

## UCL Statistics for Data Sets with Non-Detects

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From File ProUCLinput\_20-002(c)\_0-10.xls  
Full Precision OFF  
Confidence Cc 95%  
Number of Boc 2000

### Antimony

#### General Statistics

Total Number of Observations	24	Number of Distinct Observations	23
Number of Detects	6	Number of Non-Detects	18
Number of Distinct Detects	6	Number of Distinct Non-Detects	17
Minimum Detect	0.62	Minimum Non-Detect	0.891
Maximum Detect	1.12	Maximum Non-Detect	1.06
Variance Detects	0.0325	Percent Non-Detects	75%
Mean Detects	0.826	SD Detects	0.18
Median Detects	0.824	CV Detects	0.218
Skewness Detects	0.66	Kurtosis Detects	0.338
Mean of Logged Detects	-0.21	SD of Logged Detects	0.215

#### Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.955	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.165	<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	0.768	KM Standard Error of Mean	0.0506
KM SD	0.125	95% KM (BCA) UCL	0.86
95% KM (t) UCL	0.854	95% KM (Percentile Bootstrap) UCL	0.859
95% KM (z) UCL	0.851	95% KM Bootstrap t UCL	0.864
90% KM Chebyshev UCL	0.919	95% KM Chebyshev UCL	0.988
97.5% KM Chebyshev UCL	1.084	99% KM Chebyshev UCL	1.271

#### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.209	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.697	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	0.332	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)	25.98	k star (bias corrected ML)	13.1
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Theta hat (MLE)	0.0318	Theta star (bias corrected)	0.0631
nu hat (MLE)	311.8	nu star (bias corrected)	157.2
Mean (detects)	0.826		

### 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	0.62	Mean	0.763
Maximum	1.12	Median	0.746
SD	0.0937	CV	0.123
k hat (MLE)	80.28	k star (bias corrected ML	70.27
Theta hat (MLE)	0.0095	Theta star (bias corrected	0.0109
nu hat (MLE)	3853	nu star (bias corrected)	3373
Adjusted Level of Signific	0.0392		
Approximate Chi Square	3239	Adjusted Chi Square Val	3230
95% Gamma Approxima	0.794	95% Gamma Adjusted U	0.796

### Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.768	SD (KM)	0.125
Variance (KM)	0.0157	SE of Mean (KM)	0.0506
k hat (KM)	37.42	k star (KM)	32.77
nu hat (KM)	1796	nu star (KM)	1573
theta hat (KM)	0.0205	theta star (KM)	0.0234
80% gamma percentile (	0.878	90% gamma percentile (	0.944
95% gamma percentile (	1.001	99% gamma percentile (	1.114

### Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square	1482	Adjusted Chi Square Val	1476
95% Gamma Approxir	0.815	95% Gamma Adjusted	0.818

### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statist	0.971	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical	0.788	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.153	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Valu	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	0.76	Mean in Log Scale	-0.281
SD in Original Scale	0.0942	SD in Log Scale	0.111
95% t UCL (assumes r	0.793	95% Percentile Bootstr	0.794
95% BCA Bootstrap UCL	0.807	95% Bootstrap t UCL	0.815
95% H-UCL (Log ROS	0.791		

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

KM Mean (logged)	-0.277	KM Geo Mean	0.758
KM SD (logged)	0.159	95% Critical H Value (t)	1.745
KM Standard Error of Me	0.0673	95% H-UCL (KM -Log)	0.813
KM SD (logged)	0.159	95% Critical H Value (t)	1.745
KM Standard Error of Me	0.0673		

**DL/2 Statistics**

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.569	Mean in Log Scale	-0.598
SD in Original Scale	0.175	SD in Log Scale	0.254
95% t UCL (Assumes r	0.631	95% H-Stat UCL	0.625

**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	0.854
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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.

