

UCL Statistics for Data Sets with Non-Detects

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From File ProUCLinput_53-008_0-1.xls
Full Precision OFF
Confidence Cc 95%
Number of Boc 2000

Barium

General Statistics

Total Number of Observations	17	Number of Distinct Observations	17
		Number of Missing Observations	0
Minimum	27.2	Mean	56.21
Maximum	94	Median	53.9
SD	19.61	Std. Error of Mean	4.756
Coefficient of Variation	0.349	Skewness	0.447

Normal GOF Test

Shapiro Wilk Test Statistic	0.955	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical	0.892	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.164	Lilliefors GOF Test
5% Lilliefors Critical Value	0.207	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	64.52	95% Adjusted-CLT UCL	64.59
		95% Modified-t UCL (J)	64.6

Gamma GOF Test

A-D Test Statistic	0.227	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.74	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.118	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.209	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	8.582	k star (bias corrected MLE)	7.107
Theta hat (MLE)	6.55	Theta star (bias corrected MLE)	7.91
nu hat (MLE)	291.8	nu star (bias corrected)	241.6
MLE Mean (bias corrected)	56.21	MLE Sd (bias corrected)	21.09
		Approximate Chi Square	206.6
Adjusted Level of Significance	0.0346	Adjusted Chi Square Value	203.2

Assuming Gamma Distribution			
95% Approximate Garr	65.73	95% Adjusted Gamma	66.83
Lognormal GOF Test			
Shapiro Wilk Test Statist	0.966	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical	0.892	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.129	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Valu	0.207	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			

Lognormal Statistics			
Minimum of Logged Data	3.303	Mean of logged Data	3.97
Maximum of Logged Dat	4.543	SD of logged Data	0.361

Assuming Lognormal Distribution			
95% H-UCL	67.17	90% Chebyshev (MVU	71.37
95% Chebyshev (MVU	78.19	97.5% Chebyshev (MVL	87.66
99% Chebyshev (MVU	106.3		

Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			

Nonparametric Distribution Free UCLs			
95% CLT UCL	64.03	95% Jackknife UCL	64.52
95% Standard Bootstrap	63.72	95% Bootstrap-t UCL	64.94
95% Hall's Bootstrap U	64.82	95% Percentile Bootstr	63.89
95% BCA Bootstrap U	64.38		
90% Chebyshev(Mean	70.48	95% Chebyshev(Mean	76.94
97.5% Chebyshev(Mear	85.91	99% Chebyshev(Mean	103.5

Suggested UCL to Use	
95% Student's-t UCL	64.52

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. Recommendations are based upon data size, data distribution, and skewness. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cesium-137

General Statistics			
Total Number of Observa	17	Number of Distinct Obse	17
Number of Detects	13	Number of Non-Detects	4
Number of Distinct Detect	13	Number of Distinct Non-I	4
Minimum Detect	0.0924	Minimum Non-Detect	-0.048
Maximum Detect	0.607	Maximum Non-Detect	0.034
Variance Detects	0.0279	Percent Non-Detects	23.53%

Mean Detects	0.359	SD Detects	0.167
Median Detects	0.344	CV Detects	0.465
Skewness Detects	-0.06	Kurtosis Detects	-0.991

Normal GOF Test on Detects Only

Shapiro Wilk Test Statist	0.948	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical	0.866	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.153	Lilliefors GOF Test	
5% Lilliefors Critical Valu	0.234	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.263	KM Standard Error of Me	0.0561
KM SD	0.222	95% KM (BCA) UCL	0.353
95% KM (t) UCL	0.361	95% KM (Percentile Boo	0.355
95% KM (z) UCL	0.355	95% KM Bootstrap t U	0.356
90% KM Chebyshev UCL	0.431	95% KM Chebyshev UCL	0.508
97.5% KM Chebyshev U	0.614	99% KM Chebyshev UCL	0.821

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.434	Anderson-Darling GOF Test	
5% A-D Critical Value	0.737	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.21	Kolmogorov-Smirnov GOF	
5% K-S Critical Value	0.238	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.993	k star (bias corrected ML	3.123
Theta hat (MLE)	0.0898	Theta star (bias correcte	0.115
nu hat (MLE)	103.8	nu star (bias corrected)	81.2
Mean (detects)	0.359		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.263	SD (KM)	0.222
Variance (KM)	0.0494	SE of Mean (KM)	0.0561
k hat (KM)	1.399	k star (KM)	1.192
nu hat (KM)	47.58	nu star (KM)	40.52
theta hat (KM)	0.188	theta star (KM)	0.221
80% gamma percentile (	0.417	90% gamma percentile (	0.58
95% gamma percentile (	0.741	99% gamma percentile (	1.11

