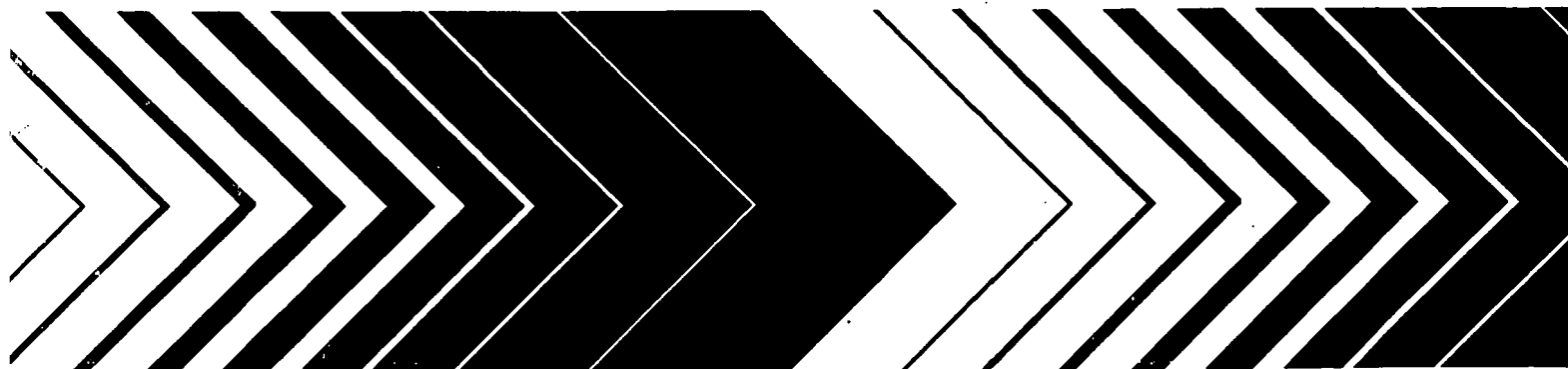


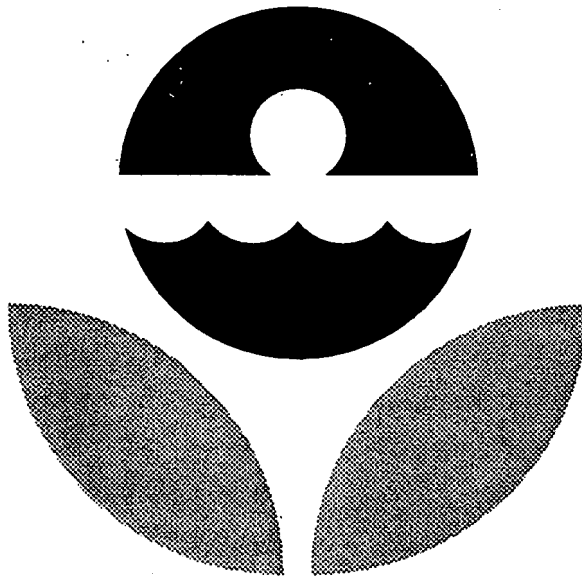


Tritium in Water Intercomparison Study

A Statistical Evaluation of the June 19, 1992 Data



Tritium in Water
Intercomparison Study
June 19, 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*; June 19, 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 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.

