&EPA

Performance Evaluation-A Intercomparison Study

A Statistical Evaluation of the October 20, 1992 Data

5168GR92NRD-A

&EPA

Performance Evaluation-A

Intercomparison Study

October 20, 1992
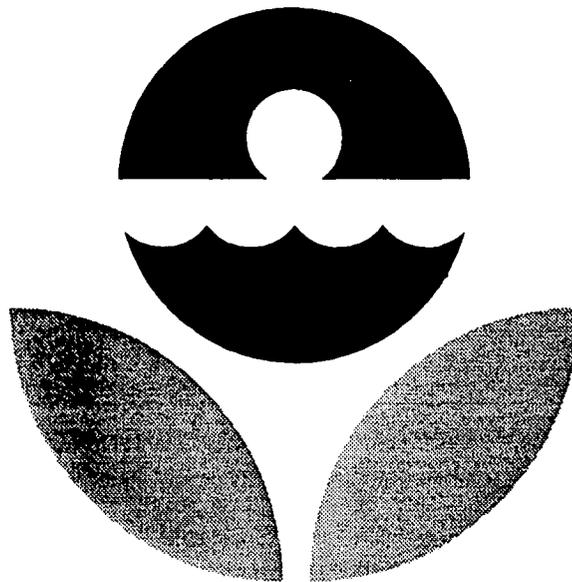
Environmental Protection Agency

Environmental Monitoring Systems Laboratory

Las Vegas, Nevada

Dear Participant,

Enclosed are the results of the Nuclear Radiation Assessment Division (EMSL-LV) Intercomparison Study for *Performance Evaluation-A; October 20, 1992.*

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 Intercomparison Program, and can be found in the Environmental Radioactivity Laboratory Intercomparison 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 Frank Novielli at 702/798-2159 or Patricia Honsa at 702/798-2141.

Sincerely,

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 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 Laboratory Intercomparison Studies Program information brochure [Draft Revision of EPA-600/4-81-004], available from Frank Novielli, EMSL-LV, 702/798-2159.

Gross Alpha   Statistical Summary   209 Participants

The known value of this nuclide is **29.0 pCi/l** with an expected precision of **7.0**; the control limits are 16.9 to 41.1; the warning regions are 16.9 to 20.9 and 37.1 to 41.1

51(24.4 %) Failed to respond

121(57.9 %) Within all limits

5(2.4 %) Outliers

5(2.4 %) Out of control
but not an outlier

27(12.9 %) In warning zone
but within control
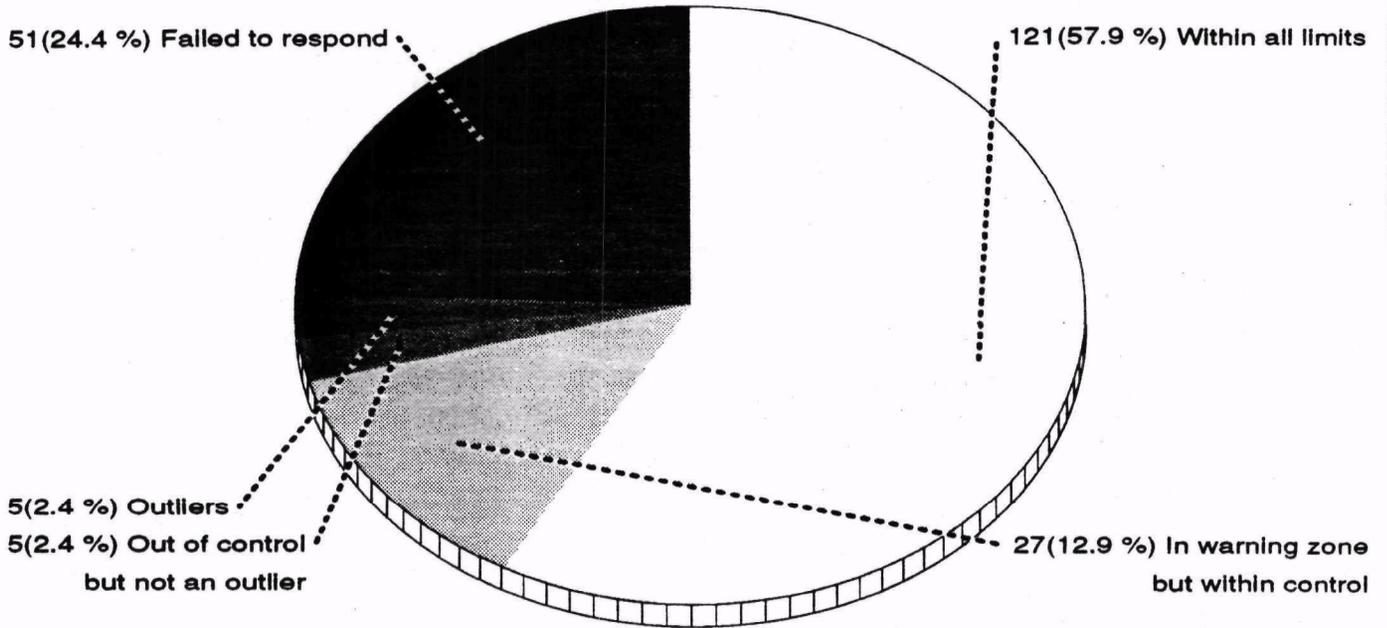
Statistic	Respondents	Non-outliers
Mean	30.19	Grand Avg 28.42
Std. Dev.	17.39	6.07
Variance	302.24	36.87
% Coef. of Var.	57.59	21.37
% deviation of mean from known value	4.09	-2.01
Norm. dev. of mean from known value	0.07	-0.10
Median	28.17	28.00
% deviation of median from known value	-2.87	-3.45
Norm. dev. of median from known value	-0.05	-0.16
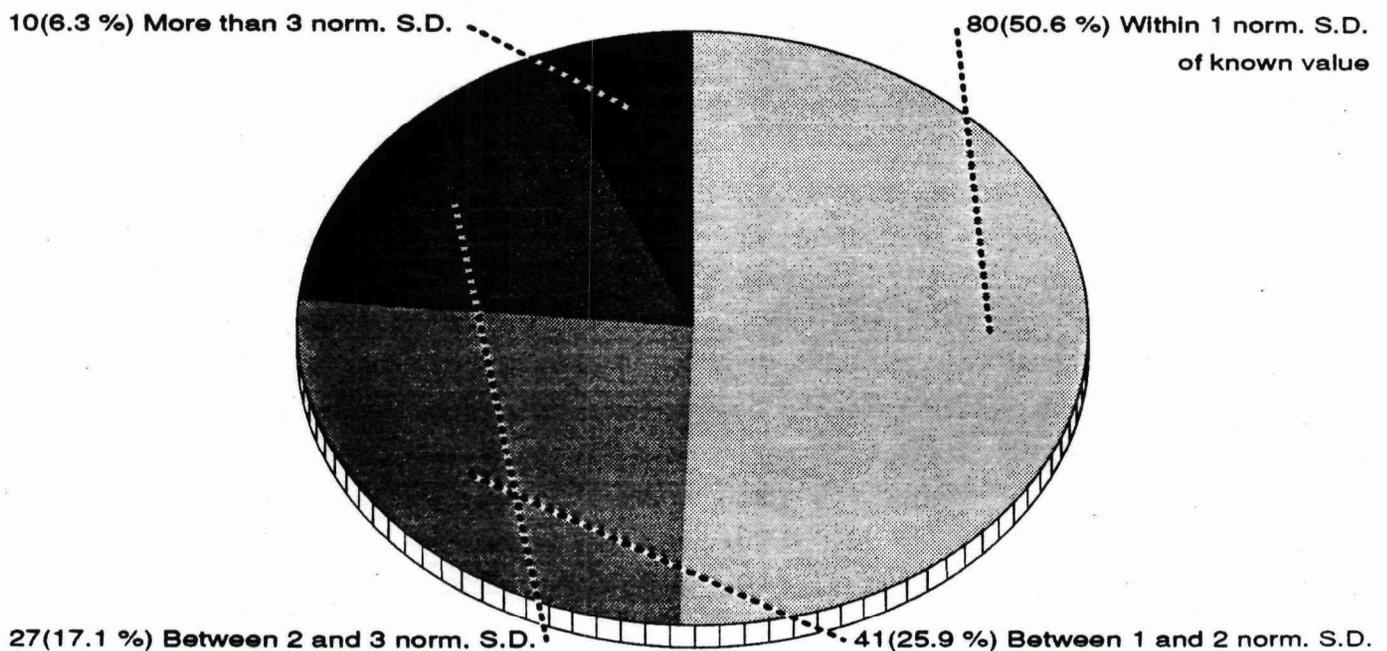
10(6.3 %) More than 3 norm. S.D.

80(50.6 %) Within 1 norm. S.D.
of known value

27(17.1 %) Between 2 and 3 norm. S.D.

41(25.9 %) Between 1 and 2 norm. S.D.

Gross Alpha

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
A	24.0	24.0	24.0	0.00	0.000	24.00	-1.09	-1.24	
AE	24.0	25.0	29.0	2.65	0.422	26.00	-0.60	-0.74	
AF	33.0	30.0	28.0	2.52	0.422	30.33	0.47	0.33	
AI	39.0	39.0	39.0	0.00	0.000	39.00	2.62	2.47	
AJ	37.0	36.0	40.0	2.08	0.338	37.67	2.29	2.14	
AK	28.0	28.0	28.0	0.00	0.000	28.00	-0.10	-0.25	
AL	25.0	29.0	27.0	2.00	0.338	27.00	-0.35	-0.49	
AO	30.0	34.0	36.0	3.06	0.506	33.33	1.22	1.07	
AP	29.0	29.0	32.0	1.73	0.253	30.00	0.39	0.25	
AR	31.0	30.0	28.0	1.53	0.253	29.67	0.31	0.16	
AU	26.0	32.0	33.0	3.79	0.591	30.33	0.47	0.33	
AW	28.0	28.0	28.0	0.00	0.000	28.00	-0.10	-0.25	
AZ	21.0	21.0	26.0	2.89	0.422	22.67	-1.42	-1.57	
BA	30.0	31.0	31.0	0.58	0.084	30.67	0.56	0.41	
BC	33.0	34.0	33.0	0.58	0.084	33.33	1.22	1.07	
BG	70.0	50.0	48.0	12.17	2.631	56.00	6.82	6.68	×
BH	28.0	29.0	30.0	1.00	0.169	29.00	0.14	0.00	
BK	22.0	23.0	24.0	1.00	0.169	23.00	-1.34	-1.48	
BL									•
BM	36.0	35.0	35.0	0.58	0.084	35.33	1.71	1.57	
BN									•
BO	21.0	20.0	20.0	0.58	0.084	20.33	-2.00	-2.14	
BS	31.0	33.0	34.0	1.53	0.253	32.67	1.05	0.91	
BW	33.0	23.0	32.0	5.51	0.844	29.33	0.23	0.08	
C	22.0	23.0	25.0	1.53	0.253	23.33	-1.26	-1.40	
CA	25.0	27.0	22.0	2.52	0.422	24.67	-0.93	-1.07	
CE	27.0	29.0	23.0	3.06	0.506	26.33	-0.52	-0.66	
CG	25.0	28.0	32.0	3.51	0.591	28.33	-0.02	-0.16	
CJ	24.0	32.0	26.0	4.16	0.675	27.33	-0.27	-0.41	
CK	25.0	24.0	26.0	1.00	0.169	25.00	-0.85	-0.99	
CO	17.0	17.0	17.0	0.00	0.000	17.00	-2.83	-2.97	
CQ	22.0	24.0	26.0	2.00	0.338	24.00	-1.09	-1.24	
CS	25.0	26.0	26.0	0.58	0.084	25.67	-0.68	-0.82	
D	39.0	41.0	40.0	1.00	0.169	40.00	2.87	2.72	
DB	25.0	26.0	26.0	0.58	0.084	25.67	-0.68	-0.82	
DD	19.0	21.0	19.0	1.15	0.169	19.67	-2.17	-2.31	
DE	35.0	35.0	36.0	0.58	0.084	35.33	1.71	1.57	
DJ									•
DL									•
DM									•
DO									•
DS	21.0	21.0	22.0	0.58	0.084	21.33	-1.75	-1.90	
DT	33.0	31.0	30.0	1.53	0.253	31.33	0.72	0.58	
DZ	25.0	27.0	26.0	1.00	0.169	26.00	-0.60	-0.74	
E	30.0	31.0	30.0	0.58	0.084	30.33	0.47	0.33	

