

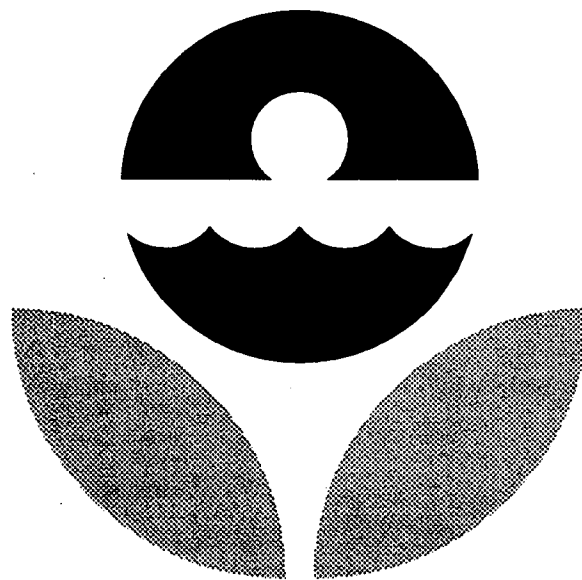


Tritium in Water Intercomparison Study

A Statistical Evaluation of the October 23, 1992 Data



Tritium in Water
Intercomparison Study
October 23, 1992



Environmental Protection Agency
Environmental Monitoring Systems Laboratory
Las Vegas, Nevada



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

Dear Participant,

Enclosed are the results of the Nuclear Radiation Assessment Division (EMSL-LV) Intercomparison Study for *Tritium in Water*; **October 23, 1992.**

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

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

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

Sincerely,

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

Frank Novielli
Senior Chemist
Radioanalysis Branch

Enclosure

NOTICE

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

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

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

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

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

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

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

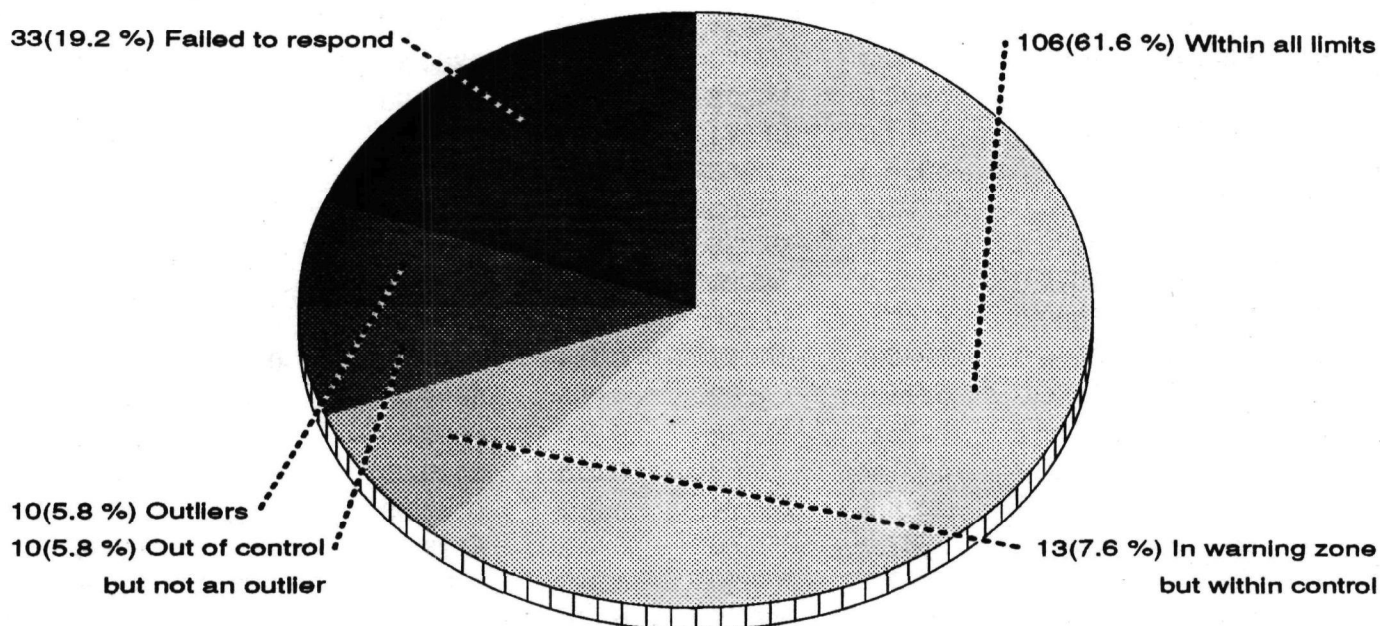
The last part is two bar chart displays showing frequency distributions of responding participants. The first chart places the known value at the center and a bar at each 0.2 unit of expected precision. The second chart places the mean of the reported measurements at the center and a bar at each 0.2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