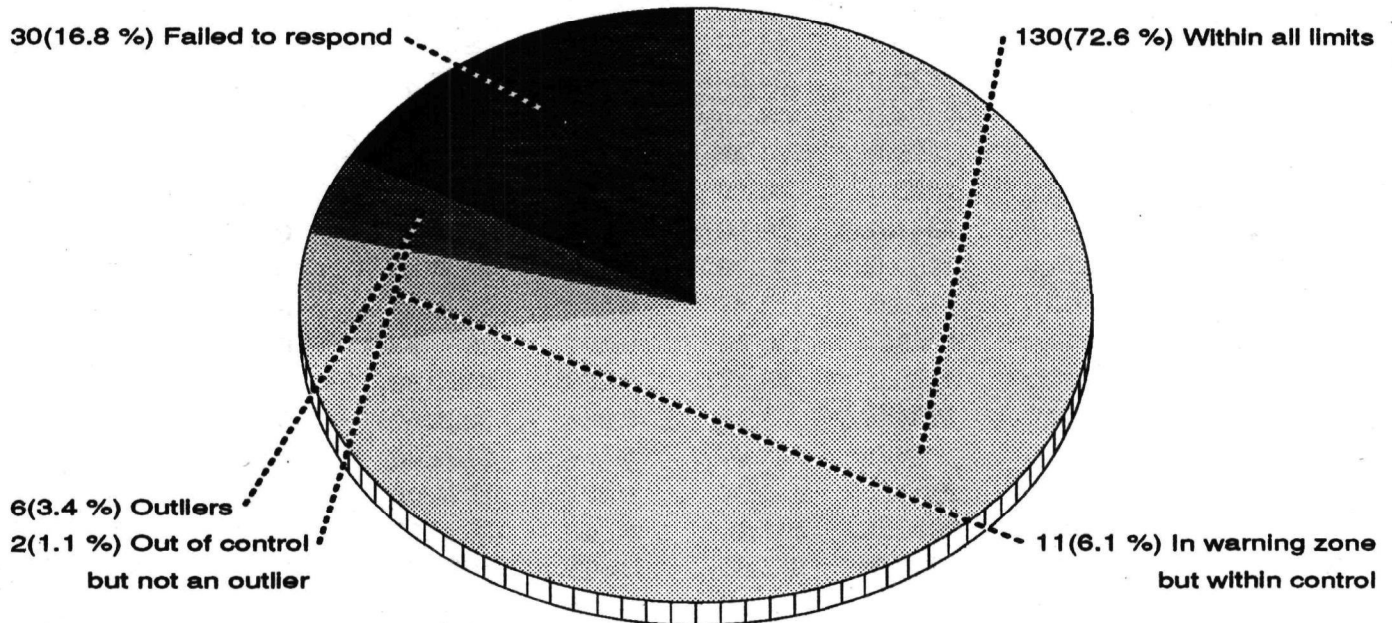
The last part is two bar chart displays showing frequency distributions of responding participants. The first chart places the known value at the center and a bar at each 0.2 unit of expected precision. The second chart places the mean of the reported measurements at the center and a bar at each 0.2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

