

# UCL Statistics for Data Sets with Non-Detects

## User Selected Options

Date/Time of Computation	ProUCL 5.16/19/17 4:32:37 PM
From File	ProUCLinput_20-002(b)_0-10.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

## Barium

### General Statistics

Total Number of Observations	21	Number of Distinct Observations	21
		Number of Missing Observations	0
Minimum	10.9	Mean	40.2
Maximum	86.7	Median	40.6
SD	21.58	Std. Error of Mean	4.71
Coefficient of Variation	0.537	Skewness	0.581

### Normal GOF Test

Shapiro Wilk Test Statistic	0.944	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.908	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.134	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.188	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	48.33	95% Adjusted-CLT UCL (Chen-1995)	48.59
		95% Modified-t UCL (Johnson-1978)	48.43

### Gamma GOF Test

A-D Test Statistic	0.279	<b>Anderson-Darling Gamma GOF Test</b>
5% A-D Critical Value	0.749	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.104	<b>Kolmogorov-Smirnov Gamma GOF Test</b>
5% K-S Critical Value	0.191	Detected data appear Gamma Distributed at 5% Significance Level

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

### Gamma Statistics

k hat (MLE)	3.425	k star (bias corrected MLE)	2.968
Theta hat (MLE)	11.74	Theta star (bias corrected MLE)	13.55
nu hat (MLE)	143.9	nu star (bias corrected)	124.6
MLE Mean (bias corrected)	40.2	MLE Sd (bias corrected)	23.34
		Approximate Chi Square Value (0.05)	99.85
Adjusted Level of Significance	0.0383	Adjusted Chi Square Value	98.15

<b>Assuming Gamma Distribution</b>			
95% Approximate Gamma UCL (use when n>=50)	50.18	95% Adjusted Gamma UCL (use when n>=50)	51.05
<b>Lognormal GOF Test</b>			
Shapiro Wilk Test Statistic	0.959	<b>Shapiro Wilk Lognormal GOF Test</b>	
5% Shapiro Wilk Critical Value	0.908	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.132	<b>Lilliefors Lognormal GOF Test</b>	
5% Lilliefors Critical Value	0.188	Data appear Lognormal at 5% Significance Level	
<b>Data appear Lognormal at 5% Significance Level</b>			
<b>Lognormal Statistics</b>			
Minimum of Logged Data	2.389	Mean of logged Data	3.541
Maximum of Logged Data	4.462	SD of logged Data	0.591
<b>Assuming Lognormal Distribution</b>			
95% H-UCL	54.05	90% Chebyshev (MVUE) UCL	57.24
95% Chebyshev (MVUE) UCL	64.74	97.5% Chebyshev (MVUE) UCL	75.15
99% Chebyshev (MVUE) UCL	95.59		
<b>Nonparametric Distribution Free UCL Statistics</b>			
<b>Data appear to follow a Discernible Distribution at 5% Significance Level</b>			
<b>Nonparametric Distribution Free UCLs</b>			
95% CLT UCL	47.95	95% Jackknife UCL	48.33
95% Standard Bootstrap UCL	47.76	95% Bootstrap-t UCL	49.02
95% Hall's Bootstrap UCL	48.94	95% Percentile Bootstrap UCL	48.04
95% BCA Bootstrap UCL	48.3		
90% Chebyshev(Mean, Sd) UCL	54.33	95% Chebyshev(Mean, Sd) UCL	60.74
97.5% Chebyshev(Mean, Sd) UCL	69.62	99% Chebyshev(Mean, Sd) UCL	87.07
<b>Suggested UCL to Use</b>			
95% Student's-t UCL	48.33		

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

## Cesium-137

<b>General Statistics</b>			
Total Number of Observations	21	Number of Distinct Observations	21
Number of Detects	6	Number of Non-Detects	15
Number of Distinct Detects	6	Number of Distinct Non-Detects	15
Minimum Detect	0.233	Minimum Non-Detect	-0.0708
Maximum Detect	0.475	Maximum Non-Detect	0.0741
Variance Detects	0.00814	Percent Non-Detects	71.43%