**Aroclor-1260****General Statistics**

Total Number of Observa	12	Number of Distinct Obse	12
		Number of Missing Obse	12
Number of Detects	11	Number of Non-Detects	1
Number of Distinct Detect	11	Number of Distinct Non-I	1
Minimum Detect	0.0022	Minimum Non-Detect	0.00337
Maximum Detect	0.0648	Maximum Non-Detect	0.00337
Variance Detects	6.0129E-4	Percent Non-Detects	8.333%
Mean Detects	0.0221	SD Detects	0.0245
Median Detects	0.0121	CV Detects	1.107
Skewness Detects	1.141	Kurtosis Detects	-0.496
Mean of Logged Detects	-4.434	SD of Logged Detects	1.218

**Normal GOF Test on Detects Only**

Shapiro Wilk Test Statist	0.751	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical	0.85	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.312	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Valu	0.251	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	0.0205	KM Standard Error of Mean	0.00697
KM SD	0.023	95% KM (BCA) UCL	0.0323
95% KM (t) UCL	0.033	95% KM (Percentile Bootstrap) UCL	0.0314
95% KM (z) UCL	0.032	95% KM Bootstrap t UCL	0.038
90% KM Chebyshev UCL	0.0414	95% KM Chebyshev UCL	0.0509
97.5% KM Chebyshev UCL	0.0641	99% KM Chebyshev UCL	0.0899

### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.569	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.755	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.201	<b>Kolmogorov-Smirnov GOF</b>
5% K-S Critical Value	0.263	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)	0.933	k star (bias corrected ML)	0.739
Theta hat (MLE)	0.0237	Theta star (bias corrected ML)	0.03
nu hat (MLE)	20.52	nu star (bias corrected)	16.26
Mean (detects)	0.0221		

### 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	0.0022	Mean	0.0211
Maximum	0.0648	Median	0.0112
SD	0.0236	CV	1.119
k hat (MLE)	0.978	k star (bias corrected ML)	0.789
Theta hat (MLE)	0.0216	Theta star (bias corrected ML)	0.0268
nu hat (MLE)	23.48	nu star (bias corrected)	18.94
Adjusted Level of Significance	0.029		
Approximate Chi Square	10.08	Adjusted Chi Square Value	9.104
95% Gamma Approximate UCL	0.0397	95% Gamma Adjusted UCL	0.044

### Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0205	SD (KM)	0.023
Variance (KM)	5.2978E-4	SE of Mean (KM)	0.00697
k hat (KM)	0.796	k star (KM)	0.652
nu hat (KM)	19.1	nu star (KM)	15.65
theta hat (KM)	0.0258	theta star (KM)	0.0315
80% gamma percentile (KM)	0.0338	90% gamma percentile (KM)	0.0524
95% gamma percentile (KM)	0.0717	99% gamma percentile (KM)	0.118

### Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square	7.719	Adjusted Chi Square Val	6.885
95% Gamma Approxima	0.0416	95% Gamma Adjusted K	0.0467

<b>Lognormal GOF Test on Detected Observations Only</b>		
Shapiro Wilk Test Statist	0.918	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical	0.85	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.153	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Valu	0.251	Detected Data appear Lognormal at 5% Significance Level
<b>Detected Data appear Lognormal at 5% Significance Level</b>		

<b>Lognormal ROS Statistics Using Imputed Non-Detects</b>			
Mean in Original Scale	0.0205	Mean in Log Scale	-4.555
SD in Original Scale	0.024	SD in Log Scale	1.234
95% t UCL (assumes r	0.033	95% Percentile Bootstr	0.0315
95% BCA Bootstrap UCL	0.0346	95% Bootstrap t UCL	0.0377
95% H-UCL (Log ROS	0.0786		

<b>Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution</b>			
KM Mean (logged)	-4.557	KM Geo Mean	0.0105
KM SD (logged)	1.185	95% Critical H Value (t	3.261
KM Standard Error of Me	0.359	95% H-UCL (KM -Log)	0.0679
KM SD (logged)	1.185	95% Critical H Value (t	3.261
KM Standard Error of Me	0.359		

<b>DL/2 Statistics</b>			
<b>DL/2 Normal</b>		<b>DL/2 Log-Transformed</b>	
Mean in Original Scale	0.0204	Mean in Log Scale	-4.597
SD in Original Scale	0.0241	SD in Log Scale	1.291
95% t UCL (Assumes r	0.0329	95% H-Stat UCL	0.0896

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

<b>Nonparametric Distribution Free UCL Statistics</b>			
<b>Detected Data appear Gamma Distributed at 5% Significance Level</b>			

<b>Suggested UCL to Use</b>			
95% KM Bootstrap t UCL	0.038	Gamma Adjusted KM-UCL	0.0467

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

## Barium

<b>General Statistics</b>			
Total Number of Observa	24	Number of Distinct Obse	24

