

UCL Statistics for Data Sets with Non-Detects

User Selected
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From File ProUCLinput_53-010_0-5.xls
Full Precision OFF
Confidence Cc 95%
Number of Boc 2000

Barium

General Statistics

Total Number of Observations	12	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	17.6	Mean	55.9
Maximum	83.9	Median	62.7
SD	20.84	Std. Error of Mean	6.017
Coefficient of Variation	0.373	Skewness	-0.68

Normal GOF Test

Shapiro Wilk Test Statistic	0.924	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.859	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.18	Lilliefors GOF Test
5% Lilliefors Critical Value	0.243	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	66.71	95% Adjusted-CLT UCL (Chen-1995)	64.54
		95% Modified-t UCL (Johnson-1978)	66.51

Gamma GOF Test

A-D Test Statistic	0.694	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.732	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.221	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.246	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.82	k star (bias corrected MLE)	4.42
Theta hat (MLE)	9.605	Theta star (bias corrected MLE)	12.65
nu hat (MLE)	139.7	nu star (bias corrected)	106.1
MLE Mean (bias corrected)	55.9	MLE Sd (bias corrected)	26.59
		Approximate Chi Square Value (0.05)	83.32
Adjusted Level of Significance	0.029	Adjusted Chi Square Value	80.24

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>50)	71.18	95% Adjusted Gamma UCL (use when n<50)	73.9
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.849	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.859	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.226	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.243	Data appear Lognormal at 5% Significance Level	
Data appear Approximate Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	2.868	Mean of logged Data	3.935
Maximum of Logged Data	4.43	SD of logged Data	0.48
Assuming Lognormal Distribution			
95% H-UCL	77.98	90% Chebyshev (MVUE) UCL	80.95
95% Chebyshev (MVUE) UCL	91.87	97.5% Chebyshev (MVUE) UCL	107
99% Chebyshev (MVUE) UCL	136.8		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	65.8	95% Jackknife UCL	66.71
95% Standard Bootstrap UCL	65.42	95% Bootstrap-t UCL	65.36
95% Hall's Bootstrap UCL	63.85	95% Percentile Bootstrap UCL	64.72
95% BCA Bootstrap UCL	64.48		
90% Chebyshev(Mean, Sd) UCL	73.95	95% Chebyshev(Mean, Sd) UCL	82.13
97.5% Chebyshev(Mean, Sd) UCL	93.48	99% Chebyshev(Mean, Sd) UCL	115.8
Suggested UCL to Use			
95% Student's-t UCL	66.71		

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.

Chromium			
General Statistics			
Total Number of Observations	12	Number of Distinct Observations	12
		Number of Missing Observations	0

Minimum	0.709	Mean	5.177
Maximum	16.2	Median	5.96
SD	4.257	Std. Error of Mean	1.229
Coefficient of Variation	0.822	Skewness	1.547
Normal GOF Test			
Shapiro Wilk Test Statistic	0.817	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.859	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.222	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.243	Data appear 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	7.383	95% Adjusted-CLT UCL (Chen-1995)	7.784
		95% Modified-t UCL (Johnson-1978)	7.475
Gamma GOF Test			
A-D Test Statistic	0.584	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	0.25	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.249	Data Not Gamma Distributed at 5% Significance Level	
Detected data follow Appr. Gamma Distribution at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	1.596	k star (bias corrected MLE)	1.252
Theta hat (MLE)	3.244	Theta star (bias corrected MLE)	4.133
nu hat (MLE)	38.3	nu star (bias corrected)	30.06
MLE Mean (bias corrected)	5.177	MLE Sd (bias corrected)	4.626
		Approximate Chi Square Value (0.05)	18.54
Adjusted Level of Significance	0.029	Adjusted Chi Square Value	17.17
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use w	8.393	95% Adjusted Gamma UCL (use when n<50)	9.062
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.912	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.859	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.278	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.243	Data Not Lognormal at 5% Significance Level	
Data appear Approximate Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-0.344	Mean of logged Data	1.299
Maximum of Logged Data	2.785	SD of logged Data	0.933
Assuming Lognormal Distribution			

95% H-UCL	12.44	90% Chebyshev (MVUE) UCL	10.04
95% Chebyshev (MVUE) UCL	12.15	97.5% Chebyshev (MVUE) UCL	15.06
99% Chebyshev (MVUE) UCL	20.79		

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

Nonparametric Distribution Free UCLs			
95% CLT UCL	7.198	95% Jackknife UCL	7.383
95% Standard Bootstrap UCL	7.099	95% Bootstrap-t UCL	8.194
95% Hall's Bootstrap UCL	15.25	95% Percentile Bootstrap UCL	7.288
95% BCA Bootstrap UCL	7.983		
90% Chebyshev(Mean, Sd) UCL	8.863	95% Chebyshev(Mean, Sd) UCL	10.53
97.5% Chebyshev(Mean, Sd) UCL	12.85	99% Chebyshev(Mean, Sd) UCL	17.4

Suggested UCL to Use
95% Student's-t UCL 7.383

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.