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Signific	0.0346
Approximate Chi Square	26.93	Adjusted Chi Square Val	25.77
95% Gamma Approxirr	0.396	95% Gamma Adjusted	0.413

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	N/A	KM Geo Mean	N/A
KM SD (logged)	N/A	95% Critical H Value (t)	N/A
KM Standard Error of Me	N/A	95% H-UCL (KM -Log)	N/A
KM SD (logged)	N/A	95% Critical H Value (t)	N/A
KM Standard Error of Me	N/A		

DL/2 Statistics

Mean in Original Scale	0.274	SD in Original Scale	0.214
95% t UCL (Assumes r	0.364		

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.361
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Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium

General Statistics

Total Number of Observa	17	Number of Distinct Obse	17
		Number of Missing Obse	0
Minimum	2.34	Mean	4.775
Maximum	8	Median	4.94
SD	1.753	Std. Error of Mean	0.425
Coefficient of Variation	0.367	Skewness	0.44

Normal GOF Test

Shapiro Wilk Test Statist	0.947	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical	0.892	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.109	Lilliefors GOF Test
5% Lilliefors Critical Valu	0.207	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5.517	95% Adjusted-CLT UC	5.523
		95% Modified-t UCL (J	5.525

Gamma GOF Test

A-D Test Statistic	0.234	Anderson-Darling Gamma GOF Test
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5% A-D Critical Value	0.74	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.115	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.209	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.806	k star (bias corrected ML	6.468
Theta hat (MLE)	0.612	Theta star (bias correcte	0.738
nu hat (MLE)	265.4	nu star (bias corrected)	219.9
MLE Mean (bias correcte	4.775	MLE Sd (bias corrected)	1.877
		Approximate Chi Square	186.6
Adjusted Level of Signific	0.0346	Adjusted Chi Square Val	183.4

Assuming Gamma Distribution

95% Approximate Garr	5.627	95% Adjusted Gamma	5.726
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Lognormal GOF Test

Shapiro Wilk Test Statist	0.962	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical	0.892	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.133	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Valu	0.207	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.85	Mean of logged Data	1.498
Maximum of Logged Dat	2.079	SD of logged Data	0.378

Assuming Lognormal Distribution

95% H-UCL	5.759	90% Chebyshev (MVU	6.121
95% Chebyshev (MVU	6.728	97.5% Chebyshev (MVL	7.57
99% Chebyshev (MVU	9.224		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	5.474	95% Jackknife UCL	5.517
95% Standard Bootstra	5.443	95% Bootstrap-t UCL	5.604
95% Hall's Bootstrap U	5.531	95% Percentile Bootstr	5.484
95% BCA Bootstrap U	5.524		
90% Chebyshev(Mean	6.05	95% Chebyshev(Mean	6.628
97.5% Chebyshev(Mear	7.43	99% Chebyshev(Mean	9.006

Suggested UCL to Use

95% Student's-t UCL	5.517
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Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper

General Statistics

Total Number of Observations	17	Number of Distinct Observations	17
		Number of Missing Observations	0
Minimum	2.28	Mean	4.395
Maximum	6.38	Median	4.57
SD	1.431	Std. Error of Mean	0.347
Coefficient of Variation	0.325	Skewness	-0.0826

Normal GOF Test

Shapiro Wilk Test Statistic	0.911	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.892	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.16	Lilliefors GOF Test
5% Lilliefors Critical Value	0.207	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5.001	95% Adjusted-CLT UC	4.959
		95% Modified-t UCL (J	5

Gamma GOF Test

A-D Test Statistic	0.667	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.739	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.169	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.209	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	9.216	k star (bias corrected MLE)	7.629
Theta hat (MLE)	0.477	Theta star (bias corrected MLE)	0.576
nu hat (MLE)	313.3	nu star (bias corrected MLE)	259.4
MLE Mean (bias corrected)	4.395	MLE Sd (bias corrected)	1.591
		Approximate Chi Square	223.1
Adjusted Level of Significance	0.0346	Adjusted Chi Square Value	219.6

Assuming Gamma Distribution

95% Approximate Gamma UCL	5.11	95% Adjusted Gamma UCL	5.192
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Lognormal GOF Test