		Number of Missing Obse	0
Minimum	9.25	Mean	37.9
Maximum	88.6	Median	30.35
SD	25.75	Std. Error of Mean	5.256
Coefficient of Variation	0.679	Skewness	0.78

### Normal GOF Test

Shapiro Wilk Test Statist	0.867	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical	0.916	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.185	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Valu	0.177	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	46.91	95% Adjusted-CLT UC	47.44
		95% Modified-t UCL (J	47.05

### Gamma GOF Test

A-D Test Statistic	0.583	<b>Anderson-Darling Gamma GOF Test</b>
5% A-D Critical Value	0.754	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.117	<b>Kolmogorov-Smirnov Gamma GOF Test</b>
5% K-S Critical Value	0.18	Detected data appear Gamma Distributed at 5% Significance Level

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

### Gamma Statistics

k hat (MLE)	2.329	k star (bias corrected ML	2.066
Theta hat (MLE)	16.27	Theta star (bias correcte	18.35
nu hat (MLE)	111.8	nu star (bias corrected)	99.15
MLE Mean (bias correcte	37.9	MLE Sd (bias corrected)	26.37
		Approximate Chi Square	77.18
Adjusted Level of Signific	0.0392	Adjusted Chi Square Val	75.82

### Assuming Gamma Distribution

95% Approximate Garr	48.69	95% Adjusted Gamma	49.56
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### Lognormal GOF Test

Shapiro Wilk Test Statist	0.945	<b>Shapiro Wilk Lognormal GOF Test</b>
5% Shapiro Wilk Critical	0.916	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.113	<b>Lilliefors Lognormal GOF Test</b>
5% Lilliefors Critical Valu	0.177	Data appear Lognormal at 5% Significance Level

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

### Lognormal Statistics

Minimum of Logged Data	2.225	Mean of logged Data	3.405
Maximum of Logged Dat	4.484	SD of logged Data	0.705

Assuming Lognormal Distribution			
95% H-UCL	53.26	90% Chebyshev (MVU	55.85
95% Chebyshev (MVU	63.88	97.5% Chebyshev (MVL	75.01
99% Chebyshev (MVU	96.89		

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

Nonparametric Distribution Free UCLs			
95% CLT UCL	46.54	95% Jackknife UCL	46.91
95% Standard Bootstrap	46.57	95% Bootstrap-t UCL	47.69
95% Hall's Bootstrap U	46.73	95% Percentile Bootstr	46.7
95% BCA Bootstrap U	47.03		
90% Chebyshev(Mean	53.67	95% Chebyshev(Mean	60.81
97.5% Chebyshev(Mear	70.72	99% Chebyshev(Mean	90.19

**Suggested UCL to Use**  
95% Adjusted Gamma U    49.56

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

**Chromium**

General Statistics			
Total Number of Observa	24	Number of Distinct Obse	24
		Number of Missing Obse	0
Minimum	3.02	Mean	16.71
Maximum	60.7	Median	6.135
SD	19.63	Std. Error of Mean	4.007
Coefficient of Variation	1.175	Skewness	1.335

Normal GOF Test		
Shapiro Wilk Test Statist	0.661	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical	0.916	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.359	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Valu	0.177	Data Not Normal at 5% Significance Level
<b>Data Not Normal at 5% Significance Level</b>		

Assuming Normal Distribution			
<b>95% Normal UCL</b>		<b>95% UCLs (Adjusted for Skewness)</b>	
95% Student's-t UCL	23.58	95% Adjusted-CLT UC	24.47
		95% Modified-t UCL (J	23.76

Gamma GOF Test		
A-D Test Statistic	2.922	<b>Anderson-Darling Gamma GOF Test</b>
5% A-D Critical Value	0.771	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.306	<b>Kolmogorov-Smirnov Gamma GOF Test</b>
5% K-S Critical Value	0.183	Data Not Gamma Distributed at 5% Significance Level
<b>Data Not Gamma Distributed at 5% Significance Level</b>		

Gamma Statistics			
k hat (MLE)	1.028	k star (bias corrected ML	0.928
Theta hat (MLE)	16.25	Theta star (bias correcte	18.01
nu hat (MLE)	49.36	nu star (bias corrected)	44.52
MLE Mean (bias correcte	16.71	MLE Sd (bias corrected)	17.35
		Approximate Chi Square	30.22
Adjusted Level of Signific	0.0392	Adjusted Chi Square Val	29.39

