United States
Environmental Protection
Agency

Environmental Monitoring
Systems Laboratory
P.O. Box 93478
Las Vegas NV 89193-3478

EPA/600/R-93/061
April 1993

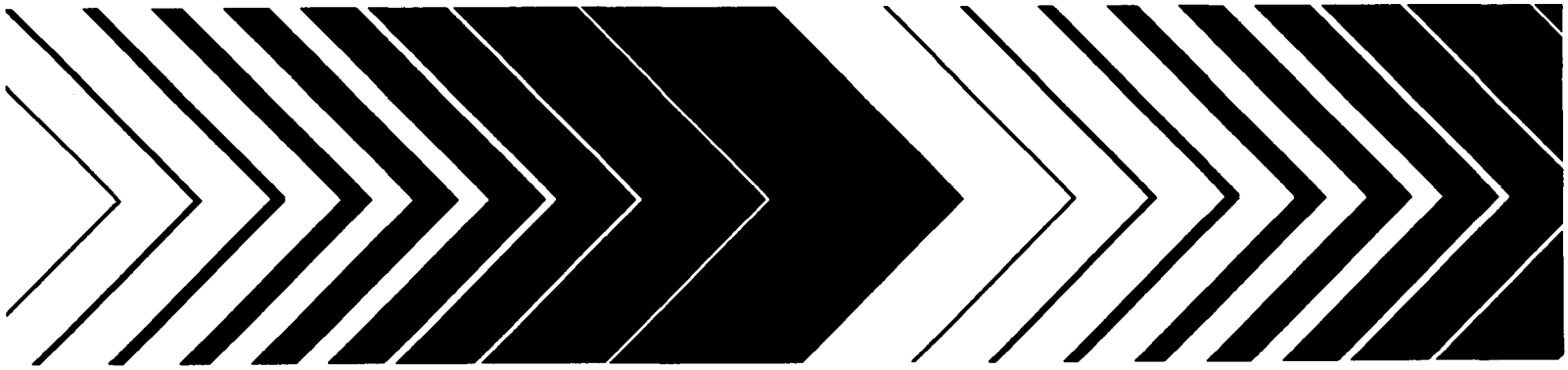
Research and Development

EPA

Iodine in Water Intercomparison Study

A Statistical Evaluation of the February 5, 1993 Data

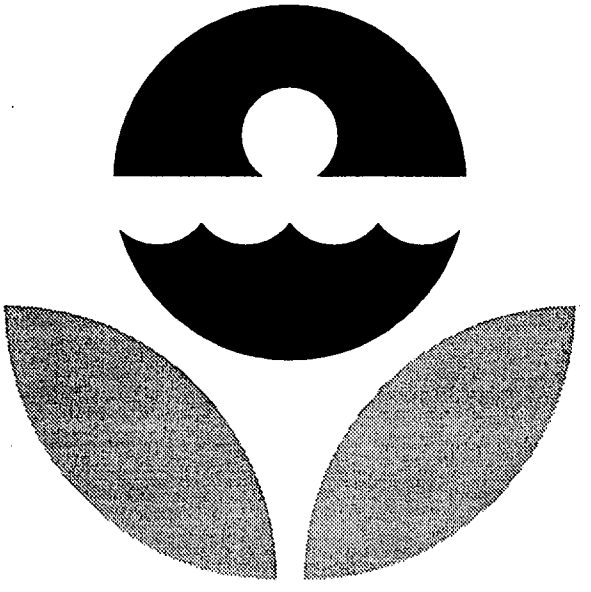
5514GR92NRD.COV-14



Iodine in Water

Intercomparison Study

February 5, 1993



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 ***Iodine in Water; February 5, 1993.***

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

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.

