

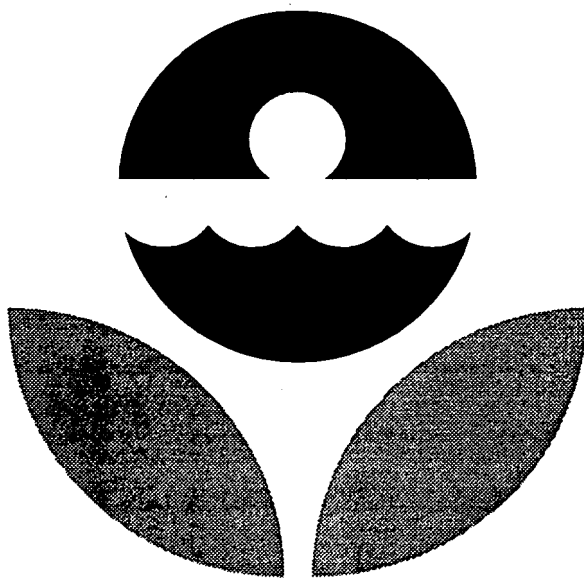


Tritium in Water Intercomparison Study

A Statistical Evaluation of the February 21, 1992 Data



Tritium in Water
Intercomparison Study
February 21, 1992



Environmental Protection Agency
Environmental Monitoring Systems Laboratory
Las Vegas, Nevada



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
ENVIRONMENTAL MONITORING SYSTEMS LABORATORY-LAS VEGAS
P.O. BOX 93478
LAS VEGAS, NEVADA 89193-3478
(702/798-2100 - FTS 545-2100)

Dear Participant,

Enclosed are the results of the Nuclear Radiation Assessment Division (EMSL-LV) Intercomparison Study for *Tritium in Water*; **February 21, 1992.**

This report introduces a new format that we hope is easier to read and interpret. Although we have tested the software that produces this report carefully, and compared the results with the previous format, there is a possibility of error. We encourage you to examine the data and inform us of any apparent discrepancies.

We especially 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, it becomes unrealistic for us to receive results by mail or FAX.

If you have any questions or comments, please send a message via the data-entry system or contact Frank Novielli at 702/798-2159 (FTS 545-2159) or Patricia Honsa at 702/798-2141 (FTS 545-2141).

Sincerely,

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

Frank Novielli
Senior Chemist
Radioanalysis Branch

Enclosure

NOTICE

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

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

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

The coin shaped pie chart at the top of the summary page shows the fate of all the samples sent out in number and percentage terms. The pie chart starts at the top and rotates clockwise. The first sector represents those participants who submitted analytical results within both the warning and control limits. The next sector represents those who are in the warning region but not out of control. The third sector represents those who are out of control, but have passed the 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.

