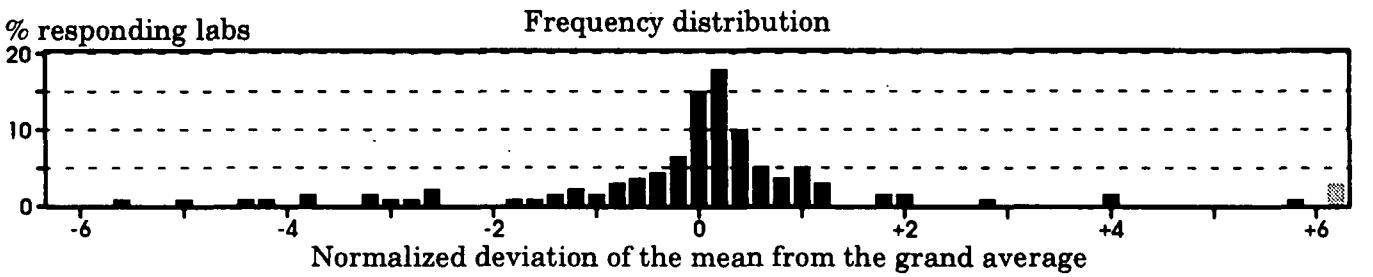
⇓ ≡ Below control limit

Uranium (Natural)

Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
9.93		CX	10.23		DE	11.27		OY
9.97		Z	10.27		PB	11.27		BH
9.97		TG	10.30		L	11.40		SX
9.97		NK	10.30		HP	11.40		RV
9.97		JP	10.40		QZ	11.47		SM
9.97		DB	10.40		CO	11.47		AL
10.00		NO	10.43		AW	11.50		AF
10.00		NJ	10.47		X	11.60		SC
10.00		LT	10.47		HL	11.60		LH
10.00		BG	10.50		GO	11.73		RG
10.00		JK	10.50		DO	11.80		RC
10.03		MS	10.53		K	12.70		VG
10.07		Y	10.57		AJ	12.90		JY
10.07		TS	10.70		CS	13.07		PW
10.07		PQ	10.70		SO	13.07		P
10.07		DZ	10.70		IE	14.57		NG
10.07		CM	10.80		FZ	16.63	×	UN
10.10		W	10.83		QM	16.73	×	UZ
10.10		GQ	11.03		T	19.80	×	LZ
10.13		J	11.03		I	20.87	×	HE
10.20		RR	11.03		BK	22.23	×	PX
10.20		AP	11.10		TU	22.43	×	PP
10.23		NH	11.20		RK	34.13	×	PC





