UCL Statistics for Data Sets with Non-Detects

User Selected
Date/Time of C ProUCL 5.16/19/17 4:43:03 PM
From File ProUCLinput_20-002(d)_0-5.xls
Full Precision OFF
Confidence Cc 95%
Number of Boc 2000

Barium

General Statistics

Total Number of Observa	16	Number of Distinct Obse	16
		Number of Missing Obse	0
Minimum	13.5	Mean	55.26
Maximum	125	Median	54.4
SD	29.19	Std. Error of Mean	7.298
Coefficient of Variation	0.528	Skewness	0.62

Normal GOF Test

Shapiro Wilk Test Statist	0.954	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical	0.887	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.102	**Lilliefors GOF Test**	
5% Lilliefors Critical Valu	0.213	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	68.05	95% Adjusted-CLT UC	68.47
		95% Modified-t UCL (J	68.24

Gamma GOF Test

A-D Test Statistic	0.328	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.743	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.139	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.216	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.377	k star (bias corrected ML	2.785
Theta hat (MLE)	16.36	Theta star (bias correcte	19.84
nu hat (MLE)	108.1	nu star (bias corrected)	89.14
MLE Mean (bias correcte	55.26	MLE Sd (bias corrected)	33.11
		Approximate Chi Square	68.37
Adjusted Level of Signific	0.0335	Adjusted Chi Square Val	66.3

Assuming Gamma Distribution

95% Approximate Gam	72.04	95% Adjusted Gamma	74.29

Lognormal GOF Test

Shapiro Wilk Test Statist	0.939	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical	0.887	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.172	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Valu	0.213	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.603	Mean of logged Data	3.857
Maximum of Logged Dat	4.828	SD of logged Data	0.615

Assuming Lognormal Distribution

95% H-UCL	80.75	90% Chebyshev (MVU	83.57
95% Chebyshev (MVU	95.89	97.5% Chebyshev (MVU	113
99% Chebyshev (MVU	146.6		

Nonparametric Distribution Free UCL Statistics

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

Nonparametric Distribution Free UCLs

95% CLT UCL	67.26	95% Jackknife UCL	68.05
95% Standard Bootstra	67	95% Bootstrap-t UCL	69.54
95% Hall's Bootstrap U	70.36	95% Percentile Bootstr	67.83
95% BCA Bootstrap UC	68.11		
90% Chebyshev(Mean	77.15	95% Chebyshev(Mean	87.07
97.5% Chebyshev(Mear	100.8	99% Chebyshev(Mean	127.9

Suggested UCL to Use

95% Student's-t UCL	68.05

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	16	Number of Distinct Obse	15
		Number of Missing Obse	0
Minimum	2.56	Mean	6.711
Maximum	19.1	Median	5.33
SD	4.768	Std. Error of Mean	1.192

Coefficient of Variation	0.711	Skewness	1.663

Normal GOF Test

Shapiro Wilk Test Statist	0.783	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical	0.887	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.273	**Lilliefors GOF Test**	
5% Lilliefors Critical Valu	0.213	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	8.8	95% Adjusted-CLT UC	9.201
		95% Modified-t UCL (J	8.883

Gamma GOF Test

A-D Test Statistic	0.69	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.745	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.199	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.217	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.833	k star (bias corrected ML	2.343
Theta hat (MLE)	2.369	Theta star (bias correcte	2.864
nu hat (MLE)	90.64	nu star (bias corrected)	74.98
MLE Mean (bias correcte	6.711	MLE Sd (bias corrected)	4.384
		Approximate Chi Square	56.04
Adjusted Level of Signific	0.0335	Adjusted Chi Square Val	54.17

Assuming Gamma Distribution

95% Approximate Gam	8.979	95% Adjusted Gamma	9.288

Lognormal GOF Test

Shapiro Wilk Test Statist	0.93	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical	0.887	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.155	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Valu	0.213	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.94	Mean of logged Data	1.717
Maximum of Logged Dat	2.95	SD of logged Data	0.602