Assuming Gamma Distribution			
95% Approximate Garr	24.62	95% Adjusted Gamma	25.31

Lognormal GOF Test		
Shapiro Wilk Test Statist	0.796	<b>Shapiro Wilk Lognormal GOF Test</b>
5% Shapiro Wilk Critical	0.916	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.255	<b>Lilliefors Lognormal GOF Test</b>
5% Lilliefors Critical Valu	0.177	Data Not Lognormal at 5% Significance Level
<b>Data Not Lognormal at 5% Significance Level</b>		

Lognormal Statistics			
Minimum of Logged Data	1.105	Mean of logged Data	2.256
Maximum of Logged Dat	4.106	SD of logged Data	1.007

Assuming Lognormal Distribution			
95% H-UCL	27.09	90% Chebyshev (MVU	26.15
95% Chebyshev (MVU	31.03	97.5% Chebyshev (MVL	37.8
99% Chebyshev (MVU	51.09		

Nonparametric Distribution Free UCL Statistics			
<b>Data do not follow a Discernible Distribution (0.05)</b>			

Nonparametric Distribution Free UCLs			
95% CLT UCL	23.3	95% Jackknife UCL	23.58
95% Standard Bootstrap	23.08	95% Bootstrap-t UCL	26.11
95% Hall's Bootstrap U	22.97	95% Percentile Bootstr	23.38
95% BCA Bootstrap UCL	24.6		
90% Chebyshev(Mean	28.73	95% Chebyshev(Mean	34.17
97.5% Chebyshev(Mear	41.73	99% Chebyshev(Mean	56.58

Suggested UCL to Use			
95% Chebyshev (Mean,	34.17		



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	24	Number of Distinct Observations	24
		Number of Missing Observations	0
Minimum	0.915	Mean	4.381
Maximum	13.7	Median	2.295
SD	4.217	Std. Error of Mean	0.861
Coefficient of Variation	0.963	Skewness	1.254

Normal GOF Test

Shapiro Wilk Test Statistic	0.726	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.916	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.336	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.177	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5.856	95% Adjusted-CLT UC	6.032
		95% Modified-t UCL (J	5.893

Gamma GOF Test

A-D Test Statistic	1.77	<b>Anderson-Darling Gamma GOF Test</b>
5% A-D Critical Value	0.763	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.263	<b>Kolmogorov-Smirnov Gamma GOF Test</b>
5% K-S Critical Value	0.181	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.443	k star (bias corrected MLE)	1.291
Theta hat (MLE)	3.035	Theta star (bias corrected MLE)	3.394
nu hat (MLE)	69.28	nu star (bias corrected)	61.95
MLE Mean (bias corrected)	4.381	MLE Sd (bias corrected)	3.856
		Approximate Chi Square	44.85
Adjusted Level of Significance	0.0392	Adjusted Chi Square Value	43.83

Assuming Gamma Distribution

95% Approximate Gamma UCL	6.051	95% Adjusted Gamma UCL	6.193
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<b>Lognormal GOF Test</b>		
Shapiro Wilk Test Statist	0.884	<b>Shapiro Wilk Lognormal GOF Test</b>
5% Shapiro Wilk Critical	0.916	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.204	<b>Lilliefors Lognormal GOF Test</b>
5% Lilliefors Critical Valu	0.177	Data Not Lognormal at 5% Significance Level
<b>Data Not Lognormal at 5% Significance Level</b>		

<b>Lognormal Statistics</b>			
Minimum of Logged Data	-0.0888	Mean of logged Data	1.092
Maximum of Logged Dat	2.617	SD of logged Data	0.861

<b>Assuming Lognormal Distribution</b>			
95% H-UCL	6.6	90% Chebyshev (MVU	6.696
95% Chebyshev (MVU	7.813	97.5% Chebyshev (MVL	9.362
99% Chebyshev (MVU	12.41		

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

<b>Nonparametric Distribution Free UCLs</b>			
95% CLT UCL	5.797	95% Jackknife UCL	5.856
95% Standard Bootstrap	5.773	95% Bootstrap-t UCL	6.266
95% Hall's Bootstrap U	5.73	95% Percentile Bootstr	5.848
95% BCA Bootstrap U	5.877		
90% Chebyshev(Mean	6.963	95% Chebyshev(Mean	8.133
97.5% Chebyshev(Mear	9.757	99% Chebyshev(Mean	12.95

