

# UCL Statistics for Data Sets with Non-Detects

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Full Precision OFF

Confidence Cc 95%

Number of Boc 2000

## Barium

### General Statistics

Total Number of Observations	27	Number of Distinct Obse	25
		Number of Missing Obse	0
Minimum	10.2	Mean	38.07
Maximum	146	Median	24.7
SD	33.86	Std. Error of Mean	6.517
Coefficient of Variation	0.89	Skewness	2.173

### Normal GOF Test

Shapiro Wilk Test Statistic	0.687	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.923	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.318	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.167	Data Not Normal at 5% Significance Level

**Data Not 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	49.19	95% Adjusted-CLT UC 51.7
		95% Modified-t UCL (J 49.64

### Gamma GOF Test

A-D Test Statistic	1.828	<b>Anderson-Darling Gamma GOF Test</b>
5% A-D Critical Value	0.756	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.255	<b>Kolmogorov-Smirnov Gamma GOF Test</b>
5% K-S Critical Value	0.17	Data Not Gamma Distributed at 5% Significance Level

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

### Gamma Statistics

k hat (MLE)	2.137	k star (bias corrected ML	1.924
Theta hat (MLE)	17.82	Theta star (bias correcte	19.79
nu hat (MLE)	115.4	nu star (bias corrected)	103.9
MLE Mean (bias corrected)	38.07	MLE Sd (bias corrected)	27.45
		Approximate Chi Square	81.38
Adjusted Level of Significance	0.0401	Adjusted Chi Square Val	80.11

### Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=£	48.61	95% Adjusted Gamma	49.38
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### Lognormal GOF Test

Shapiro Wilk Test Statistic	0.904	<b>Shapiro Wilk Lognormal GOF Test</b>
5% Shapiro Wilk Critical Value	0.923	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.203	<b>Lilliefors Lognormal GOF Test</b>
5% Lilliefors Critical Value	0.167	Data Not Lognormal at 5% Significance Level

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

### Lognormal Statistics

Minimum of Logged Data	2.322	Mean of logged Data	3.388
Maximum of Logged Data	4.984	SD of logged Data	0.663

<b>Assuming Lognormal Distribution</b>			
95% H-UCL	48.56	90% Chebyshev (MVU	51.45
95% Chebyshev (MVUE) UCL	58.23	97.5% Chebyshev (MVL	67.63
99% Chebyshev (MVUE) UCL	86.09		

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

<b>Nonparametric Distribution Free UCLs</b>			
95% CLT UCL	48.79	95% Jackknife UCL	49.19
95% Standard Bootstrap UCL	48.28	95% Bootstrap-t UCL	55.41
95% Hall's Bootstrap UCL	55.22	95% Percentile Bootstr	48.63
95% BCA Bootstrap UCL	52.76		
90% Chebyshev(Mean, Sd) UCL	57.62	95% Chebyshev(Mean	66.48
97.5% Chebyshev(Mean, Sd) UCL	78.77	99% Chebyshev(Mean	102.9

<b>Suggested UCL to Use</b>	
95% Chebyshev (Mean, Sd) UCL	66.48

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**

<b>General Statistics</b>			
Total Number of Observations	27	Number of Distinct Obse	25
		Number of Missing Obse	0
Minimum	0.508	Mean	4.83
Maximum	18.1	Median	2.52
SD	4.972	Std. Error of Mean	0.957
Coefficient of Variation	1.029	Skewness	1.623

<b>Normal GOF Test</b>			
Shapiro Wilk Test Statistic	0.777	<b>Shapiro Wilk GOF Test</b>	
5% Shapiro Wilk Critical Value	0.923	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.234	<b>Lilliefors GOF Test</b>	
5% Lilliefors Critical Value	0.167	Data Not Normal at 5% Significance Level	

**Data Not Normal at 5% Significance Level**

<b>Assuming Normal Distribution</b>			
<b>95% Normal UCL</b>		<b>95% UCLs (Adjusted for Skewness)</b>	
95% Student's-t UCL	6.462	95% Adjusted-CLT UC	6.724
		95% Modified-t UCL (J	6.512

<b>Gamma GOF Test</b>			
A-D Test Statistic	0.685	<b>Anderson-Darling Gamma GOF Test</b>	
5% A-D Critical Value	0.769	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.18	<b>Kolmogorov-Smirnov Gamma GOF Test</b>	
5% K-S Critical Value	0.172	Data Not Gamma Distributed at 5% Significance Level	