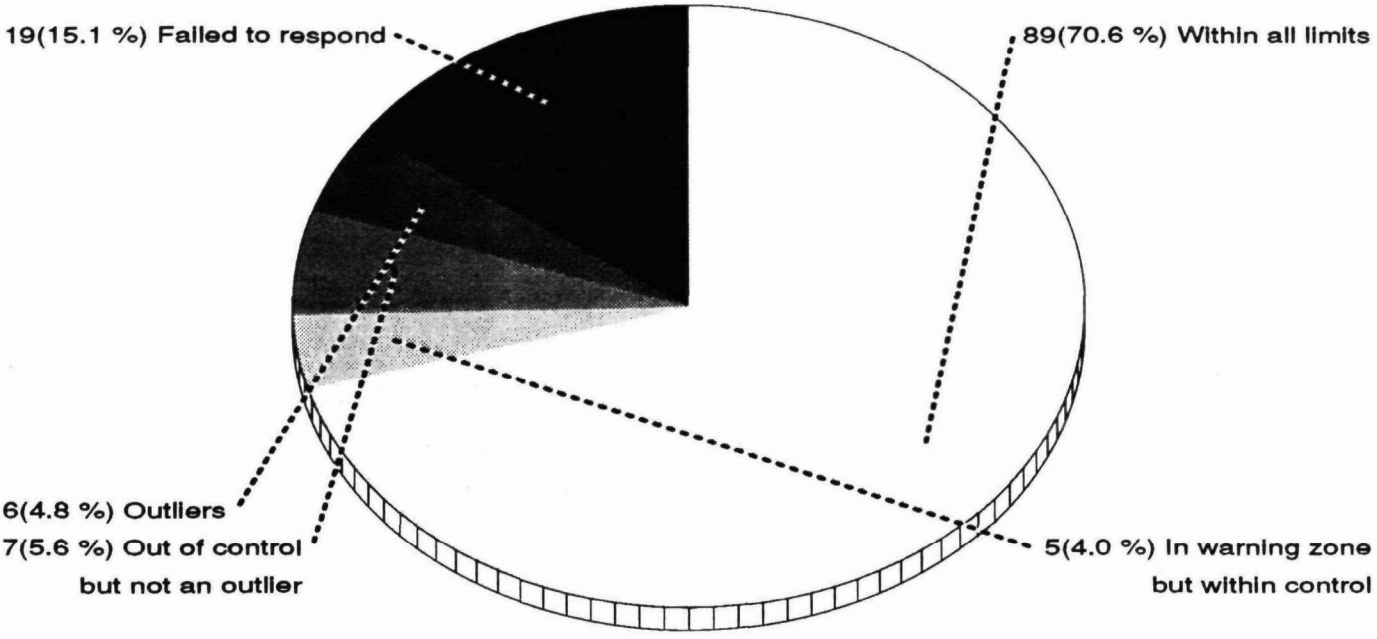
The normalized deviation of the mean from the grand average is calculated from the deviation of the mean from the grand average and the standard error of the mean values. The deviation of the mean from the grand average is calculated by subtracting the grand average from the average of the laboratory's 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.

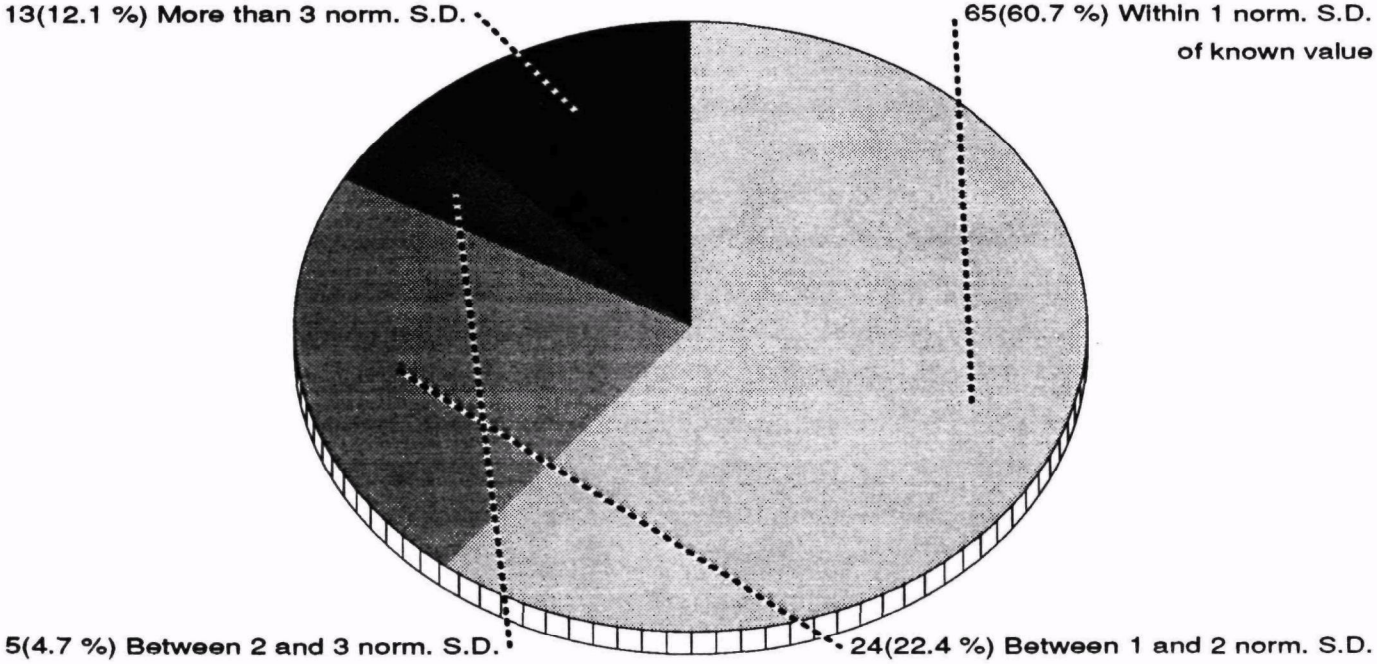
A complete explanation of the statistical calculations involved in the report may be found in the Environmental Radioactivity Laboratory Intercomparison Studies Program information brochure [Draft Revision of EPA-600/4-81-004], available from Frank Novielli, EMSL-LV, 702/798-2159.