• ≡ No data submitted
∅ ≡ Insufficient data

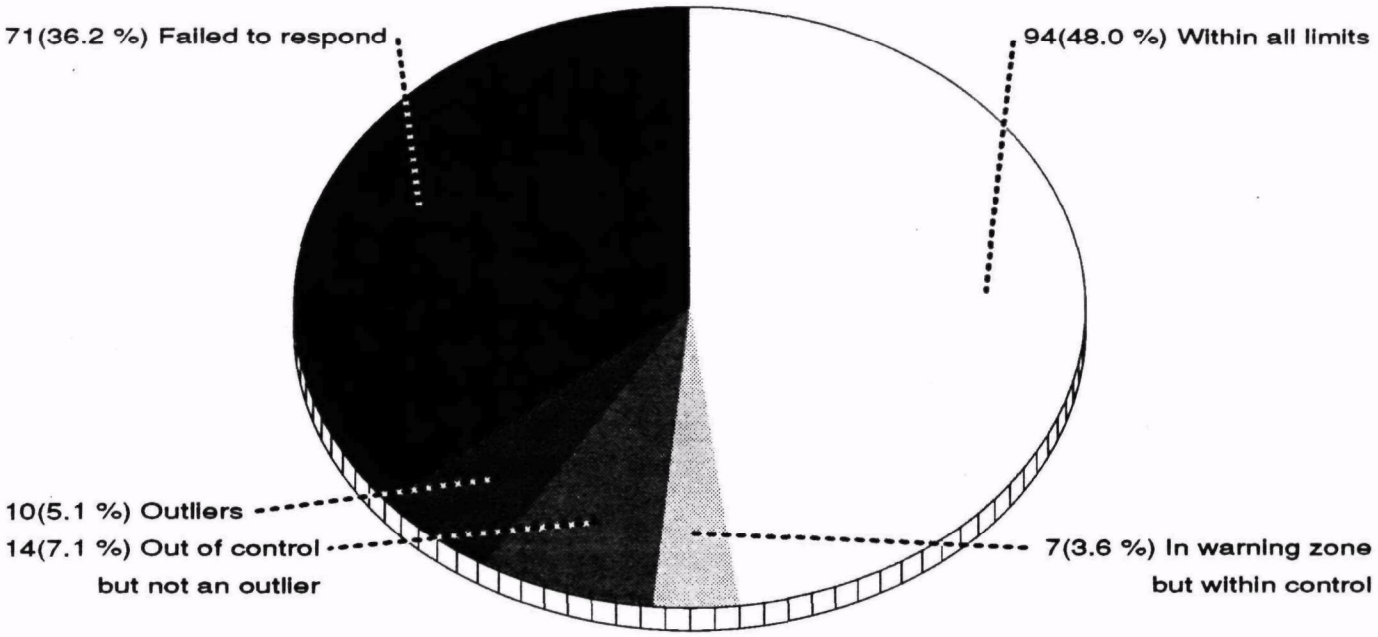
TAG SYMBOLS

× ≡ Determined to be an outlier

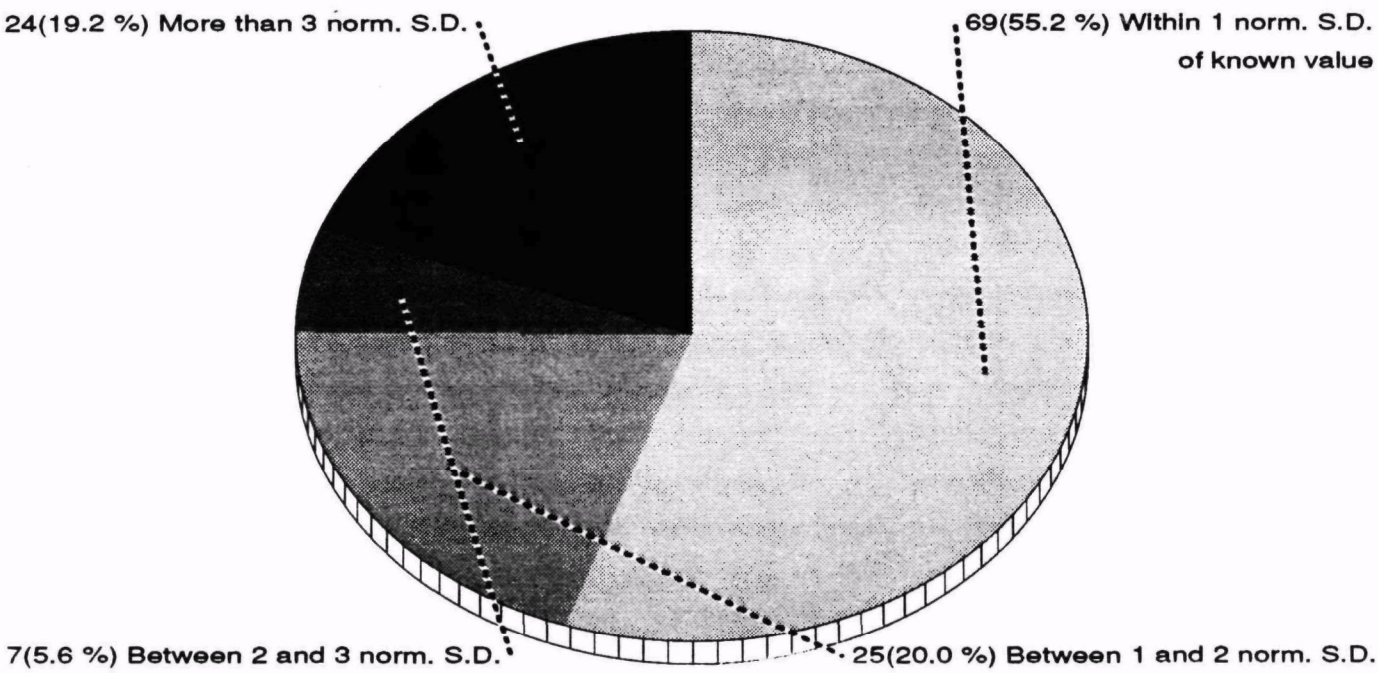
⇑ ≡ Above control limit
⇓ ≡ Below control limit

Radium-226 Statistical Summary 196 Participants

The known value of this nuclide is **19.9 pCi/l** with an expected precision of **3.0**; the control limits are 14.7 to 25.1; the warning regions are 14.7 to 16.4 and 23.4 to 25.1



Statistic	Respondents	Non-outliers
Mean	20.92	**Grand Avg 19.39**
Std. Dev.	7.54	3.51
Variance	56.83	12.34
% Coef. of Var.	36.03	18.11
% deviation of mean from known value	5.14	-2.56
Norm. dev. of mean from known value	0.14	-0.15
Median	19.50	19.40
% deviation of median from known value	-2.01	-2.51
Norm. dev. of median from known value	-0.05	-0.14



11 / 23 EMSL-LV Performance Evaluation: Uranium-Radium in Water, 11-Feb-1994

Radium-226

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
A	19.9	19.6	19.6	0.17	0.059	19.70	0.18	-0.12	
AA									•
AE	21.4	21.6	20.9	0.36	0.138	21.30	1.10	0.81	
AF	19.4	19.5	18.7	0.44	0.158	19.20	-0.11	-0.40	
AI									•
AJ	17.7	18.2	18.5	0.40	0.158	18.13	-0.73	-1.02	
AK									•
AL	18.3	18.4	19.2	0.49	0.177	18.63	-0.44	-0.73	
AP	17.1	17.3	17.4	0.15	0.059	17.27	-1.23	-1.52	
AU									•
AW	17.9	17.5	17.7	0.20	0.079	17.70	-0.98	-1.27	
AZ	17.4	17.9	18.1	0.36	0.138	17.80	-0.92	-1.21	
BA	22.1	22.8	22.8	0.40	0.138	22.57	1.83	1.54	
BC	17.7	17.7	17.5	0.12	0.039	17.63	-1.01	-1.31	
BG	29.5	29.2	28.7	0.40	0.158	29.13	5.63	5.33	⇑
BH	18.0	19.7	17.0	1.37	0.532	18.23	-0.67	-0.96	
BK	19.4	20.0	19.3	0.38	0.138	19.57	0.10	-0.19	
BL									•
BM	17.9	17.9	18.1	0.12	0.039	17.97	-0.82	-1.12	
BN	21.6	20.6	19.6	1.00	0.394	20.60	0.70	0.40	
BO	18.9	18.5	17.7	0.61	0.236	18.37	-0.59	-0.89	
C	19.4	19.2	19.0	0.20	0.079	19.20	-0.11	-0.40	
CA	20.9	18.0	19.3	1.45	0.571	19.40	0.01	-0.29	
CE	18.5	17.0	16.9	0.90	0.315	17.47	-1.11	-1.40	
CG	18.0	18.5	20.2	1.15	0.433	18.90	-0.28	-0.58	
CJ	20.0	22.0	21.0	1.00	0.394	21.00	0.93	0.64	
CK	17.0	18.0	18.0	0.58	0.197	17.67	-0.99	-1.29	
CM									•
CO									•
CQ									•
CS	20.2	20.8	20.3	0.32	0.118	20.43	0.60	0.31	
CX									•
D									•
DB	16.0	16.1	17.5	0.84	0.295	16.53	-1.65	-1.94	
DE	23.1	23.1	23.2	0.06	0.020	23.13	2.16	1.87	
DI									•
DO									•
DP									•
DT	21.6	20.6	22.3	0.85	0.335	21.50	1.22	0.92	
DZ	22.1	21.1	21.5	0.50	0.197	21.57	1.26	0.96	
E	18.6	18.6	18.0	0.35	0.118	18.40	-0.57	-0.87	
EB	20.2	19.4	20.2	0.46	0.158	19.93	0.31	0.02	
EH									•
EO	18.0	19.1	20.6	1.31	0.512	19.23	-0.09	-0.38	
EP	15.1	15.1	14.8	0.17	0.059	15.00	-2.53	-2.83	