**Detected data follow Appr. Gamma Distribution at 5% Significance Level**

<b>Gamma Statistics</b>			
k hat (MLE)	1.185	k star (bias corrected ML	1.078
Theta hat (MLE)	4.077	Theta star (bias correcte	4.482
nu hat (MLE)	63.98	nu star (bias corrected)	58.2
MLE Mean (bias corrected)	4.83	MLE Sd (bias corrected)	4.653
		Approximate Chi Square	41.66
Adjusted Level of Significance	0.0401	Adjusted Chi Square Val	40.77

## Assuming Gamma Distribution

95% Approximate Gamma UCL (use when $n \geq 5$ )	6.748	95% Adjusted Gamma	6.896
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## Lognormal GOF Test

Shapiro Wilk Test Statistic	0.954	<b>Shapiro Wilk Lognormal GOF Test</b>	
5% Shapiro Wilk Critical Value	0.923	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.123	<b>Lilliefors Lognormal GOF Test</b>	
5% Lilliefors Critical Value	0.167	Data appear Lognormal at 5% Significance Level	

## Data appear Lognormal at 5% Significance Level

## Lognormal Statistics

Minimum of Logged Data	-0.677	Mean of logged Data	1.097
Maximum of Logged Data	2.896	SD of logged Data	1.012

## Assuming Lognormal Distribution

95% H-UCL	8.273	90% Chebyshev (MVU)	8.118
95% Chebyshev (MVUE) UCL	9.592	97.5% Chebyshev (MVL)	11.64
99% Chebyshev (MVUE) UCL	15.66		

## Nonparametric Distribution Free UCL Statistics

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

## Nonparametric Distribution Free UCLs

95% CLT UCL	6.404	95% Jackknife UCL	6.462
95% Standard Bootstrap UCL	6.389	95% Bootstrap-t UCL	6.969
95% Hall's Bootstrap UCL	6.797	95% Percentile Bootstr	6.473
95% BCA Bootstrap UCL	6.753		
90% Chebyshev(Mean, Sd) UCL	7.701	95% Chebyshev(Mean	9.001
97.5% Chebyshev(Mean, Sd) UCL	10.81	99% Chebyshev(Mean	14.35

## Suggested UCL to Use

95% Adjusted Gamma UCL	6.896
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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.

## Lead

## General Statistics

Total Number of Observations	27	Number of Distinct Obse	26
		Number of Missing Obse	0
Minimum	2.65	Mean	8.433
Maximum	14.9	Median	8.66
SD	3.733	Std. Error of Mean	0.719
Coefficient of Variation	0.443	Skewness	0.17

## Normal GOF Test

Shapiro Wilk Test Statistic	0.934	<b>Shapiro Wilk GOF Test</b>	
5% Shapiro Wilk Critical Value	0.923	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.153	<b>Lilliefors GOF Test</b>	
5% Lilliefors Critical Value	0.167	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	9.658	95% Adjusted-CLT UC	9.64
		95% Modified-t UCL (J	9.662
<b>Gamma GOF Test</b>			
A-D Test Statistic	0.615	<b>Anderson-Darling Gamma GOF Test</b>	
5% A-D Critical Value	0.748	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.144	<b>Kolmogorov-Smirnov Gamma GOF Test</b>	
5% K-S Critical Value	0.169	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)	4.739	k star (bias corrected ML	4.237
Theta hat (MLE)	1.779	Theta star (bias correcte	1.99
nu hat (MLE)	255.9	nu star (bias corrected)	228.8
MLE Mean (bias corrected)	8.433	MLE Sd (bias corrected)	4.097
		Approximate Chi Square	194.8
Adjusted Level of Significance	0.0401	Adjusted Chi Square Val	192.8
<b>Assuming Gamma Distribution</b>			
95% Approximate Gamma UCL (use when n>=5	9.905	95% Adjusted Gamma	10.01
<b>Lognormal GOF Test</b>			
Shapiro Wilk Test Statistic	0.929	<b>Shapiro Wilk Lognormal GOF Test</b>	
5% Shapiro Wilk Critical Value	0.923	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.145	<b>Lilliefors Lognormal GOF Test</b>	
5% Lilliefors Critical Value	0.167	Data appear Lognormal at 5% Significance Level	
<b>Data appear Lognormal at 5% Significance Level</b>			
<b>Lognormal Statistics</b>			
Minimum of Logged Data	0.975	Mean of logged Data	2.023
Maximum of Logged Data	2.701	SD of logged Data	0.498
<b>Assuming Lognormal Distribution</b>			
95% H-UCL	10.37	90% Chebyshev (MVU	11.06
95% Chebyshev (MVUE) UCL	12.22	97.5% Chebyshev (MVL	13.82
99% Chebyshev (MVUE) UCL	16.97		
<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	9.615	95% Jackknife UCL	9.658
95% Standard Bootstrap UCL	9.57	95% Bootstrap-t UCL	9.665
95% Hall's Bootstrap UCL	9.581	95% Percentile Bootstr	9.569
95% BCA Bootstrap UCL	9.566		
90% Chebyshev(Mean, Sd) UCL	10.59	95% Chebyshev(Mean	11.56
97.5% Chebyshev(Mean, Sd) UCL	12.92	99% Chebyshev(Mean	15.58
<b>Suggested UCL to Use</b>			
95% Student's-t UCL	9.658		
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.			
<b>Nitrate</b>			
<b>General Statistics</b>			
Total Number of Observations	27	Number of Distinct Obse	25