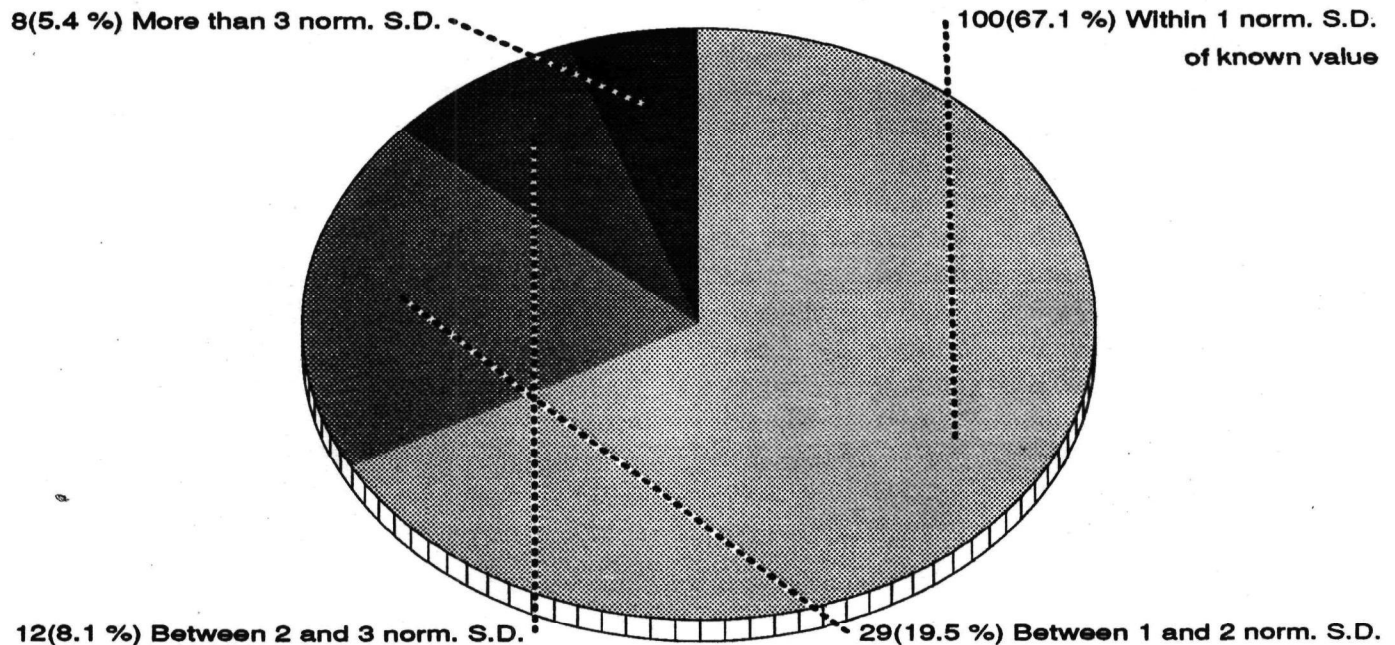
Statistical Summary

179 Participants

The known value of this nuclide is 2125.0 pCi/l with an expected precision of 347.0; the control limits are 1523.0 to 2727.0; the warning regions are 1523.0 to 1723.3 and 2526.7 to 2727.0



Statistic	Respondents	Non-outliers
Mean	2188.82	Grand Avg 2101.61
Std. Dev.	814.49	221.34
Variance	663389.97	48993.22
% Coef. of Var.	37.21	10.53
% deviation of mean from known value	3.00	-1.10
Norm. dev. of mean from known value	0.08	-0.11
Median	2094.33	2090.00
% deviation of median from known value	-1.44	-1.65
Norm. dev. of median from known value	-0.04	-0.16



