

UCL Statistics for Data Sets with Non-Detects

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From File ProUCLinput\_20-003(c)\_0-10.xls  
Full Precision OFF  
Confidence Cc 95%  
Number of Boc 2000

Cesium-137

General Statistics

Total Number of Observations	11	Number of Distinct Observations	11
Number of Detects	5	Number of Non-Detects	6
Number of Distinct Detects	5	Number of Distinct Non-Detects	6
Minimum Detect	0.154	Minimum Non-Detect	-0.0447
Maximum Detect	0.585	Maximum Non-Detect	0.0876
Variance Detects	0.0321	Percent Non-Detects	54.55%
Mean Detects	0.271	SD Detects	0.179
Median Detects	0.204	CV Detects	0.661
Skewness Detects	2.015	Kurtosis Detects	4.17

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.729	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.762	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.354	Lilliefors GOF Test
5% Lilliefors Critical Value	0.343	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	0.0989	KM Standard Error of Mean	0.0643
KM SD	0.191	95% KM (BCA) UCL	0.211
95% KM (t) UCL	0.215	95% KM (Percentile Bootstrap) UCL	0.2
95% KM (z) UCL	0.205	95% KM Bootstrap t UCL	0.192
90% KM Chebyshev UCL	0.292	95% KM Chebyshev UCL	0.379
97.5% KM Chebyshev UCL	0.501	99% KM Chebyshev UCL	0.739

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.593	Anderson-Darling GOF Test
5% A-D Critical Value	0.681	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.305	Kolmogorov-Smirnov GOF
5% K-S Critical Value	0.359	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)	3.911	k star (bias corrected MLE)	1.698
Theta hat (MLE)	0.0693	Theta star (bias corrected MLE)	0.16
nu hat (MLE)	39.11	nu star (bias corrected)	16.98
Mean (detects)	0.271		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0989	SD (KM)	0.191
Variance (KM)	0.0364	SE of Mean (KM)	0.0643
k hat (KM)	0.269	k star (KM)	0.256
nu hat (KM)	5.909	nu star (KM)	5.631
theta hat (KM)	0.368	theta star (KM)	0.386
80% gamma percentile (KM)	0.145	90% gamma percentile (KM)	0.296
95% gamma percentile (KM)	0.475	99% gamma percentile (KM)	0.95

Gamma Kaplan-Meier (KM) Statistics

Adjusted Level of Significance (β)	0.0278
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Approximate Chi Square Value (	1.454	Adjusted Chi Square Value (5.63, $\beta$ )	1.138
95% Gamma Approximate KM-L	0.383	95% Gamma Adjusted KM-UCL (use when n<50)	0.489

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

#### DL/2 Statistics

Mean in Original Scale	0.121	SD in Original Scale	0.184
95% t UCL (Assumes normalit	0.222		

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

#### Nonparametric Distribution Free UCL Statistics

**Detected Data appear Gamma Distributed at 5% Significance Level**

#### Suggested UCL to Use

95% KM Adjusted Gamma UCL	0.489	95% GROS Adjusted Gamma UCL	N/A
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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.

#### Perchlorate

#### General Statistics

Total Number of Observations	11	Number of Distinct Observations	11
Number of Detects	5	Number of Non-Detects	6
Number of Distinct Detects	5	Number of Distinct Non-Detects	6
Minimum Detect	6.6700E-4	Minimum Non-Detect	0.00206
Maximum Detect	0.01	Maximum Non-Detect	0.00219
Variance Detects	1.5914E-5	Percent Non-Detects	54.55%
Mean Detects	0.00374	SD Detects	0.00399
Median Detects	0.00144	CV Detects	1.067
Skewness Detects	1.259	Kurtosis Detects	0.439
Mean of Logged Detects	-6.092	SD of Logged Detects	1.136

#### Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.825	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.318	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.343	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	0.00229	KM Standard Error of Mean	9.3901E-4
KM SD	0.00276	95% KM (BCA) UCL	0.00404
95% KM (t) UCL	0.00399	95% KM (Percentile Bootstrap) UCL	0.00389
95% KM (z) UCL	0.00383	95% KM Bootstrap t UCL	0.00888
90% KM Chebyshev UCL	0.0051	95% KM Chebyshev UCL	0.00638
97.5% KM Chebyshev UCL	0.00815	99% KM Chebyshev UCL	0.0116

#### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.4	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.69	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.306	<b>Kolmogorov-Smirnov GOF</b>
5% K-S Critical Value	0.364	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)	1.133	k star (bias corrected MLE)	0.586
Theta hat (MLE)	0.0033	Theta star (bias corrected MLE)	0.00637
nu hat (MLE)	11.33	nu star (bias corrected)	5.865
Mean (detects)	0.00374		

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	6.6700E-4	Mean	0.00715
Maximum	0.01	Median	0.01
SD	0.00413	CV	0.577
k hat (MLE)	1.614	k star (bias corrected MLE)	1.234
Theta hat (MLE)	0.00443	Theta star (bias corrected MLE)	0.00579
nu hat (MLE)	35.51	nu star (bias corrected)	27.16
Adjusted Level of Significance ( $\beta$ )	0.0278		
Approximate Chi Square Value ( $\beta$ )	16.27	Adjusted Chi Square Value (27.16, $\beta$ )	14.92
95% Gamma Approximate UCL	0.0119	95% Gamma Adjusted UCL (use when n<50)	0.013

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00229	SD (KM)	0.00276
Variance (KM)	7.5942E-6	SE of Mean (KM)	9.3901E-4
k hat (KM)	0.689	k star (KM)	0.562
nu hat (KM)	15.16	nu star (KM)	12.36
theta hat (KM)	0.00332	theta star (KM)	0.00407
80% gamma percentile (KM)	0.00377	90% gamma percentile (KM)	0.00604
95% gamma percentile (KM)	0.00843	99% gamma percentile (KM)	0.0142

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value ( $\beta$ )	5.463	Adjusted Chi Square Value (12.36, $\beta$ )	4.737
95% Gamma Approximate KM	0.00517	95% Gamma Adjusted KM-UCL (use when n<50)	0.00597

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.92	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.254	Lilliefors GOF Test	
5% Lilliefors Critical Value	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	0.00231	Mean in Log Scale	-6.478
SD in Original Scale	0.00287	SD in Log Scale	0.808
95% t UCL (assumes normality)	0.00388	95% Percentile Bootstrap UCL	0.00389
95% BCA Bootstrap UCL	0.00466	95% Bootstrap t UCL	0.0225
95% H-UCL (Log ROS)	0.00419		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-6.522	KM Geo Mean	0.00147
KM SD (logged)	0.824	95% Critical H Value (KM-Log)	2.674
KM Standard Error of Mean (logged)	0.311	95% H-UCL (KM -Log)	0.00415
KM SD (logged)	0.824	95% Critical H Value (KM-Log)	2.674
KM Standard Error of Mean (logged)	0.311		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.00227	Mean in Log Scale	-6.509
SD in Original Scale	0.00289	SD in Log Scale	0.822

95% t UCL (Assumes normality)0.0038595% H-Stat UCL0.00418

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) UCL0.00399

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.

Thallium

General Statistics			
Total Number of Observations	11	Number of Distinct Observations	10
Number of Detects	6	Number of Non-Detects	5
Number of Distinct Detects	6	Number of Distinct Non-Detects	4
Minimum Detect	0.0776	Minimum Non-Detect	0.974
Maximum Detect	0.145	Maximum Non-Detect	1.07
Variance Detects	7.0828E-4	Percent Non-Detects	45.45%
Mean Detects	0.101	SD Detects	0.0266
Median Detects	0.0907	CV Detects	0.265
Skewness Detects	1.13	Kurtosis Detects	0.0988
Mean of Logged Detects	-2.324	SD of Logged Detects	0.248

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic0.863Shapiro Wilk GOF Test

5% Shapiro Wilk Critical Value0.788Detected Data appear Normal at 5% Significance Level

Lilliefors Test Statistic0.267Lilliefors GOF Test

5% Lilliefors Critical Value0.325Detected 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	0.101	KM Standard Error of Mean	0.0109
KM SD	0.0243	95% KM (BCA) UCL	0.118
95% KM (t) UCL	0.12	95% KM (Percentile Bootstrap) UCL	0.119
95% KM (z) UCL	0.118	95% KM Bootstrap t UCL	0.155
90% KM Chebyshev UCL	0.133	95% KM Chebyshev UCL	0.148
97.5% KM Chebyshev UCL	0.168	99% KM Chebyshev UCL	0.209