Iodine-131 Statistical Summary 126 Participants

The known value of this nuclide is **100.0 pCi/l** with an expected precision of **10.0**; the control limits are 82.7 to 117.3; the warning regions are 82.7 to 88.4 and 111.6 to 117.3



Statistic	Respondents	Non-outliers
Mean	99.80	**Grand Avg 101.36**
Std. Dev.	15.34	8.20
Variance	235.38	67.22
% Coef. of Var.	15.37	8.09
% deviation of mean from known value	-0.20	1.36
Norm. dev. of mean from known value	-0.01	0.17
Median	100.33	100.33
% deviation of median from known value	0.33	0.33
Norm. dev. of median from known value	0.02	0.04



EMSL-LV Intercomparison Study: Iodine in Water, 5-Feb-1993

Iodine-131

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
A	96.0	93.0	97.0	2.08	0.236	95.33	-1.04	-0.81	
AF	99.0	98.0	96.0	1.53	0.177	97.67	-0.64	-0.40	
AI	119.0	101.0	104.0	9.64	1.120	108.00	1.15	1.39	
AJ	108.0	101.0	97.0	5.57	0.650	102.00	0.11	0.35	
AK	102.0	105.0	98.0	3.51	0.413	101.67	0.05	0.29	
AL	98.0	90.0	97.0	4.36	0.473	95.00	-1.10	-0.87	
AN	112.0	114.0	103.0	5.86	0.650	109.67	1.44	1.67	
AP	99.0	104.0	97.0	3.61	0.413	100.00	-0.23	0.00	
AU	96.0	105.0	100.0	4.51	0.532	100.33	-0.18	0.06	
AW	91.0	93.0	95.0	2.00	0.236	93.00	-1.45	-1.21	
AY	90.0	86.0	92.0	3.06	0.354	89.33	-2.08	-1.85	
AZ	90.0	98.0	110.0	10.07	1.345	99.33	-0.35	-0.12	
BA	112.0	112.0	105.0	4.04	0.413	109.67	1.44	1.67	
BC	112.0	111.0	111.0	0.58	0.059	111.33	1.73	1.96	
BH	87.0	101.0	96.0	7.09	0.827	94.67	-1.16	-0.92	
BL	96.0	95.0	95.0	0.58	0.059	95.33	-1.04	-0.81	
BM	99.0	100.0	99.0	0.58	0.059	99.33	-0.35	-0.12	
BO	95.0	98.0	96.0	1.53	0.177	96.33	-0.87	-0.64	
BW									•
C	98.0	102.0	98.0	2.31	0.236	99.33	-0.35	-0.12	
CA	111.0	106.0	101.0	5.00	0.591	106.00	0.80	1.04	
CE	106.0	103.0	106.0	1.73	0.177	105.00	0.63	0.87	
CJ	110.0	110.0	100.0	5.77	0.591	106.67	0.92	1.15	
CP	102.0	103.0	104.0	1.00	0.118	103.00	0.28	0.52	
CQ	102.0	114.0	100.0	7.57	0.827	105.33	0.69	0.92	
D	95.0	95.0	94.0	0.58	0.059	94.67	-1.16	-0.92	
DD	97.0	101.0	92.0	4.51	0.532	96.67	-0.81	-0.58	
DE	95.0	96.0	96.0	0.58	0.059	95.67	-0.99	-0.75	
DG	92.0	87.0	90.0	2.52	0.295	89.67	-2.02	-1.79	
DJ	112.0	106.0	103.0	4.58	0.532	107.00	0.98	1.21	
DL	98.0	98.0	99.0	0.58	0.059	98.33	-0.52	-0.29	
DM	100.0	102.0	98.0	2.00	0.236	100.00	-0.23	0.00	
DR	109.0	102.0	103.0	3.79	0.413	104.67	0.57	0.81	
DT	94.0	93.0	91.0	1.53	0.177	92.67	-1.51	-1.27	
DY	101.0	98.0	99.0	1.53	0.177	99.33	-0.35	-0.12	
E	98.0	99.0	102.0	2.08	0.236	99.67	-0.29	-0.06	
EB	97.0	98.0	97.0	0.58	0.059	97.33	-0.70	-0.46	
EH	99.0	97.0	105.0	4.16	0.473	100.33	-0.18	0.06	
EL	104.0	109.0	115.0	5.51	0.650	109.33	1.38	1.62	
EX	95.0	97.0	95.0	1.15	0.118	95.67	-0.99	-0.75	
EZ	92.0	143.0	85.0	31.66	5.621	106.67	0.92	1.15	
FE	99.0	110.0	110.0	6.35	0.650	106.33	0.86	1.10	
FK	98.0	90.0	87.0	5.69	0.650	91.67	-1.68	-1.44	
FL	106.0	109.0	106.0	1.73	0.177	107.00	0.98	1.21	
FU	107.0	109.0	115.0	4.16	0.473	110.33	1.55	1.79	