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

Gross Alpha

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
EB	35.0	35.0	35.0	0.00	0.000	35.00	1.63	1.48	
EH	35.0	32.0	33.0	1.53	0.253	33.33	1.22	1.07	
EL									•
EO	36.0	32.0	34.0	2.00	0.338	34.00	1.38	1.24	
ER									•
EV	35.0	38.0	29.0	4.58	0.759	34.00	1.38	1.24	
EX									•
FE									•
FF	29.0	30.0	29.0	0.58	0.084	29.33	0.23	0.08	
FJ	21.0	23.0	30.0	4.73	0.759	24.67	-0.93	-1.07	
FK	7.0	8.0	6.0	1.00	0.169	7.00	-5.30	-5.44	×
FL	33.0	29.0	26.0	3.51	0.591	29.33	0.23	0.08	
FN	34.0	36.0	39.0	2.52	0.422	36.33	1.96	1.81	
FU	30.0	30.0	31.0	0.58	0.084	30.33	0.47	0.33	
FW	220.0	220.0	230.0	5.77	0.844	223.33	48.23	48.09	×
FZ	45.0	30.0	32.0	8.14	1.506	35.67	1.79	1.65	
GE									•
GI									•
GQ	30.0	30.0	30.0	0.00	0.000	30.00	0.39	0.25	
GT	21.0	23.0	17.0	3.06	0.506	20.33	-2.00	-2.14	
GZ	27.0	27.0	26.0	0.58	0.084	26.67	-0.43	-0.58	
HH	22.0	26.0	28.0	3.06	0.506	25.33	-0.76	-0.91	
HI	27.0	29.0	25.0	2.00	0.338	27.00	-0.35	-0.49	
HK	32.0	32.0	33.0	0.58	0.084	32.33	0.97	0.82	
HL	43.0	43.0	43.0	0.00	0.000	43.00	3.61	3.46	⇑
HN	19.0	23.0	24.0	2.65	0.422	22.00	-1.59	-1.73	
HP	26.0	26.0	26.0	0.00	0.000	26.00	-0.60	-0.74	
HU	39.0	39.0	39.0	0.00	0.000	39.00	2.62	2.47	
HY	25.0	24.0	26.0	1.00	0.169	25.00	-0.85	-0.99	
I	24.0	23.0	22.0	1.00	0.169	23.00	-1.34	-1.48	
IA									•
IC	42.0	38.0	38.0	2.31	0.338	39.33	2.70	2.56	
ID	22.0	22.0	24.0	1.15	0.169	22.67	-1.42	-1.57	
IE	32.0	33.0	34.0	1.00	0.169	33.00	1.13	0.99	
IU									•
J	29.0	27.0	27.0	1.15	0.169	27.67	-0.19	-0.33	
JE	19.0	22.0	26.0	3.51	0.591	22.33	-1.51	-1.65	
JG	31.0	29.0	33.0	2.00	0.338	31.00	0.64	0.49	
JH	63.0	60.0	61.0	1.53	0.253	61.33	8.14	8.00	×
JN	22.0	22.0	19.0	1.73	0.253	21.00	-1.84	-1.98	
JQ	24.0	25.0	29.0	2.65	0.422	26.00	-0.60	-0.74	
JS	18.0	21.0	20.0	1.53	0.253	19.67	-2.17	-2.31	
JX									•
JY	28.0	29.0	29.0	0.58	0.084	28.67	0.06	-0.08	
K	24.0	33.0	34.0	5.51	0.844	30.33	0.47	0.33	

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

Gross Alpha

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
KE	50.0	49.0	47.0	1.53	0.253	48.67	5.01	4.87	⇑
KT	29.0	30.0	30.0	0.58	0.084	29.67	0.31	0.16	
KX	27.0	31.0	31.0	2.31	0.338	29.67	0.31	0.16	
KZ	31.0	32.0	32.0	0.58	0.084	31.67	0.80	0.66	
L	27.0	30.0	30.0	1.73	0.253	29.00	0.14	0.00	
LE	22.0	21.0	19.0	1.53	0.253	20.67	-1.92	-2.06	
LF	25.0	28.0	26.0	1.53	0.253	26.33	-0.52	-0.66	
LG									•
LM									•
LR	26.0	21.0	23.0	2.52	0.422	23.33	-1.26	-1.40	
LT	24.0	26.0	25.0	1.00	0.169	25.00	-0.85	-0.99	
M	25.0	26.0	25.0	0.58	0.084	25.33	-0.76	-0.91	
MA									•
ME	37.0	32.0	34.0	2.52	0.422	34.33	1.46	1.32	
MN									•
MO									•
MP									•
MQ	21.0	22.0	22.0	0.58	0.084	21.67	-1.67	-1.81	
MS	18.0	19.0	20.0	1.00	0.169	19.00	-2.33	-2.47	
MV	28.0	33.0	30.0	2.52	0.422	30.33	0.47	0.33	
MY									•
N									•
NA	28.0	29.0	30.0	1.00	0.169	29.00	0.14	0.00	
NG									•
NH	22.0	19.0	19.0	1.73	0.253	20.00	-2.08	-2.23	
NJ	27.0	25.0	30.0	2.52	0.422	27.33	-0.27	-0.41	
NK	31.0	31.0	29.0	1.15	0.169	30.33	0.47	0.33	
NO	22.0	23.0	21.0	1.00	0.169	22.00	-1.59	-1.73	
NT	36.0	36.0	36.0	0.00	0.000	36.00	1.88	1.73	
NZ									•
O	31.0	33.0	34.0	1.53	0.253	32.67	1.05	0.91	
OE	24.0	25.0	26.0	1.00	0.169	25.00	-0.85	-0.99	
OF	75.0	74.0	72.0	1.53	0.253	73.67	11.20	11.05	×
OK									•
OL									•
OM									•
OS	31.0	30.0	29.0	1.00	0.169	30.00	0.39	0.25	
OX	20.0	18.0	19.0	1.00	0.169	19.00	-2.33	-2.47	
OY	42.0	48.0	42.0	3.46	0.506	44.00	3.86	3.71	⇑
OZ									•
P	25.0	29.0	39.0	7.21	1.345	31.00	0.64	0.49	
PA	18.0	20.0	12.0	4.16	0.675	16.67	-2.91	-3.05	⇓
PB	35.0	37.0	36.0	1.00	0.169	36.00	1.88	1.73	
PC									•
PE									•

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

Gross Alpha

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
PG	28.0	28.0	28.0	0.00	0.000	28.00	-0.10	-0.25	
PL									•
PM	24.0	27.0	24.0	1.73	0.253	25.00	-0.85	-0.99	
PP									•
PQ	22.0	22.0	19.0	1.73	0.253	21.00	-1.84	-1.98	
PR									•
PT	38.0	37.0	37.0	0.58	0.084	37.33	2.21	2.06	
PV	25.0	36.0	34.0	5.86	0.928	31.67	0.80	0.66	
PW	36.0	35.0	34.0	1.00	0.169	35.00	1.63	1.48	
PY									•
Q	21.0	20.0	19.0	1.00	0.169	20.00	-2.08	-2.23	
QC	32.0	27.0	34.0	3.61	0.591	31.00	0.64	0.49	
QK									•
QP	24.0	25.0	28.0	2.08	0.338	25.67	-0.68	-0.82	
QQ	36.0	36.0	36.0	0.00	0.000	36.00	1.88	1.73	
QT	24.0	15.0	20.0	4.51	0.759	19.67	-2.17	-2.31	
QU	38.0	42.0	40.0	2.00	0.338	40.00	2.87	2.72	
QW	39.0	41.0	40.0	1.00	0.169	40.00	2.87	2.72	
QX	19.0	19.0	20.0	0.58	0.084	19.33	-2.25	-2.39	
QZ	25.0	26.0	23.0	1.53	0.253	24.67	-0.93	-1.07	
RC	24.0	25.0	26.0	1.00	0.169	25.00	-0.85	-0.99	
RD	36.0	38.0	50.0	7.57	1.345	41.33	3.20	3.05	⇑
RE	47.0	39.0	35.0	6.11	1.024	40.33	2.95	2.80	
RF	32.0	30.0	32.0	1.15	0.169	31.33	0.72	0.58	
RG	20.0	20.0	21.0	0.58	0.084	20.33	-2.00	-2.14	
RJ	34.0	36.0	35.0	1.00	0.169	35.00	1.63	1.48	
RK	21.0	21.0	20.0	0.58	0.084	20.67	-1.92	-2.06	
RM	37.0	31.0	34.0	3.00	0.506	34.00	1.38	1.24	
RN	27.0	30.0	28.0	1.53	0.253	28.33	-0.02	-0.16	
RO									•
RP									•
RR									•
RT	25.0	23.0	24.0	1.00	0.169	24.00	-1.09	-1.24	
RU									•
RV	33.0	32.0	38.0	3.21	0.506	34.33	1.46	1.32	
RZ	27.0	29.0	31.0	2.00	0.338	29.00	0.14	0.00	
S	27.0	28.0	29.0	1.00	0.169	28.00	-0.10	-0.25	
SC	36.0	34.0	32.0	2.00	0.338	34.00	1.38	1.24	
SD	31.0	30.0	26.0	2.65	0.422	29.00	0.14	0.00	
SF	28.0	26.0	26.0	1.15	0.169	26.67	-0.43	-0.58	
SG	36.0	31.0	31.0	2.89	0.422	32.67	1.05	0.91	
SI	28.0	24.0	23.0	2.65	0.422	25.00	-0.85	-0.99	
SL	24.0	31.0	26.0	3.61	0.591	27.00	-0.35	-0.49	
SN									•
SO	18.0	18.0	22.0	2.31	0.338	19.33	-2.25	-2.39	

