UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.16/19/17 5:20:34 PM
From File	ProUCLinput_53-009_0-10.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aroclor-1254

General Statistics

Total Number of Observations	18	Number of Distinct Observations	16
Number of Detects	7	Number of Non-Detects	11
Number of Distinct Detects	7	Number of Distinct Non-Detects	9
Minimum Detect	0.0024	Minimum Non-Detect	0.00338
Maximum Detect	0.0292	Maximum Non-Detect	0.0351
Variance Detects	1.2334E-4	Percent Non-Detects	61.11%
Mean Detects	0.0128	SD Detects	0.0111
Median Detects	0.0072	CV Detects	0.869
Skewness Detects	0.569	Kurtosis Detects	-1.82
Mean of Logged Detects	-4.767	SD of Logged Detects	1.023

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.851	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.264	**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	0.00694	KM Standard Error of Mean	0.00216
KM SD	0.00822	95% KM (BCA) UCL	0.0108
95% KM (t) UCL	0.0107	95% KM (Percentile Bootstrap) UCL	0.0105
95% KM (z) UCL	0.0105	95% KM Bootstrap t UCL	0.0124
90% KM Chebyshev UCL	0.0134	95% KM Chebyshev UCL	0.0164
97.5% KM Chebyshev UCL	0.0205	99% KM Chebyshev UCL	0.0285

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.458	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.723	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.215	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.318	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)	1.369	k star (bias corrected MLE)	0.878
Theta hat (MLE)	0.00934	Theta star (bias corrected MLE)	0.0146
nu hat (MLE)	19.17	nu star (bias corrected)	12.29
Mean (detects)	0.0128		

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	0.0024	Mean	0.0111
Maximum	0.0292	Median	0.01
SD	0.00674	CV	0.609
k hat (MLE)	3.172	k star (bias corrected MLE)	2.68

Theta hat (MLE)	0.00349	Theta star (bias corrected MLE)	0.00413
nu hat (MLE)	114.2	nu star (bias corrected)	96.5
Adjusted Level of Significance (β)	0.0357		
Approximate Chi Square Value (96.50, α)	74.84	Adjusted Chi Square Value (96.50, β)	73.01
95% Gamma Approximate UCL (use when n>=50)	0.0143	95% Gamma Adjusted UCL (use when n<50)	0.0146

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00694	SD (KM)	0.00822
Variance (KM)	6.7564E-5	SE of Mean (KM)	0.00216
k hat (KM)	0.713	k star (KM)	0.631
nu hat (KM)	25.67	nu star (KM)	22.73
theta hat (KM)	0.00973	theta star (KM)	0.011
80% gamma percentile (KM)	0.0114	90% gamma percentile (KM)	0.0178
95% gamma percentile (KM)	0.0245	99% gamma percentile (KM)	0.0406

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (22.73, α)	12.88	Adjusted Chi Square Value (22.73, β)	12.18
95% Gamma Approximate KM-UCL (use when n>=50)	0.0122	95% Gamma Adjusted KM-UCL (use when n<50)	0.013

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.896	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.214	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.304	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	0.00663	Mean in Log Scale	-5.484
SD in Original Scale	0.00833	SD in Log Scale	0.871
95% t UCL (assumes normality of ROS data)	0.01	95% Percentile Bootstrap UCL	0.01
95% BCA Bootstrap UCL	0.0111	95% Bootstrap t UCL	0.0128
95% H-UCL (Log ROS)	0.0102		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.418	KM Geo Mean	0.00444
KM SD (logged)	0.825	95% Critical H Value (KM-Log)	2.395
KM Standard Error of Mean (logged)	0.23	95% H-UCL (KM -Log)	0.0101
KM SD (logged)	0.825	95% Critical H Value (KM-Log)	2.395
KM Standard Error of Mean (logged)	0.23		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00692	Mean in Log Scale	-5.604
SD in Original Scale	0.00895	SD in Log Scale	1.061
95% t UCL (Assumes normality)	0.0106	95% H-Stat UCL	0.0131

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

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.