TAG SYMBOLS

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

Iodine-131

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
GE	99.0	98.0	98.0	0.58	0.059	98.33	-0.52	-0.29	
GI	95.0	110.0	97.0	8.14	0.886	100.67	-0.12	0.12	
HE	86.0	82.0	88.0	3.06	0.354	85.33	-2.78	-2.54	
HJ	98.0	111.0	96.0	8.14	0.886	101.67	0.05	0.29	
HK	97.0	98.0	99.0	1.00	0.118	98.00	-0.58	-0.35	
HP	126.0	129.0	127.0	1.53	0.177	127.33	4.50	4.73	⇑
HU	95.0	95.0	95.0	0.00	0.000	95.00	-1.10	-0.87	
I	108.0	101.0	105.0	3.51	0.413	104.67	0.57	0.81	
IA									•
IC	102.0	105.0	106.0	2.08	0.236	104.33	0.52	0.75	
IU	105.0	106.0	100.0	3.21	0.354	103.67	0.40	0.64	
J	101.0	103.0	101.0	1.15	0.118	101.67	0.05	0.29	
JR	96.0	98.0	93.0	2.52	0.295	95.67	-0.99	-0.75	
JS	124.0	117.0	116.0	4.36	0.473	119.00	3.06	3.29	⇑
K	96.0	94.0	94.0	1.15	0.118	94.67	-1.16	-0.92	
KL	105.0	101.0	101.0	2.31	0.236	102.33	0.17	0.40	
KX	126.0	121.0	129.0	4.04	0.473	125.33	4.15	4.39	⇑
L	102.0	99.0	98.0	2.08	0.236	99.67	-0.29	-0.06	
LF	100.0	100.0	100.0	0.00	0.000	100.00	-0.23	0.00	
LT									•
M	150.0	140.0	142.0	5.29	0.591	144.00	7.39	7.62	×
MA	97.0	99.0	98.0	1.00	0.118	98.00	-0.58	-0.35	
ME									•
MN									•
MP	98.0	106.0	98.0	4.62	0.473	100.67	-0.12	0.12	
MQ	110.0	103.0	110.0	4.04	0.413	107.67	1.09	1.33	
MS	117.0	124.0	128.0	5.57	0.650	123.00	3.75	3.98	⇑
MV	100.0	95.0	95.0	2.89	0.295	96.67	-0.81	-0.58	
N	105.0	105.0	106.0	0.58	0.059	105.33	0.69	0.92	
NJ	94.0	110.0	91.0	10.21	1.233	98.33	-0.52	-0.29	
NZ	92.0	87.0	63.0	15.50	2.358	80.67	-3.58	-3.35	⇓
O	97.0	97.0	97.0	0.00	0.000	97.00	-0.75	-0.52	
OA	104.0	104.0	102.0	1.15	0.118	103.33	0.34	0.58	
OB	99.0	104.0	98.0	3.21	0.354	100.33	-0.18	0.06	
OM									•
OT	114.0	110.0	113.0	2.08	0.236	112.33	1.90	2.14	
PB	100.0	102.0	100.0	1.15	0.118	100.67	-0.12	0.12	
PC	103.0	118.0	117.0	8.39	0.886	112.67	1.96	2.19	
PE									•
PU	45.0	54.0	49.0	4.51	0.532	49.33	-9.01	-8.78	×
PV	93.0	85.0	75.0	9.02	1.120	84.33	-2.95	-2.71	
Q	104.0	103.0	98.0	3.21	0.354	101.67	0.05	0.29	
QK	126.0	134.0	136.0	5.29	0.591	132.00	5.31	5.54	×
QQ									•
QU	108.0	109.0	107.0	1.00	0.118	108.00	1.15	1.39	