Tritium

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg) (known) Tag	
A	1987.0	1998.0	1987.0	6.35	0.019	1990.67	-0.55	-0.67
AB								
AE	2200.0	2250.0	2220.0	25.17	0.085	2223.33	0.61	0.49
AF	2014.0	2074.0	2072.0	34.08	0.102	2053.33	-0.24	-0.36
AH	2234.0	2064.0	2254.0	104.40	0.323	2184.00	0.41	0.29
AI	2170.0	2240.0	2270.0	51.32	0.170	2226.67	0.62	0.51
AJ	1806.0	1830.0	1656.0	94.30	0.296	1764.00	-1.69	-1.80
AK	2039.0	2101.0	2251.0	109.00	0.361	2130.33	0.14	0.03
AP	2078.0	2275.0	1965.0	156.89	0.528	2106.00	0.02	-0.09
AU	1900.0	2100.0	2100.0	115.47	0.340	2033.33	-0.34	-0.46
AW	2128.0	1914.0	1923.0	121.04	0.364	1988.33	-0.57	-0.68
AY	2191.0	2212.0	2116.0	50.47	0.163	2173.00	0.36	0.24
AZ	2019.0	2092.0	1954.0	69.04	0.235	2021.67	-0.40	-0.52
BA	2185.0	2180.0	2118.0	37.32	0.114	2161.00	0.30	0.18
BB	1901.0	2213.0	2111.0	159.08	0.531	2075.00	-0.13	-0.25
BC	2100.0	1900.0	2080.0	110.15	0.340	2026.67	-0.37	-0.49
BG	1400.0	1900.0	1700.0	251.66	0.851	1666.67	-2.17	-2.29
BL	1965.0	1972.0	1952.0	10.15	0.034	1963.00	-0.69	-0.81
BM	9260.0	9390.0	9320.0	65.05	0.221	9323.33	36.05	35.93
BO	2120.0	2070.0	2060.0	32.15	0.102	2083.33	-0.09	-0.21
BW	2400.0	2200.0	2300.0	100.00	0.340	2300.00	0.99	0.87
C	2354.0	2372.0	2322.0	25.32	0.085	2349.33	1.24	1.12
CA	2190.0	2200.0	2070.0	72.34	0.221	2153.33	0.26	0.14
CC								
CE	2140.0	2140.0	2170.0	17.32	0.051	2150.00	0.24	0.12
CJ	2100.0	2100.0	2100.0	0.00	0.000	2100.00	-0.01	-0.12
CK	2088.0	2082.0	1913.0	99.35	0.298	2027.67	-0.37	-0.49
CM	1949.0	1802.0	1805.0	84.02	0.250	1852.00	-1.25	-1.36
CN								
CO	1830.0	1910.0	2080.0	127.67	0.426	1940.00	-0.81	-0.92
CP	1978.0	1838.0	2226.0	196.49	0.660	2014.00	-0.44	-0.55
CQ	1950.0	2070.0	2030.0	61.10	0.204	2016.67	-0.42	-0.54
CS	1950.0	2360.0	2300.0	221.43	0.698	2203.33	0.51	0.39
CX	1963.0	2078.0	2180.0	108.56	0.369	2073.67	-0.14	-0.26
D	2159.0	2062.0	1990.0	84.81	0.288	2070.33	-0.16	-0.27
DD	2070.0	2290.0	2020.0	143.64	0.460	2126.67	0.13	0.01
DE	2087.0	2088.0	2090.0	1.53	0.005	2088.33	-0.07	-0.18
DG	1990.0	2220.0	1820.0	200.75	0.681	2010.00	-0.46	-0.57
DH	2163.0	2208.0	2145.0	32.45	0.107	2172.00	0.35	0.23
DI	2160.0	2090.0	2090.0	40.41	0.119	2113.33	0.06	-0.06
DJ	2256.0	1769.0	1614.0	335.00	1.177	1879.67	-1.11	-1.22
DL								
DM	2500.0	2500.0	2510.0	5.77	0.017	2503.33	2.01	1.89
DR	1940.0	2220.0	2110.0	141.07	0.477	2090.00	-0.06	-0.17
DT	2300.0	2300.0	2300.0	0.00	0.000	2300.00	0.99	0.87