Assuming Lognormal Distribution

95% H-UCL	9.339	90% Chebyshev (MVU	9.693
95% Chebyshev (MVU	11.1	97.5% Chebyshev (MVU	13.05
99% Chebyshev (MVU	16.89		

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

Nonparametric Distribution Free UCLs

95% CLT UCL	8.671	95% Jackknife UCL	8.8
95% Standard Bootstra	8.611	95% Bootstrap-t UCL	9.759
95% Hall's Bootstrap U	9.515	95% Percentile Bootstr	8.863
95% BCA Bootstrap U(	9.133		
90% Chebyshev(Mean	10.29	95% Chebyshev(Mean	11.91
97.5% Chebyshev(Mear	14.15	99% Chebyshev(Mean	18.57

Suggested UCL to Use

95% Adjusted Gamma U	9.288

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 Observa	16	Number of Distinct Obse	16
		Number of Missing Obse	0
Minimum	1.39	Mean	6.029
Maximum	28.7	Median	4.055
SD	6.668	Std. Error of Mean	1.667
Coefficient of Variation	1.106	Skewness	2.965

Normal GOF Test

Shapiro Wilk Test Statist	0.626	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical	0.887	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.289	**Lilliefors GOF Test**
5% Lilliefors Critical Valu	0.213	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	8.951	95% Adjusted-CLT UC	10.09
		95% Modified-t UCL (J	9.157

Gamma GOF Test

A-D Test Statistic	0.723	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.754	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.194	**Kolmogorov-Smirnov Gamma GOF Test**

5% K-S Critical Value	0.219	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.62	k star (bias corrected ML	1.358
Theta hat (MLE)	3.721	Theta star (bias correcte	4.439
nu hat (MLE)	51.84	nu star (bias corrected)	43.46
MLE Mean (bias correcte	6.029	MLE Sd (bias corrected)	5.173
		Approximate Chi Square	29.34
Adjusted Level of Signific	0.0335	Adjusted Chi Square Val	28.02

Assuming Gamma Distribution

95% Approximate Gam	8.929	95% Adjusted Gamma	9.349

Lognormal GOF Test

Shapiro Wilk Test Statist	0.947	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical	0.887	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.131	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Valu	0.213	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.329	Mean of logged Data	1.457
Maximum of Logged Dat	3.357	SD of logged Data	0.786

Assuming Lognormal Distribution

95% H-UCL	9.506	90% Chebyshev (MVU	9.308
95% Chebyshev (MVU	10.94	97.5% Chebyshev (MVU	13.2
99% Chebyshev (MVU	17.65		

Nonparametric Distribution Free UCL Statistics

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

Nonparametric Distribution Free UCLs

95% CLT UCL	8.771	95% Jackknife UCL	8.951
95% Standard Bootstra	8.788	95% Bootstrap-t UCL	13.93
95% Hall's Bootstrap U	20.68	95% Percentile Bootstr	8.935
95% BCA Bootstrap UC	10.31		
90% Chebyshev(Mean	11.03	95% Chebyshev(Mean	13.29
97.5% Chebyshev(Mear	16.44	99% Chebyshev(Mean	22.62

Suggested UCL to Use

95% Adjusted Gamma U	9.349

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.

Lead

General Statistics

Total Number of Observa	16	Number of Distinct Obse	16
		Number of Missing Obse	0
Minimum	3.14	Mean	9.175
Maximum	13.2	Median	9.675
SD	2.963	Std. Error of Mean	0.741
Coefficient of Variation	0.323	Skewness	-0.941

Normal GOF Test

Shapiro Wilk Test Statist	0.892	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical	0.887	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.23	**Lilliefors GOF Test**
5% Lilliefors Critical Valu	0.213	Data Not Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	10.47	95% Adjusted-CLT UC	10.21
		95% Modified-t UCL (J	10.44