Mean Detects	0.31	SD Detects	0.0902
Median Detects	0.272	CV Detects	0.291
Skewness Detects	1.581	Kurtosis Detects	2.219

#### Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.828	<b>Shapiro Wilk GOF Test</b>	
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.286	<b>Lilliefors GOF Test</b>	
5% Lilliefors Critical Value	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	0.0379	KM Standard Error of Mean	0.0424
KM SD	0.177	95% KM (BCA) UCL	0.141
95% KM (t) UCL	0.111	95% KM (Percentile Bootstrap) UCL	0.119
95% KM (z) UCL	0.108	95% KM Bootstrap t UCL	0.0784
90% KM Chebyshev UCL	0.165	95% KM Chebyshev UCL	0.223
97.5% KM Chebyshev UCL	0.303	99% KM Chebyshev UCL	0.46

#### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.487	<b>Anderson-Darling GOF Test</b>	
5% A-D Critical Value	0.698	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.28	<b>Kolmogorov-Smirnov GOF</b>	
5% K-S Critical Value	0.332	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)	16.39	k star (bias corrected MLE)	8.306
Theta hat (MLE)	0.0189	Theta star (bias corrected MLE)	0.0373
nu hat (MLE)	196.7	nu star (bias corrected)	99.68
Mean (detects)	0.31		

#### Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0379	SD (KM)	0.177
Variance (KM)	0.0315	SE of Mean (KM)	0.0424
k hat (KM)	0.0456	k star (KM)	0.0708
nu hat (KM)	1.914	nu star (KM)	2.974
theta hat (KM)	0.831	theta star (KM)	0.535
80% gamma percentile (KM)	0.0139	90% gamma percentile (KM)	0.0824
95% gamma percentile (KM)	0.218	99% gamma percentile (KM)	0.71

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

		Adjusted Level of Significance ( $\beta$ )	0.0383
Approximate Chi Square Value (2.97, $\alpha$ )	0.365	Adjusted Chi Square Value (2.97, $\beta$ )	0.309
95% Gamma Approximate KM-UCL (use when n:	0.309	95% Gamma Adjusted KM-UCL (use v	0.364
95% Gamma Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ )			

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

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

DL/2 Statistics

Mean in Original Scale	0.0876	SD in Original Scale	0.151
95% t UCL (Assumes normality)	0.145		

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	0.111
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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.

Lead

General Statistics

Total Number of Observations	16	Number of Distinct Observations	16
		Number of Missing Observations	5
Minimum	2.35	Mean	8.06
Maximum	13.9	Median	8.26
SD	3.186	Std. Error of Mean	0.796
Coefficient of Variation	0.395	Skewness	-0.0796

Normal GOF Test

Shapiro Wilk Test Statistic	0.973	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.887	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.119	Lilliefors GOF Test
5% Lilliefors Critical Value	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	9.456	95% Adjusted-CLT UCL (Chen-1995)	9.353
		95% Modified-t UCL (Johnson-1978)	9.454