• = 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	
E	2069.0	2042.0	2072.0	16.52	0.051	2061.00	-0.20	-0.32
EA	2470.0	2510.0	2440.0	35.12	0.119	2473.33	1.86	1.74
EB	2350.0	2270.0	2270.0	46.19	0.136	2296.67	0.97	0.86
EH	1960.0	2120.0	1680.0	222.71	0.749	1920.00	-0.91	-1.02
EL	1988.0	2252.0	2192.0	138.39	0.449	2144.00	0.21	0.09
EN	2346.0	2423.0	1863.0	303.54	0.953	2210.67	0.54	0.43
EW	1735.0	1608.0	1418.0	159.54	0.540	1587.00	-2.57	-2.69
EX	2281.0	2091.0	2227.0	97.90	0.323	2199.67	0.49	0.37
FA								•
FB								•
FE	2000.0	2000.0	2100.0	57.74	0.170	2033.33	-0.34	-0.46
FJ								•
FK								•
FL	2138.0	2210.0	1962.0	127.58	0.422	2103.33	0.01	-0.11
FU	2260.0	2540.0	2780.0	260.26	0.885	2526.67	2.12	2.00
FZ	2400.0	2400.0	2000.0	230.94	0.681	2266.67	0.82	0.71
GE	2222.0	2266.0	2293.0	35.84	0.121	2260.33	0.79	0.68
GI								•
GQ	2099.0	2077.0	2055.0	22.00	0.075	2077.00	-0.12	-0.24
HI	2202.0	2164.0	2178.0	19.22	0.065	2181.33	0.40	0.28
HJ	2620.0	2850.0	2720.0	115.33	0.392	2730.00	3.14	3.02 ↑
HK	2111.0	2101.0	2221.0	66.58	0.204	2144.33	0.21	0.10
HP	2391.0	2242.0	2478.0	119.35	0.402	2370.33	1.34	1.22
HR	2266.0	2199.0	2307.0	54.52	0.184	2257.33	0.78	0.66
HU								•
I	2440.0	2440.0	2334.0	61.20	0.180	2404.67	1.51	1.40
IA								•
IC	2093.0	2130.0	2073.0	28.92	0.097	2098.67	-0.01	-0.13
IU	2109.0	1682.0	2049.0	231.16	0.727	1946.67	-0.77	-0.89
J	2148.0	2164.0	2248.0	53.72	0.170	2186.67	0.42	0.31
JG	2165.0	2246.0	2218.0	41.14	0.138	2209.67	0.54	0.42
JK								•
JM	2311.0	2339.0	2154.0	99.71	0.315	2268.00	0.83	0.71
JP	2223.0	2193.0	2157.0	33.05	0.112	2191.00	0.45	0.33
JR	1850.0	1920.0	2060.0	106.93	0.357	1943.33	-0.79	-0.91
JS	2163.0	1895.0	1810.0	184.24	0.601	1956.00	-0.73	-0.84
JY	2020.0	2120.0	2270.0	125.83	0.426	2136.67	0.17	0.06
K	1932.0	2600.0	2522.0	365.24	1.261	2351.33	1.25	1.13
KH								•
KM	1608.0	2249.0	2281.0	379.66	1.277	2046.00	-0.28	-0.39
KX	2020.0	2050.0	2060.0	20.82	0.068	2043.33	-0.29	-0.41
L	2015.0	2008.0	1977.0	20.22	0.065	2000.00	-0.51	-0.62
LA								•
LE	2050.0	2090.0	2000.0	45.09	0.153	2046.67	-0.27	-0.39
LF	2400.0	2400.0	2200.0	115.47	0.340	2333.33	1.16	1.04