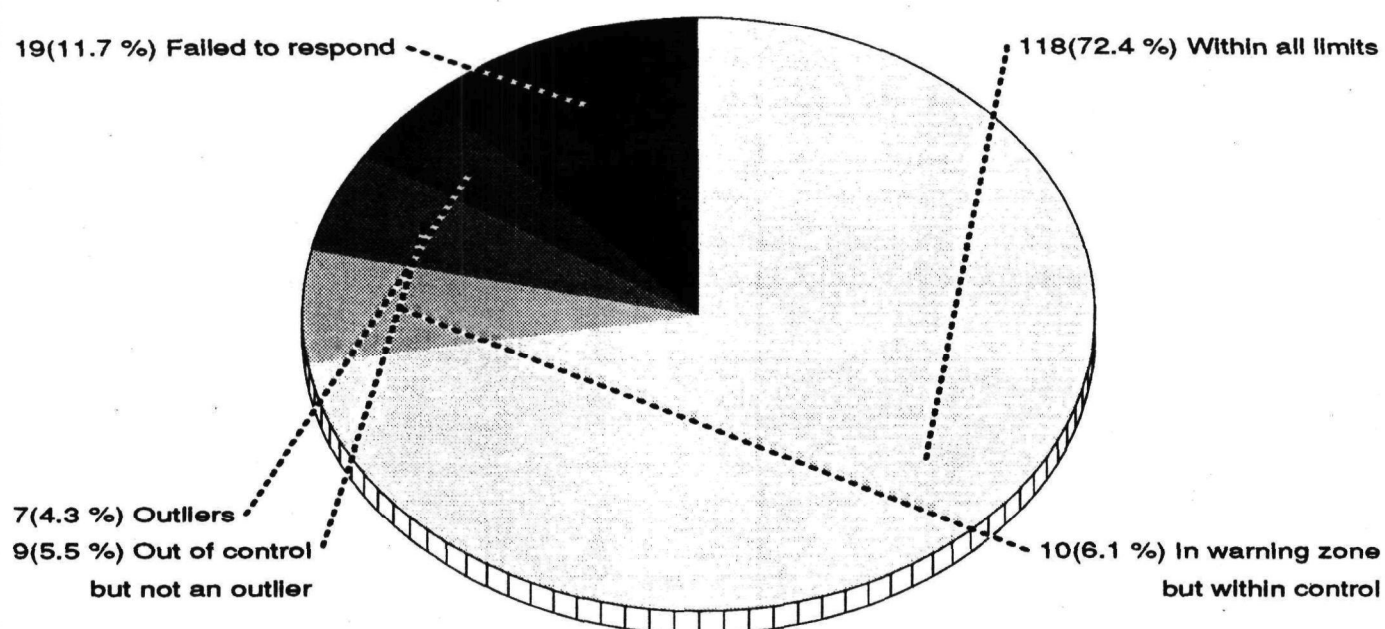
The second part is an alphabetical listing, in lab-code order, of submitted data and several calculated quantities. An entry that is shaded has been rejected because of one of the reasons listed above or failure of the outlier test. The fifth and sixth columns are a measure of laboratory precision. The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

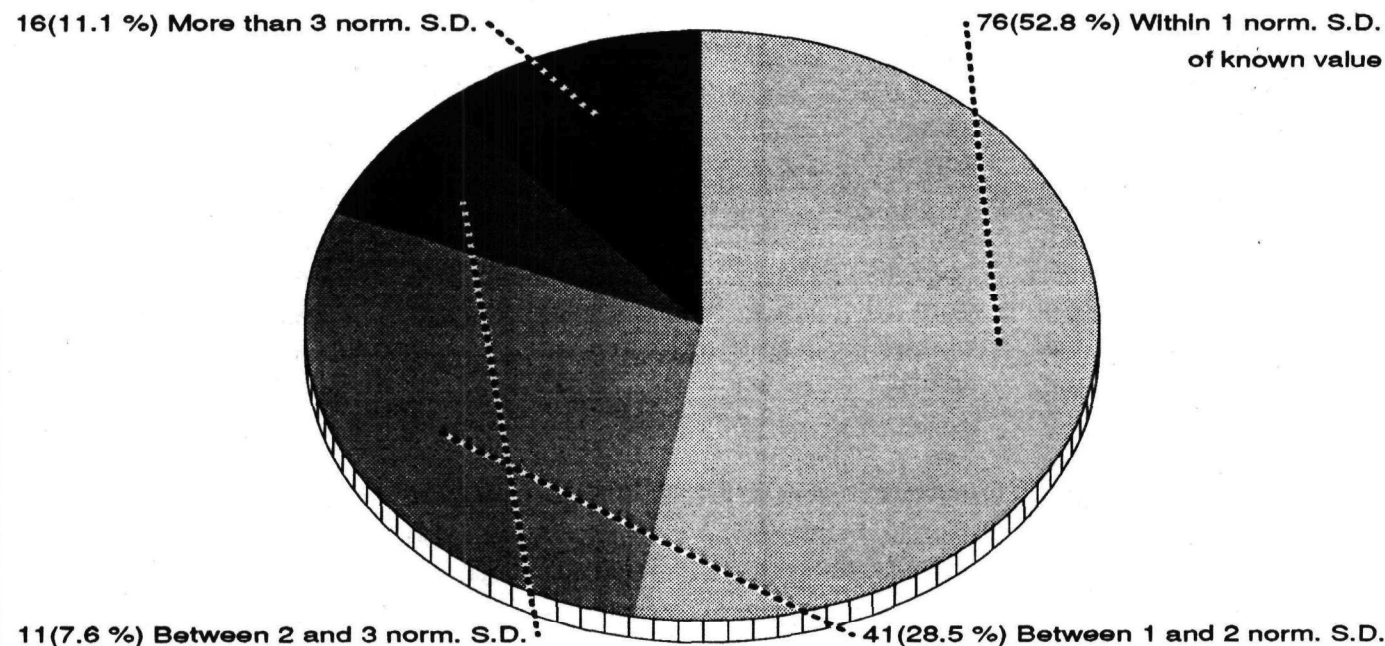
The last part is two bar chart displays showing frequency distributions of responding participants. The first chart places the known value at the center and a bar at each 0.2 unit of expected precision. The second chart places the mean of the reported measurements at the center and a bar at each 0.2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