Shapiro Wilk Test Statistic	0.896	Shapiro Wilk Lognormal GOF Test
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5% Shapiro Wilk Critical 0.892 Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic 0.162 **Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value 0.207 Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.824	Mean of logged Data	1.425
Maximum of Logged Data	1.853	SD of logged Data	0.352

Assuming Lognormal Distribution

95% H-UCL	5.23	90% Chebyshev (MVU)	5.555
95% Chebyshev (MVU)	6.075	97.5% Chebyshev (MVL)	6.796
99% Chebyshev (MVU)	8.213		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4.966	95% Jackknife UCL	5.001
95% Standard Bootstrap	4.962	95% Bootstrap-t UCL	5.008
95% Hall's Bootstrap UCL	4.936	95% Percentile Bootstrap	4.957
95% BCA Bootstrap UCL	4.939		
90% Chebyshev(Mean)	5.436	95% Chebyshev(Mean)	5.908
97.5% Chebyshev(Mean)	6.562	99% Chebyshev(Mean)	7.848

Suggested UCL to Use

95% Student's-t UCL	5.001
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Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. Recommendations are based upon data size, data distribution, and skewness. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positively skewed data sets.

Cyanide (Total)

General Statistics

Total Number of Observations	17	Number of Distinct Observations	16
Number of Detects	5	Number of Non-Detects	12
Number of Distinct Detects	5	Number of Distinct Non-Detects	11
Minimum Detect	0.081	Minimum Non-Detect	0.221
Maximum Detect	14.9	Maximum Non-Detect	0.269
Variance Detects	40.38	Percent Non-Detects	70.59%
Mean Detects	3.938	SD Detects	6.355
Median Detects	0.485	CV Detects	1.614

Skewness Detects	1.889	Kurtosis Detects	3.508
Mean of Logged Detects	-0.242	SD of Logged Detects	2.247

Normal GOF Test on Detects Only

Shapiro Wilk Test Statist	0.723	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical	0.762	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.307	Lilliefors GOF Test
5% Lilliefors Critical Valu	0.343	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.231	KM Standard Error of Me	0.961
KM SD	3.544	95% KM (BCA) UCL	2.933
95% KM (t) UCL	2.908	95% KM (Percentile Boo	2.965
95% KM (z) UCL	2.811	95% KM Bootstrap t U	28.74
90% KM Chebyshev UCL	4.113	95% KM Chebyshev UCL	5.419
97.5% KM Chebyshev U	7.232	99% KM Chebyshev UCL	10.79

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.379	Anderson-Darling GOF Test
5% A-D Critical Value	0.724	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.271	Kolmogorov-Smirnov GOF
5% K-S Critical Value	0.375	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.407	k star (bias corrected ML	0.296
Theta hat (MLE)	9.68	Theta star (bias correcte	13.3
nu hat (MLE)	4.068	nu star (bias corrected)	2.961
Mean (detects)	3.938		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1.165
Maximum	14.9	Median	0.01
SD	3.674	CV	3.153
k hat (MLE)	0.21	k star (bias corrected ML	0.212
Theta hat (MLE)	5.545	Theta star (bias correcte	5.49
nu hat (MLE)	7.145	nu star (bias corrected)	7.217
Adjusted Level of Signific	0.0346		
Approximate Chi Square	2.291	Adjusted Chi Square Val	2.011
95% Gamma Approxima	3.672	95% Gamma Adjusted U	4.183