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic0.425Anderson-Darling GOF Test

5% A-D Critical Value0.697Detected data appear Gamma Distributed at 5% Significance Level

K-S Test Statistic0.254Kolmogorov-Smirnov GOF

5% K-S Critical Value0.332Detected 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)	18.83	k star (bias corrected MLE)	9.529
Theta hat (MLE)	0.00534	Theta star (bias corrected MLE)	0.0106
nu hat (MLE)	226	nu star (bias corrected)	114.3
Mean (detects)	0.101		

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	0.0776	Mean	0.1
Maximum	0.145	Median	0.0993
SD	0.0199	CV	0.198
k hat (MLE)	30.56	k star (bias corrected MLE)	22.29
Theta hat (MLE)	0.00327	Theta star (bias corrected MLE)	0.00449
nu hat (MLE)	672.4	nu star (bias corrected)	490.4
Adjusted Level of Significance ( $\beta$ )	0.0278		
Approximate Chi Square Value ( $\beta$ )	440	Adjusted Chi Square Value (490.35, $\beta$ )	432.2
95% Gamma Approximate UCL	0.112	95% Gamma Adjusted UCL (use when n<50)	0.114

#### Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.101	SD (KM)	0.0243
Variance (KM)	5.9023E-4	SE of Mean (KM)	0.0109
k hat (KM)	17.14	k star (KM)	12.52
nu hat (KM)	377	nu star (KM)	275.5
theta hat (KM)	0.00587	theta star (KM)	0.00803
80% gamma percentile (KM)	0.123	90% gamma percentile (KM)	0.138
95% gamma percentile (KM)	0.151	99% gamma percentile (KM)	0.178

#### Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value ( $\beta$ )	238.1	Adjusted Chi Square Value (275.49, $\beta$ )	232.4
95% Gamma Approximate KM	0.116	95% Gamma Adjusted KM-UCL (use when n<50)	0.119

#### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.892	<b>Shapiro Wilk GOF Test</b>	
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.235	<b>Lilliefors GOF Test</b>	
5% Lilliefors Critical Value	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	0.0995	Mean in Log Scale	-2.324
SD in Original Scale	0.0197	SD in Log Scale	0.185
95% t UCL (assumes normality)	0.11	95% Percentile Bootstrap UCL	0.11
95% BCA Bootstrap UCL	0.111	95% Bootstrap t UCL	0.115
95% H-UCL (Log ROS)	0.111		

#### Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.324	KM Geo Mean	0.0979
KM SD (logged)	0.226	95% Critical H Value (KM-Log)	1.882
KM Standard Error of Mean (log)	0.101	95% H-UCL (KM -Log)	0.115
KM SD (logged)	0.226	95% Critical H Value (KM-Log)	1.882
KM Standard Error of Mean (log)	0.101		

#### DL/2 Statistics

<b>DL/2 Normal</b>		<b>DL/2 Log-Transformed</b>	
Mean in Original Scale	0.287	Mean in Log Scale	-1.572
SD in Original Scale	0.216	SD in Log Scale	0.881
95% t UCL (Assumes normality)	0.406	95% H-Stat UCL	0.664

#### 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	0.12
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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.

Uranium-234

General Statistics

Total Number of Observations	11	Number of Distinct Observations	11
		Number of Missing Observations	0
Minimum	1.31	Mean	2.166
Maximum	3.16	Median	2.17
SD	0.611	Std. Error of Mean	0.184
Coefficient of Variation	0.282	Skewness	0.199

Normal GOF Test

Shapiro Wilk Test Statistic	0.958	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.85	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.135	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.251	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

<b>95% Normal UCL</b>		<b>95% UCLs (Adjusted for Skewness)</b>	
95% Student's-t UCL	2.5	95% Adjusted-CLT UCL (Chen-1995)	2.481
		95% Modified-t UCL (Johnson-1978)	2.502