Tritium**Statistical Summary****163 Participants**

The known value of this nuclide is **7904.0 pCi/l** with an expected precision of **790.0**; the control limits are 6533.4 to 9274.6, and the warning levels are 6989.5 to 8818.5



Statistic	Respondents	Non-outliers
Mean	7697.72	Grand Avg 7942.78
Std. Dev.	1576.54	702.00
Variance	2485475.03	492803.57
% Coef. of Var.	20.48	8.84
% deviation of mean from known value	-2.61	0.49
Norm. dev. of mean from known value	-0.13	0.06
Median	7952.67	7975.33
% deviation of median from known value	0.62	0.90
Norm. dev. of median from known value	0.03	0.10



Tritium								
Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg) (known) Tag	
A	8946.0	8989.0	9033.0	43.51	0.065	8989.33	2.29	2.38
AB	9700.0	9600.0	9300.0	208.17	0.299	9533.33	3.49	3.57 ↑
AE	8460.0	8500.0	8340.0	83.27	0.120	8433.33	1.08	1.16
AF	8015.0	8095.0	7918.0	88.62	0.132	8009.33	0.15	0.23
AH	7945.0	8006.0	8006.0	35.27	0.046	7985.67	0.09	0.18
AI	7820.0	7640.0	7510.0	155.66	0.232	7656.67	-0.63	-0.54
AJ	6909.0	6831.0	6937.0	54.95	0.079	6892.33	-2.30	-2.22
AK	8690.0	8735.0	8592.0	73.10	0.107	8672.33	1.60	1.68
AP	8083.0	8226.0	8139.0	72.04	0.107	8149.33	0.45	0.54
AU	7400.0	7600.0	7700.0	152.75	0.224	7566.67	-0.82	-0.74
AW	7841.0	7841.0	7799.0	24.22	0.031	7827.00	-0.25	-0.17
AY	7785.0	7919.0	7803.0	72.74	0.100	7835.67	-0.23	-0.15
AZ	8973.0	8631.0	8186.0	394.62	0.588	8596.67	1.43	1.52
BA	7736.0	7840.0	7779.0	52.29	0.078	7785.00	-0.35	-0.26
BB	7803.0	7878.0	8006.0	102.64	0.152	7895.67	-0.10	-0.02
BC	7040.0	7330.0	6750.0	290.01	0.434	7040.00	-1.98	-1.89
BG	8700.0	8700.0	8500.0	115.47	0.150	8633.33	1.51	1.60
BI	7040.0	7090.0	6970.0	60.31	0.090	7033.33	-1.99	-1.91
BL	7971.0	7973.0	7982.0	5.60	0.008	7975.33	0.07	0.16
BM	8610.0	8780.0	8650.0	88.90	0.127	8680.00	1.62	1.70
BO	7500.0	7500.0	7490.0	5.60	0.007	7496.67	-0.98	-0.89
BW	8900.0	8100.0	8500.0	400.00	0.598	8500.00	1.22	1.31
C	7784.0	7741.0	7827.0	42.99	0.064	7784.00	-0.35	-0.26
CA	7695.0	7781.0	7666.0	59.82	0.086	7714.00	-0.50	-0.42
CC	4290.0	3650.0	4500.0	442.76	0.636	4146.67	-8.32	-8.24 ×
CE	8200.0	8500.0	8320.0	151.00	0.224	8340.00	0.87	0.96
CJ	7900.0	7700.0	7800.0	100.00	0.150	7800.00	-0.31	-0.23
CK	7639.0	7565.0	7725.0	80.07	0.120	7643.00	-0.66	-0.57
CM								•
CN	7041.0	7003.0	6632.0	225.97	0.306	6892.00	-2.30	-2.22
CO	8180.0	7960.0	8470.0	255.80	0.381	8203.33	0.57	0.66
CP	7923.0	8000.0	7962.0	38.52	0.058	7961.67	0.04	0.13
CQ	8600.0	9020.0	8700.0	219.39	0.314	8773.33	1.82	1.91
CS	8700.0	8800.0	8500.0	152.75	0.224	8666.67	1.59	1.67
CU								•
CX	7338.0	7322.0	8239.0	524.88	0.686	7633.00	-0.68	-0.59
D	8106.0	8022.0	7767.0	176.55	0.253	7965.00	0.05	0.13
DD	7480.0	7630.0	7570.0	75.52	0.112	7560.00	-0.84	-0.75
DE	7526.0	7534.0	7542.0	8.12	0.012	7534.00	-0.90	-0.81
DG	8140.0	7730.0	8230.0	266.53	0.374	8033.33	0.20	0.28
DH	8040.0	8160.0	8200.0	83.27	0.120	8133.33	0.42	0.50
DI	7263.0	8460.0	7447.0	644.57	0.895	7723.33	-0.48	-0.40
DJ	9492.0	10120.0	9866.0	315.91	0.470	9826.00	4.13	4.21 ↑
DL	8372.0	7985.0	8318.0	209.59	0.289	8225.00	0.62	0.70
DM	8340.0	8360.0	8320.0	20.00	0.030	8340.00	0.87	0.96