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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
LM								•
LR	1953.0	1863.0	2254.0	204.77	0.666	2023.33	-0.39	-0.51
LS								•
M	1750.0	1750.0	1725.0	14.43	0.043	1741.67	-1.80	-1.91
MA	2019.0	1930.0	1960.0	45.28	0.151	1969.67	-0.66	-0.78
ME	2620.0	2590.0	2240.0	211.27	0.647	2483.33	1.91	1.79
ML	2370.0	2330.0	2270.0	50.33	0.170	2323.33	1.11	0.99
MN	1550.0	1670.0	1700.0	79.37	0.255	1640.00	-2.30	-2.42
MQ	1880.0	1940.0	1920.0	30.55	0.102	1913.33	-0.94	-1.06
MS	2000.0	2000.0	2000.0	0.00	0.000	2000.00	-0.51	-0.62
MT	2290.0	2311.0	2265.0	23.03	0.078	2288.67	0.93	0.82
N	2193.0	2248.0	2159.0	44.91	0.151	2200.00	0.49	0.37
NH	1964.0	2087.0	2303.0	171.61	0.577	2118.00	0.08	-0.03
NI	2205.0	2249.0	2273.0	34.49	0.116	2242.33	0.70	0.59
NJ	70.0	72.0	81.0	5.86	0.019	74.33	-10.12	-10.24
NK								•
NO								•
NP	2499.0	2393.0	2244.0	128.10	0.434	2378.67	1.38	1.27
O	2167.0	2091.0	2449.0	188.62	0.609	2235.67	0.67	0.55
OA	2400.0	2400.0	2400.0	0.00	0.000	2400.00	1.49	1.37
OK	1863.0	2019.0	1695.0	162.04	0.552	1859.00	-1.21	-1.33
OL	1734.0	2087.0	2009.0	185.44	0.601	1943.33	-0.79	-0.91
OM								•
OT	1990.0	2020.0	2520.0	297.71	0.902	2176.67	0.37	0.26
PB	2014.0	2053.0	1933.0	61.21	0.204	2000.00	-0.51	-0.62
PC								•
PD								•
PJ	2124.0	1729.0	1838.0	204.00	0.672	1897.00	-1.02	-1.14
PM	2172.0	2109.0	2193.0	43.71	0.143	2158.00	0.28	0.16
PP								•
PQ	2880.0	2690.0	2570.0	156.31	0.528	2713.33	3.05	2.94
PV	2070.0	1903.0	2056.0	92.64	0.284	2009.67	-0.46	-0.58
FY								•
Q	2600.0	3000.0	2300.0	351.19	1.365	2633.33	2.65	2.54
QA	2468.0	2564.0	2539.0	49.81	0.163	2523.67	2.11	1.99
QC	1593.0	1725.0	1770.0	91.99	0.301	1696.00	-2.02	-2.14
QD	1506.0	1656.0	1355.0	150.50	0.512	1505.67	-2.97	-3.09
QI	2479.0	2147.0	2325.0	166.14	0.565	2317.00	1.08	0.96
QK	2396.0	2351.0	2367.0	22.81	0.077	2371.33	1.35	1.23
QL	2000.0	2090.0	2040.0	45.09	0.153	2043.33	-0.29	-0.41
QM	1795.0	1804.0	1854.0	31.79	0.100	1817.67	-1.42	-1.53
QP	2427.0	2353.0	2372.0	38.43	0.126	2384.00	1.41	1.29
QT	2405.0	1635.0	2405.0	444.56	1.592	2148.33	0.23	0.12
QU	1869.0	1849.0	1725.0	78.01	0.245	1814.33	-1.43	-1.55
QW	1780.0	1810.0	1846.0	33.05	0.112	1812.00	-1.45	-1.56