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

Gross Alpha

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
SR	32.0	31.0	33.0	1.00	0.169	32.00	0.89	0.74	
SS	21.0	18.0	21.0	1.73	0.253	20.00	-2.08	-2.23	
ST									•
SW									•
SX	27.0	30.0	29.0	1.53	0.253	28.67	0.06	-0.08	
SZ	29.0	28.0	25.0	2.08	0.338	27.33	-0.27	-0.41	
T	25.0	26.0	29.0	2.08	0.338	26.67	-0.43	-0.58	
TA									•
TE	20.0	30.0	28.0	5.29	0.844	26.00	-0.60	-0.74	
TG	23.0	23.0	29.0	3.46	0.506	25.00	-0.85	-0.99	
TH	24.0	23.0	25.0	1.00	0.169	24.00	-1.09	-1.24	
TI	33.0	27.0	26.0	3.79	0.591	28.67	0.06	-0.08	
TK									•
TL	19.0	18.0	18.0	0.58	0.084	18.33	-2.50	-2.64	
TM	25.0	25.0	25.0	0.00	0.000	25.00	-0.85	-0.99	
TN	17.0	19.0	20.0	1.53	0.253	18.67	-2.41	-2.56	
TP	35.0	36.0	36.0	0.58	0.084	35.67	1.79	1.65	
TQ	32.0	32.0	31.0	0.58	0.084	31.67	0.80	0.66	
TR									•
TS									•
TT									•
TV									•
TW									•
TY	17.0	24.0	25.0	4.36	0.675	22.00	-1.59	-1.73	
TZ									•
U	25.0	24.0	26.0	1.00	0.169	25.00	-0.85	-0.99	
UA	28.0	30.0	26.0	2.00	0.338	28.00	-0.10	-0.25	
W	26.0	25.0	26.0	0.58	0.084	25.67	-0.68	-0.82	
X	33.0	33.0	30.0	1.73	0.253	32.00	0.89	0.74	

Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
7.00	×	FK	20.00		Q	22.00		HN
16.67	⇓	PA	20.00		NH	22.33		JE
17.00		CO	20.33		RG	22.67		ID
18.33		TL	20.33		GT	22.67		AZ
18.67		TN	20.33		BO	23.00		I
19.00		OX	20.67		RK	23.00		BK
19.00		MS	20.67		LE	23.33		LR
19.33		SO	21.00		PQ	23.33		C
19.33		QX	21.00		JN	24.00		TH
19.67		QT	21.33		DS	24.00		RT
19.67		JS	21.67		MQ	24.00		CQ
19.67		DD	22.00		TY	24.00		A
20.00		SS	22.00		NO	24.67		QZ

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

Gross Alpha

Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
24.67		FJ	28.00		AK	32.67		O
24.67		CA	28.33		RN	32.67		BS
25.00		U	28.33		CG	33.00		IE
25.00		TM	28.67		TI	33.33		EH
25.00		TG	28.67		SX	33.33		BC
25.00		SI	28.67		JY	33.33		AO
25.00		RC	29.00		SD	34.00		SC
25.00		PM	29.00		RZ	34.00		RM
25.00		OE	29.00		NA	34.00		EV
25.00		LT	29.00		L	34.00		EO
25.00		HY	29.00		BH	34.33		RV
25.00		CK	29.33		FL	34.33		ME
25.33		M	29.33		FF	35.00		RJ
25.33		HH	29.33		BW	35.00		PW
25.67		W	29.67		KX	35.00		EB
25.67		QP	29.67		KT	35.33		DE
25.67		DB	29.67		AR	35.33		BM
25.67		CS	30.00		OS	35.67		TP
26.00		TE	30.00		GQ	35.67		FZ
26.00		JQ	30.00		AP	36.00		QQ
26.00		HP	30.33		NK	36.00		PB
26.00		DZ	30.33		MV	36.00		NT
26.00		AE	30.33		K	36.33		FN
26.33		LF	30.33		FU	37.33		PT
26.33		CE	30.33		E	37.67		AJ
26.67		T	30.33		AU	39.00		HU
26.67		SF	30.33		AF	39.00		AI
26.67		GZ	30.67		BA	39.33		IC
27.00		SL	31.00		QC	40.00		QW
27.00		HI	31.00		P	40.00		QU
27.00		AL	31.00		JG	40.00		D
27.33		SZ	31.33		RF	40.33		RE
27.33		NJ	31.33		DT	41.33	⇑	RD
27.33		CJ	31.67		TQ	43.00	⇑	HL
27.67		J	31.67		PV	44.00	⇑	OY
28.00		UA	31.67		KZ	48.67	⇑	KE
28.00		S	32.00		X	56.00	×	BG
28.00		PG	32.00		SR	61.33	×	JH
28.00		AW	32.33		HK	73.67	×	OF
			32.67		SG	223.33	×	FW

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

Gross Alpha

% responding labs

Frequency distribution

Normalized deviation of the mean from the known value

% responding labs

Frequency distribution

Normalized deviation of the mean from the grand average
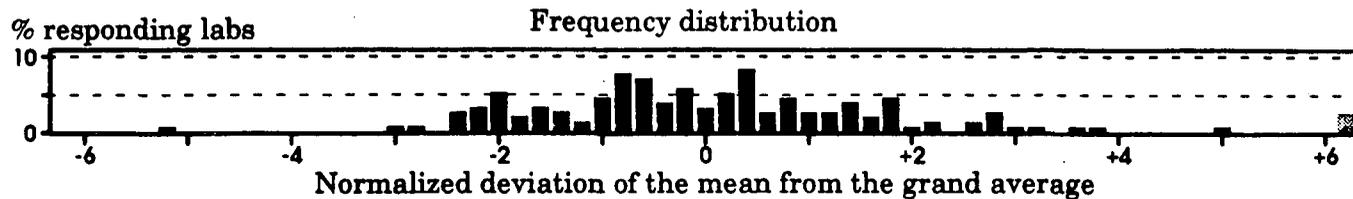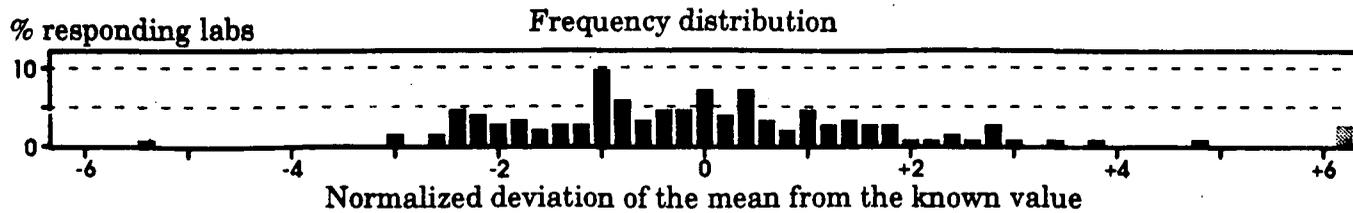
Radium-226   Statistical Summary   209 Participants

The known value of this nuclide is **7.4 pCi/l** with an expected precision of **1.1**; the control limits are 5.5 to 9.3; the warning regions are 5.5 to 6.1 and 8.7 to 9.3

112(53.6 %) Failed to respond

75(35.9 %) Within all limits

5(2.4 %) Outliers

12(5.7 %) Out of control
but not an outlier

5(2.4 %) In warning zone
but within control
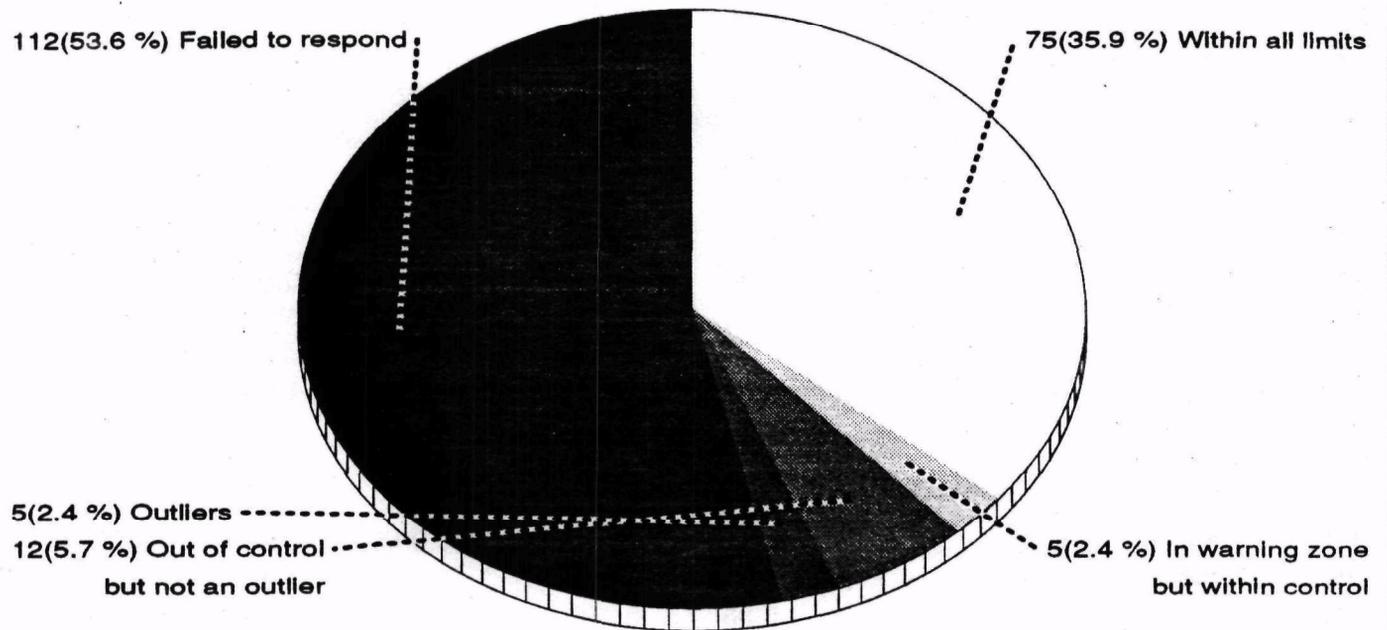
Statistic	Respondents	Non-outliers
Mean	9.54	**Grand Avg 7.49**
Std. Dev.	11.72	1.16
Variance	137.42	1.34
% Coef. of Var.	122.88	15.46
% deviation of mean from known value	28.92	1.19
Norm. dev. of mean from known value	0.18	0.08
Median	7.37	7.33
% deviation of median from known value	-0.45	-0.90
Norm. dev. of median from known value	0.00	-0.06
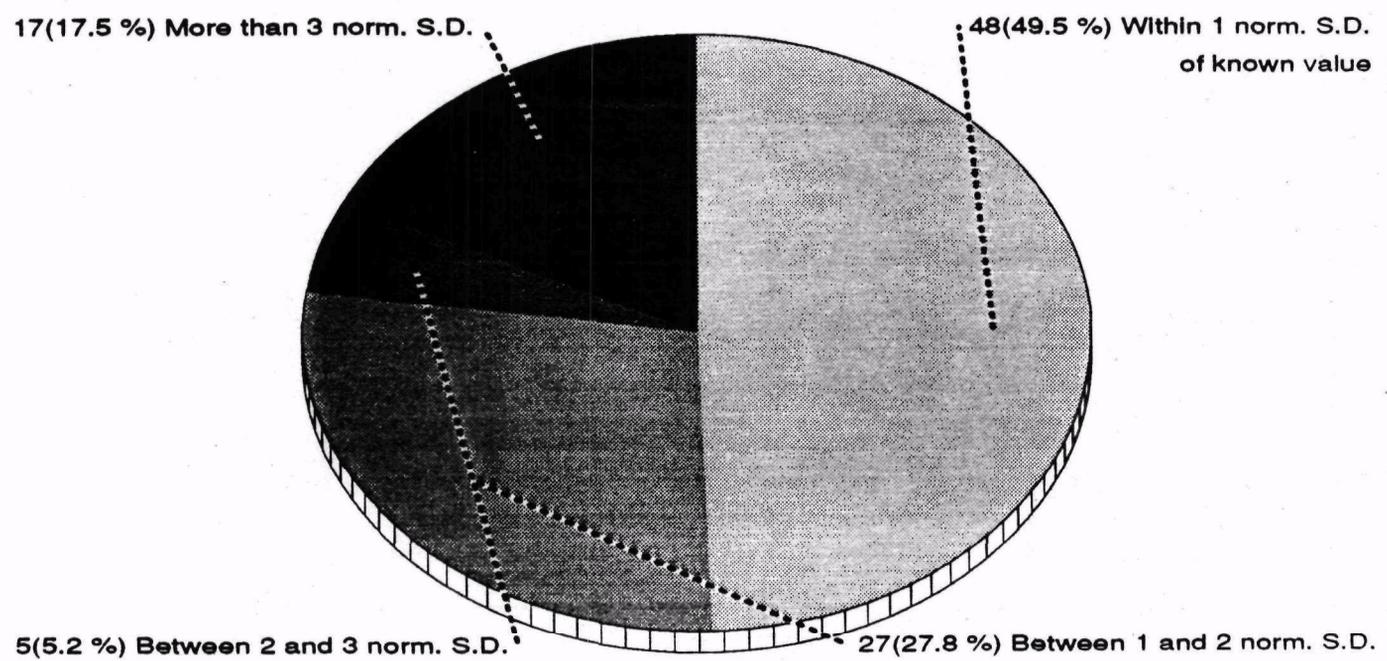
17(17.5 %) More than 3 norm. S.D.