• = No data submitted

TAG SYMBOLS

↑ = Above control limit

∅ = Insufficient data

× = Determined to be an outlier

↓ = Below control limit

Tritium

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg) (known)		Tag
DR	8090.0	8160.0	8280.0	96.08	0.142	8176.67	0.51	0.60	
DT	8000.0	8000.0	8000.0	0.00	0.000	8000.00	0.13	0.21	
E	7333.0	7327.0	7324.0	4.90	0.007	7328.00	-1.35	-1.26	
EA	7920.0	8040.0	8030.0	66.57	0.090	7996.67	0.12	0.20	
EB	7707.0	7770.0	7891.0	93.50	0.138	7789.33	-0.34	-0.25	
EH	7150.0	7340.0	7510.0	180.10	0.269	7333.33	-1.34	-1.25	
EL	8588.0	8966.0	8994.0	226.76	0.304	8849.33	1.99	2.07	
EN	7643.0	7258.0	7482.0	193.36	0.288	7461.00	-1.06	-0.97	
EW	5180.0	4662.0	7038.0	1249.39	2.479	5626.67	-5.08	-4.99	↓
EX	6929.0	6918.0	6829.0	54.85	0.075	6892.00	-2.30	-2.22	
FA									•
FB									•
FE	8000.0	7900.0	7800.0	100.00	0.150	7900.00	-0.09	-0.01	
FJ	7500.0	7780.0	8100.0	300.22	0.449	7793.33	-0.33	-0.24	
FK	3637.0	3543.0	3579.0	47.43	0.070	3586.33	-9.55	-9.47	×
FL	7682.0	7764.0	8385.0	384.40	0.526	7943.67	0.00	0.09	
FU									•
FZ	8470.0	7910.0	8270.0	283.79	0.419	8216.67	0.60	0.69	
GE	8318.0	7985.0	8372.0	209.59	0.289	8225.00	0.62	0.70	
HI	7247.0	7209.0	7130.0	59.66	0.087	7195.33	-1.64	-1.55	
HJ	8270.0	8260.0	8220.0	26.42	0.037	8250.00	0.67	0.76	
HK	8278.0	8544.0	8544.0	153.57	0.199	8455.33	1.12	1.21	
HP	12687.0	11761.0	12043.0	474.65	0.692	12163.67	9.25	9.34	×
HR	8231.0	8241.0	8091.0	83.88	0.112	8187.67	0.54	0.62	
HU									•
I	7905.0	7725.0	7676.0	120.60	0.171	7768.67	-0.38	-0.30	
IC	8090.0	8348.0	7990.0	184.73	0.268	8142.67	0.44	0.52	
IU	7560.0	6750.0	7425.0	433.96	0.606	7245.00	-1.53	-1.44	
J	7821.0	7908.0	7974.0	76.75	0.114	7901.00	-0.09	-0.01	
JM	9512.0	8986.0	9525.0	307.51	0.403	9341.00	3.07	3.15	↑
JP	8503.0	8445.0	8343.0	81.02	0.120	8430.33	1.07	1.15	
JR	7010.0	6930.0	7130.0	100.67	0.150	7023.33	-2.02	-1.93	
JS	6300.0	6200.0	6500.0	152.75	0.224	6333.33	-3.53	-3.44	↓
JY	7650.0	7890.0	7700.0	126.64	0.179	7746.67	-0.43	-0.34	
K									•
KM	7830.0	8775.0	8532.0	490.72	0.707	8379.00	0.96	1.04	
KX	8200.0	8100.0	8080.0	64.29	0.090	8126.67	0.40	0.49	
L	7880.0	7729.0	7943.0	109.97	0.160	7850.67	-0.20	-0.12	
LA	8550.0	8790.0	8670.0	120.01	0.179	8670.00	1.59	1.68	
LE	7500.0	7770.0	7640.0	135.02	0.202	7636.67	-0.67	-0.59	
LF	8000.0	8400.0	8100.0	208.17	0.299	8166.67	0.49	0.58	
LM									•
LR	8293.0	8594.0	8180.0	214.00	0.310	8355.67	0.91	0.99	
LS	82.0	86.0	101.0	10.02	0.014	89.67	-17.22	-17.13	×
M	7500.0	7600.0	7500.0	57.74	0.075	7533.33	-0.90	-0.81	