Gamma GOF Test

A-D Test Statistic	0.437	<b>Anderson-Darling Gamma GOF Test</b>	
5% A-D Critical Value	0.741	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.173	<b>Kolmogorov-Smirnov Gamma GOF Test</b>	
5% K-S Critical Value	0.216	Detected data appear Gamma Distributed at 5% Significance Level	
<b>Detected data appear Gamma Distributed at 5% Significance Level</b>			
<b>Gamma Statistics</b>			
k hat (MLE)	5.613	k star (bias corrected MLE)	4.602
Theta hat (MLE)	1.436	Theta star (bias corrected MLE)	1.751
nu hat (MLE)	179.6	nu star (bias corrected)	147.3
MLE Mean (bias corrected)	8.06	MLE Sd (bias corrected)	3.757
		Approximate Chi Square Value (0.05)	120.2
Adjusted Level of Significance	0.0335	Adjusted Chi Square Value	117.4
<b>Assuming Gamma Distribution</b>			
95% Approximate Gamma UCL (use when n>=50)	9.873	95% Adjusted Gamma UCL (use when n>=50)	10.11
<b>Lognormal GOF Test</b>			
Shapiro Wilk Test Statistic	0.917	<b>Shapiro Wilk Lognormal GOF Test</b>	
5% Shapiro Wilk Critical Value	0.887	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.194	<b>Lilliefors Lognormal GOF Test</b>	
5% Lilliefors Critical Value	0.213	Data appear Lognormal at 5% Significance Level	
<b>Data appear Lognormal at 5% Significance Level</b>			
<b>Lognormal Statistics</b>			
Minimum of Logged Data	0.854	Mean of logged Data	1.995
Maximum of Logged Data	2.632	SD of logged Data	0.475
<b>Assuming Lognormal Distribution</b>			
95% H-UCL	10.55	90% Chebyshev (MVUE) UCL	11.16
95% Chebyshev (MVUE) UCL	12.51	97.5% Chebyshev (MVUE) UCL	14.39
99% Chebyshev (MVUE) UCL	18.09		
<b>Nonparametric Distribution Free UCL Statistics</b>			
<b>Data appear to follow a Discernible Distribution at 5% Significance Level</b>			
<b>Nonparametric Distribution Free UCLs</b>			
95% CLT UCL	9.37	95% Jackknife UCL	9.456
95% Standard Bootstrap UCL	9.332	95% Bootstrap-t UCL	9.443
95% Hall's Bootstrap UCL	9.346	95% Percentile Bootstrap UCL	9.29
95% BCA Bootstrap UCL	9.299		
90% Chebyshev(Mean, Sd) UCL	10.45	95% Chebyshev(Mean, Sd) UCL	11.53
97.5% Chebyshev(Mean, Sd) UCL	13.03	99% Chebyshev(Mean, Sd) UCL	15.98
<b>Suggested UCL to Use</b>			
95% Student's-t UCL	9.456		

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.**

**Perchlorate**

**General Statistics**

Total Number of Observations	21	Number of Distinct Observations	18
Number of Detects	10	Number of Non-Detects	11
Number of Distinct Detects	10	Number of Distinct Non-Detects	8
Minimum Detect	5.5500E-4	Minimum Non-Detect	0.00204
Maximum Detect	0.00213	Maximum Non-Detect	0.00223
Variance Detects	2.2877E-7	Percent Non-Detects	52.38%
Mean Detects	9.3370E-4	SD Detects	4.7830E-4
Median Detects	7.5550E-4	CV Detects	0.512
Skewness Detects	2.021	Kurtosis Detects	4.481
Mean of Logged Detects	-7.066	SD of Logged Detects	0.419

**Normal GOF Test on Detects Only**

Shapiro Wilk Test Statistic	0.771	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.842	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.221	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.262	Detected Data appear Normal at 5% Significance Level

**Detected Data appear Approximate Normal at 5% Significance Level**

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

KM Mean	8.7462E-4	KM Standard Error of Mean	1.0704E-4
KM SD	3.7669E-4	95% KM (BCA) UCL	0.00105
95% KM (t) UCL	0.00106	95% KM (Percentile Bootstrap) UCL	0.00105
95% KM (z) UCL	0.00105	95% KM Bootstrap t UCL	0.0012
90% KM Chebyshev UCL	0.0012	95% KM Chebyshev UCL	0.00134
97.5% KM Chebyshev UCL	0.00154	99% KM Chebyshev UCL	0.00194