TAG SYMBOLS

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

Radium-226

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
ER	19.9	19.2	18.8	0.56	0.217	19.30	-0.05	-0.35	
FE	25.6	23.6	23.2	1.29	0.473	24.13	2.74	2.44	
FJ									•
FK									•
FN	19.3	20.3	23.0	1.91	0.728	20.87	0.85	0.56	
FP									•
FZ	5.2	3.8	4.4	0.70	0.276	4.47	-8.62	-8.91	×
GG									•
GN	13.9	13.8	13.5	0.21	0.079	13.73	-3.27	-3.56	⇓
GO	21.9	21.2	21.7	0.36	0.138	21.60	1.28	0.98	
GQ	16.0	16.2	16.2	0.12	0.039	16.13	-1.88	-2.17	
HE	39.3	39.9	42.2	1.53	0.571	40.47	12.17	11.87	×
HK	19.6	20.6	19.7	0.55	0.197	19.97	0.33	0.04	
HL	19.1	19.2	19.1	0.06	0.020	19.13	-0.15	-0.44	
HP	18.3	21.3	20.9	1.63	0.591	20.17	0.45	0.15	
HU	19.9	19.8	19.8	0.06	0.020	19.83	0.26	-0.04	
I	21.1	23.5	21.5	1.29	0.473	22.03	1.53	1.23	
IA									•
ID	18.2	20.5	19.0	1.17	0.453	19.23	-0.09	-0.38	
IE									•
J	16.5	20.2	19.5	1.97	0.728	18.73	-0.38	-0.67	
JE									•
JG	15.0	13.1	16.5	1.70	0.669	14.87	-2.61	-2.91	
JK									•
JN	18.0	18.9	19.7	0.85	0.335	18.87	-0.30	-0.60	
JP									•
JS	20.1	17.4	20.3	1.62	0.571	19.27	-0.07	-0.37	
JU									•
JX	39.9	40.9	40.5	0.50	0.197	40.43	12.15	11.85	×
JY									•
K	17.1	18.2	18.5	0.74	0.276	17.93	-0.84	-1.14	
KF									•
KH	18.4	18.6	18.2	0.20	0.079	18.40	-0.57	-0.87	
KL	18.6	22.3	18.6	2.14	0.728	19.83	0.26	-0.04	
L	17.9	17.9	17.5	0.23	0.079	17.77	-0.94	-1.23	
LA									•
LB									•
LG									•
LH									•
LM									•
LS									•
LT	20.2	20.5	20.1	0.21	0.079	20.27	0.51	0.21	
LZ	18.3	18.1	18.3	0.12	0.039	18.23	-0.67	-0.96	
M	8.4	8.8	8.5	0.21	0.079	8.57	-6.25	-6.54	⇓
MN									•

• ≡ No data submitted

TAG SYMBOLS

⇑ ≡ Above control limit

∅ ≡ Insufficient data

× ≡ Determined to be an outlier

⇓ ≡ Below control limit

13 / 23 EMSL-LV Performance Evaluation: Uranium-Radium in Water, 11-Feb-1994

Radium-226

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
MS	19.1	23.2	25.8	3.38	1.608	22.70	1.91	1.62	
MY	39.6	39.8	39.5	0.15	0.059	39.63	11.69	11.39	×
N	20.8	21.7	21.3	0.45	0.177	21.27	1.08	0.79	
NA									•
NC									•
NG	21.3	20.9	21.1	0.20	0.079	21.10	0.99	0.69	
NH	20.7	17.8	19.8	1.48	0.571	19.43	0.03	-0.27	
NJ	30.0	42.0	34.0	6.11	3.596	35.33	9.20	8.91	×
NK									•
NO	23.0	24.0	25.0	1.00	0.394	24.00	2.66	2.37	
NT	18.8	19.5	20.2	0.70	0.276	19.50	0.06	-0.23	
OB	21.0	21.0	21.0	0.00	0.000	21.00	0.93	0.64	
OF	22.0	10.3	3.5	9.36	6.033	11.93	-4.31	-4.60	⇓
OK									•
OS									•
OX	19.8	19.6	19.6	0.12	0.039	19.67	0.16	-0.13	
OY	19.8	18.7	19.6	0.59	0.217	19.37	-0.01	-0.31	
OZ									•
P	25.7	26.3	24.9	0.70	0.276	25.63	3.60	3.31	⇑
PB	18.2	19.8	18.5	0.85	0.315	18.83	-0.32	-0.62	
PC	23.7	24.9	26.1	1.20	0.473	24.90	3.18	2.89	
PE									•
PG	21.3	20.0	20.1	0.72	0.256	20.47	0.62	0.33	
PP	41.5	41.4	41.7	0.15	0.059	41.53	12.78	12.49	×
PQ									•
PT	18.9	18.0	20.4	1.21	0.473	19.10	-0.17	-0.46	
PV	40.7	35.6	42.9	3.74	1.833	39.73	11.75	11.45	×
PW	26.5	22.4	20.5	3.07	1.345	23.13	2.16	1.87	
PX	37.6	39.3	40.7	1.55	0.610	39.20	11.44	11.14	×
PY									•
Q	22.0	20.6	23.7	1.55	0.610	22.10	1.56	1.27	
QB	19.3	19.2	19.3	0.06	0.020	19.27	-0.07	-0.37	
QJ									•
QM	19.8	19.8	19.9	0.06	0.020	19.83	0.26	-0.04	
QQ									•
QU	18.8	18.8	19.1	0.17	0.059	18.90	-0.28	-0.58	
QX									•
QZ	20.4	18.2	18.5	1.19	0.433	19.03	-0.21	-0.50	
R	18.2	16.1	15.5	1.42	0.532	16.60	-1.61	-1.91	
RC	14.5	10.8	12.4	1.86	0.728	12.57	-3.94	-4.23	⇓
RD									•
RF									•
RG									•
RK	10.3	9.4	9.9	0.45	0.177	9.87	-5.50	-5.79	⇓
RL									•