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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	
QX	5183.0	5134.0	5205.0	36.36	0.121	5174.00	15.34	15.22 ×
QZ	2030.0	2074.0	2074.0	25.40	0.075	2059.33	-0.21	-0.33
R	2247.0	2183.0	2277.0	48.01	0.160	2235.67	0.67	0.55
RC								•
RH	2018.0	1870.0	1874.0	84.32	0.252	1920.67	-0.90	-1.02
RM	1629.0	1593.0	1724.0	67.68	0.223	1648.67	-2.26	-2.38
RN	2200.0	2200.0	2200.0	0.00	0.000	2200.00	0.49	0.37
RO	2396.0	2108.0	2077.0	175.91	0.543	2193.67	0.46	0.34
RQ								•
RR	2140.0	2050.0	2060.0	49.33	0.153	2083.33	-0.09	-0.21
RS								•
RU	1670.0	1704.0	1704.0	19.63	0.058	1692.67	-2.04	-2.16
RV								•
RX	1579.0	1634.0	2042.0	252.94	0.788	1751.67	-1.75	-1.86
S	2060.0	2020.0	2060.0	23.09	0.068	2046.67	-0.27	-0.39
SA	5144.0	3153.0	3647.0	1036.75	5.551	3981.33	9.38	9.27 ×
SC	1970.0	2060.0	2040.0	47.26	0.153	2023.33	-0.39	-0.51
SD	2369.0	2377.0	2040.0	192.30	0.574	2262.00	0.80	0.68
SF	1892.0	1913.0	2086.0	106.46	0.330	1963.67	-0.69	-0.81
SI	2100.0	2200.0	2100.0	57.74	0.170	2133.33	0.16	0.04
SK	2100.0	2600.0	2200.0	264.58	0.851	2300.00	0.99	0.87
SM	1602.0	1624.0	1700.0	51.42	0.167	1642.00	-2.29	-2.41
SN	2220.0	2222.0	2150.0	41.00	0.123	2197.33	0.48	0.36
SQ								•
SS	1982.0	1954.0	1873.0	56.61	0.186	1936.33	-0.82	-0.94
ST	1788.0	2201.0	2097.0	214.81	0.703	2028.67	-0.36	-0.48
SU	1941.0	2207.0	2099.0	133.78	0.453	2082.33	-0.10	-0.21
SW	1960.0	1960.0	1860.0	57.74	0.170	1926.67	-0.87	-0.99
SY	6423.0	6843.0	6574.0	212.75	0.715	6613.33	22.52	22.40 ×
SZ	2155.0	2033.0	2095.0	61.00	0.208	2094.33	-0.04	-0.15
T	2050.0	2110.0	2100.0	32.15	0.102	2086.67	-0.07	-0.19
TA								•
TC								•
TE	466.0	436.0	413.0	26.58	0.090	438.33	-8.30	-8.42 ×
TF	1893.0	1606.0	1611.0	164.28	0.489	1703.33	-1.99	-2.10
TG	1895.0	1582.0	1824.0	164.10	0.533	1767.00	-1.67	-1.79
TI	2016.0	2028.0	2163.0	81.63	0.250	2069.00	-0.16	-0.28
TL	1781.0	1881.0	1865.0	53.72	0.170	1842.33	-1.29	-1.41
TO	2260.0	2140.0	2220.0	61.10	0.204	2206.67	0.52	0.41
U	2411.0	2621.0	2384.0	129.74	0.403	2472.00	1.85	1.73
W	2210.0	2210.0	2210.0	0.00	0.000	2210.00	0.54	0.42
X	2400.0	2700.0	2500.0	152.75	0.511	2533.33	2.15	2.04
Y	1909.0	2247.0	1828.0	222.25	0.713	1994.67	-0.53	-0.65
Z	2033.0	2048.0	2015.0	16.52	0.056	2032.00	-0.35	-0.46

• = No data submitted

TAG SYMBOLS

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Tritium**Data sorted by Laboratory Average**

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
74.33	×	NJ	2014.00		CP	2150.00		CE
438.33	×	TE	2016.67		CQ	2153.33		CA
1505.67	↓	QD	2021.67		AZ	2158.00		PM
1587.00		EW	2023.33		SC	2161.00		BA
1640.00		MN	2023.33		LR	2172.00		DH
1642.00		SM	2026.67		BC	2173.00		AY
1648.67		RM	2027.67		CK	2176.67		OT
1666.67		BG	2028.67		ST	2181.33		HI
1692.67		RU	2032.00		Z	2184.00		AH
1696.00		QC	2033.33		FE	2186.67		J
1703.33		TF	2033.33		AU	2191.00		JP
1741.67		M	2043.33		QL	2193.67		RO
1751.67		RX	2043.33		KX	2197.33		SN
1764.00		AJ	2046.00		KM	2199.67		EX
1767.00		TG	2046.67		S	2200.00		RN
1812.00		QW	2046.67		LE	2200.00		N
1814.33		QU	2053.33		AF	2203.33		CS
1817.67		QM	2059.33		QZ	2206.67		TO
1842.33		TL	2061.00		E	2209.67		JG
1852.00		CM	2069.00		TI	2210.00		W
1859.00		OK	2070.33		D	2210.67		EN
1879.67		DJ	2073.67		CX	2223.33		AE
1897.00		PJ	2075.00		BB	2226.67		AI
1913.33		MQ	2077.00		GQ	2235.67		R
1920.00		EH	2082.33		SU	2235.67		O
1920.67		RH	2083.33		RR	2242.33		NI
1926.67		SW	2083.33		BO	2257.33		HR
1936.33		SS	2086.67		T	2260.33		GE
1940.00		CO	2088.33		DE	2262.00		SD
1943.33		OL	2090.00		DR	2266.67		FZ
1943.33		JR	2094.33		SZ	2268.00		JM
1946.67		IU	2098.67		IC	2288.67		MT
1956.00		JS	2100.00		CJ	2296.67		EB
1963.00		BL	2103.33		FL	2300.00		SK
1963.67		SF	2106.00		AP	2300.00		DT
1969.67		MA	2113.33		DI	2300.00		BW
1988.33		AW	2118.00		NH	2317.00		QI
1990.67		A	2126.67		DD	2323.33		ML
1994.67		Y	2130.33		AK	2333.33		LF
2000.00		PB	2133.33		SI	2349.33		C
2000.00		MS	2136.67		JY	2351.33		K
2000.00		L	2144.00		EL	2370.33		HP
2009.67		PV	2144.33		HK	2371.33		QK
2010.00		DG	2148.33		QT	2378.67		NP