Gamma GOF Test

A-D Test Statistic	0.219	<b>Anderson-Darling Gamma GOF Test</b>
5% A-D Critical Value	0.729	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.116	<b>Kolmogorov-Smirnov Gamma GOF Test</b>
5% K-S Critical Value	0.255	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	13.44	k star (bias corrected MLE)	9.839
Theta hat (MLE)	0.161	Theta star (bias corrected MLE)	0.22
nu hat (MLE)	295.8	nu star (bias corrected)	216.5
MLE Mean (bias corrected)	2.166	MLE Sd (bias corrected)	0.691
		Approximate Chi Square Value (0.05)	183.4
Adjusted Level of Significance	0.0278	Adjusted Chi Square Value	178.4

Assuming Gamma Distribution

95% Approximate Gamma UC	2.557	95% Adjusted Gamma UCL (use when n<50)	2.628
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Lognormal GOF Test

Shapiro Wilk Test Statistic	0.953	<b>Shapiro Wilk Lognormal GOF Test</b>
5% Shapiro Wilk Critical Value	0.85	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.111	<b>Lilliefors Lognormal GOF Test</b>
5% Lilliefors Critical Value	0.251	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	0.735
Maximum of Logged Data	1.151	SD of logged Data	0.292

Assuming Lognormal Distribution

95% H-UCL	2.604	90% Chebyshev (MVUE) UCL	2.745
95% Chebyshev (MVUE) UCL	3.006	97.5% Chebyshev (MVUE) UCL	3.369
99% Chebyshev (MVUE) UCL	4.081		

Nonparametric Distribution Free UCL Statistics

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

Nonparametric Distribution Free UCLs

95% CLT UCL	2.469	95% Jackknife UCL	2.5
95% Standard Bootstrap UCL	2.457	95% Bootstrap-t UCL	2.522
95% Hall's Bootstrap UCL	2.481	95% Percentile Bootstrap UCL	2.465
95% BCA Bootstrap UCL	2.457		
90% Chebyshev(Mean, Sd) U	2.719	95% Chebyshev(Mean, Sd) UCL	2.969
97.5% Chebyshev(Mean, Sd) U	3.316	99% Chebyshev(Mean, Sd) UCL	3.998

Suggested UCL to Use

95% Student's-t UCL	2.5
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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.

Uranium-235/236

General Statistics

Total Number of Observations	11	Number of Distinct Observations	11
		Number of Missing Observations	0
Minimum	0.062	Mean	0.125
Maximum	0.216	Median	0.12
SD	0.048	Std. Error of Mean	0.0145
Coefficient of Variation	0.384	Skewness	0.533

Normal GOF Test

Shapiro Wilk Test Statistic	0.949	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.85	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.159	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.251	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

<b>95% Normal UCL</b>		<b>95% UCLs (Adjusted for Skewness)</b>	
95% Student's-t UCL	0.151	95% Adjusted-CLT UCL (Chen-1995)	0.151
		95% Modified-t UCL (Johnson-1978)	0.151

Gamma GOF Test

A-D Test Statistic	0.237	<b>Anderson-Darling Gamma GOF Test</b>
5% A-D Critical Value	0.73	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.12	<b>Kolmogorov-Smirnov Gamma GOF Test</b>
5% K-S Critical Value	0.256	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.352	k star (bias corrected MLE)	5.408
Theta hat (MLE)	0.017	Theta star (bias corrected MLE)	0.0231
nu hat (MLE)	161.8	nu star (bias corrected)	119
MLE Mean (bias corrected)	0.125	MLE Sd (bias corrected)	0.0537
		Approximate Chi Square Value (0.05)	94.79
Adjusted Level of Significance	0.0278	Adjusted Chi Square Value	91.27

Assuming Gamma Distribution

95% Approximate Gamma UC	0.157	95% Adjusted Gamma UCL (use when n<50)	0.163
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Lognormal GOF Test

Shapiro Wilk Test Statistic	0.953	<b>Shapiro Wilk Lognormal GOF Test</b>
5% Shapiro Wilk Critical Value	0.85	Data appear Lognormal at 5% Significance Level

Lilliefors Test Statistic	0.145	<b>Lilliefors Lognormal GOF Test</b>
5% Lilliefors Critical Value	0.251	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

**Lognormal Statistics**

Minimum of Logged Data	-2.781	Mean of logged Data	-2.151
Maximum of Logged Data	-1.532	SD of logged Data	0.398