• ≡ No data submitted

∅ ≡ Insufficient data

TAG SYMBOLS

× ≡ Determined to be an outlier

⇑ ≡ Above control limit

⇓ ≡ Below control limit

Iodine-131

Lab	Res. 1	Res. 2	Res. 3	Exper. Sigma	Rng anal (R + SR)	Average	Normalized deviation (grand-avg)	(known)	Tag
QX									•
QZ									•
R	99.0	97.0	100.0	1.53	0.177	98.67	-0.47	-0.23	
RC	61.0	73.0	67.0	6.00	0.709	67.00	-5.95	-5.72	×
RL	20.0	21.0	21.0	0.58	0.059	20.67	-13.98	-13.74	×
RM	93.0	84.0	125.0	21.55	3.708	100.67	-0.12	0.12	
RQ									•
S	100.0	99.0	99.0	0.58	0.059	99.33	-0.35	-0.12	
SC	104.0	104.0	105.0	0.58	0.059	104.33	0.52	0.75	
SF	90.0	89.0	90.0	0.58	0.059	89.67	-2.02	-1.79	
SK	112.0	97.0	100.0	7.94	0.886	103.00	0.28	0.52	
SM	93.0	86.0	89.0	3.51	0.413	89.33	-2.08	-1.85	
SS	97.0	94.0	94.0	1.73	0.177	95.00	-1.10	-0.87	
ST									•
SW	103.0	96.0	89.0	7.00	0.827	96.00	-0.93	-0.69	
SZ	114.0	111.0	113.0	1.53	0.177	112.67	1.96	2.19	
TA	104.0	140.0	110.0	19.29	3.146	118.00	2.88	3.12	⇑
TE	94.0	103.0	107.0	6.66	0.768	101.33	0.00	0.23	
TG	105.0	101.0	105.0	2.31	0.236	103.67	0.40	0.64	
TI	128.0	117.0	124.0	5.57	0.650	123.00	3.75	3.98	⇑
TL	108.0	111.0	106.0	2.52	0.295	108.33	1.21	1.44	
TQ	101.0	95.0	99.0	3.06	0.354	98.33	-0.52	-0.29	
TR									•
TS									•
TV	27.0	30.0	28.0	1.53	0.177	28.33	-12.65	-12.41	×
TW									•
TZ									•
U	89.0	103.0	77.0	13.01	2.020	89.67	-2.02	-1.79	
UB									•
UC									•
UE									•
UI	88.0	91.0	92.0	2.08	0.236	90.33	-1.91	-1.67	
W	97.0	92.0	99.0	3.61	0.413	96.00	-0.93	-0.69	
X	95.0	109.0	100.0	7.09	0.827	101.33	0.00	0.23	
Y	105.0	107.0	96.0	5.86	0.650	102.67	0.23	0.46	
Z	98.0	101.0	105.0	3.51	0.413	101.33	0.00	0.23	

Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
20.67	×	RL	85.33		HE	90.33		UI
28.33	×	TV	89.33		SM	91.67		FK
49.33	×	PU	89.33		AY	92.67		DT
67.00	×	RC	89.67		U	93.00		AW
80.67	⇓	NZ	89.67		SF	94.67		K
84.33		PV	89.67		DG	94.67		D