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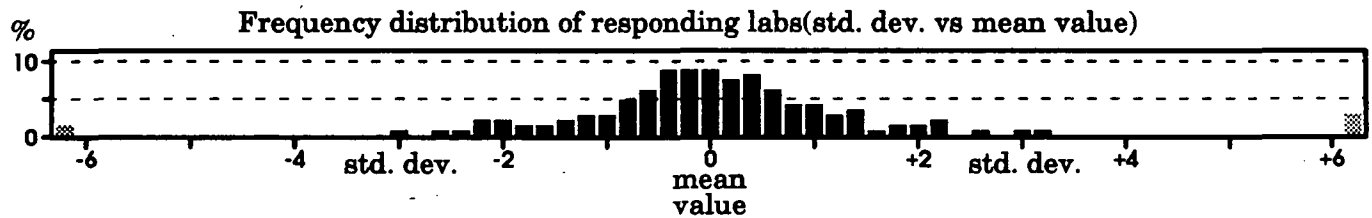
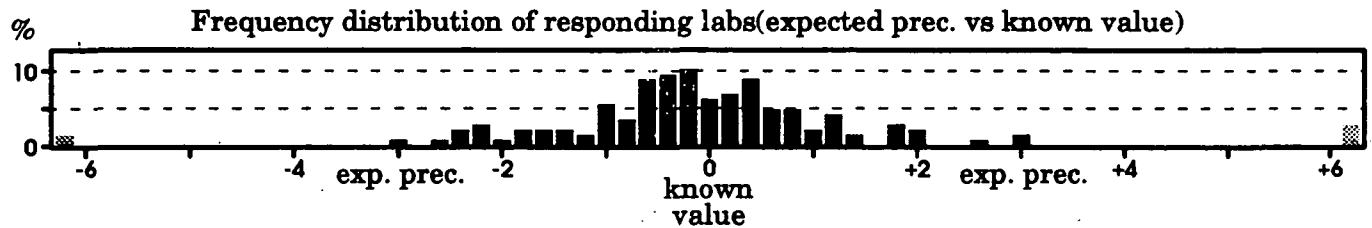
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Tritium**Data sorted by Laboratory Average**

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
2384.00		QP	2483.33		ME	2713.33		PQ
2400.00		OA	2503.33		DM	2730.00	↑	HJ
2404.67		I	2523.67		QA	3981.33	×	SA
2472.00		U	2526.67		FU	5174.00	×	QX
2473.33		EA	2533.33		X	6613.33	×	SY
			2633.33		Q	9323.33	×	BM



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