• ≡ No data submitted
∅ ≡ Insufficient data

TAG SYMBOLS
× ≡ Determined to be an outlier

⇑ ≡ Above control limit
⇓ ≡ Below control limit

Radium-226

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	Normalized deviation (known)	Tag
RM	19.3	22.4	18.4	2.10	0.788	20.03	0.37	0.08	
RP									•
RR									•
RV	76.6	77.1	59.1	10.25	5.846	70.93	29.76	29.46	×
RW									•
RX									•
RZ	19.9	19.6	18.5	0.74	0.276	19.33	-0.03	-0.33	
S	20.4	20.5	20.6	0.10	0.039	20.50	0.64	0.35	
SA									•
SC	16.3	20.3	18.5	2.00	0.788	18.37	-0.59	-0.89	
SD	18.7	19.2	20.4	0.87	0.335	19.43	0.03	-0.27	
SF	16.9	17.3	15.7	0.83	0.315	16.63	-1.59	-1.89	
SI	25.8	26.9	27.0	0.67	0.236	26.57	4.14	3.85	⇑
SL									•
SM	18.5	18.7	18.4	0.15	0.059	18.53	-0.49	-0.79	
SO									•
SS	19.6	19.5	19.4	0.10	0.039	19.50	0.06	-0.23	
ST	19.9	19.6	19.9	0.17	0.059	19.80	0.24	-0.06	
SW	35.9	31.9	33.5	2.01	0.788	33.77	8.30	8.01	×
SX	24.3	17.9	19.3	3.36	1.495	20.50	0.64	0.35	
SZ	18.7	18.6	18.6	0.06	0.020	18.63	-0.44	-0.73	
T	20.1	20.1	19.4	0.40	0.138	19.87	0.28	-0.02	
TA									•
TD	22.7	16.6	22.5	3.47	1.383	20.60	0.70	0.40	
TE	14.0	13.4	18.8	2.96	1.120	15.40	-2.30	-2.60	
TG	18.0	19.0	15.0	2.08	0.788	17.33	-1.19	-1.48	
TH	9.2	10.3	8.0	1.15	0.453	9.17	-5.90	-6.20	⇓
TI	16.7	17.0	15.9	0.57	0.217	16.53	-1.65	-1.94	
TK	30.8	27.4	34.1	3.35	1.608	30.77	6.57	6.27	⇑
TL	15.1	12.4	6.7	4.29	2.245	11.40	-4.61	-4.91	⇓
TN	20.9	20.7	18.3	1.45	0.512	19.97	0.33	0.04	
TQ	21.7	20.7	22.9	1.10	0.433	21.77	1.37	1.08	
TR									•
TS	19.8	19.3	20.9	0.82	0.315	20.00	0.35	0.06	
TU	18.4	18.8	18.6	0.20	0.079	18.60	-0.46	-0.75	
TV									•
TW									•
U	19.7	18.3	19.6	0.78	0.276	19.20	-0.11	-0.40	
UB									•
UE	21.6	22.1	23.9	1.21	0.453	22.53	1.81	1.52	
UI	20.0	20.4	19.9	0.26	0.098	20.10	0.41	0.12	
UL									•
UN	29.8	29.4	31.3	1.00	0.374	30.17	6.22	5.93	⇑
UP	17.9	18.5	18.1	0.31	0.118	18.17	-0.71	-1.00	
UQ	20.0	19.2	19.8	0.42	0.158	19.67	0.16	-0.13	

TAG SYMBOLS

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

15 / 23 EMSL-LV Performance Evaluation: Uranium-Radium in Water, 11-Feb-1994

Radium-226

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
US	18.3	22.2	17.0	2.71	1.045	19.17	-0.13	-0.42	
UW	20.1	19.1	20.6	0.76	0.295	19.93	0.31	0.02	
UZ									•
VA									•
VG	24.3	24.4	27.9	2.05	0.709	25.53	3.55	3.25	⇑
VH									•
VI									•
VK									•
VL	10.0	11.2	11.2	0.69	0.236	10.80	-4.96	-5.25	⇓
VN									•
VQ									•
W	18.5	20.5	21.4	1.48	0.571	20.13	0.43	0.13	
WA	20.2	20.1	20.0	0.10	0.039	20.10	0.41	0.12	
X	22.5	23.8	22.3	0.81	0.295	22.87	2.01	1.71	
Y									•
Z									•

Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
4.47	×	FZ	17.97		BM	19.23		EO
8.57	⇓	M	18.13		AJ	19.27		QB
9.17	⇓	TH	18.17		UP	19.27		JS
9.87	⇓	RK	18.23		LZ	19.30		ER
10.80	⇓	VL	18.23		BH	19.33		RZ
11.40	⇓	TL	18.37		SC	19.37		OY
11.93	⇓	OF	18.37		BO	19.40		CA
12.57	⇓	RC	18.40		KH	19.43		NH
13.73	⇓	GN	18.40		E	19.43		SD
14.87		JG	18.53		SM	19.50		SS
15.00		EP	18.60		TU	19.50		NT
15.40		TE	18.63		SZ	19.57		BK
16.13		GQ	18.63		AL	19.67		UQ
16.53		TI	18.73		J	19.67		OX
16.53		DB	18.83		PB	19.70		A
16.60		R	18.87		JN	19.80		ST
16.63		SF	18.90		QU	19.83		QM
17.27		AP	18.90		CG	19.83		KL
17.33		TG	19.03		QZ	19.83		HU
17.47		CE	19.10		PT	19.87		T
17.63		BC	19.13		HL	19.93		UW
17.67		CK	19.17		US	19.93		EB
17.70		AW	19.20		U	19.97		TN
17.77		L	19.20		C	19.97		HK
17.80		AZ	19.20		AF	20.00		TS
17.93		K	19.23		ID	20.03		RM