Barium

General Statistics

Total Number of Observations	18	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	8.03	Mean	76.01
Maximum	250	Median	33.95
SD	85.46	Std. Error of Mean	20.14
Coefficient of Variation	1.124	Skewness	1.323

Normal GOF Test

Shapiro Wilk Test Statistic	0.712	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.296	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.202	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	111.1	95% Adjusted-CLT UCL (Chen-1995)	115.9
		95% Modified-t UCL (Johnson-1978)	112.1

Gamma GOF Test

A-D Test Statistic	1.218	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.766	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.235	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.209	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.043	k star (bias corrected MLE)	0.906
Theta hat (MLE)	72.87	Theta star (bias corrected MLE)	83.87
nu hat (MLE)	37.55	nu star (bias corrected)	32.63
MLE Mean (bias corrected)	76.01	MLE Sd (bias corrected)	79.84
		Approximate Chi Square Value (0.05)	20.57
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	19.65

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	120.6	95% Adjusted Gamma UCL (use when n<50)	126.2

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.909	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.177	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.202	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.083	Mean of logged Data	3.78
Maximum of Logged Data	5.521	SD of logged Data	1.057

Assuming Lognormal Distribution

95% H-UCL	154	90% Chebyshev (MVUE) UCL	134.5
95% Chebyshev (MVUE) UCL	162.3	97.5% Chebyshev (MVUE) UCL	200.8
99% Chebyshev (MVUE) UCL	276.5		

Nonparametric Distribution Free UCL Statistics

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

Nonparametric Distribution Free UCLs

95% CLT UCL	109.1	95% Jackknife UCL	111.1
95% Standard Bootstrap UCL	109.2	95% Bootstrap-t UCL	123.2
95% Hall's Bootstrap UCL	103.4	95% Percentile Bootstrap UCL	109

95% BCA Bootstrap UCL	115.2		
90% Chebyshev(Mean, Sd) UCL	136.4	95% Chebyshev(Mean, Sd) UCL	163.8
97.5% Chebyshev(Mean, Sd) UCL	201.8	99% Chebyshev(Mean, Sd) UCL	276.4

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL 163.8

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 Observations	18	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	1.2	Mean	5.507
Maximum	14.9	Median	5.085
SD	3.378	Std. Error of Mean	0.796
Coefficient of Variation	0.613	Skewness	1.165

Normal GOF Test

Shapiro Wilk Test Statistic	0.907	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.119	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.202	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	6.892	95% Adjusted-CLT UCL (Chen-1995)	7.05
		95% Modified-t UCL (Johnson-1978)	6.929

Gamma GOF Test

A-D Test Statistic	0.263	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.747	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.129	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.205	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 MLE)	2.398
Theta hat (MLE)	1.944	Theta star (bias corrected MLE)	2.297
nu hat (MLE)	102	nu star (bias corrected)	86.31
MLE Mean (bias corrected)	5.507	MLE Sd (bias corrected)	3.557
		Approximate Chi Square Value (0.05)	65.9
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	64.18

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	7.213	95% Adjusted Gamma UCL (use when n<50)	7.406

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.968	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.148	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.202	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.182	Mean of logged Data	1.519
Maximum of Logged Data	2.701	SD of logged Data	0.656

Assuming Lognormal Distribution

95% H-UCL	8.028	90% Chebyshev (MVUE) UCL	8.327
95% Chebyshev (MVUE) UCL	9.568	97.5% Chebyshev (MVUE) UCL	11.29
99% Chebyshev (MVUE) UCL	14.67		

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

Nonparametric Distribution Free UCLs

95% CLT UCL	6.817	95% Jackknife UCL	6.892
95% Standard Bootstrap UCL	6.81	95% Bootstrap-t UCL	7.236
95% Hall's Bootstrap UCL	7.433	95% Percentile Bootstrap UCL	6.797
95% BCA Bootstrap UCL	7.112		
90% Chebyshev(Mean, Sd) UCL	7.896	95% Chebyshev(Mean, Sd) UCL	8.977
97.5% Chebyshev(Mean, Sd) UCL	10.48	99% Chebyshev(Mean, Sd) UCL	13.43

Suggested UCL to Use
95% Student's-t UCL 6.892

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	18	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	0.938	Mean	4.206
Maximum	11.8	Median	3.85
SD	3.11	Std. Error of Mean	0.733
Coefficient of Variation	0.739	Skewness	1.073