**Gamma GOF Tests on Detected Observations Only**

A-D Test Statistic	0.549	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.729	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.203	<b>Kolmogorov-Smirnov GOF</b>
5% K-S Critical Value	0.267	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)	5.751	k star (bias corrected MLE)	4.093
Theta hat (MLE)	1.6235E-4	Theta star (bias corrected MLE)	2.2815E-4

nu hat (MLE)	115	nu star (bias corrected)	81.85
Mean (detects)	9.3370E-4		

### 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	5.5500E-4	Mean	0.00568
Maximum	0.01	Median	0.01
SD	0.00465	CV	0.818
k hat (MLE)	0.957	k star (bias corrected MLE)	0.852
Theta hat (MLE)	0.00594	Theta star (bias corrected MLE)	0.00667
nu hat (MLE)	40.18	nu star (bias corrected)	35.77
Adjusted Level of Significance ( $\beta$ )	0.0383		
Approximate Chi Square Value (35.77, $\alpha$ )	23.09	Adjusted Chi Square Value (35.77, $\beta$ )	22.3
95% Gamma Approximate UCL (use when $n \geq 50$ )	0.00881	95% Gamma Adjusted UCL (use when $r$	0.00911

### Estimates of Gamma Parameters using KM Estimates

Mean (KM)	8.7462E-4	SD (KM)	3.7669E-4
Variance (KM)	1.4190E-7	SE of Mean (KM)	1.0704E-4
k hat (KM)	5.391	k star (KM)	4.653
nu hat (KM)	226.4	nu star (KM)	195.4
theta hat (KM)	1.6224E-4	theta star (KM)	1.8799E-4
80% gamma percentile (KM)	0.00119	90% gamma percentile (KM)	0.00142
95% gamma percentile (KM)	0.00163	99% gamma percentile (KM)	0.00208

### Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (195.41, $\alpha$ )	164.1	Adjusted Chi Square Value (195.41, $\beta$ )	161.9
95% Gamma Approximate KM-UCL (use when $n$ :	0.00104	95% Gamma Adjusted KM-UCL (use $v$	0.00106

### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.898	<b>Shapiro Wilk GOF Test</b>	
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.178	<b>Lilliefors GOF Test</b>	
5% Lilliefors Critical Value	0.262	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	8.6548E-4	Mean in Log Scale	-7.102
SD in Original Scale	3.3633E-4	SD in Log Scale	0.299
95% t UCL (assumes normality of ROS data)	9.9207E-4	95% Percentile Bootstrap UCL	0.001
95% BCA Bootstrap UCL	0.00106	95% Bootstrap t UCL	0.00112
95% H-UCL (Log ROS)	9.7325E-4		

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

KM Mean (logged)	-7.111	KM Geo Mean	8.1612E-4
KM SD (logged)	0.35	95% Critical H Value (KM-Log)	1.868
KM Standard Error of Mean (logged)	0.106	95% H-UCL (KM -Log)	0.001
KM SD (logged)	0.35	95% Critical H Value (KM-Log)	1.868
KM Standard Error of Mean (logged)	0.106		

## DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	9.9652E-4	Mean in Log Scale	-6.956
SD in Original Scale	3.2732E-4	SD in Log Scale	0.301
95% t UCL (Assumes normality)	0.00112	95% H-Stat UCL	0.00113

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

## Nonparametric Distribution Free UCL Statistics

**Detected Data appear Approximate Normal Distributed at 5% Significance Level**

### Suggested UCL to Use

95% KM (t) UCL	0.00106
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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.

## Uranium-235/236

### General Statistics

Total Number of Observations	21	Number of Distinct Observations	21
Number of Detects	7	Number of Non-Detects	14
Number of Distinct Detects	7	Number of Distinct Non-Detects	14
Minimum Detect	0.073	Minimum Non-Detect	0.017
Maximum Detect	0.108	Maximum Non-Detect	0.0787
Variance Detects	1.4615E-4	Percent Non-Detects	66.67%
Mean Detects	0.0913	SD Detects	0.0121
Median Detects	0.0913	CV Detects	0.132
Skewness Detects	-0.0264	Kurtosis Detects	-0.558
Mean of Logged Detects	-2.401	SD of Logged Detects	0.134

### Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.976	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.138	<b>Lilliefors GOF Test</b>
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	0.042	KM Standard Error of Mean	0.00844
KM SD	0.0356	95% KM (BCA) UCL	0.0655
95% KM (t) UCL	0.0565	95% KM (Percentile Bootstrap) UCL	0.0598
95% KM (z) UCL	0.0558	95% KM Bootstrap t UCL	0.0527
90% KM Chebyshev UCL	0.0673	95% KM Chebyshev UCL	0.0787
97.5% KM Chebyshev UCL	0.0947	99% KM Chebyshev UCL	0.126

**Gamma GOF Tests on Detected Observations Only**

A-D Test Statistic	0.179	<b>Anderson-Darling GOF Test</b>	
5% A-D Critical Value	0.708	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.154	<b>Kolmogorov-Smirnov GOF</b>	
5% K-S Critical Value	0.311	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)	65.61	k star (bias corrected MLE)	37.58
Theta hat (MLE)	0.00139	Theta star (bias corrected MLE)	0.00243
nu hat (MLE)	918.5	nu star (bias corrected)	526.2
Mean (detects)	0.0913		

**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	0.0529	Mean	0.0658
Maximum	0.108	Median	0.0529
SD	0.0196	CV	0.298
k hat (MLE)	13.67	k star (bias corrected MLE)	11.75
Theta hat (MLE)	0.00481	Theta star (bias corrected MLE)	0.0056
nu hat (MLE)	574.3	nu star (bias corrected)	493.6
Adjusted Level of Significance ( $\beta$ )	0.0383		
Approximate Chi Square Value (493.57, $\alpha$ )	443.1	Adjusted Chi Square Value (493.57, $\beta$ )	439.4
95% Gamma Approximate UCL (use when $n \geq 50$ )	0.0733	95% Gamma Adjusted UCL (use when r	0.0739

**Estimates of Gamma Parameters using KM Estimates**

Mean (KM)	0.042	SD (KM)	0.0356
Variance (KM)	0.00127	SE of Mean (KM)	0.00844
k hat (KM)	1.386	k star (KM)	1.22
nu hat (KM)	58.21	nu star (KM)	51.23
theta hat (KM)	0.0303	theta star (KM)	0.0344
80% gamma percentile (KM)	0.0663	90% gamma percentile (KM)	0.092
95% gamma percentile (KM)	0.117	99% gamma percentile (KM)	0.175

<b>Gamma Kaplan-Meier (KM) Statistics</b>			
Approximate Chi Square Value (51.23, $\alpha$ )	35.79	Adjusted Chi Square Value (51.23, $\beta$ )	34.8
95% Gamma Approximate KM-UCL (use when n:	0.0601	95% Gamma Adjusted KM-UCL (use v	0.0618

**Lognormal GOF Test on Detected Observations Only**

Shapiro Wilk Test Statistic	0.975	<b>Shapiro Wilk GOF Test</b>	
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.133	<b>Lilliefors GOF Test</b>	
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	0.0691	Mean in Log Scale	-2.699
SD in Original Scale	0.0174	SD in Log Scale	0.228
95% t UCL (assumes normality of ROS data)	0.0756	95% Percentile Bootstrap UCL	0.0754
95% BCA Bootstrap UCL	0.0762	95% Bootstrap t UCL	0.077
95% H-UCL (Log ROS)	0.0756		

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

KM Mean (logged)	-3.512	KM Geo Mean	0.0298
KM SD (logged)	0.793	95% Critical H Value (KM-Log)	2.299
KM Standard Error of Mean (logged)	0.188	95% H-UCL (KM -Log)	0.0615
KM SD (logged)	0.793	95% Critical H Value (KM-Log)	2.299
KM Standard Error of Mean (logged)	0.188		

**DL/2 Statistics**

<b>DL/2 Normal</b>		<b>DL/2 Log-Transformed</b>	
Mean in Original Scale	0.0468	Mean in Log Scale	-3.324
SD in Original Scale	0.0338	SD in Log Scale	0.756
95% t UCL (Assumes normality)	0.0595	95% H-Stat UCL	0.0701

**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	0.0565
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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.