Gamma GOF Test

A-D Test Statistic	1.179	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.74	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.273	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.215	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.409	k star (bias corrected ML	6.062
Theta hat (MLE)	1.238	Theta star (bias correcte	1.514
nu hat (MLE)	237.1	nu star (bias corrected)	194
MLE Mean (bias correcte	9.175	MLE Sd (bias corrected)	3.727
		Approximate Chi Square	162.8
Adjusted Level of Signific	0.0335	Adjusted Chi Square Val	159.5

Assuming Gamma Distribution

95% Approximate Gam	10.94	95% Adjusted Gamma	11.16

Lognormal GOF Test

Shapiro Wilk Test Statist	0.803	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical	0.887	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.284	**Lilliefors Lognormal GOF Test**

5% Lilliefors Critical Valu	0.213	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.144	Mean of logged Data	2.147
Maximum of Logged Dat	2.58	SD of logged Data	0.421

Assuming Lognormal Distribution

95% H-UCL	11.59	90% Chebyshev (MVU	12.3
95% Chebyshev (MVU	13.66	97.5% Chebyshev (MVU	15.55
99% Chebyshev (MVU	19.25		

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

Nonparametric Distribution Free UCLs

95% CLT UCL	10.39	95% Jackknife UCL	10.47
95% Standard Bootstra	10.34	95% Bootstrap-t UCL	10.32
95% Hall's Bootstrap U	10.24	95% Percentile Bootstr	10.31
95% BCA Bootstrap UC	10.19		
90% Chebyshev(Mean	11.4	95% Chebyshev(Mean	12.4
97.5% Chebyshev(Mear	13.8	99% Chebyshev(Mean	16.55

Suggested UCL to Use

95% Student's-t UCL	10.47

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.

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 positvely skewed data sets.

Manganese

General Statistics

Total Number of Observa	16	Number of Distinct Obse	15
		Number of Missing Obse	0
Minimum	178	Mean	341.6
Maximum	494	Median	347
SD	93.06	Std. Error of Mean	23.27
Coefficient of Variation	0.272	Skewness	-0.315

Normal GOF Test

Shapiro Wilk Test Statist	0.95	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical	0.887	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.131	**Lilliefors GOF Test**
5% Lilliefors Critical Valu	0.213	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	382.4	95% Adjusted-CLT UC	377.9
		95% Modified-t UCL (J	382.1

Gamma GOF Test

A-D Test Statistic	0.542	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.738	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.168	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.215	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	12.57	k star (bias corrected ML	10.26
Theta hat (MLE)	27.17	Theta star (bias correcte	33.31
nu hat (MLE)	402.3	nu star (bias corrected)	328.2
MLE Mean (bias correcte	341.6	MLE Sd (bias corrected)	106.7
		Approximate Chi Square	287.2
Adjusted Level of Signific	0.0335	Adjusted Chi Square Val	282.9

Assuming Gamma Distribution

95% Approximate Gam	390.4	95% Adjusted Gamma	396.4

Lognormal GOF Test

Shapiro Wilk Test Statist	0.899	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical	0.887	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.183	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Valu	0.213	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.182	Mean of logged Data	5.793
Maximum of Logged Dat	6.203	SD of logged Data	0.306

Assuming Lognormal Distribution

95% H-UCL	398.7	90% Chebyshev (MVU	422.4
95% Chebyshev (MVU	458.5	97.5% Chebyshev (MVU	508.5
99% Chebyshev (MVU	606.8		

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

Nonparametric Distribution Free UCLs

95% CLT UCL	379.9	95% Jackknife UCL	382.4
95% Standard Bootstra	378	95% Bootstrap-t UCL	380.6
95% Hall's Bootstrap U	379.8	95% Percentile Bootstr	375.3
95% BCA Bootstrap UC	377		
90% Chebyshev(Mean	411.4	95% Chebyshev(Mean	443
97.5% Chebyshev(Mear	486.9	99% Chebyshev(Mean	573.1

Suggested UCL to Use

95% Student's-t UCL	382.4

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 positvely skewed data sets.