• ≡ No data submitted

∅ ≡ Insufficient data

TAG SYMBOLS

× ≡ Determined to be an outlier

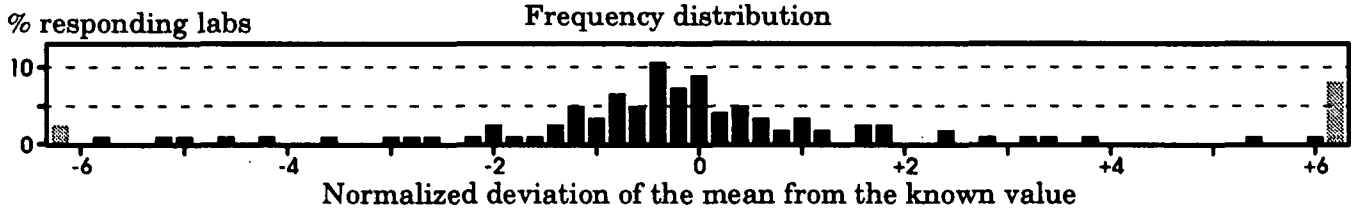
⇑ ≡ Above control limit

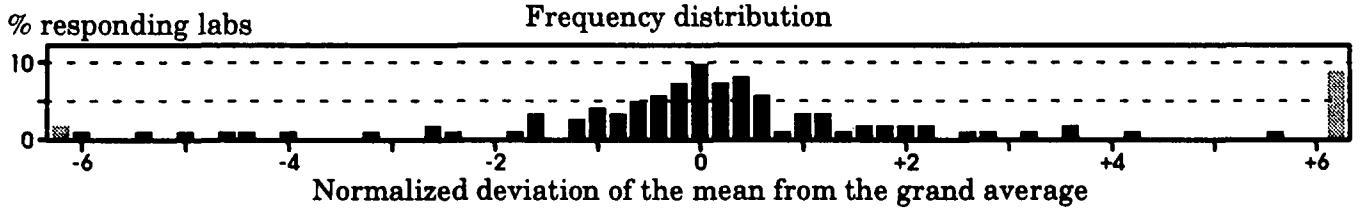
⇓ ≡ Below control limit

Radium-226

Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
20.10		WA	21.27		N	24.90		PC
20.10		UI	21.30		AE	25.53	⇑	VG
20.13		W	21.50		DT	25.63	⇑	P
20.17		HP	21.57		DZ	26.57	⇑	SI
20.27		LT	21.60		GO	29.13	⇑	BG
20.43		CS	21.77		TQ	30.17	⇑	UN
20.47		PG	22.03		I	30.77	⇑	TK
20.50		SX	22.10		Q	33.77	×	SW
20.50		S	22.53		UE	35.33	×	NJ
20.60		TD	22.57		BA	39.20	×	PX
20.60		BN	22.70		MS	39.63	×	MY
20.87		FN	22.87		X	39.73	×	PV
21.00		OB	23.13		PW	40.43	×	JX
21.00		CJ	23.13		DE	40.47	×	HE
21.10		NG	24.00		NO	41.53	×	PP
			24.13		FE	70.93	×	RV





• ≡ No data submitted
Ø ≡ Insufficient data

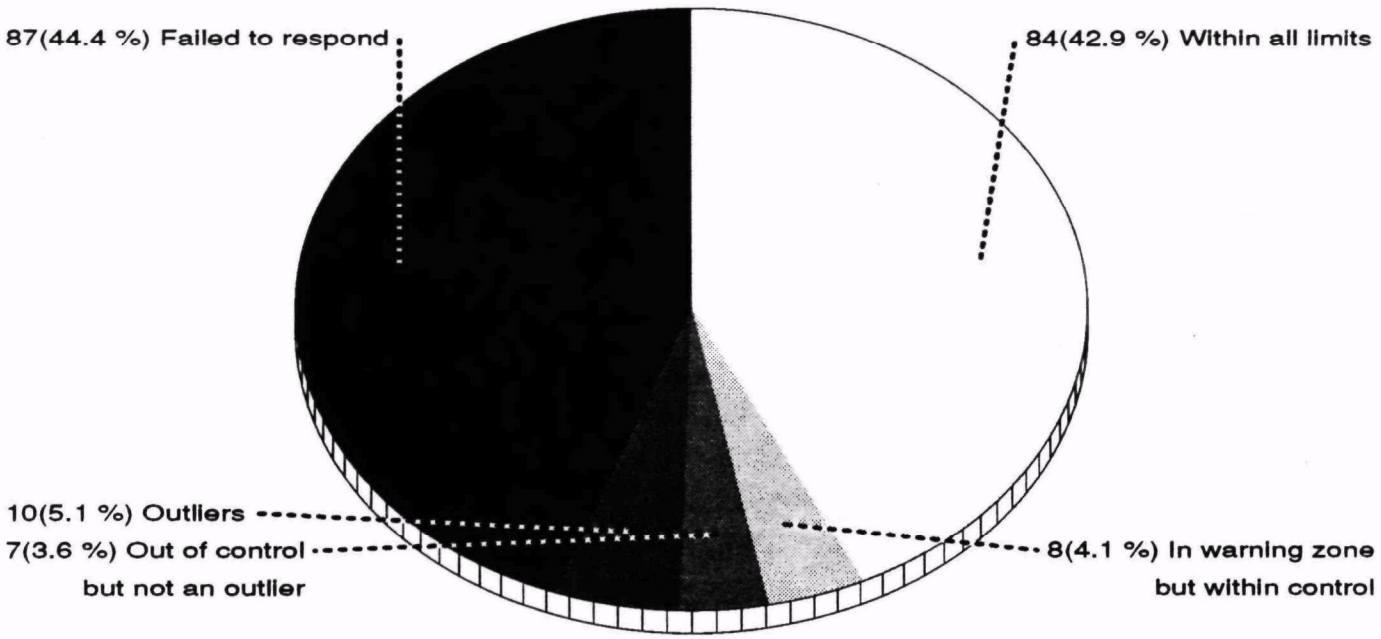
TAG SYMBOLS

× ≡ Determined to be an outlier

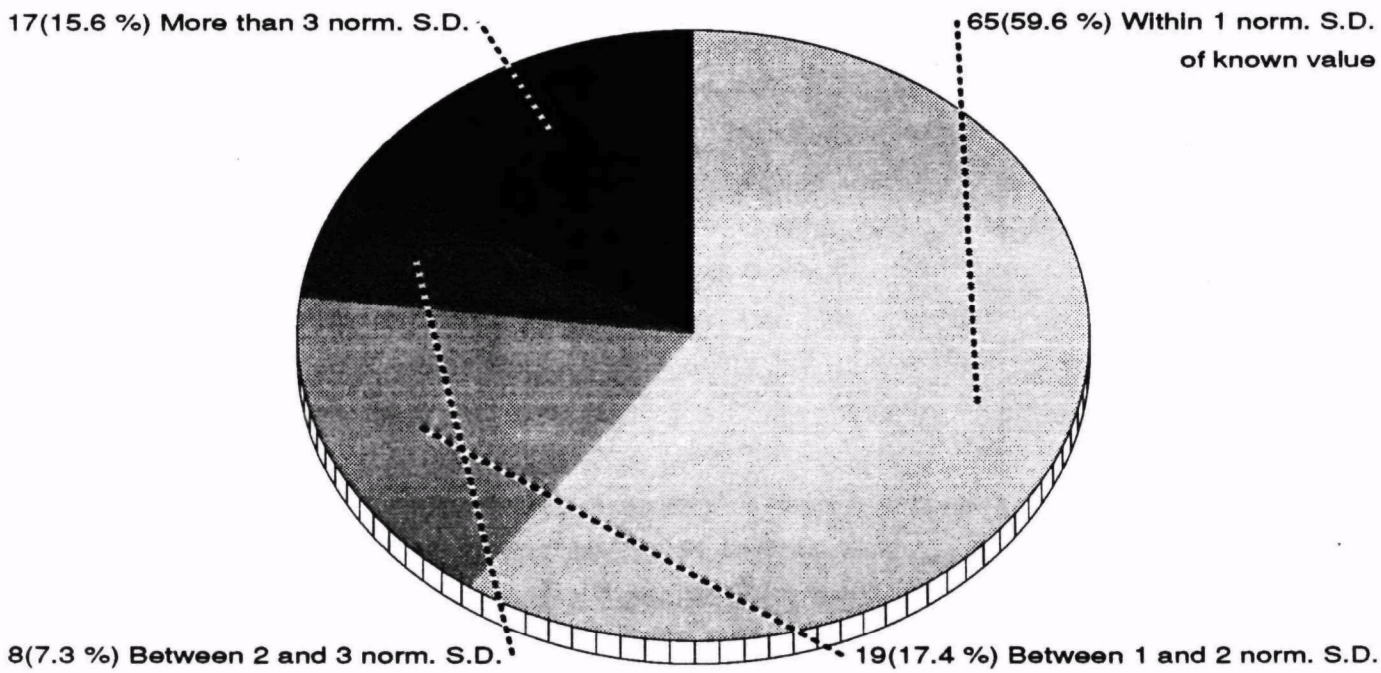
⇑ ≡ Above control limit
⇓ ≡ Below control limit