• = No data submitted

TAG SYMBOLS

↑ = Above control limit

∅ = Insufficient data

× = Determined to be an outlier

↓ = Below control limit

Tritium									
Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg) (known)		Tag
MA	7313.0	7508.0	7475.0	104.38	0.146	7432.00	-1.12	-1.03	
ME	8690.0	8410.0	8360.0	177.87	0.247	8486.67	1.19	1.28	
ML	10216.0	10044.0	10058.0	95.55	0.129	10106.00	4.74	4.83	↑
MN									•
MQ	8340.0	8510.0	8290.0	115.34	0.164	8380.00	0.96	1.04	
MS	8180.0	8030.0	8090.0	75.52	0.112	8100.00	0.34	0.43	
MT	7580.0	7595.0	7650.0	36.88	0.052	7608.33	-0.73	-0.65	
MV									•
N	7699.0	7669.0	7634.0	32.49	0.049	7667.33	-0.60	-0.52	
NH	7740.0	7535.0	7801.0	139.34	0.199	7692.00	-0.55	-0.46	
NI	7864.0	7526.0	7333.0	268.78	0.397	7574.33	-0.81	-0.72	
NJ	6600.0	6500.0	6700.0	100.00	0.150	6600.00	-2.94	-2.86	
NK									•
NP	8133.0	9074.0	8022.0	578.00	0.787	8409.67	1.02	1.11	
OA	7400.0	7750.0	7880.0	248.26	0.359	7676.67	-0.58	-0.50	
OL									•
OM	6622.0	6847.0	7072.0	224.99	0.336	6847.00	-2.40	-2.32	
OT									•
PB	7154.0	7121.0	7226.0	53.73	0.079	7167.00	-1.70	-1.62	
PC	6203.0	6256.0	6078.0	91.40	0.133	6179.00	-3.87	-3.78	↓
PD	8300.0	8660.0	7200.0	760.61	1.175	8053.33	0.24	0.33	
PJ									•
PM	84.0	83.0	84.0	0.58	0.001	83.67	-17.23	-17.15	×
PP									•
PQ	8930.0	9080.0	8360.0	379.87	0.538	8790.00	1.86	1.94	
PV	7823.0	7905.0	8012.0	94.77	0.141	7913.33	-0.06	0.02	
Q	7717.0	8479.0	8915.0	606.35	0.896	8370.33	0.94	1.02	
QC	8059.0	8024.0	8007.0	26.57	0.039	8030.00	0.19	0.28	
QD	8300.0	8600.0	8750.0	229.12	0.336	8550.00	1.33	1.42	
QI	8717.0	8138.0	8563.0	299.88	0.433	8472.67	1.16	1.25	
QJ	7.0	7.0	8.0	0.58	0.001	7.33	-17.40	-17.31	×
QK	8145.0	8180.0	8189.0	23.31	0.033	8171.33	0.50	0.59	
QL	7640.0	7716.0	7592.0	62.52	0.093	7649.33	-0.64	-0.56	
QM	6965.0	6988.0	6900.0	45.68	0.066	6951.00	-2.17	-2.09	
QP	8196.0	8351.0	8436.0	121.69	0.179	8327.67	0.84	0.93	
QT	248.0	254.0	198.0	30.75	0.042	233.33	-16.90	-16.82	×
QU									•
QW	7201.0	6900.0	6900.0	173.78	0.225	7000.33	-2.07	-1.98	
QX	8773.0	8819.0	8630.0	98.55	0.141	8740.67	1.75	1.83	
QZ	8498.0	8306.0	8326.0	105.56	0.144	8376.67	0.95	1.04	
R	7910.0	8040.0	8180.0	135.02	0.202	8043.33	0.22	0.31	
RM	7162.0	7113.0	7193.0	40.30	0.060	7156.00	-1.72	-1.64	
RN	8500.0	8500.0	8600.0	57.74	0.075	8533.33	1.29	1.38	
RO	8272.0	8376.0	8127.0	125.06	0.186	8258.33	0.69	0.78	
RQ	6940.0	7060.0	6940.0	69.28	0.090	6980.00	-2.11	-2.03	