48(49.5 %) Within 1 norm. S.D.
of known value

5(5.2 %) Between 2 and 3 norm. S.D.

27(27.8 %) Between 1 and 2 norm. S.D.

Radium-226

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
A	6.6	6.8	6.5	0.15	0.161	6.63	-1.35	-1.21	
AE	6.6	6.6	7.1	0.29	0.268	6.77	-1.14	-1.00	
AF	6.7	6.6	6.7	0.06	0.054	6.67	-1.29	-1.15	
AI	8.8	8.0	8.4	0.40	0.430	8.40	1.44	1.57	
AJ									•
AK	11.6	10.0	10.1	0.90	0.859	10.57	4.85	4.99	⇑
AL	6.9	6.5	7.0	0.26	0.268	6.80	-1.08	-0.94	
AO									•
AP	7.0	7.1	7.1	0.06	0.054	7.07	-0.66	-0.52	
AR									•
AU									•
AW	7.4	6.3	5.8	0.82	0.859	6.50	-1.56	-1.42	
AZ	7.0	8.0	6.5	0.76	0.805	7.17	-0.51	-0.37	
BA	7.5	8.4	8.0	0.45	0.483	7.97	0.75	0.89	
BC	7.7	7.6	7.7	0.06	0.054	7.67	0.28	0.42	
BG	5.6	6.6	5.8	0.53	0.537	6.00	-2.34	-2.20	
BH	6.9	6.1	6.7	0.42	0.430	6.57	-1.45	-1.31	
BK	7.3	6.9	7.6	0.35	0.376	7.27	-0.35	-0.21	
BL									•
BM	6.7	6.8	6.7	0.06	0.054	6.73	-1.19	-1.05	
BN									•
BO	6.7	7.1	7.0	0.21	0.215	6.93	-0.87	-0.73	
BS									•
BW									•
C	8.2	7.8	8.2	0.23	0.215	8.07	0.91	1.05	
CA	7.3	7.2	6.9	0.21	0.215	7.13	-0.56	-0.42	
CE	7.0	7.6	6.8	0.42	0.430	7.13	-0.56	-0.42	
CG	6.3	7.1	7.7	0.70	0.752	7.03	-0.72	-0.58	
CJ	7.0	8.0	6.7	0.68	0.698	7.23	-0.40	-0.26	
CK	6.2	6.8	6.9	0.38	0.376	6.63	-1.35	-1.21	
CO									•
CQ									•
CS	7.3	7.1	6.9	0.20	0.215	7.10	-0.61	-0.47	
D									•
DB	7.1	6.4	6.7	0.35	0.376	6.73	-1.19	-1.05	
DD									•
DE	6.6	6.5	6.5	0.06	0.054	6.53	-1.50	-1.36	
DJ									•
DL									•
DM									•
DO									•
DS									•
DT	8.0	8.1	8.1	0.06	0.054	8.07	0.91	1.05	
DZ	8.0	7.7	7.7	0.17	0.161	7.80	0.49	0.63	
E	6.6	7.5	6.7	0.49	0.483	6.93	-0.87	-0.73	

• ≡ No data submitted	**TAG SYMBOLS**	⇑ ≡ Above control limit
Ø ≡ Insufficient data	× ≡ Determined to be an outlier	⇓ ≡ 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
EB									•
EH									•
EL									•
EO	7.2	7.2	7.7	0.29	0.268	7.37	-0.19	-0.05	
ER									•
EV									•
EX									•
FE									•
FF	47.0	45.0	47.0	1.15	1.141	46.33	61.16	61.30	×
FJ									•
FK									•
FL									•
FN	7.0	7.3	8.2	0.62	0.644	7.50	0.02	0.16	
FU									•
FW									•
FZ									•
GE									•
GI									•
GQ	7.1	7.0	7.2	0.10	0.107	7.10	-0.61	-0.47	
GT									•
GZ	8.2	8.1	8.0	0.10	0.107	8.10	0.96	1.10	
HH									•
HI									•
HK	7.8	7.3	7.5	0.25	0.268	7.53	0.07	0.21	
HL	7.3	7.7	7.9	0.31	0.322	7.63	0.23	0.37	
HN									•
HP	8.1	8.2	8.0	0.10	0.107	8.10	0.96	1.10	
HU	7.1	7.2	7.2	0.06	0.054	7.17	-0.51	-0.37	
HY	7.2	7.2	7.9	0.40	0.376	7.43	-0.09	0.05	
I	9.3	8.0	8.1	0.72	0.698	8.47	1.54	1.68	
IA									•
IC									•
ID	6.2	5.7	6.7	0.50	0.537	6.20	-2.03	-1.89	
IE									•
IU									•
J	7.6	7.8	7.7	0.10	0.107	7.70	0.33	0.47	
JE	9.9	8.6	8.1	0.93	0.967	8.87	2.17	2.31	
JG	9.5	8.3	7.6	0.96	1.039	8.47	1.54	1.68	
JH									•
JN									•
JQ									•
JS	9.6	9.0	9.8	0.42	0.430	9.47	3.11	3.25	⇑
JX	7.9	7.9	7.8	0.06	0.054	7.87	0.60	0.73	
JY	4.9	5.1	4.6	0.25	0.268	4.87	-4.13	-3.99	⇓
K	6.9	6.3	6.2	0.38	0.376	6.47	-1.61	-1.47	

|	**TAG SYMBOLS**	
• ≡ No data submitted		⇑ ≡ Above control limit
∅ ≡ Insufficient data	× ≡ Determined to be an outlier	⇓ ≡ 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
KE									•
KT									•
KX									•
KZ	8.3	8.3	7.3	0.58	0.537	7.97	0.75	0.89	
L	7.5	7.2	7.0	0.25	0.268	7.23	-0.40	-0.26	
LE									•
LF									•
LG									•
LM									•
LR									•
LT	7.5	7.2	7.3	0.15	0.161	7.33	-0.24	-0.10	
M	7.2	8.9	7.9	0.85	0.913	8.00	0.81	0.94	
MA									•
ME	8.3	7.7	7.1	0.60	0.644	7.70	0.33	0.47	
MN									•
MO									•
MP									•
MQ									•
MS									•
MV									•
MY									•
N									•
NA									•
NG									•
NH	7.7	6.9	7.2	0.40	0.430	7.27	-0.35	-0.21	
NJ	11.0	9.1	7.9	1.56	2.266	9.33	2.91	3.04	⇑
NK									•
NO	7.2	7.3	7.5	0.15	0.161	7.33	-0.24	-0.10	
NT	6.5	6.1	6.3	0.20	0.215	6.30	-1.87	-1.73	
NZ									•
O									•
OE									•
OF	9.0	9.0	7.4	0.92	0.859	8.47	1.54	1.68	
OK	112.5	110.5	109.2	1.66	2.470	110.73	162.57	162.71	×
OL									•
OM									•
OS									•
OX	7.8	7.7	7.8	0.06	0.054	7.77	0.44	0.58	
OY	6.0	6.5	6.4	0.26	0.268	6.30	-1.87	-1.73	
OZ									•
P	7.2	8.5	8.7	0.81	0.805	8.13	1.02	1.15	
PA									•
PB	7.6	7.4	7.8	0.20	0.215	7.60	0.18	0.31	
PC	20.0	19.0	19.0	0.58	0.537	19.33	18.65	18.79	×
PE									•

	TAG SYMBOLS	
• ≡ No data submitted		⇑ ≡ Above control limit
∅ ≡ Insufficient data	× ≡ Determined to be an outlier	⇓ ≡ 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
PG	7.4	6.4	5.9	0.76	0.805	6.57	-1.45	-1.31	
PL									•
PM	5.7	6.2	6.3	0.32	0.322	6.07	-2.24	-2.10	
PP	6.7	6.6	6.3	0.21	0.215	6.53	-1.50	-1.36	
PQ									•
PR									•
PT	7.8	8.2	7.8	0.23	0.215	7.93	0.70	0.84	
PV	6.9	6.7	6.2	0.36	0.376	6.60	-1.40	-1.26	
PW	36.2	39.4	40.8	2.36	3.800	38.80	49.30	49.44	×
PY									•
Q	7.4	8.4	7.9	0.50	0.537	7.90	0.65	0.79	
QC									•
QK									•
QP									•
QQ									•
QT	4.3	4.4	6.3	1.13	1.141	5.00	-3.92	-3.78	⇓
QU	7.6	8.1	7.7	0.26	0.268	7.80	0.49	0.63	
QW									•
QX	10.0	10.4	10.2	0.20	0.215	10.20	4.27	4.41	⇑
QZ	7.2	6.5	6.8	0.35	0.376	6.83	-1.03	-0.89	
RC	8.1	9.0	9.5	0.71	0.752	8.87	2.17	2.31	
RD									•
RE									•
RF	10.3	9.8	9.2	0.55	0.591	9.77	3.59	3.73	⇑
RG	6.3	9.0	9.0	1.56	1.857	8.10	0.96	1.10	
RJ									•
RK									•
RM	7.9	8.8	9.1	0.62	0.644	8.60	1.75	1.89	
RN	6.6	7.7	6.9	0.57	0.591	7.07	-0.66	-0.52	
RO									•
RP									•
RR									•
RT									•
RU									•
RV	6.4	7.6	7.2	0.61	0.644	7.07	-0.66	-0.52	
RZ	7.4	7.4	7.3	0.06	0.054	7.37	-0.19	-0.05	
S	6.9	6.9	7.0	0.06	0.054	6.93	-0.87	-0.73	
SC	7.5	7.0	7.2	0.25	0.268	7.23	-0.40	-0.26	
SD	9.6	9.2	8.2	0.72	0.752	9.00	2.38	2.52	
SF	7.3	6.6	6.7	0.38	0.376	6.87	-0.98	-0.84	
SG									•
SI	5.0	5.3	5.0	0.17	0.161	5.10	-3.76	-3.62	⇓
SL									•
SN									•
SO									•