Number of Detects	20	Number of Non-Detects	7
Number of Distinct Detects	20	Number of Distinct Non-I	5
Minimum Detect	1.03	Minimum Non-Detect	1.04
Maximum Detect	29.6	Maximum Non-Detect	1.37
Variance Detects	40.8	Percent Non-Detects	25.93%
Mean Detects	3.601	SD Detects	6.388
Median Detects	1.505	CV Detects	1.774
Skewness Detects	3.95	Kurtosis Detects	16.34
Mean of Logged Detects	0.761	SD of Logged Detects	0.811

#### Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.409	<b>Shapiro Wilk GOF Test</b>	
5% Shapiro Wilk Critical Value	0.905	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.4	<b>Lilliefors GOF Test</b>	
5% Lilliefors Critical Value	0.192	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	2.937	KM Standard Error of Me	1.081
KM SD	5.475	95% KM (BCA) UCL	5.058
95% KM (t) UCL	4.781	95% KM (Percentile Bc	4.9
95% KM (z) UCL	4.715	95% KM Bootstrap t U	12.67
90% KM Chebyshev UCL	6.18	95% KM Chebyshev UCL	7.649
97.5% KM Chebyshev UCL	9.688	99% KM Chebyshev UCL	13.69

#### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.936	<b>Anderson-Darling GOF Test</b>	
5% A-D Critical Value	0.766	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.32	<b>Kolmogorov-Smirnov GOF</b>	
5% K-S Critical Value	0.199	Detected Data Not Gamma Distributed at 5% Significance Level	

#### Detected Data Not Gamma Distributed at 5% Significance Level

#### Gamma Statistics on Detected Data Only

k hat (MLE)	1.098	k star (bias corrected ML	0.966
Theta hat (MLE)	3.281	Theta star (bias correcte	3.727
nu hat (MLE)	43.9	nu star (bias corrected)	38.65
Mean (detects)	3.601		

#### Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	2.67
Maximum	29.6	Median	1.46
SD	5.691	CV	2.131
k hat (MLE)	0.407	k star (bias corrected ML	0.386
Theta hat (MLE)	6.561	Theta star (bias correcte	6.909
nu hat (MLE)	21.98	nu star (bias corrected)	20.87
Adjusted Level of Significance ( $\beta$ )	0.0401		
Approximate Chi Square Value (20.87, $\alpha$ )	11.49	Adjusted Chi Square Val	11.05
95% Gamma Approximate UCL (use when $n \geq 50$ )	4.848	95% Gamma Adjusted U	5.043

#### Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.937	SD (KM)	5.475
Variance (KM)	29.97	SE of Mean (KM)	1.081
k hat (KM)	0.288	k star (KM)	0.28
nu hat (KM)	15.54	nu star (KM)	15.15
theta hat (KM)	10.21	theta star (KM)	10.47
80% gamma percentile (KM)	4.424	90% gamma percentile (	8.727

95% gamma percentile (KM)	13.72	99% gamma percentile (	26.82
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### Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (15.15, $\alpha$ )	7.363	Adjusted Chi Square Val	7.017
95% Gamma Approximate KM-UCL (use when r	6.041	95% Gamma Adjusted	6.339

### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.749	<b>Shapiro Wilk GOF Test</b>	
5% Shapiro Wilk Critical Value	0.905	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.22	<b>Lilliefors GOF Test</b>	
5% Lilliefors Critical Value	0.192	Detected Data Not Lognormal at 5% Significance Level	

### Detected Data Not Lognormal at 5% Significance Level

### Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.807	Mean in Log Scale	0.399
SD in Original Scale	5.629	SD in Log Scale	0.938
95% t UCL (assumes normality of ROS data)	4.655	95% Percentile Bootstr	4.83
95% BCA Bootstrap UCL	6.193	95% Bootstrap t UCL	11.75
95% H-UCL (Log ROS)	3.624		

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

KM Mean (logged)	0.573	KM Geo Mean	1.774
KM SD (logged)	0.751	95% Critical H Value (t	2.217
KM Standard Error of Mean (logged)	0.148	95% H-UCL (KM -Log)	3.26
KM SD (logged)	0.751	95% Critical H Value (t	2.217
KM Standard Error of Mean (logged)	0.148		

### DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	2.81	Mean in Log Scale	0.407
SD in Original Scale	5.628	SD in Log Scale	0.924
95% t UCL (Assumes normality)	4.657	95% H-Stat UCL	3.574

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

### Nonparametric Distribution Free UCL Statistics

### Data do not follow a Discernible Distribution at 5% Significance Level

### Suggested UCL to Use

95% KM (Chebyshev) UCL	7.649
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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	27	Number of Distinct Obse	23
Number of Detects	9	Number of Non-Detects	18
Number of Distinct Detects	9	Number of Distinct Non-I	14
Minimum Detect	5.5000E-4	Minimum Non-Detect	0.00205
Maximum Detect	0.00151	Maximum Non-Detect	0.00276
Variance Detects	1.1789E-7	Percent Non-Detects	66.67%
Mean Detects	9.2533E-4	SD Detects	3.4335E-4
Median Detects	8.8200E-4	CV Detects	0.371
Skewness Detects	0.663	Kurtosis Detects	-0.6
Mean of Logged Detects	-7.045	SD of Logged Detects	0.367

### Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.9	<b>Shapiro Wilk GOF Test</b>	
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5% Shapiro Wilk Critical Value	0.829	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.211	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.274	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	9.2533E-4	KM Standard Error of Mean	1.1445E-4
KM SD	3.2372E-4	95% KM (BCA) UCL	0.00113
95% KM (t) UCL	0.00112	95% KM (Percentile Bootstrap) UCL	0.00111
95% KM (z) UCL	0.00111	95% KM Bootstrap t UCL	0.00121
90% KM Chebyshev UCL	0.00127	95% KM Chebyshev UCL	0.00142
97.5% KM Chebyshev UCL	0.00164	99% KM Chebyshev UCL	0.00206

#### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.371	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.722	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.173	<b>Kolmogorov-Smirnov GOF</b>
5% K-S Critical Value	0.279	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)	8.486	k star (bias corrected ML)	5.732
Theta hat (MLE)	1.0904E-4	Theta star (bias corrected ML)	1.6144E-4
nu hat (MLE)	152.8	nu star (bias corrected)	103.2
Mean (detects)	9.2533E-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	5.5000E-4	Mean	0.00698
Maximum	0.01	Median	0.01
SD	0.00436	CV	0.626
k hat (MLE)	1.244	k star (bias corrected ML)	1.13
Theta hat (MLE)	0.00561	Theta star (bias corrected ML)	0.00617
nu hat (MLE)	67.15	nu star (bias corrected)	61.02
Adjusted Level of Significance ( $\beta$ )	0.0401		
Approximate Chi Square Value (61.02, $\alpha$ )	44.06	Adjusted Chi Square Value	43.14
95% Gamma Approximate UCL (use when $n \geq 50$ )	0.00966	95% Gamma Adjusted UCL	0.00987

#### Estimates of Gamma Parameters using KM Estimates

Mean (KM)	9.2533E-4	SD (KM)	3.2372E-4
Variance (KM)	1.0479E-7	SE of Mean (KM)	1.1445E-4
k hat (KM)	8.171	k star (KM)	7.288
nu hat (KM)	441.2	nu star (KM)	393.5
theta hat (KM)	1.1325E-4	theta star (KM)	1.2697E-4
80% gamma percentile (KM)	0.00119	90% gamma percentile (KM)	0.00138
95% gamma percentile (KM)	0.00155	99% gamma percentile (KM)	0.0019