Tritium

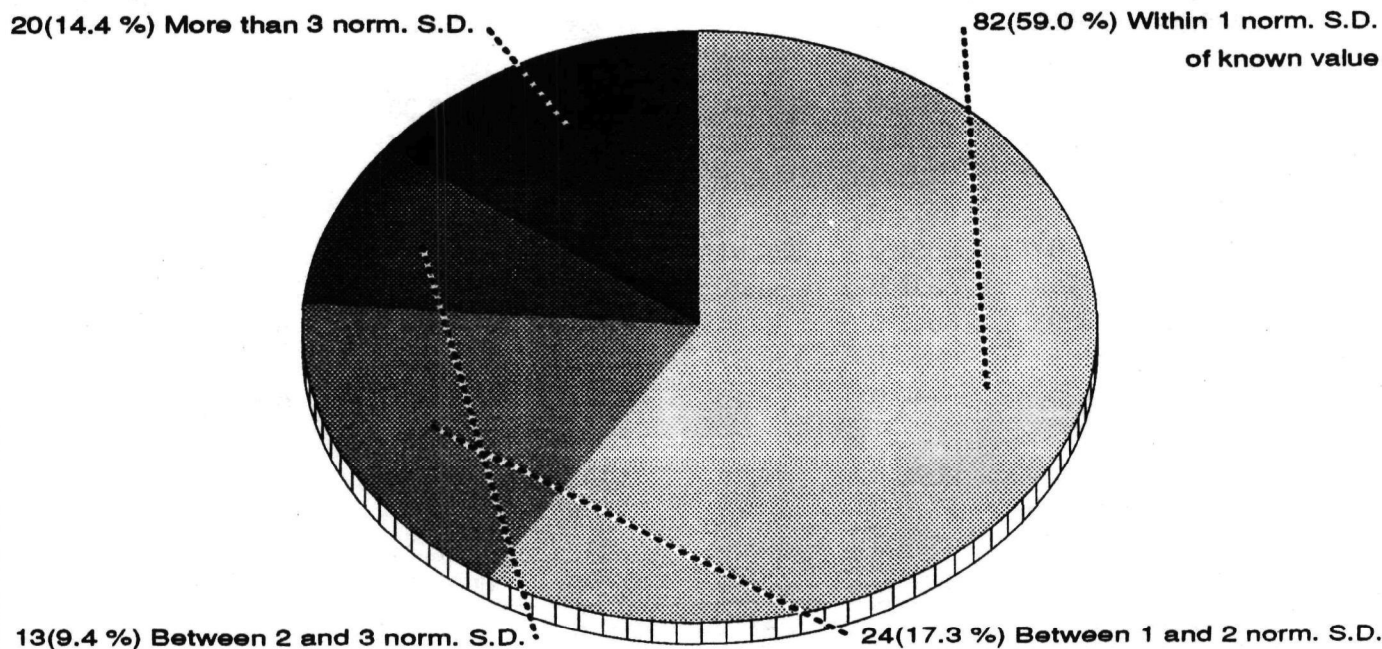
Statistical Summary

172 Participants

The known value of this nuclide is **5962.0 pCi/l** with an expected precision of **596.0**; the control limits are 4928.0 to 6996.0; the warning regions are 4928.0 to 5272.1 and 6651.9 to 6996.0



Statistic	Respondents	Non-outliers
Mean	6201.84	Grand Avg 5997.40
Std. Dev.	4667.63	565.83
Variance	21786750.49	320164.99
% Coef. of Var.	75.26	9.43
% deviation of mean from known value	4.02	0.59
Norm. dev. of mean from known value	0.05	0.06
Median	5953.33	5961.67
% deviation of median from known value	-0.15	-0.01
Norm. dev. of median from known value	0.00	0.00