	TAG SYMBOLS	
• ≡ No data submitted		⇑ ≡ Above control limit
∅ ≡ Insufficient data	× ≡ Determined to be an outlier	⇓ ≡ 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
SR									•
SS	7.0	7.4	7.0	0.23	0.215	7.13	-0.56	-0.42	
ST									•
SW									•
SX									•
SZ	7.0	6.8	7.2	0.20	0.215	7.00	-0.77	-0.63	
T	7.2	7.7	7.6	0.26	0.268	7.50	0.02	0.16	
TA									•
TE	22.3	21.4	20.0	1.16	1.448	21.23	21.64	21.78	×
TG	10.6	9.2	10.6	0.81	0.752	10.13	4.16	4.30	⇑
TH									•
TI	3.4	5.6	4.4	1.10	1.345	4.47	-4.76	-4.62	⇓
TK									•
TL									•
TM									•
TN	10.2	10.0	9.4	0.42	0.430	9.87	3.74	3.88	⇑
TP									•
TQ	8.5	7.9	8.5	0.35	0.322	8.30	1.28	1.42	
TR									•
TS	12.7	10.3	10.4	1.36	1.550	11.13	5.74	5.88	⇑
TT									•
TV									•
TW									•
TY									•
TZ									•
U	8.0	7.5	6.8	0.60	0.644	7.43	-0.09	0.05	
UA									•
W	7.4	7.7	7.2	0.25	0.268	7.43	-0.09	0.05	
X									•

Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
4.47	⇓	TI	6.57		PG	6.93		BO
4.87	⇓	JY	6.57		BH	6.93		S
5.00	⇓	QT	6.60		PV	7.00		SZ
5.10	⇓	SI	6.63		CK	7.03	∘	CG
6.00		BG	6.63		A	7.07		RV
6.07		PM	6.67		AF	7.07		RN
6.20		ID	6.73		DB	7.07		AP
6.30		OY	6.73		BM	7.10		GQ
6.30		NT	6.77		AE	7.10		CS
6.47		K	6.80		AL	7.13		SS
6.50		AW	6.83		QZ	7.13		CE
6.53		PP	6.87		SF	7.13		CA
6.53		DE	6.93		E	7.17		HU

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

Radium-226

Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
7.17		AZ	7.70		ME	8.47		OF
7.23		SC	7.70		J	8.47		JG
7.23		L	7.77		OX	8.47		I
7.23		CJ	7.80		QU	8.60		RM
7.27		NH	7.80		DZ	8.87		RC
7.27		BK	7.87		JX	8.87		JE
7.33		NO	7.90		Q	9.00		SD
7.33		LT	7.93		PT	9.33	⇑	NJ
7.37		RZ	7.97		BA	9.47	⇑	JS
7.37		EO	7.97		KZ	9.77	⇑	RF
7.43		W	8.00		M	9.87	⇑	TN
7.43		HY	8.07		DT	10.13	⇑	TG
7.43		U	8.07		C	10.20	⇑	QX
7.50		T	8.10		RG	10.57	⇑	AK
7.50		FN	8.10		HP	11.13	⇑	TS
7.53		HK	8.10		GZ	19.33	×	PC
7.60		PB	8.13		P	21.23	×	TE
7.63		HL	8.30		TQ	38.80	×	PW
7.67		BC	8.40		AI	46.33	×	FF
						110.73	×	OK
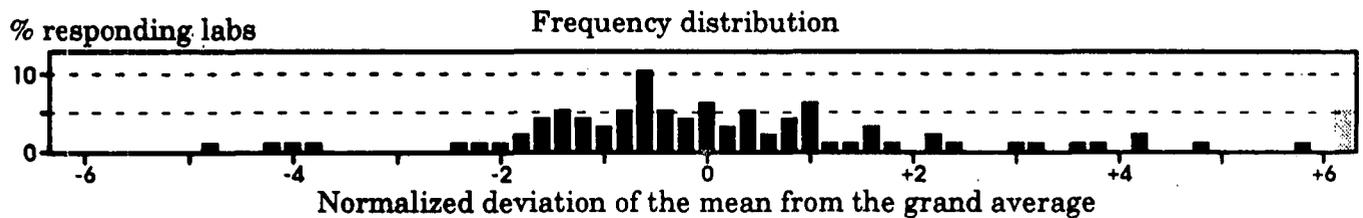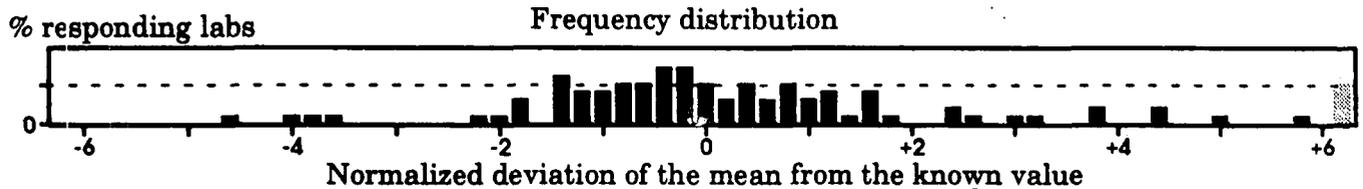
% responding labs — **Frequency distribution**

Normalized deviation of the mean from the known value

% responding labs — **Frequency distribution**

Normalized deviation of the mean from the grand average

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

Radium-228   Statistical Summary   209 Participants

The known value of this nuclide is **10.0 pCi/l** with an expected precision of **2.5**; the control limits are 5.7 to 14.3; the warning regions are 5.7 to 7.1 and 12.9 to 14.3

119(56.9 %) Failed to respond

71(34.0 %) Within all limits

5(2.4 %) Outliers

10(4.8 %) Out of control but not an outlier

4(1.9 %) In warning zone but within control
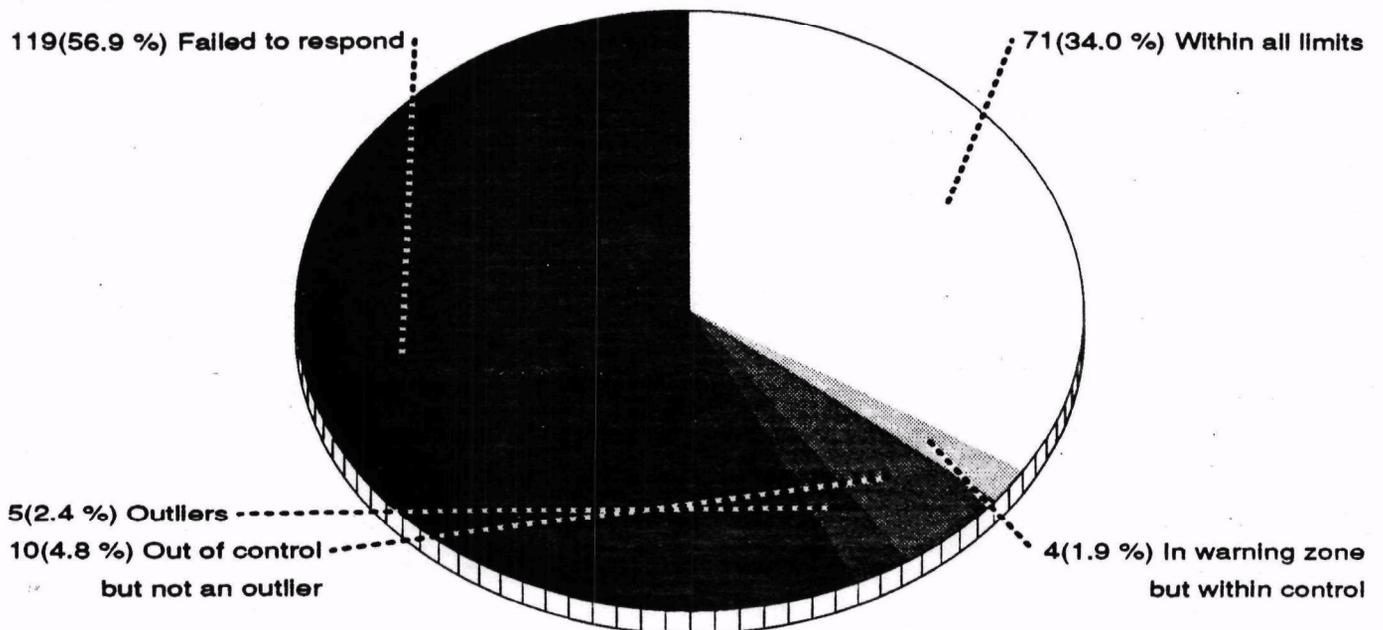
Statistic	Respondents	Non-outliers
Mean	13.85	**Grand Avg 10.15**
Std. Dev.	32.86	2.45
Variance	1079.66	6.02
% Coef. of Var.	237.23	24.17
% deviation of mean from known value	38.51	1.51
Norm. dev. of mean from known value	0.12	0.06
Median	10.22	10.13
% deviation of median from known value	2.17	1.33
Norm. dev. of median from known value	0.01	0.05
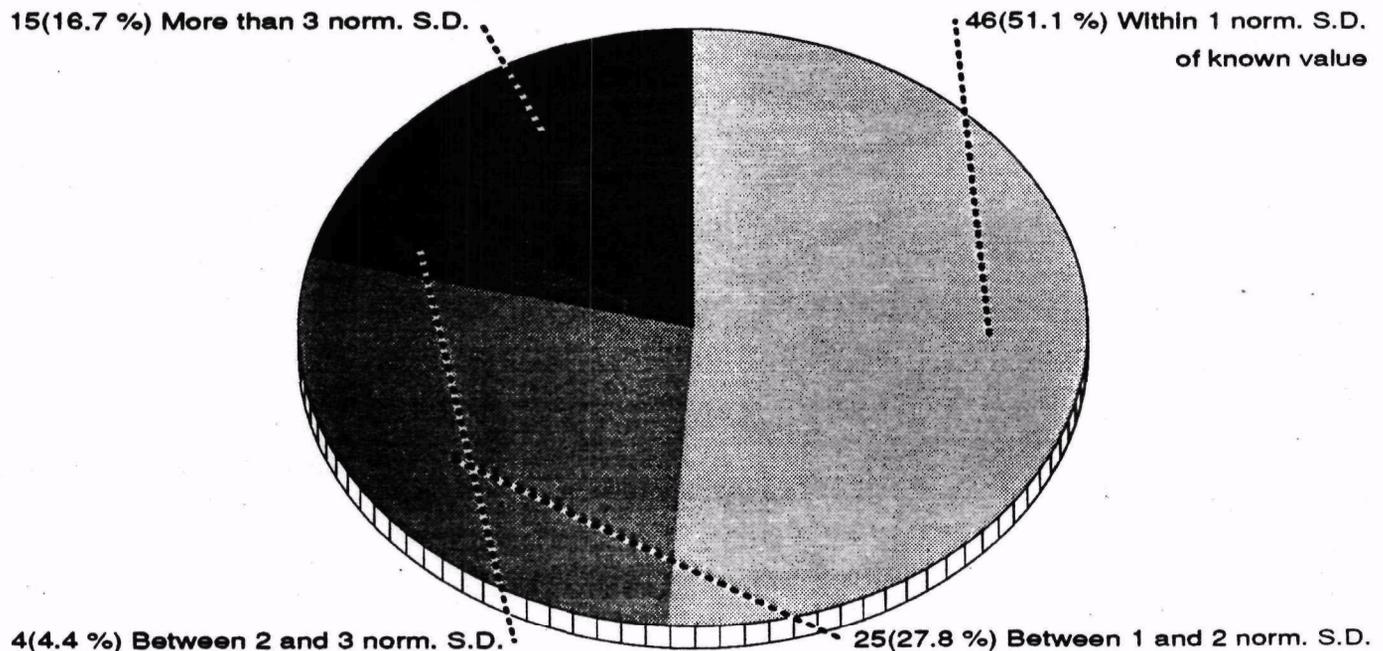
15(16.7 %) More than 3 norm. S.D.

46(51.1 %) Within 1 norm. S.D. of known value

4(4.4 %) Between 2 and 3 norm. S.D.

25(27.8 %) Between 1 and 2 norm. S.D.