Perchlorate

General Statistics

Total Number of Observa	16	Number of Distinct Obse	15
Number of Detects	6	Number of Non-Detects	10
Number of Distinct Detec	6	Number of Distinct Non-I	9
Minimum Detect	6.7500E-4	Minimum Non-Detect	0.00203
Maximum Detect	0.00254	Maximum Non-Detect	0.00233
Variance Detects	5.6937E-7	Percent Non-Detects	62.5%
Mean Detects	0.00149	SD Detects	7.5457E-4
Median Detects	0.00146	CV Detects	0.507
Skewness Detects	0.286	Kurtosis Detects	-1.911
Mean of Logged Detects	-6.629	SD of Logged Detects	0.543

Normal GOF Test on Detects Only

Shapiro Wilk Test Statist	0.906	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical	0.788	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.228	**Lilliefors GOF Test**	
5% Lilliefors Critical Valu	0.325	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	0.00136	KM Standard Error of Me	2.6643E-4
KM SD	6.1470E-4	95% KM (BCA) UCL	0.00178
95% KM (t) UCL	0.00182	95% KM (Percentile Boo	0.00178

95% KM (z) UCL	0.00179	95% KM Bootstrap t UC	0.00207
90% KM Chebyshev UCL	0.00215	95% KM Chebyshev UCL	0.00252
97.5% KM Chebyshev U	0.00302	99% KM Chebyshev UCL	0.00401

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.384	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.699	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.248	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.333	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)	4.404	k star (bias corrected ML	2.313
Theta hat (MLE)	3.3768E-4	Theta star (bias correcte	6.4291E-4
nu hat (MLE)	52.84	nu star (bias corrected)	27.76
Mean (detects)	0.00149		

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	6.7500E-4	Mean	0.00681
Maximum	0.01	Median	0.01
SD	0.00428	CV	0.629
k hat (MLE)	1.48	k star (bias corrected ML	1.244
Theta hat (MLE)	0.0046	Theta star (bias correcte	0.00547
nu hat (MLE)	47.37	nu star (bias corrected)	39.82
Adjusted Level of Signific	0.0335		
Approximate Chi Square	26.36	Adjusted Chi Square Val	25.12
95% Gamma Approxima	0.0103	95% Gamma Adjusted U	0.0108

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00136	SD (KM)	6.1470E-4
Variance (KM)	3.7786E-7	SE of Mean (KM)	2.6643E-4
k hat (KM)	4.862	k star (KM)	3.992
nu hat (KM)	155.6	nu star (KM)	127.7
theta hat (KM)	2.7879E-4	theta star (KM)	3.3954E-4
80% gamma percentile (	0.00187	90% gamma percentile (	0.00226
95% gamma percentile (	0.00263	99% gamma percentile (	0.00341

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square	102.6	Adjusted Chi Square Val	100.1
95% Gamma Approxim	0.00169	95% Gamma Adjusted	0.00173

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statist	0.909	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical	0.788	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.242	**Lilliefors GOF Test**	
5% Lilliefors Critical Valu	0.325	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	0.00127	Mean in Log Scale	-6.727
SD in Original Scale	4.7744E-4	SD in Log Scale	0.332
95% t UCL (assumes r	0.00148	95% Percentile Bootstr	0.00147
95% BCA Bootstrap U(	0.00152	95% Bootstrap t UCL	0.00161
95% H-UCL (Log ROS	0.00149		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-6.71	KM Geo Mean	0.00122
KM SD (logged)	0.465	95% Critical H Value (K	2.015
KM Standard Error of Me	0.208	95% H-UCL (KM -Log)	0.00173
KM SD (logged)	0.465	95% Critical H Value (K	2.015
KM Standard Error of Me	0.208		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00124	Mean in Log Scale	-6.751
SD in Original Scale	4.8009E-4	SD in Log Scale	0.33
95% t UCL (Assumes r	0.00145	95% H-Stat UCL	0.00145

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	0.00182

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-234

General Statistics

Total Number of Observa	16	Number of Distinct Obse	16
		Number of Missing Obse	0
Minimum	0.685	Mean	2.132
Maximum	15	Median	1.24
SD	3.476	Std. Error of Mean	0.869