Estimates of Gamma Parameters using KM Estimates			
Mean (KM)	1.231	SD (KM)	3.544
Variance (KM)	12.56	SE of Mean (KM)	0.961
k hat (KM)	0.121	k star (KM)	0.139
nu hat (KM)	4.1	nu star (KM)	4.71
theta hat (KM)	10.2	theta star (KM)	8.883
80% gamma percentile (	1.25	90% gamma percentile (	3.603
95% gamma percentile (	6.873	99% gamma percentile (	16.52
Gamma Kaplan-Meier (KM) Statistics			
Approximate Chi Square	1.021	Adjusted Chi Square Val	0.856
95% Gamma Approxir	5.679	95% Gamma Adjusted	6.771
Lognormal GOF Test on Detected Observations Only			
Shapiro Wilk Test Statist	0.92	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical	0.762	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.194	Lilliefors GOF Test	
5% Lilliefors Critical Valu	0.343	Detected Data appear Lognormal at 5% Significance Level	
Detected Data appear Lognormal at 5% Significance Level			
Lognormal ROS Statistics Using Imputed Non-Detects			
Mean in Original Scale	1.23	Mean in Log Scale	-1.719
SD in Original Scale	3.653	SD in Log Scale	1.518
95% t UCL (assumes r	2.777	95% Percentile Bootstr	2.786
95% BCA Bootstrap UCL	4.05	95% Bootstrap t UCL	43.61
95% H-UCL (Log ROS	2.154		
Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution			
KM Mean (logged)	-1.695	KM Geo Mean	0.184
KM SD (logged)	1.449	95% Critical H Value (t	3.396
KM Standard Error of Me	0.413	95% H-UCL (KM -Log)	1.794
KM SD (logged)	1.449	95% Critical H Value (t	3.396
KM Standard Error of Me	0.413		
DL/2 Statistics			
DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	1.247	Mean in Log Scale	-1.534
SD in Original Scale	3.647	SD in Log Scale	1.415
95% t UCL (Assumes r	2.792	95% H-Stat UCL	1.913
DL/2 is not a recommended method, provided for comparisons and historical reasons			
Nonparametric Distribution Free UCL Statistics			
Detected Data appear Approximate Normal Distributed at 5% Significance Level			
Suggested UCL to Use			
95% KM (t) UCL	2.908		

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel

General Statistics

Total Number of Observations	17	Number of Distinct Observations	17
		Number of Missing Observations	0
Minimum	2.53	Mean	5.066
Maximum	12.6	Median	4.11
SD	2.596	Std. Error of Mean	0.63
Coefficient of Variation	0.513	Skewness	2.023

Normal GOF Test

Shapiro Wilk Test Statistic	0.754	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.892	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.294	Lilliefors GOF Test
5% Lilliefors Critical Value	0.207	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	6.165	95% Adjusted-CLT UCL	6.432
		95% Modified-t UCL (J)	6.217

Gamma GOF Test

A-D Test Statistic	1.002	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.741	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.232	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.21	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.646	k star (bias corrected MLE)	4.689
Theta hat (MLE)	0.897	Theta star (bias corrected MLE)	1.08
nu hat (MLE)	192	nu star (bias corrected)	159.4
MLE Mean (bias corrected)	5.066	MLE Sd (bias corrected)	2.339
		Approximate Chi Square	131.2
Adjusted Level of Significance	0.0346	Adjusted Chi Square Value	128.6

Assuming Gamma Distribution

95% Approximate Gamma	6.154	95% Adjusted Gamma	6.282
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Lognormal GOF Test

Shapiro Wilk Test Statist	0.903	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical	0.892	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.201	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Valu	0.207	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.928	Mean of logged Data	1.531
Maximum of Logged Dat	2.534	SD of logged Data	0.412

Assuming Lognormal Distribution

95% H-UCL	6.153	90% Chebyshev (MVU	6.541
95% Chebyshev (MVU	7.235	97.5% Chebyshev (MVL	8.2
99% Chebyshev (MVU	10.09		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	6.102	95% Jackknife UCL	6.165
95% Standard Bootstrap	6.068	95% Bootstrap-t UCL	6.998
95% Hall's Bootstrap U	10.91	95% Percentile Bootstrap	6.141
95% BCA Bootstrap U	6.379		
90% Chebyshev(Mean	6.955	95% Chebyshev(Mean	7.811
97.5% Chebyshev(Mear	8.998	99% Chebyshev(Mean	11.33

Suggested UCL to Use

95% Student's-t UCL	6.165	or 95% Modified-t UCL	6.217
or 95% H-UCL	6.153		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.

H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.

It is therefore recommended to avoid the use of H-statistic based 95% UCLs.

Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Plutonium-239/240

General Statistics

Total Number of Observa	17	Number of Distinct Obse	17
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Number of Detects	7	Number of Non-Detects	10
Number of Distinct Detects	7	Number of Distinct Non-Detects	10
Minimum Detect	0.0206	Minimum Non-Detect	-0.0342
Maximum Detect	0.0467	Maximum Non-Detect	0.0318
Variance Detects	8.4151E-5	Percent Non-Detects	58.82%
Mean Detects	0.0348	SD Detects	0.00917
Median Detects	0.039	CV Detects	0.264
Skewness Detects	-0.527	Kurtosis Detects	-0.747