Radium-228

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
A	11.8	12.9	13.4	0.82	0.378	12.70	1.77	1.87	
AE	9.2	8.5	8.8	0.35	0.165	8.83	-0.91	-0.81	
AF	9.6	9.4	9.7	0.15	0.071	9.57	-0.40	-0.30	
AI	11.3	11.1	10.8	0.25	0.118	11.07	0.63	0.74	
AJ									•
AK	9.7	12.9	10.3	1.70	0.756	10.97	0.57	0.67	
AL	11.2	10.3	8.5	1.37	0.638	10.00	-0.10	0.00	
AO									•
AP	3.7	3.4	3.6	0.15	0.071	3.57	-4.56	-4.46	⇓
AR									•
AU									•
AW	1.5	1.4	1.8	0.21	0.095	1.57	-5.95	-5.84	×
AZ	6.5	4.5	3.7	1.44	0.662	4.90	-3.64	-3.53	⇓
BA	10.3	9.4	10.5	0.59	0.260	10.07	-0.06	0.05	
BC	10.9	10.8	10.5	0.21	0.095	10.73	0.40	0.51	
BG									•
BH	10.2	11.9	11.6	0.91	0.402	11.23	0.75	0.85	
BK	9.6	10.7	10.6	0.61	0.260	10.30	0.10	0.21	
BL									•
BM	11.7	11.6	11.1	0.32	0.142	11.47	0.91	1.02	
BN									•
BO	8.6	11.1	10.7	1.34	0.591	10.13	-0.01	0.09	
BS									•
BW									•
C	8.6	8.6	8.5	0.06	0.024	8.57	-1.10	-0.99	
CA	12.0	11.6	11.0	0.50	0.236	11.53	0.96	1.06	
CE	10.8	10.9	9.4	0.84	0.354	10.37	0.15	0.25	
CG	10.7	9.0	9.6	0.86	0.402	9.77	-0.27	-0.16	
CJ	10.0	11.0	10.0	0.58	0.236	10.33	0.13	0.23	
CK	14.8	17.3	13.8	1.80	0.827	15.30	3.57	3.67	⇑
CO									•
CQ									•
CS	11.7	9.3	11.5	1.33	0.567	10.83	0.47	0.58	
D									•
DB	8.5	9.5	9.0	0.50	0.236	9.00	-0.80	-0.69	
DD									•
DE	9.9	9.9	9.8	0.06	0.024	9.87	-0.20	-0.09	
DJ									•
DL									•
DM									•
DO									•
DS									•
DT	9.5	9.3	8.5	0.53	0.236	9.10	-0.73	-0.62	
DZ	11.5	11.8	11.6	0.15	0.071	11.63	1.03	1.13	
E									•

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

Radium-228

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
EB									•
EH									•
EL									•
EO	10.8	10.4	11.0	0.31	0.142	10.73	0.40	0.51	
ER									•
EV									•
EX									•
FE									•
FF									•
FJ									•
FK									•
FL									•
FN	10.7	10.7	10.2	0.29	0.118	10.53	0.26	0.37	
FU									•
FW									•
FZ									•
GE									•
GI									•
GQ	9.8	10.3	9.4	0.45	0.213	9.83	-0.22	-0.12	
GT									•
GZ									•
HH									•
HI									•
HK	10.6	10.8	9.7	0.59	0.260	10.37	0.15	0.25	
HL	9.0	8.0	10.1	1.05	0.496	9.03	-0.77	-0.67	
HN									•
HP	10.5	11.3	12.7	1.11	0.520	11.50	0.93	1.04	
HU									•
HY									•
I	10.0	9.2	10.7	0.75	0.354	9.97	-0.13	-0.02	
IA									•
IC									•
ID	8.6	7.7	8.3	0.46	0.213	8.20	-1.35	-1.25	
IE									•
IU									•
J	11.7	11.0	11.0	0.40	0.165	11.23	0.75	0.85	
JE	5.2	6.8	5.2	0.92	0.378	5.73	-3.06	-2.96	
JG	11.3	11.4	11.7	0.21	0.095	11.47	0.91	1.02	
JH									•
JN									•
JQ									•
JS	11.0	9.6	11.0	0.81	0.331	10.53	0.26	0.37	
JX	12.6	12.1	13.1	0.50	0.236	12.60	1.70	1.80	
JY	6.7	8.8	7.0	1.14	0.496	7.50	-1.84	-1.73	
K	6.5	8.8	6.8	1.25	0.543	7.37	-1.93	-1.82	

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

Radium-228

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
KE									•
KT									•
KX									•
KZ	9.4	9.1	9.5	0.21	0.095	9.33	-0.57	-0.46	
L	9.7	9.7	9.7	0.00	0.000	9.70	-0.31	-0.21	
LE									•
LF									•
LG									•
LM									•
LR									•
LT	12.1	11.2	10.3	0.90	0.425	11.20	0.73	0.83	
M	9.6	10.9	9.0	0.97	0.449	9.83	-0.22	-0.12	
MA									•
ME	6.8	6.2	7.6	0.70	0.331	6.87	-2.28	-2.17	
MN									•
MO									•
MP									•
MQ									•
MS									•
MV									•
MY									•
N									•
NA									•
NG									•
NH	9.6	11.1	8.4	1.35	0.638	9.70	-0.31	-0.21	
NJ	17.0	24.0	23.0	3.79	2.245	21.33	7.75	7.85	×
NK									•
NO	12.3	13.4	16.5	2.18	0.992	14.07	2.71	2.82	
NT	9.6	9.0	10.1	0.55	0.260	9.57	-0.40	-0.30	
NZ									•
O									•
OE									•
OF	10.5	9.1	8.2	1.16	0.543	9.27	-0.61	-0.51	
OK	325.0	315.0	322.0	5.13	3.596	320.67	215.13	215.24	×
OL									•
OM									•
OS									•
OX	10.2	10.1	10.1	0.06	0.024	10.13	-0.01	0.09	
OY	11.1	17.6	14.9	3.27	2.020	14.53	3.04	3.14	⇑
OZ									•
P	4.5	6.1	5.2	0.80	0.378	5.27	-3.38	-3.28	⇓
PA									•
PB	10.8	10.6	11.0	0.20	0.095	10.80	0.45	0.55	
PC	16.2	18.4	15.4	1.55	0.709	16.67	4.51	4.62	⇑
PE									•

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

Radium-228

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
PG									•
PL									•
PM	12.8	12.4	10.5	1.23	0.543	11.90	1.21	1.32	
PP	8.0	8.1	8.7	0.38	0.165	8.27	-1.31	-1.20	
PQ									•
PR									•
PT									•
PV	12.8	12.4	10.5	1.23	0.543	11.90	1.21	1.32	
PW	3.8	4.5	4.9	0.56	0.260	4.40	-3.98	-3.88	⇓
PY									•
Q	7.6	7.5	9.3	1.01	0.425	8.13	-1.40	-1.29	
QC									•
QK									•
QP									•
QQ									•
QT	8.6	14.3	29.4	10.75	8.456	17.43	5.05	5.15	⇑
QU	8.3	9.7	10.0	0.91	0.402	9.33	-0.57	-0.46	
QW									•
QX	12.0	15.0	12.0	1.73	0.709	13.00	1.97	2.08	
QZ	11.6	10.8	10.7	0.49	0.213	11.03	0.61	0.72	
RC	13.9	10.4	12.2	1.75	0.827	12.17	1.40	1.50	
RD	6.1	7.3	8.0	0.96	0.449	7.13	-2.09	-1.99	
RE									•
RF	11.1	10.5	10.8	0.30	0.142	10.80	0.45	0.55	
RG	19.0	19.0	21.0	1.15	0.473	19.67	6.59	6.70	×
RJ									•
RK	20.5	23.1	17.9	2.60	1.435	20.50	7.17	7.27	×
RM	9.9	9.2	8.5	0.70	0.331	9.20	-0.66	-0.55	
RN	9.7	12.4	13.3	1.87	0.851	11.80	1.14	1.25	
RO									•
RP									•
RR									•
RT									•
RU									•
RV	8.1	8.8	10.8	1.40	0.638	9.23	-0.64	-0.53	
RZ	11.2	11.9	11.3	0.38	0.165	11.47	0.91	1.02	
S	8.0	8.0	8.1	0.06	0.024	8.03	-1.47	-1.36	
SC	13.2	12.8	9.0	2.32	0.992	11.67	1.05	1.15	
SD	10.4	9.1	9.1	0.75	0.307	9.53	-0.43	-0.32	
SF	11.2	12.6	12.6	0.81	0.331	12.13	1.37	1.48	
SG									•
SI	4.5	4.4	4.5	0.06	0.024	4.47	-3.94	-3.83	⇓
SL									•
SN									•
SO									•

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

Radium-228

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
SR									•
SS	11.9	10.1	11.9	1.04	0.425	11.30	0.80	0.90	
ST									•
SW									•
SX	9.9	10.0	10.5	0.32	0.142	10.13	-0.01	0.09	
SZ	12.5	14.2	10.8	1.70	0.803	12.50	1.63	1.73	
T	9.3	10.9	9.1	0.99	0.425	9.77	-0.27	-0.16	
TA									•
TE									•
TG									•
TH									•
TI	6.0	6.5	9.1	1.66	0.732	7.20	-2.04	-1.94	
TK									•
TL									•
TM									•
TN	12.4	12.0	13.0	0.50	0.236	12.47	1.60	1.71	
TP									•
TQ	8.5	8.4	8.8	0.21	0.095	8.57	-1.10	-0.99	
TR									•
TS	16.4	13.2	13.6	1.74	0.756	14.40	2.94	3.05	⇑
TT									•
TV									•
TW									•
TY									•
TZ									•
U	8.9	6.3	8.9	1.50	0.614	8.03	-1.47	-1.36	
UA									•
W	9.6	9.4	11.2	0.99	0.425	10.07	-0.06	0.05	
X									•

Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
1.57	×	AW	8.03		S	9.33		QU
3.57	⇓	AP	8.13		Q	9.33		KZ
4.40	⇓	PW	8.20		ID	9.53		SD
4.47	⇓	SI	8.27		PP	9.57		NT
4.90	⇓	AZ	8.57		TQ	9.57		AF
5.27	⇓	P	8.57		C	9.70		NH
5.73		JE	8.83		AE	9.70		L
6.87		ME	9.00		DB	9.77		T
7.13		RD	9.03		HL	9.77		CG
7.20		TI	9.10		DT	9.83		M
7.37		K	9.20		RM	9.83		GQ
7.50		JY	9.23		RV	9.87		DE
8.03		U	9.27		OF	9.97		I