Tritium

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg) (known) Tag	
A	5660.0	5688.0	5494.0	104.87	0.192	5614.00	-1.11	-1.01
AB	6810.0	6770.0	6650.0	83.28	0.159	6743.33	2.17	2.27
AE	6300.0	6200.0	6300.0	57.74	0.099	6266.67	0.78	0.89
AF	5757.0	5701.0	5976.0	145.32	0.273	5811.33	-0.54	-0.44
AH	6677.0	6950.0	6827.0	136.71	0.271	6818.00	2.38	2.49
AI	4400.0	4400.0	4270.0	75.06	0.129	4356.67	-4.77	-4.67
AJ	5225.0	5324.0	5191.0	69.09	0.132	5246.67	-2.18	-2.08
AK	7065.0	6830.0	6777.0	153.28	0.285	6890.67	2.60	2.70
AP	5927.0	5975.0	6025.0	48.99	0.097	5975.67	-0.06	0.04
AU	5900.0	6000.0	6100.0	100.00	0.198	6000.00	0.01	0.11
AW	5867.0	5818.0	5963.0	73.77	0.144	5882.67	-0.33	-0.23
AY	5660.0	5726.0	5711.0	34.62	0.065	5699.00	-0.87	-0.76
AZ	5907.0	5610.0	5973.0	193.36	0.360	5830.00	-0.49	-0.38
BA	5813.0	5816.0	5831.0	9.59	0.018	5820.00	-0.52	-0.41
BB	5992.0	6175.0	6263.0	138.24	0.269	6143.33	0.42	0.53
BC	6612.0	6136.0	6237.0	250.80	0.472	6328.33	0.96	1.06
BG	5100.0	5500.0	5300.0	200.00	0.396	5300.00	-2.03	-1.92
BL	5800.0	5841.0	5911.0	56.12	0.110	5850.67	-0.43	-0.32
BM	6920.0	6620.0	6840.0	155.35	0.297	6793.33	2.31	2.42
BO	6090.0	6240.0	6260.0	92.93	0.168	6196.67	0.58	0.68
BW	5900.0	5600.0	5500.0	208.17	0.396	5666.67	-0.96	-0.86
C	6194.0	6164.0	6224.0	30.03	0.059	6194.00	0.57	0.67
CA	5920.0	5820.0	5950.0	68.08	0.129	5896.67	-0.29	-0.19
CC	5000.0	5600.0	6200.0	600.00	1.361	5600.00	-1.15	-1.05
CE	6270.0	6170.0	6080.0	95.04	0.188	6173.33	0.51	0.61
CJ	5700.0	5700.0	5600.0	57.74	0.099	5666.67	-0.96	-0.86
CK	5577.0	5663.0	5749.0	85.99	0.170	5663.00	-0.97	-0.87
CM	200.0	196.0	199.0	2.08	0.004	198.33	-16.85	-16.75
CN								
CO	5460.0	5230.0	5470.0	135.77	0.238	5386.67	-1.77	-1.67
CP	5977.0	6089.0	6033.0	55.99	0.111	6033.00	0.10	0.21
CQ	6410.0	6460.0	6670.0	137.96	0.258	6513.33	1.50	1.60
CS	7010.0	7020.0	7050.0	20.91	0.040	7026.67	2.99	3.09
CX	7160.0	5285.0	6421.0	944.48	2.635	6288.67	0.85	0.95
D	5723.0	6038.0	5929.0	159.97	0.312	5896.67	-0.29	-0.19
DD	6460.0	5830.0	6320.0	330.81	0.624	6203.33	0.60	0.70
DE	5447.0	5479.0	5515.0	34.00	0.067	5480.33	-1.50	-1.40
DG	6080.0	6000.0	5940.0	70.24	0.139	6006.67	0.03	0.13
DH	6758.0	6989.0	6929.0	119.87	0.229	6892.00	2.60	2.70
DI	6070.0	6190.0	6160.0	62.45	0.119	6140.00	0.41	0.52
DJ								
DL	5554.0	5467.0	5650.0	91.53	0.181	5557.00	-1.28	-1.18
DM	5650.0	5670.0	5790.0	75.73	0.139	5703.33	-0.85	-0.75
DR	5721.0	5750.0	5636.0	59.26	0.113	5702.33	-0.86	-0.75
DT	6100.0	6000.0	6000.0	57.74	0.099	6033.33	0.10	0.21