• = No data submitted

TAG SYMBOLS

↑ = Above control limit

∅ = Insufficient data

× = Determined to be an outlier

↓ = Below control limit

Tritium

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg) (known)		Tag
RR	8049.0	8150.0	7997.0	77.80	0.114	8065.33	0.27	0.35	
RS	5936.0	6000.0	5978.0	32.55	0.048	5971.33	-4.32	-4.24	↓
RX	8808.0	8410.0	8336.0	253.85	0.353	8518.00	1.26	1.35	
RY	7944.0	8337.0	7919.0	234.45	0.313	8066.67	0.27	0.36	
S	7500.0	7640.0	7590.0	70.93	0.105	7576.67	-0.80	-0.72	
SA	10900.0	9680.0	9340.0	820.33	1.317	9973.33	4.45	4.54	↑
SC	7510.0	7630.0	7760.0	125.05	0.187	7633.33	-0.68	-0.59	
SD									•
SE									•
SF	7287.0	7446.0	7037.0	206.18	0.306	7256.67	-1.50	-1.42	
SI	7350.0	7500.0	7250.0	125.85	0.187	7366.67	-1.26	-1.18	
SK	7330.0	7330.0	7330.0	1.41	0.000	7330.00	-1.34	-1.26	
SM	7730.0	7790.0	8070.0	181.48	0.254	7863.33	-0.17	-0.09	
SN	7939.0	8093.0	8000.0	77.55	0.115	8010.67	0.15	0.23	
SQ									•
SS	7393.0	7481.0	7801.0	214.71	0.305	7558.33	-0.84	-0.76	
ST	8848.0	8244.0	8529.0	302.16	0.452	8540.33	1.31	1.40	
SU	7214.0	7194.0	7298.0	55.20	0.078	7235.33	-1.55	-1.47	
SW	8390.0	8220.0	8060.0	165.02	0.247	8223.33	0.62	0.70	
SY	8559.0	8371.0	8103.0	229.17	0.341	8344.33	0.88	0.97	
SZ	7887.0	7798.0	7894.0	53.55	0.072	7859.67	-0.18	-0.10	
T	8210.0	8140.0	8220.0	43.57	0.060	8190.00	0.54	0.63	
TA	7650.0	7520.0	7000.0	343.94	0.486	7390.00	-1.21	-1.13	
U	8880.0	8940.0	8630.0	164.41	0.232	8816.67	1.92	2.00	
W	8760.0	8740.0	8760.0	11.55	0.015	8753.33	1.78	1.86	
X	9087.0	8370.0	9715.0	672.99	1.011	9057.33	2.44	2.53	
Y	8447.0	8169.0	8161.0	162.86	0.214	8259.00	0.69	0.78	
Z	7903.0	7779.0	7716.0	95.16	0.140	7799.33	-0.31	-0.23	

Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
7.33	×	QJ	6892.33		AJ	7330.00		SK
83.67	×	PM	6951.00		QM	7333.33		EH
89.67	×	LS	6980.00		RQ	7366.67		SI
233.33	×	QT	7000.33		QW	7390.00		TA
3586.33	×	FK	7023.33		JR	7432.00		MA
4146.67	×	CC	7033.33		BI	7461.00		EN
5626.67	↓	EW	7040.00		BC	7496.67		BO
5971.33	↓	RS	7156.00		RM	7533.33		M
6179.00	↓	PC	7167.00		PB	7534.00		DE
6333.33	↓	JS	7195.33		HI	7558.33		SS
6600.00		NJ	7235.33		SU	7560.00		DD
6847.00		OM	7245.00		IU	7566.67		AU
6892.00		EX	7256.67		SF	7574.33		NI
6892.00		CN	7328.00		E	7576.67		S

• = No data submitted

TAG SYMBOLS

↑ = Above control limit

∅ = Insufficient data

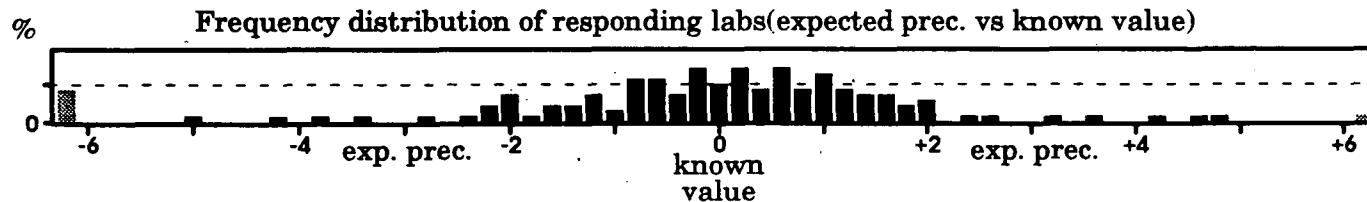
× = Determined to be an outlier

↓ = Below control limit

Tritium

Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
7608.33		MT	7996.67		EA	8376.67		QZ
7633.00		CX	8000.00		DT	8379.00		KM
7633.33		SC	8009.33		AF	8380.00		MQ
7636.67		LE	8010.67		SN	8409.67		NP
7643.00		CK	8030.00		QC	8430.33		JP
7649.33		QL	8033.33		DG	8433.33		AE
7656.67		AI	8043.33		R	8455.33		HK
7667.33		N	8053.33		PD	8472.67		QI
7676.67		OA	8065.33		RR	8486.67		ME
7692.00		NH	8066.67		RY	8500.00		BW
7714.00		CA	8100.00		MS	8518.00		RX
7723.33		DI	8126.67		KX	8533.33		RN
7746.67		JY	8133.33		DH	8540.33		ST
7768.67		I	8142.67		IC	8550.00		QD
7784.00		C	8149.33		AP	8596.67		AZ
7785.00		BA	8166.67		LF	8633.33		BG
7789.33		EB	8171.33		QK	8666.67		CS
7793.33		FJ	8176.67		DR	8670.00		LA
7799.33		Z	8187.67		HR	8672.33		AK
7800.00		CJ	8190.00		T	8680.00		BM
7827.00		AW	8203.33		CO	8740.67		QX
7835.67		AY	8216.67		FZ	8753.33		W
7850.67		L	8223.33		SW	8773.33		CQ
7859.67		SZ	8225.00		GE	8790.00		PQ
7863.33		SM	8225.00		DL	8816.67		U
7895.67		BB	8250.00		HJ	8849.33		EL
7900.00		FE	8258.33		RO	8989.33		A
7901.00		J	8259.00		Y	9057.33		X
7913.33		PV	8327.67		QP	9341.00	↑↑	JM
7943.67		FL	8340.00		DM	9533.33	↑↑	AB
7961.67		CP	8340.00		CE	9826.00	↑↑	DJ
7965.00		D	8344.33		SY	9973.33	↑↑	SA
7975.33		BL	8355.67		LR	10106.00	↑↑	ML
7985.67		AH	8370.33		Q	12163.67	×	HP



• ≡ No data submitted

TAG SYMBOLS

↑↑ ≡ Above control limit

∅ ≡ Insufficient data

× ≡ Determined to be an outlier

↓↓ ≡ Below control limit

Tritium