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

Radium-228

Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
10.00		AL	10.97		AK	12.13		SF
10.07		W	11.03		QZ	12.17		RC
10.07		BA	11.07		AI	12.47		TN
10.13		SX	11.20		LT	12.50		SZ
10.13		OX	11.23		J	12.60		JX
10.13		BO	11.23		BH	12.70		A
10.30		BK	11.30		SS	13.00		QX
10.33		CJ	11.47		RZ	14.07		NO
10.37		HK	11.47		JG	14.40	⇑	TS
10.37		CE	11.47		BM	14.53	⇑	OY
10.53		JS	11.50		HP	15.30	⇑	CK
10.53		FN	11.53		CA	16.67	⇑	PC
10.73		EO	11.63		DZ	17.43	⇑	QT
10.73		BC	11.67		SC	19.67	×	RG
10.80		RF	11.80		RN	20.50	×	RK
10.80		PB	11.90		PV	21.33	× ·	NJ
10.83		CS	11.90		PM	320.67	×	OK
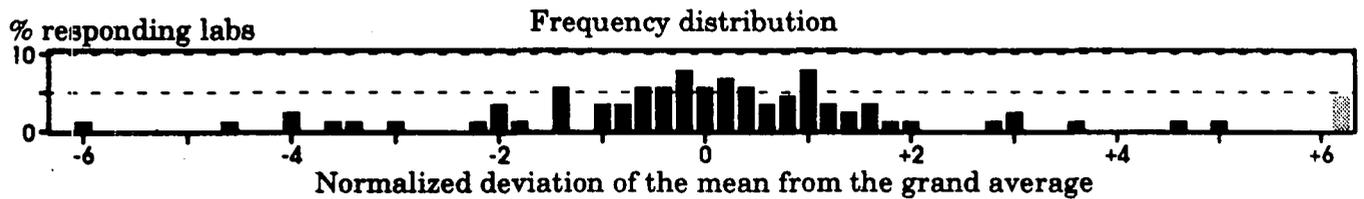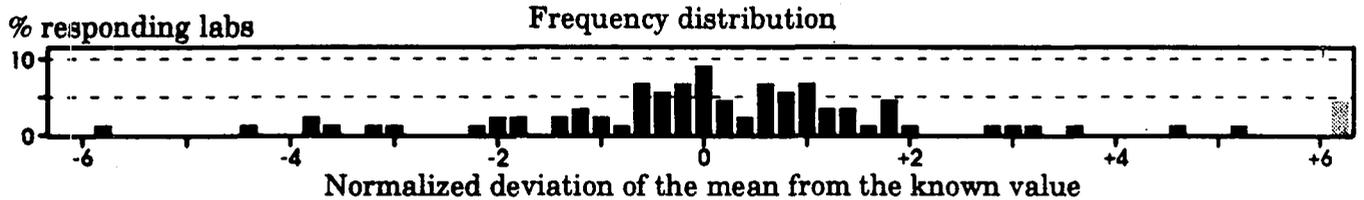
Frequency distribution

% responding labs

Normalized deviation of the mean from the known value

Frequency distribution

% responding labs

Normalized deviation of the mean from the grand average

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

Uranium (Natural)   Statistical Summary   209 Participants

The known value of this nuclide is **10.2 pCi/l** with an expected precision of **3.0**; the control limits are 5.0 to 15.4; the warning regions are 5.0 to 6.7 and 13.7 to 15.4

101(48.3 %) Failed to respond

88(42.1 %) Within all limits

7(3.3 %) Outliers

7(3.3 %) Out of control but not an outlier

6(2.9 %) In warning zone but within control
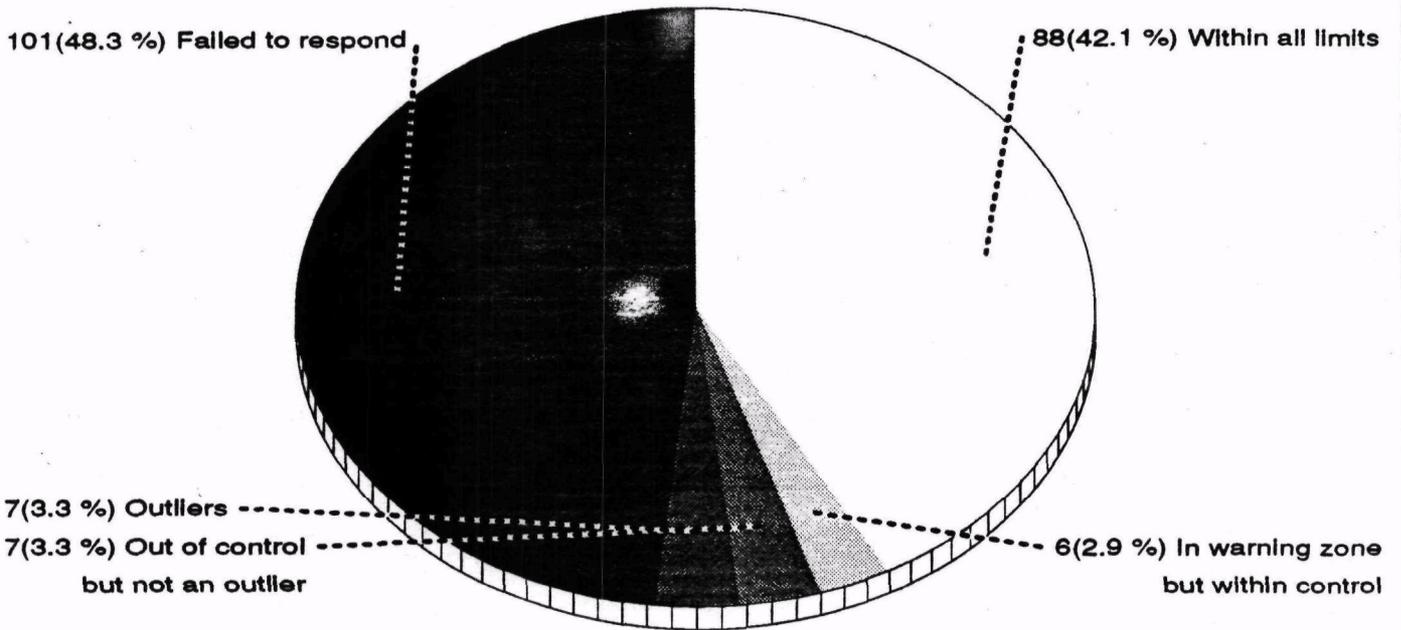
Statistic	Respondents	Non-outliers
Mean	11.03	**Grand Avg 9.74**
Std. Dev.	6.77	2.17
Variance	45.86	4.72
% Coef. of Var.	61.42	22.31
% deviation of mean from known value	8.09	-4.49
Norm. dev. of mean from known value	0.12	-0.21
Median	10.00	10.00
% deviation of median from known value	-1.96	-1.96
Norm. dev. of median from known value	-0.03	-0.09
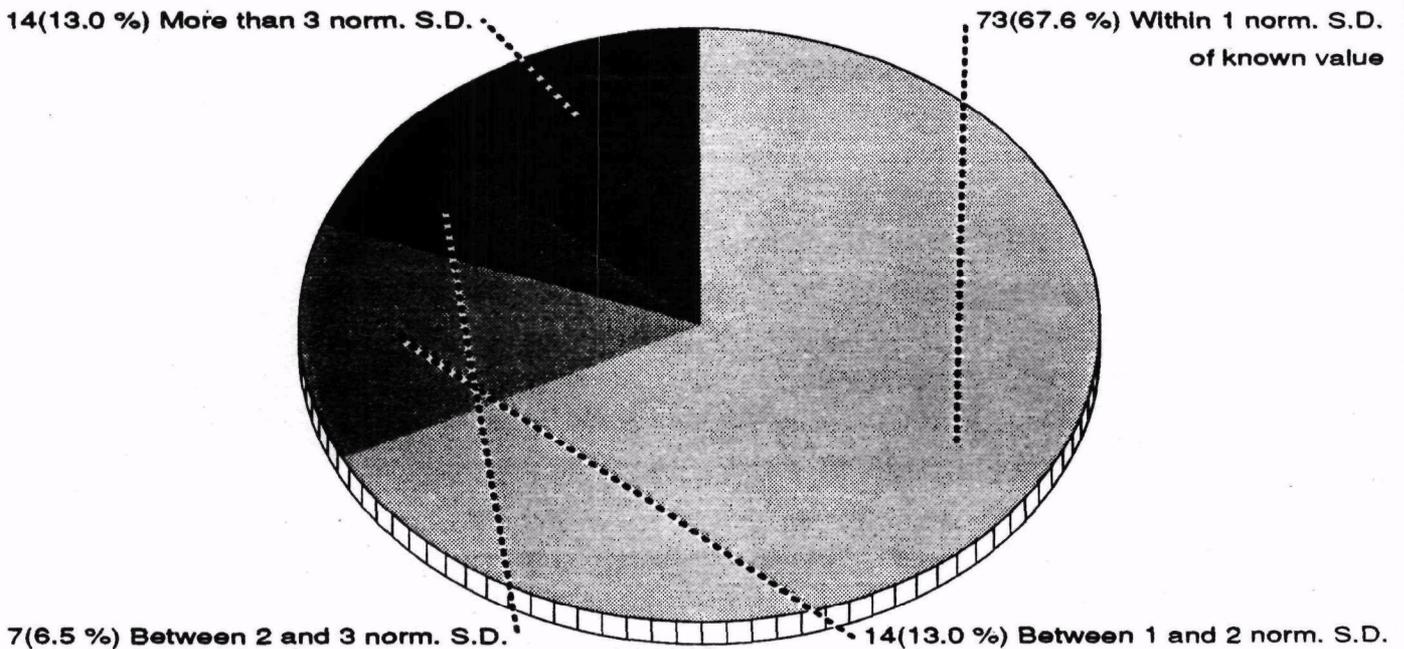
14(13.0 %) More than 3 norm. S.D.

73(67.6 %) Within 1 norm. S.D. of known value

7(6.5 %) Between 2 and 3 norm. S.D.

14(13.0 %) Between 1 and 2 norm. S.D.

Uranium (Natural)

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
A	10.8	11.7	12.5	0.85	0.335	11.67	1.11	0.85	
AE	13.1	13.1	16.8	2.14	0.728	14.33	2.65	2.39	
AF	11.5	10.1	10.9	0.70	0.276	10.83	0.63	0.37	
AI	10.6	9.2	10.2	0.72	0.276	10.00	0.15	-0.12	
AJ	10.0	10.0	13.0	1.73	0.591	11.00	0.73	0.46	
AK	13.0	11.2	12.5	0.93	0.354	12.23	1.44	1.17	
AL	7.6	8.8	7.6	0.69	0.236	8.00	-1.01	-1.27	
AO									•
AP									•
AR									•
AU									•
AW	5.9	6.2	5.3	0.46	0.177	5.80	-2.28	-2.54	
AZ	11.2	11.3	11.3	0.06	0.020	11.27	0.88	0.62	
BA	9.6	9.2	9.7	0.26	0.098	9.50	-0.14	-0.40	
BC	9.1	8.7	8.6	0.26	0.098	8.80	-0.54	-0.81	
BG	10.1	10.1	10.3	0.12	0.039	10.17	0.25	-0.02	
BH	7.7	7.7	7.9	0.12	0.039	7.77	-1.14	-1.40	
BK	8.6	8.8	8.9	0.15	0.059	8.77	-0.56	-0.83	
BL									•
BM	4.4	4.6	4.9	0.25	0.098	4.63	-2.95	-3.21	⇓
BN									•
BO	9.6	10.2	9.2	0.50	0.197	9.67	-0.04	-0.31	
BS									•
BW									•
C	9.0	8.8	8.9	0.10	0.039	8.90	-0.49	-0.75	
CA	10.0	9.7	9.5	0.25	0.098	9.73	0.00	-0.27	
CE	12.6	11.7	11.8	0.49	0.177	12.03	1.32	1.06	
CG	11.0	10.0	10.0	0.58	0.197	10.33	0.34	0.08	
CJ	11.0	11.0	11.0	0.00	0.000	11.00	0.73	0.46	
CK	9.1	9.5	9.6	0.26	0.098	9.40	-0.20	-0.46	
CO	9.6	9.4	9.5	0.10	0.039	9.50	-0.14	-0.40	
CQ									•
CS	11.1	11.4	11.7	0.30	0.118	11.40	0.96	0.69	
D	10.1	10.1	10.0	0.06	0.020	10.07	0.19	-0.08	
DB	10.0	11.0	9.0	1.00	0.394	10.00	0.15	-0.12	
DD									•
DE	10.5	10.5	10.5	0.00	0.000	10.50	0.44	0.17	
DJ									•
DL									•
DM									•
DO	24.3	24.0	22.0	1.25	0.453	23.43	7.90	7.64	×
DS									•
DT	10.0	10.2	8.7	0.81	0.295	9.63	-0.06	-0.33	
DZ	9.8	10.5	10.9	0.56	0.217	10.40	0.38	0.12	
E	10.6	9.5	9.0	0.82	0.315	9.70	-0.02	-0.29	