Copper

General Statistics			
Total Number of Observations	12	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	0.68	Mean	3.045
Maximum	5.97	Median	3.1
SD	2.1	Std. Error of Mean	0.606
Coefficient of Variation	0.69	Skewness	0.044

Normal GOF Test			
Shapiro Wilk Test Statistic	0.803	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.859	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.276	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.243	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	4.134	95% Adjusted-CLT UCL (Chen-1995)	4.05

Gamma GOF Test

A-D Test Statistic	1.094	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.743	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.303	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.249	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level**Gamma Statistics**

k hat (MLE)	1.822	k star (bias corrected MLE)	1.422
Theta hat (MLE)	1.671	Theta star (bias corrected MLE)	2.141
nu hat (MLE)	43.73	nu star (bias corrected)	34.13
MLE Mean (bias corrected)	3.045	MLE Sd (bias corrected)	2.554
		Approximate Chi Square Value (0.05)	21.77
Adjusted Level of Significance	0.029	Adjusted Chi Square Value	20.27

Assuming Gamma Distribution

95% Approximate Gamma UCL (use w	4.775	95% Adjusted Gamma UCL (use when n<50)	5.127
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Lognormal GOF Test

Shapiro Wilk Test Statistic	0.822	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.859	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.297	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.243	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level**Lognormal Statistics**

Minimum of Logged Data	-0.386	Mean of logged Data	0.815
Maximum of Logged Data	1.787	SD of logged Data	0.865

Assuming Lognormal Distribution

95% H-UCL	6.605	90% Chebyshev (MVUE) UCL	5.657
95% Chebyshev (MVUE) UCL	6.79	97.5% Chebyshev (MVUE) UCL	8.362
99% Chebyshev (MVUE) UCL	11.45		

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

95% CLT UCL	4.042	95% Jackknife UCL	4.134
95% Standard Bootstrap UCL	3.992	95% Bootstrap-t UCL	4.11
95% Hall's Bootstrap UCL	3.889	95% Percentile Bootstrap UCL	4.017
95% BCA Bootstrap UCL	4.084		
90% Chebyshev(Mean, Sd) UCL	4.864	95% Chebyshev(Mean, Sd) UCL	5.687
97.5% Chebyshev(Mean, Sd) UCL	6.831	99% Chebyshev(Mean, Sd) UCL	9.076

Suggested UCL to Use	
95% Chebyshev (Mean, Sd) UCL	5.687

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	12	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	1.79	Mean	9.531
Maximum	18.3	Median	9.57
SD	6.836	Std. Error of Mean	1.973
Coefficient of Variation	0.717	Skewness	0.036

Normal GOF Test

Shapiro Wilk Test Statistic	0.807	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.859	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.248	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.243	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	13.07	95% Adjusted-CLT UCL (Chen-1995)	12.8
		95% Modified-t UCL (Johnson-1978)	13.08

Gamma GOF Test

A-D Test Statistic	1.027	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.744	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.285	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.249	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.638	k star (bias corrected MLE)	1.284
Theta hat (MLE)	5.82	Theta star (bias corrected MLE)	7.424
nu hat (MLE)	39.3	nu star (bias corrected)	30.81
MLE Mean (bias corrected)	9.531	MLE Sd (bias corrected)	8.412
		Approximate Chi Square Value (0.05)	19.13
Adjusted Level of Significance	0.029	Adjusted Chi Square Value	17.74

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>50)	15.35	95% Adjusted Gamma UCL (use when n<50)	16.55
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Lognormal GOF Test

Shapiro Wilk Test Statistic	0.829	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.859	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.284	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.243	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.582	Mean of logged Data	1.919
Maximum of Logged Data	2.907	SD of logged Data	0.924

Assuming Lognormal Distribution

95% H-UCL	22.66	90% Chebyshev (MVUE) UCL	18.45
95% Chebyshev (MVUE) UCL	22.29	97.5% Chebyshev (MVUE) UCL	27.62
99% Chebyshev (MVUE) UCL	38.09		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	12.78	95% Jackknife UCL	13.07
95% Standard Bootstrap UCL	12.62	95% Bootstrap-t UCL	13.1
95% Hall's Bootstrap UCL	12.36	95% Percentile Bootstrap UCL	12.52
95% BCA Bootstrap UCL	12.84		
90% Chebyshev(Mean, Sd) UCL	15.45	95% Chebyshev(Mean, Sd) UCL	18.13
97.5% Chebyshev(Mean, Sd) UCL	21.85	99% Chebyshev(Mean, Sd) UCL	29.16

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	18.13
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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.