Normal GOF Test on Detects Only

Shapiro Wilk Test Statist	0.932	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical	0.803	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.248	Lilliefors GOF Test
5% Lilliefors Critical Value	0.304	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	-0.00518	KM Standard Error of Mean	0.00913
KM SD	0.0344	95% KM (BCA) UCL	0.022
95% KM (t) UCL	0.0107	95% KM (Percentile Bootstrap) UCL	0.0188
95% KM (z) UCL	0.00983	95% KM Bootstrap t UCL	0.00706
90% KM Chebyshev UCL	0.0222	95% KM Chebyshev UCL	0.0346
97.5% KM Chebyshev UCL	0.0518	99% KM Chebyshev UCL	0.0856

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.422	Anderson-Darling GOF Test
5% A-D Critical Value	0.708	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.275	Kolmogorov-Smirnov GOF
5% K-S Critical Value	0.312	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	14.9	k star (bias corrected MLE)	8.608
Theta hat (MLE)	0.00234	Theta star (bias corrected MLE)	0.00404
nu hat (MLE)	208.6	nu star (bias corrected)	120.5
Mean (detects)	0.0348		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	-0.00518	SD (KM)	0.0344
Variance (KM)	0.00118	SE of Mean (KM)	0.00913
k hat (KM)	0.0227	k star (KM)	0.0579
nu hat (KM)	0.773	nu star (KM)	1.97
theta hat (KM)	-0.228	theta star (KM)	-0.0895
80% gamma percentile (KM)	-0.00113	90% gamma percentile (KM)	-0.00941
95% gamma percentile (KM)	-0.0288	99% gamma percentile (KM)	-0.106

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Signific	0.0346
Approximate Chi Square	0.147	Adjusted Chi Square Val	0.125
95% Gamma Approxir	-0.0695	95% Gamma Adjusted	-0.0815
95% Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50)			

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	N/A	KM Geo Mean	N/A
KM SD (logged)	N/A	95% Critical H Value (t	N/A
KM Standard Error of Me	N/A	95% H-UCL (KM -Log)	N/A
KM SD (logged)	N/A	95% Critical H Value (t	N/A
KM Standard Error of Me	N/A		

DL/2 Statistics

Mean in Original Scale	0.0152	SD in Original Scale	0.0189
95% t UCL (Assumes r	0.0232		

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0107
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Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Tritium

General Statistics

Total Number of Observa	17	Number of Distinct Obse	17
Number of Detects	8	Number of Non-Detects	9
Number of Distinct Detect	8	Number of Distinct Non-I	9
Minimum Detect	0.00762	Minimum Non-Detect	-0.00107
Maximum Detect	0.14	Maximum Non-Detect	0.0156
Variance Detects	0.00206	Percent Non-Detects	52.94%
Mean Detects	0.0347	SD Detects	0.0454
Median Detects	0.0177	CV Detects	1.308
Skewness Detects	2.256	Kurtosis Detects	5.133

Normal GOF Test on Detects Only

Shapiro Wilk Test Statist	0.656	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical	0.818	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.382	Lilliefors GOF Test
5% Lilliefors Critical Valu	0.283	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0164	KM Standard Error of Me	0.00882
KM SD	0.0339	95% KM (BCA) UCL	0.035
95% KM (t) UCL	0.0318	95% KM (Percentile Bo	0.0321
95% KM (z) UCL	0.0309	95% KM Bootstrap t U	0.0623
90% KM Chebyshev UCL	0.0429	95% KM Chebyshev UCL	0.0548
97.5% KM Chebyshev U	0.0715	99% KM Chebyshev UCL	0.104

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.746	Anderson-Darling GOF Test
5% A-D Critical Value	0.734	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.336	Kolmogorov-Smirnov GOF
5% K-S Critical Value	0.301	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.078	k star (bias corrected ML	0.757
Theta hat (MLE)	0.0322	Theta star (bias correcte	0.0458
nu hat (MLE)	17.25	nu star (bias corrected)	12.12
Mean (detects)	0.0347		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0164	SD (KM)	0.0339
Variance (KM)	0.00115	SE of Mean (KM)	0.00882
k hat (KM)	0.234	k star (KM)	0.232
nu hat (KM)	7.946	nu star (KM)	7.877
theta hat (KM)	0.0702	theta star (KM)	0.0708
80% gamma percentile (	0.0231	90% gamma percentile (	0.0495
95% gamma percentile (	0.0812	99% gamma percentile (	0.167

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Signific	0.0346
Approximate Chi Square	2.664	Adjusted Chi Square Val	2.357
95% Gamma Approxirr	0.0485	95% Gamma Adjusted	0.0548