	TAG SYMBOLS	
• ≡ No data submitted		⇑ ≡ Above control limit
∅ ≡ Insufficient data	× ≡ Determined to be an outlier	⇓ ≡ 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
EB	10.0	10.4	10.7	0.35	0.138	10.37	0.36	0.10	
EH									•
EL									•
EO									•
ER									•
EV									•
EX									•
FE	10.0	10.0	10.0	0.00	0.000	10.00	0.15	-0.12	
FF									•
FJ	23.6	23.1	23.4	0.25	0.098	23.37	7.87	7.60	×
FK									•
FL									•
FN	10.5	11.0	11.2	0.36	0.138	10.90	0.67	0.40	
FU									•
FW									•
FZ	10.0	9.8	11.0	0.64	0.236	10.27	0.30	0.04	
GE									•
GI									•
GQ	11.6	10.0	11.2	0.83	0.315	10.93	0.69	0.42	
GT									•
GZ	7.4	7.8	8.3	0.45	0.177	7.83	-1.10	-1.37	
HH									•
HI									•
HK	6.1	6.1	7.2	0.64	0.217	6.47	-1.89	-2.16	
HL	9.5	9.5	9.5	0.00	0.000	9.50	-0.14	-0.40	
HN									•
HP	6.9	9.1	8.3	1.11	0.433	8.10	-0.95	-1.21	
HU									•
HY	9.2	10.3	9.5	0.57	0.217	9.67	-0.04	-0.31	
I	10.7	10.9	11.0	0.15	0.059	10.87	0.65	0.38	
IA									•
IC									•
ID	8.2	8.2	8.9	0.40	0.138	8.43	-0.76	-1.02	
IE	10.0	10.3	11.8	0.96	0.354	10.70	0.55	0.29	
IU									•
J	10.4	10.2	10.7	0.25	0.098	10.43	0.40	0.13	
JE	8.7	9.2	9.1	0.26	0.098	9.00	-0.43	-0.69	
JG									•
JH									•
JN									•
JQ									•
JS	10.0	9.9	10.0	0.06	0.020	9.97	0.13	-0.13	
JX									•
JY	12.0	11.0	11.0	0.58	0.197	11.33	0.92	0.65	
K	9.0	9.9	10.0	0.55	0.197	9.63	-0.06	-0.33	

	TAG SYMBOLS	
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Ø ≡ Insufficient data	× ≡ Determined to be an outlier	⇓ ≡ 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
KE									•
KT	3.8	4.0	3.9	0.10	0.039	3.90	-3.37	-3.64	⇓
KX									•
KZ									•
L	11.5	11.5	10.9	0.35	0.118	11.30	0.90	0.64	
LE									•
LF									•
LG									•
LM									•
LR									•
LT	11.9	11.5	11.7	0.20	0.079	11.70	1.13	0.87	
M									•
MA									•
ME	9.8	9.2	10.0	0.42	0.158	9.67	-0.04	-0.31	
MN									•
MO									•
MP									•
MQ									•
MS	9.5	9.6	9.7	0.10	0.039	9.60	-0.08	-0.35	
MV									•
MY									•
N									•
NA	9.0	10.0	11.0	1.00	0.394	10.00	0.15	-0.12	
NG									•
NH	11.0	11.1	10.2	0.49	0.177	10.77	0.59	0.33	
NJ	9.1	8.3	9.2	0.49	0.177	8.87	-0.51	-0.77	
NK	8.1	8.1	7.6	0.29	0.098	7.93	-1.04	-1.31	
NO	8.6	9.2	10.5	0.97	0.374	9.43	-0.18	-0.44	
NT	10.1	12.6	11.4	1.25	0.492	11.37	0.94	0.67	
NZ									•
O									•
OE									•
OF	14.2	14.2	12.6	0.92	0.315	13.67	2.27	2.00	
OK									•
OL									•
OM									•
OS	9.6	10.3	10.3	0.40	0.138	10.07	0.19	-0.08	
OX									•
OY	11.0	11.1	11.4	0.21	0.079	11.17	0.82	0.56	
OZ	9.9	9.6	10.3	0.35	0.138	9.93	0.11	-0.15	
P	6.1	2.0	3.0	2.14	0.807	3.70	-3.49	-3.75	⇓
PA									•
PB	11.2	10.8	11.0	0.20	0.079	11.00	0.73	0.46	
PC	45.4	45.3	44.0	0.78	0.276	44.90	20.30	20.03	×
PE									•

	TAG SYMBOLS	
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Uranium (Natural)

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
PG									•
PL									•
PM	4.9	4.8	5.1	0.15	0.059	4.93	-2.78	-3.04	⇓
PP	10.6	10.6	10.4	0.12	0.039	10.53	0.46	0.19	
PQ	10.3	10.1	10.1	0.12	0.039	10.17	0.25	-0.02	
PR									•
PT	9.4	9.0	9.2	0.20	0.079	9.20	-0.31	-0.58	
PV	4.7	4.1	4.0	0.38	0.138	4.27	-3.16	-3.43	⇓
PW	44.0	42.0	40.0	2.00	0.788	42.00	18.62	18.36	×
PY									•
Q	8.2	9.0	9.7	0.75	0.295	8.97	-0.45	-0.71	
QC									•
QK									•
QP									•
QQ	7.5	7.2	7.6	0.21	0.079	7.43	-1.33	-1.60	
QT									•
QU	19.3	20.3	19.6	0.51	0.197	19.73	5.77	5.50	×
QW									•
QX	14.2	13.1	15.1	1.00	0.394	14.13	2.54	2.27	
QZ	8.0	7.8	7.3	0.36	0.138	7.70	-1.18	-1.44	
RC	10.8	14.3	10.8	2.02	0.689	11.97	1.28	1.02	
RD	15.2	15.0	15.1	0.10	0.039	15.10	3.09	2.83	
RE									•
RF	9.8	9.8	9.8	0.00	0.000	9.80	0.03	-0.23	
RG	10.0	10.0	10.0	0.00	0.000	10.00	0.15	-0.12	
RJ									•
RK	13.3	11.7	12.5	0.80	0.315	12.50	1.59	1.33	
RM	7.6	7.8	7.1	0.36	0.138	7.50	-1.29	-1.56	
RN	9.9	9.9	10.8	0.52	0.177	10.20	0.26	0.00	
RO									•
RP	11.3	11.3	11.3	0.00	0.000	11.30	0.90	0.64	
RR									•
RT									•
RU									•
RV									•
RZ	9.7	9.7	8.5	0.69	0.236	9.30	-0.26	-0.52	
S	9.3	9.6	8.9	0.35	0.138	9.27	-0.27	-0.54	
SC	9.9	10.0	9.5	0.26	0.098	9.80	0.03	-0.23	
SD	9.1	10.1	10.8	0.85	0.335	10.00	0.15	-0.12	
SF	10.2	10.4	10.8	0.31	0.118	10.47	0.42	0.15	
SG									•
SI	3.0	2.8	2.8	0.12	0.039	2.87	-3.97	-4.23	⇓
SL	16.0	11.0	18.0	3.61	1.720	15.00	3.04	2.77	
SN									•
SO	4.2	4.8	5.7	0.75	0.295	4.90	-2.80	-3.06	⇓

	TAG SYMBOLS	
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Uranium (Natural)

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
SR									•
SS	9.9	9.6	9.7	0.15	0.059	9.73	0.00	-0.27	
ST									•
SW									•
SX									•
SZ	9.7	10.0	10.5	0.40	0.158	10.07	0.19	-0.08	
T	10.8	13.3	11.7	1.27	0.492	11.93	1.27	1.00	
TA									•
TE	8.7	9.2	8.7	0.29	0.098	8.87	-0.51	-0.77	
TG	10.5	10.7	9.4	0.70	0.256	10.20	0.26	0.00	
TH									•
TI	9.6	8.3	9.1	0.66	0.256	9.00	-0.43	-0.69	
TK									•
TL	10.5	9.8	9.4	0.56	0.217	9.90	0.09	-0.17	
TM									•
TN									•
TP	10.2	10.2	10.3	0.06	0.020	10.23	0.28	0.02	
TQ	9.6	9.6	9.3	0.17	0.059	9.50	-0.14	-0.40	
TR									•
TS	50.1	54.5	51.6	2.24	0.866	52.07	24.44	24.17	×
TT									•
TV	1.3	1.3	1.3	0.00	0.000	1.30	-4.87	-5.14	×
TW									•
TY									•
TZ									•
U									•
UA									•
W	10.0	12.3	11.1	1.15	0.453	11.13	0.80	0.54	
X	10.3	11.7	9.7	1.03	0.394	10.57	0.48	0.21	

Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
1.30	×	TV	7.77		BH	9.00		TI
2.87	⇓	SI	7.83		GZ	9.20		PT
3.70	⇓	P	7.93		NK	9.27		S
3.90	⇓	KT	8.00		AL	9.30		RZ
4.27	⇓	PV	8.10		HP	9.40		CK
4.63	⇓	BM	8.43		ID	9.43		NO
4.90	⇓	SO	8.77		BK	9.50		HL
4.93	⇓	PM	8.80		BC	9.50		CO
5.80		AW	8.87		TE	9.50		BA
6.47		HK	8.87		NJ	9.50		TQ
7.43		QQ	8.90		C	9.60		MS
7.50		RM	8.97		Q	9.63		K
7.70		QZ	9.00		JE	9.63		DT

TAG SYMBOLS

• ≡ No data submitted
Ø ≡ Insufficient data
× ≡ 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
9.67		ME	10.20		RN	11.30		RP
9.67		HY	10.23		TP	11.30		L
9.67		BO	10.27		FZ	11.33		JY
9.70		E	10.33		CG	11.37		NT
9.73		SS	10.37		EB	11.40		CS
9.73		CA	10.40		DZ	11.67		A
9.80		SC	10.43		J	11.70		LT
9.80		RF	10.47		SF	11.93		T
9.90		TL	10.50		DE	11.97		RC
9.93		OZ	10.53		PP	12.03		CE
9.97		JS	10.57		X	12.23		AK
10.00		RG	10.70		IE	12.50		RK
10.00		NA	10.77		NH	13.67		OF
10.00		FE	10.83		AF	14.13		QX
10.00		DB	10.87		I	14.33		AE
10.00		AI	10.90		FN	15.00		SL
10.00		SD	10.93		GQ	15.10		RD
10.07		SZ	11.00		PB	19.73	×	QU
10.07		OS	11.00		CJ	23.37	×	FJ
10.07		D	11.00		AJ	23.43	×	DO
10.17		PQ	11.13		W	42.00	×	PW
10.17		BG	11.17		OY	44.90	×	PC
10.20		TG	11.27		AZ	52.07	×	TS

% responding labs — Frequency distribution — Normalized deviation of the mean from the known value

% responding labs — Frequency distribution — Normalized deviation of the mean from the grand average

	TAG SYMBOLS	
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∅ ≡ Insufficient data	× ≡ Determined to be an outlier	⇓ ≡ Below control limit