Normal GOF Test

Shapiro Wilk Test Statistic	0.867	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.214	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.202	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	5.481	95% Adjusted-CLT UCL (Chen-1995)	5.61
		95% Modified-t UCL (Johnson-1978)	5.512

Gamma GOF Test

A-D Test Statistic	0.528	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.752	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.184	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.206	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.076	k star (bias corrected MLE)	1.767
Theta hat (MLE)	2.026	Theta star (bias corrected MLE)	2.38
nu hat (MLE)	74.74	nu star (bias corrected)	63.61

MLE Mean (bias corrected)	4.206	MLE Sd (bias corrected)	3.164
		Approximate Chi Square Value (0.05)	46.27
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	44.85

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	5.783	95% Adjusted Gamma UCL (use when n<50)	5.966

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.947	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.158	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.202	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.064	Mean of logged Data	1.177
Maximum of Logged Data	2.468	SD of logged Data	0.753

Assuming Lognormal Distribution

95% H-UCL	6.558	90% Chebyshev (MVUE) UCL	6.632
95% Chebyshev (MVUE) UCL	7.723	97.5% Chebyshev (MVUE) UCL	9.237
99% Chebyshev (MVUE) UCL	12.21		

Nonparametric Distribution Free UCL Statistics

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

Nonparametric Distribution Free UCLs

95% CLT UCL	5.412	95% Jackknife UCL	5.481
95% Standard Bootstrap UCL	5.392	95% Bootstrap-t UCL	5.822
95% Hall's Bootstrap UCL	5.659	95% Percentile Bootstrap UCL	5.406
95% BCA Bootstrap UCL	5.558		
90% Chebyshev(Mean, Sd) UCL	6.405	95% Chebyshev(Mean, Sd) UCL	7.401
97.5% Chebyshev(Mean, Sd) UCL	8.783	99% Chebyshev(Mean, Sd) UCL	11.5

Suggested UCL to Use

95% Adjusted Gamma UCL 5.966

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 Observations	18	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	3.38	Mean	19.33
Maximum	201	Median	6.94
SD	45.65	Std. Error of Mean	10.76
Coefficient of Variation	2.362	Skewness	4.15

Normal GOF Test

Shapiro Wilk Test Statistic	0.342	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.401	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.202	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	38.04	95% Adjusted-CLT UCL (Chen-1995)	48.27
		95% Modified-t UCL (Johnson-1978)	39.8

Gamma GOF Test

A-D Test Statistic	2.8	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.777	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.341	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.211	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.774	k star (bias corrected MLE)	0.682
Theta hat (MLE)	24.98	Theta star (bias corrected MLE)	28.35
nu hat (MLE)	27.85	nu star (bias corrected)	24.54
MLE Mean (bias corrected)	19.33	MLE Sd (bias corrected)	23.41
		Approximate Chi Square Value (0.05)	14.26
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	13.51

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	33.26	95% Adjusted Gamma UCL (use when n<50)	35.11

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.781	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.224	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.202	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.218	Mean of logged Data	2.191
Maximum of Logged Data	5.303	SD of logged Data	0.938

Assuming Lognormal Distribution

95% H-UCL	24.8	90% Chebyshev (MVUE) UCL	23.24
95% Chebyshev (MVUE) UCL	27.68	97.5% Chebyshev (MVUE) UCL	33.84
99% Chebyshev (MVUE) UCL	45.95		

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

Nonparametric Distribution Free UCLs

95% CLT UCL	37.02	95% Jackknife UCL	38.04
95% Standard Bootstrap UCL	35.97	95% Bootstrap-t UCL	174.9
95% Hall's Bootstrap UCL	108.7	95% Percentile Bootstrap UCL	40.1
95% BCA Bootstrap UCL	52.96		
90% Chebyshev(Mean, Sd) UCL	51.6	95% Chebyshev(Mean, Sd) UCL	66.22
97.5% Chebyshev(Mean, Sd) UCL	86.52	99% Chebyshev(Mean, Sd) UCL	126.4

Suggested UCL to Use
95% Chebyshev (Mean, Sd) UCL 66.22

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	18	Number of Distinct Observations	17
		Number of Missing Observations	0
Minimum	1.31	Mean	3.856
Maximum	9.5	Median	2.905
SD	2.417	Std. Error of Mean	0.57
Coefficient of Variation	0.627	Skewness	0.904