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

Approximate Chi Square Value (393.53, $\alpha$ )	348.6	Adjusted Chi Square Value	345.9
95% Gamma Approximate KM-UCL (use when $n \geq 50$ )	0.00104	95% Gamma Adjusted UCL	0.00105

#### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.921	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.164	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.274	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	8.9392E-4	Mean in Log Scale	-7.045
SD in Original Scale	2.1246E-4	SD in Log Scale	0.229
95% t UCL (assumes normality of ROS data)	9.6366E-4	95% Percentile Bootstrap	9.6339E-4
95% BCA Bootstrap UCL	9.7279E-4	95% Bootstrap t UCL	9.7356E-4
95% H-UCL (Log ROS)	9.6860E-4		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-7.045	KM Geo Mean	8.7138E-4
KM SD (logged)	0.346	95% Critical H Value (t)	1.851
KM Standard Error of Mean (logged)	0.122	95% H-UCL (KM -Log)	0.00105
KM SD (logged)	0.346	95% Critical H Value (t)	1.851
KM Standard Error of Mean (logged)	0.122		

DL/2 Statistics

DL/2 Normal

DL/2 Log-Transformed

Mean in Original Scale	0.00105	Mean in Log Scale	-6.888
SD in Original Scale	2.2567E-4	SD in Log Scale	0.243
95% t UCL (Assumes normality)	0.00112	95% H-Stat UCL	0.00114

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	0.00112
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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	27	Number of Distinct Obse	26
Number of Detects	14	Number of Non-Detects	13
Number of Distinct Detects	14	Number of Distinct Non-I	12
Minimum Detect	0.0539	Minimum Non-Detect	0.0193
Maximum Detect	0.0983	Maximum Non-Detect	0.0717
Variance Detects	2.1160E-4	Percent Non-Detects	48.15%
Mean Detects	0.0743	SD Detects	0.0145
Median Detects	0.0711	CV Detects	0.196
Skewness Detects	0.265	Kurtosis Detects	-1.008
Mean of Logged Detects	-2.617	SD of Logged Detects	0.197

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.951	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.874	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.135	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.226	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	0.0484	KM Standard Error of Me	0.00588
KM SD	0.0291	95% KM (BCA) UCL	0.0635
95% KM (t) UCL	0.0584	95% KM (Percentile Boo	0.0611
95% KM (z) UCL	0.0581	95% KM Bootstrap t U	0.0576
90% KM Chebyshev UCL	0.0661	95% KM Chebyshev UCL	0.074
97.5% KM Chebyshev UCL	0.0851	99% KM Chebyshev UCL	0.107



### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.228	<b>Anderson-Darling GOF Test</b>	
5% A-D Critical Value	0.734	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.113	<b>Kolmogorov-Smirnov GOF</b>	
5% K-S Critical Value	0.228	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)	28.17	k star (bias corrected ML	22.18
Theta hat (MLE)	0.00264	Theta star (bias correcte	0.00335
nu hat (MLE)	788.6	nu star (bias corrected)	621
Mean (detects)	0.0743		

### 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	0.0348	Mean	0.0583
Maximum	0.0983	Median	0.0539
SD	0.0199	CV	0.341
k hat (MLE)	9.545	k star (bias corrected ML	8.509
Theta hat (MLE)	0.00611	Theta star (bias correcte	0.00686
nu hat (MLE)	515.4	nu star (bias corrected)	459.5
Adjusted Level of Significance ( $\beta$ )	0.0401		
Approximate Chi Square Value (459.49, $\alpha$ )	410.8	Adjusted Chi Square Val	407.9
95% Gamma Approximate UCL (use when $n \geq 50$ )	0.0653	95% Gamma Adjusted U	0.0657

### Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0484	SD (KM)	0.0291
Variance (KM)	8.4951E-4	SE of Mean (KM)	0.00588
k hat (KM)	2.759	k star (KM)	2.477
nu hat (KM)	149	nu star (KM)	133.8
theta hat (KM)	0.0175	theta star (KM)	0.0195
80% gamma percentile (KM)	0.0707	90% gamma percentile (	0.0896
95% gamma percentile (KM)	0.107	99% gamma percentile (	0.147

### Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (133.78, $\alpha$ )	108.1	Adjusted Chi Square Val	106.6
95% Gamma Approximate KM-UCL (use when $r$	0.0599	95% Gamma Adjusted	0.0608

### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.957	<b>Shapiro Wilk GOF Test</b>	
5% Shapiro Wilk Critical Value	0.874	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0994	<b>Lilliefors GOF Test</b>	
5% Lilliefors Critical Value	0.226	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	0.0602	Mean in Log Scale	-2.852
SD in Original Scale	0.0182	SD in Log Scale	0.287
95% t UCL (assumes normality of ROS data)	0.0661	95% Percentile Bootstr	0.0659
95% BCA Bootstrap UCL	0.0663	95% Bootstrap t UCL	0.0666
95% H-UCL (Log ROS)	0.0666		

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

KM Mean (logged)	-3.242	KM Geo Mean	0.0391
KM SD (logged)	0.676	95% Critical H Value (t	2.136
KM Standard Error of Mean (logged)	0.137	95% H-UCL (KM -Log)	0.0652

KM SD (logged)	0.676	95% Critical H Value (t)	2.136
KM Standard Error of Mean (logged)	0.137		

## DL/2 Statistics

### DL/2 Normal

Mean in Original Scale	0.0488	Mean in Log Scale	-3.229
SD in Original Scale	0.0292	SD in Log Scale	0.692
95% t UCL (Assumes normality)	0.0584	95% H-Stat UCL	0.0674

### DL/2 Log-Transformed

**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	0.0584
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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	27	Number of Distinct Obse	25
		Number of Missing Obse	0
Minimum	0.678	Mean	1.144
Maximum	2.08	Median	1.07
SD	0.323	Std. Error of Mean	0.0622
Coefficient of Variation	0.283	Skewness	0.991

### Normal GOF Test

Shapiro Wilk Test Statistic	0.943	<b>Shapiro Wilk GOF Test</b>	
5% Shapiro Wilk Critical Value	0.923	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.11	<b>Lilliefors GOF Test</b>	
5% Lilliefors Critical Value	0.167	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	1.25	95% Adjusted-CLT UC	1.259
		95% Modified-t UCL (J	1.252

### Gamma GOF Test

A-D Test Statistic	0.16	<b>Anderson-Darling Gamma GOF Test</b>	
5% A-D Critical Value	0.744	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.0815	<b>Kolmogorov-Smirnov Gamma GOF Test</b>	
5% K-S Critical Value	0.168	Detected data appear Gamma Distributed at 5% Significance Level	

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

### Gamma Statistics

k hat (MLE)	14.05	k star (bias corrected ML	12.52
Theta hat (MLE)	0.0814	Theta star (bias correcte	0.0914
nu hat (MLE)	758.8	nu star (bias corrected)	675.8
MLE Mean (bias corrected)	1.144	MLE Sd (bias corrected)	0.323
		Approximate Chi Square	616.5
Adjusted Level of Significance	0.0401	Adjusted Chi Square Val	612.9

### Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=£	1.254	95% Adjusted Gamma	1.261
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**Lognormal GOF Test**

Shapiro Wilk Test Statistic	0.988	<b>Shapiro Wilk Lognormal GOF Test</b>	
5% Shapiro Wilk Critical Value	0.923	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0639	<b>Lilliefors Lognormal GOF Test</b>	
5% Lilliefors Critical Value	0.167	Data appear Lognormal at 5% Significance Level	

**Data appear Lognormal at 5% Significance Level**

**Lognormal Statistics**

Minimum of Logged Data	-0.389	Mean of logged Data	0.0986
Maximum of Logged Data	0.732	SD of logged Data	0.271

**Assuming Lognormal Distribution**

95% H-UCL	1.26	90% Chebyshev (MVU)	1.324
95% Chebyshev (MVUE) UCL	1.406	97.5% Chebyshev (MVL)	1.52
99% Chebyshev (MVUE) UCL	1.744		

**Nonparametric Distribution Free UCL Statistics**

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

**Nonparametric Distribution Free UCLs**

95% CLT UCL	1.246	95% Jackknife UCL	1.25
95% Standard Bootstrap UCL	1.246	95% Bootstrap-t UCL	1.268
95% Hall's Bootstrap UCL	1.265	95% Percentile Bootstr	1.247
95% BCA Bootstrap UCL	1.255		
90% Chebyshev(Mean, Sd) UCL	1.331	95% Chebyshev(Mean	1.415
97.5% Chebyshev(Mean, Sd) UCL	1.533	99% Chebyshev(Mean	1.763

**Suggested UCL to Use**

95% Student's-t UCL	1.25
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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.