**Suggested UCL to Use**  
95% Chebyshev (Mean, 8.133

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

<b>General Statistics</b>			
Total Number of Observa	24	Number of Distinct Obse	24
		Number of Missing Obse	0
Minimum	2.54	Mean	9.511
Maximum	24.6	Median	7.155
SD	7.238	Std. Error of Mean	1.477
Coefficient of Variation	0.761	Skewness	1.035

## Normal GOF Test

Shapiro Wilk Test Statist	0.792	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical	0.916	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.257	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.177	Data Not Normal at 5% Significance Level
<b>Data Not Normal at 5% Significance Level</b>		

### Assuming Normal Distribution

<b>95% Normal UCL</b>		<b>95% UCLs (Adjusted for Skewness)</b>	
95% Student's-t UCL	12.04	95% Adjusted-CLT UC	12.27
		95% Modified-t UCL (J	12.1

### Gamma GOF Test

A-D Test Statistic	1.145	<b>Anderson-Darling Gamma GOF Test</b>
5% A-D Critical Value	0.755	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.179	<b>Kolmogorov-Smirnov Gamma GOF Test</b>
5% K-S Critical Value	0.18	Detected data appear Gamma Distributed at 5% Significance Level

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

### Gamma Statistics

k hat (MLE)	2.08	k star (bias corrected ML	1.848
Theta hat (MLE)	4.573	Theta star (bias correcte	5.148
nu hat (MLE)	99.83	nu star (bias corrected)	88.69
MLE Mean (bias correcte	9.511	MLE Sd (bias corrected)	6.997
		Approximate Chi Square	67.97
Adjusted Level of Signific	0.0392	Adjusted Chi Square Val	66.7

### Assuming Gamma Distribution

95% Approximate Garr	12.41	95% Adjusted Gamma	12.65
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### Lognormal GOF Test

Shapiro Wilk Test Statist	0.913	<b>Shapiro Wilk Lognormal GOF Test</b>
5% Shapiro Wilk Critical	0.916	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.161	<b>Lilliefors Lognormal GOF Test</b>
5% Lilliefors Critical Value	0.177	Data appear Lognormal at 5% Significance Level

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

### Lognormal Statistics

Minimum of Logged Data	0.932	Mean of logged Data	1.993
Maximum of Logged Dat	3.203	SD of logged Data	0.727

### Assuming Lognormal Distribution

95% H-UCL	13.35	90% Chebyshev (MVU	13.95
95% Chebyshev (MVU	16	97.5% Chebyshev (MVL	18.85
99% Chebyshev (MVU	24.44		

### Nonparametric Distribution Free UCL Statistics

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

Nonparametric Distribution Free UCLs

95% CLT UCL	11.94	95% Jackknife UCL	12.04
95% Standard Bootstrap	11.91	95% Bootstrap-t UCL	12.57
95% Hall's Bootstrap U	12.11	95% Percentile Bootstr	12.2
95% BCA Bootstrap U	12.06		
90% Chebyshev(Mean	13.94	95% Chebyshev(Mean	15.95
97.5% Chebyshev(Mear	18.74	99% Chebyshev(Mean	24.21

Suggested UCL to Use

95% Adjusted Gamma U	12.65
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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.

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General Statistics

Total Number of Observa	24	Number of Distinct Obse	17
Number of Detects	9	Number of Non-Detects	15
Number of Distinct Detect	9	Number of Distinct Non-I	8
Minimum Detect	6.7500E-4	Minimum Non-Detect	0.00203
Maximum Detect	0.00451	Maximum Non-Detect	0.00242
Variance Detects	1.5874E-6	Percent Non-Detects	62.5%
Mean Detects	0.00163	SD Detects	0.00126
Median Detects	0.00114	CV Detects	0.772
Skewness Detects	1.759	Kurtosis Detects	3.1
Mean of Logged Detects	-6.631	SD of Logged Detects	0.663

Normal GOF Test on Detects Only

Shapiro Wilk Test Statist	0.791	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical	0.829	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.224	Lilliefors GOF Test
5% Lilliefors Critical Valu	0.274	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	0.00129	KM Standard Error of Me	2.2453E-4
KM SD	8.4586E-4	95% KM (BCA) UCL	0.00165
95% KM (t) UCL	0.00167	95% KM (Percentile Boo	0.00167
95% KM (z) UCL	0.00166	95% KM Bootstrap t U	0.00186
90% KM Chebyshev UCL	0.00196	95% KM Chebyshev UCL	0.00227