Normal GOF Test

Shapiro Wilk Test Statistic	0.891	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.225	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.202	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	4.846	95% Adjusted-CLT UCL (Chen-1995)	4.922
		95% Modified-t UCL (Johnson-1978)	4.867

Gamma GOF Test

A-D Test Statistic	0.492	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.747	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.202	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.205	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.848	k star (bias corrected MLE)	2.41
Theta hat (MLE)	1.354	Theta star (bias corrected MLE)	1.599
nu hat (MLE)	102.5	nu star (bias corrected)	86.78
MLE Mean (bias corrected)	3.856	MLE Sd (bias corrected)	2.483
		Approximate Chi Square Value (0.05)	66.3
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	64.59

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	5.046	95% Adjusted Gamma UCL (use when n<50)	5.18

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.939	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.173	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.202	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.27	Mean of logged Data	1.164
Maximum of Logged Data	2.251	SD of logged Data	0.632

Assuming Lognormal Distribution

95% H-UCL	5.445	90% Chebyshev (MVUE) UCL	5.676
95% Chebyshev (MVUE) UCL	6.498	97.5% Chebyshev (MVUE) UCL	7.64
99% Chebyshev (MVUE) UCL	9.883		

Nonparametric Distribution Free UCL Statistics

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

Nonparametric Distribution Free UCLs

95% CLT UCL	4.792	95% Jackknife UCL	4.846
95% Standard Bootstrap UCL	4.755	95% Bootstrap-t UCL	4.967
95% Hall's Bootstrap UCL	4.982	95% Percentile Bootstrap UCL	4.792
95% BCA Bootstrap UCL	4.847		

90% Chebyshev(Mean, Sd) UCL	5.564	95% Chebyshev(Mean, Sd) UCL	6.338
97.5% Chebyshev(Mean, Sd) UCL	7.413	99% Chebyshev(Mean, Sd) UCL	9.523

Suggested UCL to Use

95% Adjusted Gamma UCL 5.18

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.

Vanadium

General Statistics

Total Number of Observations	18	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	2.03	Mean	13.67
Maximum	36	Median	8.755
SD	11.79	Std. Error of Mean	2.779
Coefficient of Variation	0.863	Skewness	0.718

Normal GOF Test

Shapiro Wilk Test Statistic	0.84	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.237	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.202	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	18.5	95% Adjusted-CLT UCL (Chen-1995)	18.74
		95% Modified-t UCL (Johnson-1978)	18.58

Gamma GOF Test

A-D Test Statistic	0.963	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.76	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.249	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.208	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.338	k star (bias corrected MLE)	1.152
Theta hat (MLE)	10.21	Theta star (bias corrected MLE)	11.86
nu hat (MLE)	48.17	nu star (bias corrected)	41.48
MLE Mean (bias corrected)	13.67	MLE Sd (bias corrected)	12.73
		Approximate Chi Square Value (0.05)	27.72
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	26.64

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	20.46	95% Adjusted Gamma UCL (use when n<50)	21.28

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.886	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.235	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.202	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.708	Mean of logged Data	2.197

Maximum of Logged Data	3.584	SD of logged Data	0.98

Assuming Lognormal Distribution

95% H-UCL	27.02	90% Chebyshev (MVUE) UCL	24.76
95% Chebyshev (MVUE) UCL	29.62	97.5% Chebyshev (MVUE) UCL	36.38
99% Chebyshev (MVUE) UCL	49.64		

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

Nonparametric Distribution Free UCLs

95% CLT UCL	18.24	95% Jackknife UCL	18.5
95% Standard Bootstrap UCL	17.99	95% Bootstrap-t UCL	19.16
95% Hall's Bootstrap UCL	18.1	95% Percentile Bootstrap UCL	18.1
95% BCA Bootstrap UCL	18.24		
90% Chebyshev(Mean, Sd) UCL	22.01	95% Chebyshev(Mean, Sd) UCL	25.78
97.5% Chebyshev(Mean, Sd) UCL	31.03	99% Chebyshev(Mean, Sd) UCL	41.32

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	25.78

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.