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Tritium

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg) (known)		Tag
E	6023.0	5957.0	6053.0	49.10	0.095	6011.00	0.04	0.14	
EA	6520.0	6460.0	6430.0	45.85	0.089	6470.00	1.37	1.48	
EB	5670.0	5870.0	5960.0	148.44	0.287	5833.33	-0.48	-0.37	
EH	5500.0	5320.0	5300.0	110.15	0.198	5373.33	-1.81	-1.71	
EL	6060.0	6490.0	6020.0	260.58	0.466	6190.00	0.56	0.66	
EX	5911.0	5896.0	5900.0	7.74	0.015	5902.33	-0.28	-0.17	
FA	6186.0	6021.0	6073.0	84.36	0.164	6093.33	0.28	0.38	
FB									•
FE	5800.0	5800.0	5800.0	0.00	0.000	5800.00	-0.57	-0.47	
FJ									•
FL	58.0	59.0	54.0	2.65	0.005	57.00	-17.26	-17.16	×
FU									•
FZ	9400.0	7300.0	7500.0	1159.02	3.059	8066.67	6.01	6.12	×
GE	5650.0	5467.0	5554.0	91.53	0.181	5557.00	-1.28	-1.18	
GQ	5600.0	5100.0	5400.0	251.66	0.496	5366.67	-1.83	-1.73	
HI	5862.0	5800.0	5868.0	37.67	0.067	5843.33	-0.45	-0.34	
HJ	6180.0	6130.0	6120.0	32.18	0.059	6143.33	0.42	0.53	
HK	6010.0	6130.0	6186.0	89.93	0.174	6108.67	0.32	0.43	
HP	6536.0	6366.0	6404.0	89.24	0.168	6435.33	1.27	1.38	
HR									•
HU	6144.0	6120.0	6155.0	17.88	0.035	6139.67	0.41	0.52	
I	5738.0	5779.0	5849.0	56.14	0.110	5788.67	-0.61	-0.50	
IA									•
IC	6120.0	6205.0	6006.0	99.86	0.197	6110.33	0.33	0.43	
IU	5027.0	5459.0	5135.0	224.82	0.428	5207.00	-2.30	-2.19	
J	5822.0	6036.0	6334.0	257.15	0.507	6064.00	0.19	0.30	
JE	6196.0	5859.0	5887.0	187.01	0.334	5980.67	-0.05	0.05	
JG									•
JK	5901.0	6171.0	6216.0	170.36	0.312	6096.00	0.29	0.39	
JM	7215.0	6733.0	7272.0	296.12	0.534	7073.33	3.13	3.23	↑
JP									•
JR	5260.0	5230.0	5090.0	90.74	0.168	5193.33	-2.34	-2.23	
JS	6800.0	7540.0	7340.0	382.80	0.733	7226.67	3.57	3.68	↑
JY	6120.0	6450.0	6230.0	168.03	0.327	6266.67	0.78	0.89	
K	5993.0	5177.0	6018.0	478.50	0.833	5729.33	-0.78	-0.68	
KH	6081.0	5892.0	5866.0	117.35	0.213	5946.33	-0.15	-0.05	
KM	5838.0	6351.0	7081.0	624.65	1.442	6423.33	1.24	1.34	
KX	5910.0	5890.0	5860.0	25.17	0.050	5886.67	-0.32	-0.22	
L	5861.0	5907.0	5878.0	23.28	0.046	5882.00	-0.34	-0.23	
LA									•
LF	6100.0	6000.0	6000.0	57.74	0.099	6033.33	0.10	0.21	
LM									•
LR	6233.0	5706.0	6030.0	265.80	0.522	5989.67	-0.02	0.08	
LS									•
LT	6293.0	6245.0	6310.0	33.72	0.064	6282.67	0.83	0.93	