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	N/A	KM Geo Mean	N/A
KM SD (logged)	N/A	95% Critical H Value (t	N/A
KM Standard Error of Me	N/A	95% H-UCL (KM -Log)	N/A
KM SD (logged)	N/A	95% Critical H Value (t	N/A
KM Standard Error of Me	N/A		

DL/2 Statistics

Mean in Original Scale	0.0181	SD in Original Scale	0.0341
95% t UCL (Assumes r	0.0326		

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use
99% KM (Chebyshev) UCL 0.104

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. Recommendations are based upon data size, data distribution, and skewness. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Uranium-235/236

General Statistics

Total Number of Observations	17	Number of Distinct Observations	17
Number of Detects	9	Number of Non-Detects	8
Number of Distinct Detects	9	Number of Distinct Non-Detects	8
Minimum Detect	0.0554	Minimum Non-Detect	0.0301
Maximum Detect	0.1	Maximum Non-Detect	0.0563
Variance Detects	2.3247E-4	Percent Non-Detects	47.06%
Mean Detects	0.0691	SD Detects	0.0152
Median Detects	0.0633	CV Detects	0.221
Skewness Detects	1.197	Kurtosis Detects	0.643
Mean of Logged Detects	-2.693	SD of Logged Detects	0.206

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.852	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.236	Lilliefors GOF Test
5% Lilliefors Critical Value	0.274	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0509	KM Standard Error of Mean	0.00569
KM SD	0.022	95% KM (BCA) UCL	0.0657
95% KM (t) UCL	0.0608	95% KM (Percentile Bootstrap) UCL	0.0622
95% KM (z) UCL	0.0603	95% KM Bootstrap t UCL	0.0601
90% KM Chebyshev UCL	0.068	95% KM Chebyshev UCL	0.0757
97.5% KM Chebyshev UCL	0.0864	99% KM Chebyshev UCL	0.108

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.549	Anderson-Darling GOF Test
5% A-D Critical Value	0.721	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.219	Kolmogorov-Smirnov GOF
5% K-S Critical Value	0.279	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	25.55	k star (bias corrected ML	17.11
Theta hat (MLE)	0.0027	Theta star (bias correcte	0.00404
nu hat (MLE)	459.8	nu star (bias corrected)	307.9
Mean (detects)	0.0691		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.032	Mean	0.0517
Maximum	0.1	Median	0.0554
SD	0.0218	CV	0.421
k hat (MLE)	6.416	k star (bias corrected ML	5.323
Theta hat (MLE)	0.00807	Theta star (bias correcte	0.00972
nu hat (MLE)	218.1	nu star (bias corrected)	181
Adjusted Level of Signific	0.0346		
Approximate Chi Square	150.9	Adjusted Chi Square Val	148
95% Gamma Approxima	0.0621	95% Gamma Adjusted U	0.0633

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0509	SD (KM)	0.022
Variance (KM)	4.8447E-4	SE of Mean (KM)	0.00569
k hat (KM)	5.35	k star (KM)	4.445
nu hat (KM)	181.9	nu star (KM)	151.1
theta hat (KM)	0.00952	theta star (KM)	0.0115
80% gamma percentile (	0.0693	90% gamma percentile (	0.0833
95% gamma percentile (	0.096	99% gamma percentile (	0.123

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square	123.7	Adjusted Chi Square Val	121.1
95% Gamma Approxirr	0.0622	95% Gamma Adjusted	0.0635

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statist	0.881	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical	0.829	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.204	Lilliefors GOF Test
5% Lilliefors Critical Valu	0.274	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.055	Mean in Log Scale	-2.95
SD in Original Scale	0.0188	SD in Log Scale	0.317
95% t UCL (assumes r	0.0629	95% Percentile Bootstr	0.0628

95% BCA Bootstrap UCL	0.0641	95% Bootstrap t UCL	0.0653
95% H-UCL (Log ROS)	0.0638		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-3.07	KM Geo Mean	0.0464
KM SD (logged)	0.427	95% Critical H Value (t)	1.966
KM Standard Error of Mean	0.111	95% H-UCL (KM -Log)	0.0628
KM SD (logged)	0.427	95% Critical H Value (t)	1.966
KM Standard Error of Mean	0.111		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0466	Mean in Log Scale	-3.242
SD in Original Scale	0.0269	SD in Log Scale	0.629
95% t UCL (Assumes normality)	0.058	95% H-Stat UCL	0.067

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0608
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Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.