**Assuming Lognormal Distribution**

95% H-UCL	0.163	90% Chebyshev (MVUE) UCL	0.171
95% Chebyshev (MVUE) UCL	0.191	97.5% Chebyshev (MVUE) UCL	0.22
99% Chebyshev (MVUE) UCL	0.276		

**Nonparametric Distribution Free UCL Statistics**

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

**Nonparametric Distribution Free UCLs**

95% CLT UCL	0.149	95% Jackknife UCL	0.151
95% Standard Bootstrap UCL	0.148	95% Bootstrap-t UCL	0.153
95% Hall's Bootstrap UCL	0.154	95% Percentile Bootstrap UCL	0.148
95% BCA Bootstrap UCL	0.15		
90% Chebyshev(Mean, Sd) UCL	0.168	95% Chebyshev(Mean, Sd) UCL	0.188
97.5% Chebyshev(Mean, Sd) UCL	0.215	99% Chebyshev(Mean, Sd) UCL	0.269

**Suggested UCL to Use**

95% Student's-t UCL	0.151
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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.

**Uranium-238**

**General Statistics**

Total Number of Observations	11	Number of Distinct Observations	11
		Number of Missing Observations	0
Minimum	1.4	Mean	2.296
Maximum	3.43	Median	2.22
SD	0.662	Std. Error of Mean	0.2
Coefficient of Variation	0.288	Skewness	0.446

**Normal GOF Test**

Shapiro Wilk Test Statistic	0.942	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.85	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.159	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.251	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

**Assuming Normal Distribution**

<b>95% Normal UCL</b>		<b>95% UCLs (Adjusted for Skewness)</b>	
95% Student's-t UCL	2.658	95% Adjusted-CLT UCL (Chen-1995)	2.653
		95% Modified-t UCL (Johnson-1978)	2.663

**Gamma GOF Test**

A-D Test Statistic	0.256	<b>Anderson-Darling Gamma GOF Test</b>
5% A-D Critical Value	0.729	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.151	<b>Kolmogorov-Smirnov Gamma GOF Test</b>
5% K-S Critical Value	0.255	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level



Gamma Statistics			
k hat (MLE)	13.4	k star (bias corrected MLE)	9.806
Theta hat (MLE)	0.171	Theta star (bias corrected MLE)	0.234
nu hat (MLE)	294.8	nu star (bias corrected)	215.7
MLE Mean (bias corrected)	2.296	MLE Sd (bias corrected)	0.733
		Approximate Chi Square Value (0.05)	182.7
Adjusted Level of Significance	0.0278	Adjusted Chi Square Value	177.8

Assuming Gamma Distribution			
95% Approximate Gamma UC	2.711	95% Adjusted Gamma UCL (use when n<50)	2.786

<b>Lognormal GOF Test</b>		
Shapiro Wilk Test Statistic	0.961	<b>Shapiro Wilk Lognormal GOF Test</b>
5% Shapiro Wilk Critical Value	0.85	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.137	<b>Lilliefors Lognormal GOF Test</b>
5% Lilliefors Critical Value	0.251	Data appear Lognormal at 5% Significance Level
<b>Data appear Lognormal at 5% Significance Level</b>		

Lognormal Statistics			
Minimum of Logged Data	0.336	Mean of logged Data	0.794
Maximum of Logged Data	1.233	SD of logged Data	0.289

Assuming Lognormal Distribution			
95% H-UCL	2.752	90% Chebyshev (MVUE) UCL	2.901
95% Chebyshev (MVUE) UCL	3.175	97.5% Chebyshev (MVUE) UCL	3.555
99% Chebyshev (MVUE) UCL	4.302		

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

Nonparametric Distribution Free UCLs			
95% CLT UCL	2.625	95% Jackknife UCL	2.658
95% Standard Bootstrap UCL	2.616	95% Bootstrap-t UCL	2.698
95% Hall's Bootstrap UCL	2.619	95% Percentile Bootstrap UCL	2.606
95% BCA Bootstrap UCL	2.644		
90% Chebyshev(Mean, Sd) U	2.895	95% Chebyshev(Mean, Sd) UCL	3.167
97.5% Chebyshev(Mean, Sd) U	3.543	99% Chebyshev(Mean, Sd) UCL	4.283

Suggested UCL to Use	
95% Student's-t UCL	2.658

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.