Radium-228 Statistical Summary 196 Participants

The known value of this nuclide is **14.7 pCi/l** with an expected precision of **3.7**; the control limits are 8.3 to 21.1; the warning regions are 8.3 to 10.4 and 19.0 to 21.1



Statistic	Respondents	Non-outliers
Mean	15.97	**Grand Avg 14.09**
Std. Dev.	8.08	3.07
Variance	65.30	9.43
% Coef. of Var.	50.60	21.80
% deviation of mean from known value	8.63	-4.16
Norm. dev. of mean from known value	0.16	-0.20
Median	14.80	14.10
% deviation of median from known value	0.68	-4.08
Norm. dev. of median from known value	0.01	-0.20



 EMSL-LV Performance Evaluation: Uranium-Radium in Water, 11-Feb-1994

Radium-228

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
A	8.2	9.4	6.5	1.46	0.463	8.03	-2.83	-3.12	⇓
AA									•
AE	13.1	12.7	13.5	0.40	0.128	13.10	-0.46	-0.75	
AF	15.9	15.9	16.1	0.12	0.032	15.97	0.88	0.59	
AI	17.3	15.5	14.9	1.25	0.383	15.90	0.85	0.56	
AJ	13.7	14.0	14.6	0.46	0.144	14.10	0.01	-0.28	
AK									•
AL	17.2	17.1	15.1	1.18	0.335	16.47	1.11	0.83	
AP	16.6	15.6	14.5	1.05	0.335	15.57	0.69	0.41	
AU									•
AW	11.3	12.8	11.4	0.84	0.239	11.83	-1.06	-1.34	
AZ	15.5	15.0	14.4	0.55	0.176	14.97	0.41	0.12	
BA	16.2	15.5	13.6	1.35	0.415	15.10	0.47	0.19	
BC	11.3	11.5	12.0	0.36	0.112	11.60	-1.16	-1.45	
BG									•
BH	16.7	18.2	18.3	0.90	0.255	17.73	1.71	1.42	
BK	14.2	12.7	14.9	1.12	0.351	13.93	-0.07	-0.36	
BL									•
BM	16.8	16.2	16.0	0.42	0.128	16.33	1.05	0.76	
BN									•
BO	11.9	11.6	12.0	0.21	0.064	11.83	-1.06	-1.34	
C	13.3	13.0	13.4	0.21	0.064	13.23	-0.40	-0.69	
CA	15.4	15.5	14.1	0.78	0.223	15.00	0.43	0.14	
CE	13.8	12.3	13.4	0.78	0.239	13.17	-0.43	-0.72	
CG	15.3	16.6	15.0	0.85	0.255	15.63	0.72	0.44	
CJ	17.0	14.0	16.0	1.53	0.479	15.67	0.74	0.45	
CK	14.0	13.0	13.0	0.58	0.160	13.33	-0.35	-0.64	
CM									•
CO									•
CQ									•
CS	13.0	13.8	14.4	0.70	0.223	13.73	-0.17	-0.45	
CX									•
D									•
DB	13.1	12.6	12.9	0.25	0.080	12.87	-0.57	-0.86	
DE	15.8	15.8	15.8	0.00	0.000	15.80	0.80	0.51	
DI									•
DO									•
DP									•
DT	14.8	15.2	16.0	0.61	0.192	15.33	0.58	0.30	
DZ	13.7	14.1	13.4	0.35	0.112	13.73	-0.17	-0.45	
E									•
EB	13.5	12.5	13.0	0.50	0.160	13.00	-0.51	-0.80	
EH									•
EO	10.3	12.6	11.9	1.18	0.367	11.60	-1.16	-1.45	
EP	11.3	11.0	11.1	0.15	0.048	11.13	-1.38	-1.67	