Coefficient of Variation	1.63	Skewness	3.839

Normal GOF Test

Shapiro Wilk Test Statist	0.382	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical	0.887	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.449	**Lilliefors GOF Test**	
5% Lilliefors Critical Valu	0.213	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	3.655	95% Adjusted-CLT UC	4.452
		95% Modified-t UCL (J	3.794

Gamma GOF Test

A-D Test Statistic	2.991	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.758	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.413	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.22	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.324	k star (bias corrected ML	1.117
Theta hat (MLE)	1.611	Theta star (bias correcte	1.908
nu hat (MLE)	42.35	nu star (bias corrected)	35.74
MLE Mean (bias correcte	2.132	MLE Sd (bias corrected)	2.017
		Approximate Chi Square	23.06
Adjusted Level of Signific	0.0335	Adjusted Chi Square Val	21.91

Assuming Gamma Distribution

95% Approximate Gam	3.304	95% Adjusted Gamma	3.478

Lognormal GOF Test

Shapiro Wilk Test Statist	0.673	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical	0.887	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.343	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Valu	0.213	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.378	Mean of logged Data	0.334
Maximum of Logged Dat	2.708	SD of logged Data	0.72

Assuming Lognormal Distribution

95% H-UCL	2.777	90% Chebyshev (MVU	2.789
95% Chebyshev (MVU	3.249	97.5% Chebyshev (MVU	3.887
99% Chebyshev (MVU	5.14		

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	3.561	95% Jackknife UCL	3.655
95% Standard Bootstra	3.518	95% Bootstrap-t UCL	17.86
95% Hall's Bootstrap U	14.58	95% Percentile Bootstr	3.806
95% BCA Bootstrap UC	4.806		
90% Chebyshev(Mean	4.739	95% Chebyshev(Mean	5.92
97.5% Chebyshev(Mear	7.559	99% Chebyshev(Mean	10.78

Suggested UCL to Use

95% Chebyshev (Mean,	5.92

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 Observa	16	Number of Distinct Obse	16
Number of Detects	12	Number of Non-Detects	4
Number of Distinct Detec	12	Number of Distinct Non-I	4
Minimum Detect	0.0652	Minimum Non-Detect	0.0229
Maximum Detect	0.775	Maximum Non-Detect	0.0716
Variance Detects	0.0391	Percent Non-Detects	25%
Mean Detects	0.152	SD Detects	0.198
Median Detects	0.0959	CV Detects	1.3
Skewness Detects	3.37	Kurtosis Detects	11.51
Mean of Logged Detects	-2.202	SD of Logged Detects	0.657

Normal GOF Test on Detects Only

Shapiro Wilk Test Statist	0.431	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical	0.859	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.425	**Lilliefors GOF Test**
5% Lilliefors Critical Valu	0.243	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	0.121	KM Standard Error of Me	0.0451
KM SD	0.173	95% KM (BCA) UCL	0.213
95% KM (t) UCL	0.2	95% KM (Percentile Bo	0.207
95% KM (z) UCL	0.195	95% KM Bootstrap t UC	0.416
90% KM Chebyshev UCI	0.256	95% KM Chebyshev UCI	0.318

97.5% KM Chebyshev U	0.403	99% KM Chebyshev UCI	0.57

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.271	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.744	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.406	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.249	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)	1.719	k star (bias corrected ML	1.345
Theta hat (MLE)	0.0885	Theta star (bias correcte	0.113
nu hat (MLE)	41.26	nu star (bias corrected)	32.28
Mean (detects)	0.152		

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	0.117
Maximum	0.775	Median	0.0871
SD	0.181	CV	1.552
k hat (MLE)	0.896	k star (bias corrected ML	0.769
Theta hat (MLE)	0.13	Theta star (bias correcte	0.152
nu hat (MLE)	28.66	nu star (bias corrected)	24.62
Adjusted Level of Signific	0.0335		
Approximate Chi Square	14.32	Adjusted Chi Square Val	13.43
95% Gamma Approxima	0.2	95% Gamma Adjusted U	0.214