• ≡ No data submitted
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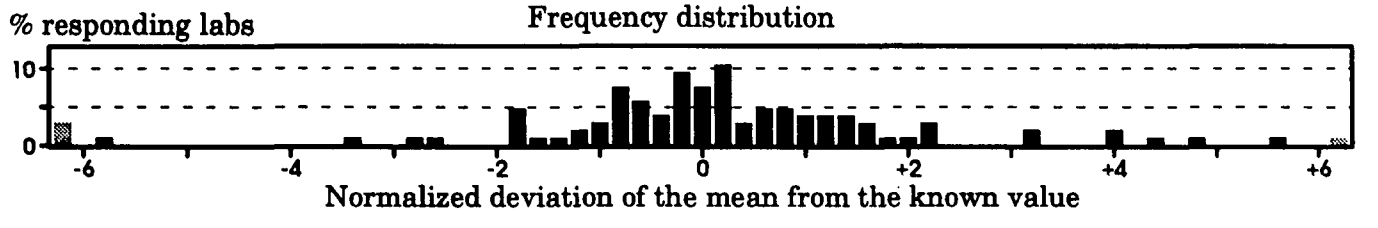
⇓ ≡ Below control limit

Iodine-131

Data sorted by Laboratory Average

Average	Tag	Lab	Average	Tag	Lab	Average	Tag	Lab
94.67		BH	99.67		L	104.67		DR
95.00		SS	99.67		E	105.00		CE
95.00		HU	100.00		LF	105.33		N
95.00		AL	100.00		DM	105.33		CQ
95.33		BL	100.00		AP	106.00		CA
95.33		A	100.33		OB	106.33		FE
95.67		JR	100.33		EH	106.67		EZ
95.67		EX	100.33		AU	106.67		CJ
95.67		DE	100.67		RM	107.00		FL
96.00		W	100.67		PB	107.00		DJ
96.00		SW	100.67		MP	107.67		MQ
96.33		BO	100.67		GI	108.00		QU
96.67		MV	101.33		Z	108.00		AI
96.67		DD	101.33		X	108.33		TL
97.00		O	101.33		TE	109.33		EL
97.33		EB	101.67		Q	109.67		BA
97.67		AF	101.67		J	109.67		AN
98.00		MA	101.67		HJ	110.33		FU
98.00		HK	101.67		AK	111.33		BC
98.33		TQ	102.00		AJ	112.33		OT
98.33		NJ	102.33		KL	112.67		SZ
98.33		GE	102.67		Y	112.67		PC
98.33		DL	103.00		SK	118.00	⇑	TA
98.67		R	103.00		CP	119.00	⇑	JS
99.33		S	103.33		OA	123.00	⇑	TI
99.33		DY	103.67		TG	123.00	⇑	MS
99.33		C	103.67		IU	125.33	⇑	KX
99.33		BM	104.33		SC	127.33	⇑	HP
99.33		AZ	104.33		IC	132.00	×	QK
			104.67		I	144.00	×	M



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∅ ≡ Insufficient data

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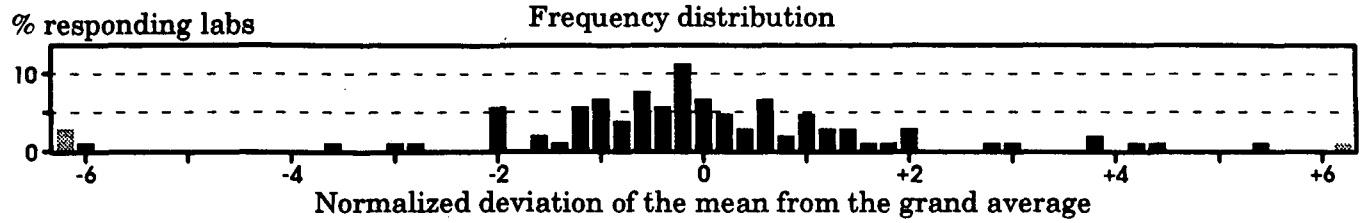
⇑ ≡ Above control limit
⇓ ≡ Below control limit

Iodine-131


% responding labs
Frequency distribution
10
0
-6
-4
-2
0
+2
+4
+6
Normalized deviation of the mean from the grand average