• ≡ No data submitted

∅ ≡ Insufficient data

TAG SYMBOLS

× ≡ Determined to be an outlier

⇑ ≡ Above control limit

⇓ ≡ Below control limit

Radium-228

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	Normalized deviation (known)	Tag
ER									•
FE									•
FJ									•
FK									•
FN	17.1	18.0	17.5	0.45	0.144	17.53	1.61	1.33	
FP									•
FZ	1.0	1.2	0.7	0.25	0.080	0.97	-6.14	-6.43	×
GG									•
GN	16.3	15.8	15.6	0.36	0.112	15.90	0.85	0.56	
GO	21.2	25.9	22.2	2.48	0.750	23.10	4.22	3.93	⇑
GQ	10.8	10.0	9.3	0.75	0.239	10.03	-1.90	-2.18	
HE	31.6	34.8	34.7	1.82	0.511	33.70	9.18	8.89	×
HK	11.4	12.0	12.4	0.50	0.160	11.93	-1.01	-1.30	
HL	13.6	12.5	12.6	0.61	0.176	12.90	-0.56	-0.84	
HP	13.6	13.4	14.2	0.42	0.128	13.73	-0.17	-0.45	
HU									•
I	11.9	12.9	11.7	0.64	0.192	12.17	-0.90	-1.19	
IA									•
ID	20.3	20.2	19.6	0.38	0.112	20.03	2.78	2.50	
IE									•
J	13.3	13.9	14.3	0.50	0.160	13.83	-0.12	-0.41	
JE									•
JG	19.3	20.6	21.3	1.01	0.319	20.40	2.95	2.67	
JK									•
JN									•
JP									•
JS	13.6	14.3	12.9	0.70	0.223	13.60	-0.23	-0.51	
JU									•
JX	27.4	29.6	28.5	1.10	0.351	28.50	6.75	6.46	×
JY									•
K	17.0	15.8	17.4	0.83	0.255	16.73	1.24	0.95	
KF									•
KH	15.2	16.0	15.6	0.40	0.128	15.60	0.71	0.42	
KL	18.0	18.5	17.1	0.71	0.223	17.87	1.77	1.48	
L	15.1	15.5	15.4	0.21	0.064	15.33	0.58	0.30	
LA									•
LB									•
LG									•
LH									•
LM									•
LS									•
LT	12.7	11.5	13.7	1.10	0.351	12.63	-0.68	-0.97	
LZ									•
M	7.0	7.5	7.6	0.32	0.096	7.37	-3.15	-3.43	⇓
MN									•

• ≡ No data submitted

∅ ≡ Insufficient data

TAG SYMBOLS

× ≡ Determined to be an outlier

⇑ ≡ Above control limit

⇓ ≡ Below control limit

20 / 23 EMSL-LV Performance Evaluation: Uranium-Radium in Water, 11-Feb-1994

Radium-228

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	Normalized deviation (known)	Tag
MS	4.5	3.8	4.7	0.47	0.144	4.33	-4.57	-4.85	⇓
MY									•
N	13.9	15.7	15.1	0.92	0.287	14.90	0.38	0.09	
NA									•
NC									•
NG	9.5	10.9	10.3	0.70	0.223	10.23	-1.80	-2.09	
NH	15.0	17.6	16.7	1.32	0.415	16.43	1.10	0.81	
NJ	62.0	68.0	61.0	3.79	1.224	63.67	23.21	22.92	×
NK									•
NO	15.2	16.1	17.8	1.32	0.415	16.37	1.07	0.78	
NT	13.8	14.3	13.2	0.55	0.176	13.77	-0.15	-0.44	
OB									•
OF	21.2	14.5	13.6	4.15	1.406	16.43	1.10	0.81	
OK									•
OS									•
OX	15.2	14.4	14.9	0.40	0.128	14.83	0.35	0.06	
OY	11.6	10.4	10.7	0.62	0.192	10.90	-1.49	-1.78	
OZ									•
P	14.1	16.1	14.3	1.10	0.319	14.83	0.35	0.06	
PB	14.5	15.3	14.8	0.40	0.128	14.87	0.36	0.08	
PC	18.6	19.4	20.3	0.85	0.271	19.43	2.50	2.22	
PE									•
PG									•
PP	29.0	37.4	31.6	4.30	1.649	32.67	8.70	8.41	×
PQ									•
PT	39.4	36.0	36.6	1.81	0.543	37.33	10.88	10.60	×
PV	14.8	15.9	17.1	1.15	0.367	15.93	0.86	0.58	
PW	13.0	13.1	12.4	0.38	0.112	12.83	-0.59	-0.87	
PX									•
PY									•
Q	22.2	20.3	18.4	1.90	0.607	20.30	2.91	2.62	
QB									•
QJ									•
QM									•
QQ									•
QU	4.9	6.8	9.8	2.47	0.782	7.17	-3.24	-3.53	⇓
QX									•
QZ	14.6	14.4	14.2	0.20	0.064	14.40	0.15	-0.14	
R									•
RC	18.1	14.9	13.5	2.36	0.734	15.50	0.66	0.37	
RD									•
RF									•
RG									•
RK	35.3	37.3	33.2	2.05	0.655	35.27	9.91	9.63	×
RL									•

• ≡ No data submitted
∅ ≡ Insufficient data

TAG SYMBOLS

× ≡ Determined to be an outlier

⇑ ≡ Above control limit
⇓ ≡ Below control limit

Radium-228

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	Normalized deviation (known)	Tag
RM	17.1	20.0	19.9	1.65	0.463	19.00	2.30	2.01	
RP									•
RR									•
RV	13.4	12.4	14.4	1.00	0.319	13.40	-0.32	-0.61	
RW									•
RX									•
RZ	15.6	16.1	16.8	0.60	0.192	16.17	0.97	0.69	
S	13.3	13.1	13.3	0.12	0.032	13.23	-0.40	-0.69	
SA									•
SC	8.5	8.4	8.1	0.21	0.064	8.33	-2.69	-2.98	
SD	13.1	14.6	12.9	0.93	0.271	13.53	-0.26	-0.55	
SF	14.9	16.3	13.2	1.55	0.495	14.80	0.33	0.05	
SI	15.9	11.1	12.5	2.47	0.766	13.17	-0.43	-0.72	
SL									•
SM	12.2	14.5	16.4	2.10	0.670	14.37	0.13	-0.16	
SO									•
SS	12.2	15.0	15.0	1.62	0.447	14.07	-0.01	-0.30	
ST	11.4	12.3	14.1	1.37	0.431	12.60	-0.70	-0.98	
SW	7.1	6.2	6.3	0.49	0.144	6.53	-3.54	-3.82	⇓
SX	12.8	11.9	13.3	0.71	0.223	12.67	-0.67	-0.95	
SZ	11.3	11.6	10.1	0.79	0.239	11.00	-1.45	-1.73	
T	15.6	16.5	15.4	0.59	0.176	15.83	0.82	0.53	
TA									•
TD	46.8	40.6	49.8	4.69	1.893	45.73	14.81	14.53	×
TE	15.4	16.4	15.7	0.51	0.160	15.83	0.82	0.53	
TG	12.1	12.5	11.8	0.35	0.112	12.13	-0.91	-1.20	
TH	5.5	6.1	4.8	0.65	0.208	5.47	-4.04	-4.32	⇓
TI	13.5	13.4	13.5	0.06	0.016	13.47	-0.29	-0.58	
TK	42.9	38.2	47.8	4.80	2.014	42.97	13.52	13.23	×
TL	16.1	13.8	16.2	1.36	0.383	15.37	0.60	0.31	
TN	16.7	13.4	21.2	3.92	1.467	17.10	1.41	1.12	
TQ	16.3	16.1	17.2	0.59	0.176	16.53	1.14	0.86	
TR									•
TS	15.7	16.4	14.6	0.91	0.287	15.57	0.69	0.41	
TU									•
TV									•
TW									•
U	15.1	12.0	12.5	1.66	0.495	13.20	-0.42	-0.70	
UB									•
UE	14.5	15.6	18.4	2.01	0.623	16.17	0.97	0.69	
UI	24.7	27.2	23.4	1.93	0.607	25.10	5.16	4.87	×
UL									•
UN	12.3	12.0	12.1	0.15	0.048	12.13	-0.91	-1.20	
UP	11.6	12.8	11.8	0.64	0.192	12.07	-0.95	-1.23	
UQ	12.6	12.2	11.8	0.40	0.128	12.20	-0.88	-1.17	