Total Number of Observations	21	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	0.723	Mean	1.282
Maximum	2.06	Median	1.09
SD	0.456	Std. Error of Mean	0.0995
Coefficient of Variation	0.356	Skewness	0.444
<b>Normal GOF Test</b>			
Shapiro Wilk Test Statistic	0.884	<b>Shapiro Wilk GOF Test</b>	
5% Shapiro Wilk Critical Value	0.908	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.227	<b>Lilliefors GOF Test</b>	
5% Lilliefors Critical Value	0.188	Data Not Normal at 5% Significance Level	
<b>Data Not Normal at 5% Significance Level</b>			
<b>Assuming Normal Distribution</b>			
<b>95% Normal UCL</b>		<b>95% UCLs (Adjusted for Skewness)</b>	
95% Student's-t UCL	1.454	95% Adjusted-CLT UCL (Chen-1995)	1.456
		95% Modified-t UCL (Johnson-1978)	1.456
<b>Gamma GOF Test</b>			
A-D Test Statistic	0.849	<b>Anderson-Darling Gamma GOF Test</b>	
5% A-D Critical Value	0.743	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.197	<b>Kolmogorov-Smirnov Gamma GOF Test</b>	
5% K-S Critical Value	0.19	Data Not Gamma Distributed at 5% Significance Level	
<b>Data Not Gamma Distributed at 5% Significance Level</b>			
<b>Gamma Statistics</b>			
k hat (MLE)	8.531	k star (bias corrected MLE)	7.344
Theta hat (MLE)	0.15	Theta star (bias corrected MLE)	0.175
nu hat (MLE)	358.3	nu star (bias corrected)	308.5
MLE Mean (bias corrected)	1.282	MLE Sd (bias corrected)	0.473
		Approximate Chi Square Value (0.05)	268.8
Adjusted Level of Significance	0.0383	Adjusted Chi Square Value	265.9
<b>Assuming Gamma Distribution</b>			
95% Approximate Gamma UCL (use when n>=50)	1.472	95% Adjusted Gamma UCL (use when n>=50)	1.488
<b>Lognormal GOF Test</b>			
Shapiro Wilk Test Statistic	0.911	<b>Shapiro Wilk Lognormal GOF Test</b>	
5% Shapiro Wilk Critical Value	0.908	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.176	<b>Lilliefors Lognormal GOF Test</b>	
5% Lilliefors Critical Value	0.188	Data appear Lognormal at 5% Significance Level	
<b>Data appear Lognormal at 5% Significance Level</b>			
<b>Lognormal Statistics</b>			
Minimum of Logged Data	-0.324	Mean of logged Data	0.189
Maximum of Logged Data	0.723	SD of logged Data	0.354

**Assuming Lognormal Distribution**

95% H-UCL	1.491	90% Chebyshev (MVUE) UCL	1.584
95% Chebyshev (MVUE) UCL	1.721	97.5% Chebyshev (MVUE) UCL	1.912
99% Chebyshev (MVUE) UCL	2.285		

**Nonparametric Distribution Free UCL Statistics**

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

**Nonparametric Distribution Free UCLs**

95% CLT UCL	1.446	95% Jackknife UCL	1.454
95% Standard Bootstrap UCL	1.444	95% Bootstrap-t UCL	1.469
95% Hall's Bootstrap UCL	1.448	95% Percentile Bootstrap UCL	1.443
95% BCA Bootstrap UCL	1.462		
90% Chebyshev(Mean, Sd) UCL	1.581	95% Chebyshev(Mean, Sd) UCL	1.716
97.5% Chebyshev(Mean, Sd) UCL	1.904	99% Chebyshev(Mean, Sd) UCL	2.272

**Suggested UCL to Use**

95% Student's-t UCL	1.454	or 95% Modified-t UCL	1.456
or 95% H-UCL	1.491		

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

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

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

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

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

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

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

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