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.121	SD (KM)	0.173
Variance (KM)	0.0298	SE of Mean (KM)	0.0451
k hat (KM)	0.49	k star (KM)	0.44
nu hat (KM)	15.67	nu star (KM)	14.07
theta hat (KM)	0.247	theta star (KM)	0.275
80% gamma percentile (	0.197	90% gamma percentile (	0.336
95% gamma percentile (	0.486	99% gamma percentile (	0.861

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square	6.617	Adjusted Chi Square Val	6.044
95% Gamma Approxim	0.257	95% Gamma Adjusted	0.281

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statist	0.653	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical	0.859	Detected Data Not Lognormal at 5% Significance Level

Lilliefors Test Statistic	0.359	**Lilliefors GOF Test**	
5% Lilliefors Critical Valu	0.243	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.122	Mean in Log Scale	-2.506
SD in Original Scale	0.178	SD in Log Scale	0.785
95% t UCL (assumes r	0.2	95% Percentile Bootstr	0.207
95% BCA Bootstrap U(	0.249	95% Bootstrap t UCL	0.448
95% H-UCL (Log ROS	0.18		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.568	KM Geo Mean	0.0767
KM SD (logged)	0.852	95% Critical H Value (K	2.485
KM Standard Error of Me	0.226	95% H-UCL (KM -Log)	0.19
KM SD (logged)	0.852	95% Critical H Value (K	2.485
KM Standard Error of Me	0.226		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.12	Mean in Log Scale	-2.624
SD in Original Scale	0.179	SD in Log Scale	0.977
95% t UCL (Assumes r	0.198	95% H-Stat UCL	0.229

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

95% KM (Chebyshev) U(	0.318

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-238

General Statistics

Total Number of Observa	16	Number of Distinct Obse	15
		Number of Missing Obse	0
Minimum	0.717	Mean	2.178
Maximum	15.4	Median	1.24
SD	3.564	Std. Error of Mean	0.891
Coefficient of Variation	1.636	Skewness	3.864

Normal GOF Test

Shapiro Wilk Test Statist	0.375	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical	0.887	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.457	**Lilliefors GOF Test**
5% Lilliefors Critical Valu	0.213	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	3.74	95% Adjusted-CLT UC	4.563
		95% Modified-t UCL (J	3.883

Gamma GOF Test

A-D Test Statistic	3.054	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.758	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.434	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.22	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.336	k star (bias corrected ML	1.127
Theta hat (MLE)	1.63	Theta star (bias correcte	1.932
nu hat (MLE)	42.76	nu star (bias corrected)	36.08
MLE Mean (bias correcte	2.178	MLE Sd (bias corrected)	2.051
		Approximate Chi Square	23.33
Adjusted Level of Signific	0.0335	Adjusted Chi Square Val	22.17

Assuming Gamma Distribution

95% Approximate Gam	3.368	95% Adjusted Gamma	3.544

Lognormal GOF Test

Shapiro Wilk Test Statist	0.661	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical	0.887	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.372	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Valu	0.213	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.333	Mean of logged Data	0.36
Maximum of Logged Dat	2.734	SD of logged Data	0.71

Assuming Lognormal Distribution

95% H-UCL	2.808	90% Chebyshev (MVU	2.83
95% Chebyshev (MVU	3.292	97.5% Chebyshev (MVU	3.934
99% Chebyshev (MVU	5.194		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	3.643	95% Jackknife UCL	3.74
95% Standard Bootstra	3.628	95% Bootstrap-t UCL	17.92
95% Hall's Bootstrap U	14.55	95% Percentile Bootstr	3.953
95% BCA Bootstrap UC	4.893		
90% Chebyshev(Mean	4.851	95% Chebyshev(Mean	6.061
97.5% Chebyshev(Mear	7.742	99% Chebyshev(Mean	11.04

Suggested UCL to Use

95% Chebyshev (Mean,	6.061

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.