• = No data submitted

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Tritium

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg) (known)		Tag
M	7700.0	7850.0	7800.0	76.36	0.149	7783.33	5.19	5.29	↑
MA	5717.0	5596.0	5301.0	213.98	0.412	5538.00	-1.34	-1.23	
ME	5760.0	5730.0	5440.0	176.74	0.317	5643.33	-1.03	-0.93	
ML	8103.0	8362.0	8054.0	165.51	0.305	8173.00	6.32	6.43	×
MN									•
MQ	5680.0	5620.0	5650.0	30.03	0.059	5650.00	-1.01	-0.91	
MS	5870.0	6170.0	5999.0	150.49	0.297	6013.00	0.05	0.15	
MT	5729.0	5762.0	6009.0	153.03	0.277	5833.33	-0.48	-0.37	
MV	5609.0	5806.0	5898.0	147.64	0.286	5771.00	-0.66	-0.56	
N									•
NB									•
NH	5798.0	5846.0	5975.0	91.53	0.175	5873.00	-0.36	-0.26	
NI	8366.0	7542.0	7588.0	463.03	0.817	7832.00	5.33	5.43	↑
NJ									•
NP	5902.0	5648.0	5810.0	128.60	0.252	5786.67	-0.61	-0.51	
O	5841.0	5889.0	5850.0	25.53	0.048	5860.00	-0.40	-0.30	
OA	6000.0	6200.0	6200.0	115.47	0.198	6133.33	0.40	0.50	
OL	28.0	26.0	27.0	1.00	0.002	27.00	-17.35	-17.25	×
OM									•
OT	6120.0	5530.0	5980.0	308.28	0.585	5876.67	-0.35	-0.25	
PB	5735.0	5755.0	5835.0	52.90	0.099	5775.00	-0.65	-0.54	
PC									•
PE									•
PJ	6360.0	5934.0	5271.0	548.78	1.151	5855.00	-0.41	-0.31	
PP	6014.0	5851.0	5995.0	89.14	0.162	5953.33	-0.13	-0.03	
PQ	5500.0	6400.0	6100.0	458.26	0.892	6000.00	0.01	0.11	
PT	6303.0	6256.0	6199.0	52.07	0.103	6252.67	0.74	0.84	
PV	6018.0	5186.0	6426.0	631.97	1.436	5876.67	-0.35	-0.25	
PY									•
Q	6500.0	6800.0	6500.0	173.21	0.297	6600.00	1.75	1.85	
QA	4402.0	4379.0	3936.0	262.66	0.462	4239.00	-5.11	-5.01	↓
QC									•
QD									•
QI	4130.0	4680.0	4230.0	292.97	0.545	4346.67	-4.80	-4.69	↓
QJ	6070.0	5760.0	5900.0	155.25	0.307	5910.00	-0.25	-0.15	
QP	6610.0	6500.0	6880.0	195.54	0.377	6663.33	1.94	2.04	
QQ									•
QT	6085.0	6110.0	6195.0	57.67	0.109	6130.00	0.39	0.49	
QU	4865.0	4889.0	5039.0	94.29	0.172	4931.00	-3.10	-3.00	
QW	4890.0	5090.0	4980.0	100.17	0.198	4986.67	-2.94	-2.83	
QX	6528.0	6433.0	6403.0	65.25	0.124	6454.67	1.33	1.43	
QZ	6160.0	6177.0	6006.0	94.21	0.169	6114.33	0.34	0.44	
R	5611.0	5532.0	5611.0	45.60	0.078	5584.67	-1.20	-1.10	
RC	6940.0	6530.0	6840.0	213.77	0.406	6770.00	2.25	2.35	
RH	5282.0	5461.0	5252.0	113.01	0.207	5331.67	-1.93	-1.83	

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Tritium

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg) (known)		Tag
RM	5908.0	5648.0	5695.0	138.55	0.258	5750.33	-0.72	-0.62	
RN	5650.0	5470.0	5680.0	113.58	0.208	5600.00	-1.15	-1.05	
RO	2785.0	2509.0	2582.0	143.01	0.274	2625.33	-9.80	-9.70	x
RQ	5642.0	5642.0	5642.0	1.41	0.000	5642.00	-1.03	-0.93	
RR									•
RS									•
RU									•
RV	1911.0	1463.0	1772.0	229.31	0.444	1715.33	-12.44	-12.34	x
RX	5758.0	5731.0	5734.0	14.78	0.027	5741.00	-0.75	-0.64	
S	5700.0	5960.0	5550.0	207.45	0.406	5736.67	-0.76	-0.65	
SA									•
SC	7156.0	8178.0	7774.0	514.72	1.024	7702.67	4.96	5.06	↑
SD	6036.0	6315.0	6176.0	139.50	0.277	6175.67	0.52	0.62	
SI	5.0	5.0	6.0	0.58	0.001	5.33	-17.41	-17.31	x
SK									•
SS	5361.0	5272.0	5198.0	81.62	0.162	5277.00	-2.09	-1.99	
ST	5753.0	6200.0	5932.0	224.97	0.443	5961.67	-0.10	0.00	
SU	6746.0	6800.0	6580.0	114.64	0.218	6708.67	2.07	2.17	
SZ	6357.0	6508.0	6298.0	108.31	0.208	6387.67	1.13	1.24	
T	6030.0	5960.0	6130.0	85.44	0.168	6040.00	0.12	0.23	
TA									•
TC									•
TE	58750.0	58970.0	58580.0	195.13	0.387	58766.67	153.35	153.46	x
TF									•
TG	6322.0	6066.0	6518.0	226.67	0.448	6302.00	0.89	0.99	
TH	5500.0	5800.0	5700.0	152.75	0.297	5666.67	-0.96	-0.86	
TI	8220.0	9160.0	8890.0	483.97	0.932	8756.67	8.02	8.12	x
TL	6064.0	6271.0	6220.0	107.84	0.205	6185.00	0.55	0.65	
TW									•
TZ									•
U	7360.0	7140.0	6840.0	261.02	0.515	7113.33	3.24	3.35	↑
UF	5757.0	5714.0	6068.0	193.17	0.351	5846.33	-0.44	-0.34	
UH	7500.0	5900.0	4000.0	1752.14	5.702	5800.00	-0.57	-0.47	
W	6190.0	6130.0	6100.0	45.83	0.089	6140.00	0.41	0.52	
X	6630.0	6130.0	6390.0	250.07	0.496	6383.33	1.12	1.22	
Y	6057.0	7258.0	5878.0	750.43	1.700	6397.67	1.16	1.27	
Z	5930.0	6012.0	6057.0	64.40	0.126	5999.67	0.01	0.11	

Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
5.33	x	SI	2625.33	x	RO	4986.67		QW
27.00	x	OL	4239.00	↓	QA	5193.33		JR
57.00	x	FL	4346.67	↓	QI	5207.00		IU
198.33	x	CM	4356.67	↓	AI	5246.67		AJ
1715.33	x	RV	4931.00		QU	5277.00		SS

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Tritium**Data sorted by Laboratory Average**

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
5300.00		BG	5855.00		PJ	6173.33		CE
5331.67		RH	5860.00		O	6175.67		SD
5366.67		GQ	5873.00		NH	6185.00		TL
5373.33		EH	5876.67		PV	6190.00		EL
5386.67		CO	5876.67		OT	6194.00		C
5480.33		DE	5882.00		L	6196.67		BO
5538.00		MA	5882.67		AW	6203.33		DD
5557.00		GE	5886.67		KX	6252.67		PT
5557.00		DL	5896.67		D	6266.67		JY
5584.67		R	5896.67		CA	6266.67		AE
5600.00		RN	5902.33		EX	6282.67		LT
5600.00		CC	5910.00		QJ	6288.67		CX
5614.00		A	5946.33		KH	6302.00		TG
5642.00		RQ	5953.33		PP	6328.33		BC
5643.33		ME	5961.67		ST	6383.33		X
5650.00		MQ	5975.67		AP	6387.67		SZ
5663.00		CK	5980.67		JE	6397.67		Y
5666.67		TH	5989.67		LR	6423.33		KM
5666.67		CJ	5999.67		Z	6435.33		HP
5666.67		BW	6000.00		PQ	6454.67		QX
5699.00		AY	6000.00		AU	6470.00		EA
5702.33		DR	6006.67		DG	6513.33		CQ
5703.33		DM	6011.00		E	6600.00		Q
5729.33		K	6013.00		MS	6663.33		QP
5736.67		S	6033.00		CP	6708.67		SU
5741.00		RX	6033.33		LF	6743.33		AB
5750.33		RM	6033.33		DT	6770.00		RC
5771.00		MV	6040.00		T	6793.33		BM
5775.00		PB	6064.00		J	6818.00		AH
5786.67		NP	6093.33		FA	6890.67		AK
5788.67		I	6096.00		JK	6892.00		DH
5800.00		UH	6108.67		HK	7026.67	↑↑	CS
5800.00		FE	6110.33		IC	7073.33	↑↑	JM
5811.33		AF	6114.33		QZ	7113.33	↑↑	U
5820.00		BA	6130.00		QT	7226.67	↑↑	JS
5830.00		AZ	6133.33		OA	7702.67	↑↑	SC
5833.33		MT	6139.67		HU	7783.33	↑↑	M
5833.33		EB	6140.00		W	7832.00	↑↑	NI
5843.33		HI	6140.00		DI	8066.67	×	FZ
5846.33		UF	6143.33		HJ	8173.00	×	ML
5850.67		BL	6143.33		BB	8756.67	×	TI
						58766.67	×	TE

• = No data submitted

TAG SYMBOLS

↑↑ = Above control limit

∅ = Insufficient data

× = Determined to be an outlier

↓↓ = Below control limit

Tritium