• ≡ No data submitted

∅ ≡ Insufficient data

TAG SYMBOLS

× ≡ Determined to be an outlier

⇑ ≡ Above control limit

⇓ ≡ Below control limit

22 / 23 EMSL-LV Performance Evaluation: Uranium-Radium in Water, 11-Feb-1994

Radium-228

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
US									•
UW	16.2	15.0	16.0	0.64	0.192	15.73	0.77	0.48	
UZ									•
VA									•
VG	17.6	13.5	16.5	2.12	0.655	15.87	0.83	0.55	
VH									•
VI									•
VK									•
VL	17.6	11.4	14.0	3.11	0.990	14.33	0.11	-0.17	
VN									•
VQ									•
W	12.1	12.8	12.0	0.44	0.128	12.30	-0.84	-1.12	
WA	13.6	13.5	13.7	0.10	0.032	13.60	-0.23	-0.51	
X	16.4	17.0	17.8	0.70	0.223	17.07	1.39	1.11	
Y									•
Z									•

Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
0.97	×	FZ	12.67		SX	14.37		SM
4.33	⇓	MS	12.83		PW	14.40		QZ
5.47	⇓	TH	12.87		DB	14.80		SF
6.53	⇓	SW	12.90		HL	14.83		P
7.17	⇓	QU	13.00		EB	14.83		OX
7.37	⇓	M	13.10		AE	14.87		PB
8.03	⇓	A	13.17		SI	14.90		N
8.33		SC	13.17		CE	14.97		AZ
10.03		GQ	13.20		U	15.00		CA
10.23		NG	13.23		S	15.10		BA
10.90		OY	13.23		C	15.33		L
11.00		SZ	13.33		CK	15.33		DT
11.13		EP	13.40		RV	15.37		TL
11.60		EO	13.47		TI	15.50		RC
11.60		BC	13.53		SD	15.57		TS
11.83		BO	13.60		WA	15.57		AP
11.83		AW	13.60		JS	15.60		KH
11.93		HK	13.73		HP	15.63		CG
12.07		UP	13.73		DZ	15.67		CJ
12.13		UN	13.73		CS	15.73		UW
12.13		TG	13.77		NT	15.80		DE
12.17		I	13.83		J	15.83		TE
12.20		UQ	13.93		BK	15.83		T
12.30		W	14.07		SS	15.87		VG
12.60		ST	14.10		AJ	15.90		GN
12.63		LT	14.33		VL	15.90		AI

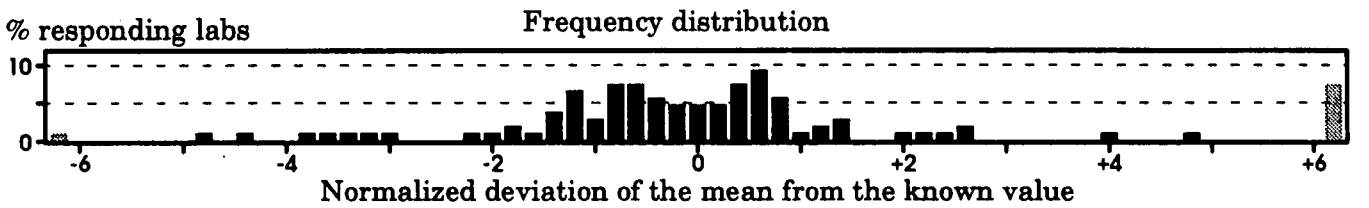
TAG SYMBOLS

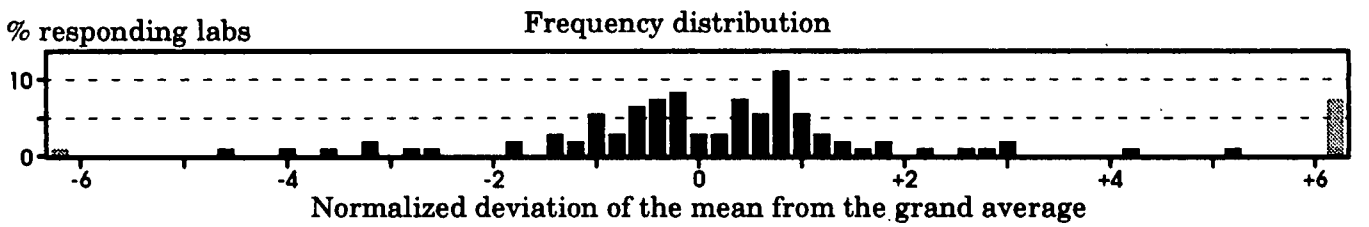
• ≡ No data submitted
∅ ≡ Insufficient data
× ≡ Determined to be an outlier
⇑ ≡ Above control limit
⇓ ≡ Below control limit

Radium-228

Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
15.93		**PV**	16.73		**K**	20.40		**JG**
15.97		**AF**	17.07		**X**	23.10	⇑	**GO**
16.17		**UE**	17.10		**TN**	25.10	×	**UI**
16.17		**RZ**	17.53		**FN**	28.50	×	**JX**
16.33		**BM**	17.73		**BH**	32.67	×	**PP**
16.37		**NO**	17.87		**KL**	33.70	×	**HE**
16.43		**OF**	19.00		**RM**	35.27	×	**RK**
16.43		**NH**	19.43		**PC**	37.33	×	**PT**
16.47		**AL**	20.03		**ID**	42.97	×	**TK**
16.53		**TQ**	20.30		**Q**	45.73	×	**TD**
						63.67	×	**NJ**





• ≡ No data submitted
∅ ≡ Insufficient data

TAG SYMBOLS

× ≡ Determined to be an outlier

⇑ ≡ Above control limit
⇓ ≡ Below control limit