97.5% KM Chebyshev U 0.00269 99% KM Chebyshev UCI 0.00352

### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.457	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.728	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.18	<b>Kolmogorov-Smirnov GOF</b>
5% K-S Critical Value	0.282	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)	2.495	k star (bias corrected ML	1.737
Theta hat (MLE)	6.5447E-4	Theta star (bias correcte	9.3985E-4
nu hat (MLE)	44.91	nu star (bias corrected)	31.27
Mean (detects)	0.00163		

### 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	6.7500E-4	Mean	0.00686
Maximum	0.01	Median	0.01
SD	0.0042	CV	0.613
k hat (MLE)	1.449	k star (bias corrected ML	1.296
Theta hat (MLE)	0.00474	Theta star (bias correcte	0.0053
nu hat (MLE)	69.56	nu star (bias corrected)	62.19
Adjusted Level of Signific	0.0392		
Approximate Chi Square	45.05	Adjusted Chi Square Val	44.03
95% Gamma Approxima	0.00947	95% Gamma Adjusted U	0.00969

### Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00129	SD (KM)	8.4586E-4
Variance (KM)	7.1548E-7	SE of Mean (KM)	2.2453E-4
k hat (KM)	2.315	k star (KM)	2.053
nu hat (KM)	111.1	nu star (KM)	98.56
theta hat (KM)	5.5594E-4	theta star (KM)	6.2676E-4
80% gamma percentile (	0.00192	90% gamma percentile (	0.00249
95% gamma percentile (	0.00303	99% gamma percentile (	0.00422

### Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square	76.66	Adjusted Chi Square Val	75.3
95% Gamma Approxirr	0.00165	95% Gamma Adjusted	0.00168

### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statist	0.91	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical	0.829	Detected Data appear Lognormal at 5% Significance Level

Lilliefors Test Statistic	0.17	<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	0.00128	Mean in Log Scale	-6.787
SD in Original Scale	8.2383E-4	SD in Log Scale	0.459
95% t UCL (assumes r	0.00156	95% Percentile Bootstr	0.00155
95% BCA Bootstrap UCL	0.00165	95% Bootstrap t UCL	0.00181
95% H-UCL (Log ROS	0.00151		

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

KM Mean (logged)	-6.802	KM Geo Mean	0.00111
KM SD (logged)	0.504	95% Critical H Value (t)	1.984
KM Standard Error of Me	0.159	95% H-UCL (KM -Log)	0.00155
KM SD (logged)	0.504	95% Critical H Value (t)	1.984
KM Standard Error of Me	0.159		

### DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.00128	Mean in Log Scale	-6.765
SD in Original Scale	7.9560E-4	SD in Log Scale	0.408
95% t UCL (Assumes r	0.00156	95% H-Stat UCL	0.00147

**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	0.00167
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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.

### Silver

#### General Statistics

Total Number of Observations	24	Number of Distinct Observations	24
Number of Detects	9	Number of Non-Detects	15
Number of Distinct Detects	9	Number of Distinct Non-Detects	15
Minimum Detect	0.108	Minimum Non-Detect	0.191
Maximum Detect	2.31	Maximum Non-Detect	0.541

Variance Detects	0.808	Percent Non-Detects	62.5%
Mean Detects	1.255	SD Detects	0.899
Median Detects	1.74	CV Detects	0.716
Skewness Detects	-0.479	Kurtosis Detects	-1.785
Mean of Logged Detects	-0.307	SD of Logged Detects	1.342

#### Normal GOF Test on Detects Only

Shapiro Wilk Test Statist	0.83	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical	0.829	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.261	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Valu	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	0.55	KM Standard Error of Me	0.163
KM SD	0.754	95% KM (BCA) UCL	0.852
95% KM (t) UCL	0.83	95% KM (Percentile Boo	0.824
95% KM (z) UCL	0.818	95% KM Bootstrap t U	0.867
90% KM Chebyshev UCL	1.04	95% KM Chebyshev UCL	1.262
97.5% KM Chebyshev U	1.57	99% KM Chebyshev UCL	2.175

#### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.121	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.742	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.306	<b>Kolmogorov-Smirnov GOF</b>
5% K-S Critical Value	0.286	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)	1.072	k star (bias corrected ML	0.789
Theta hat (MLE)	1.171	Theta star (bias correcte	1.591
nu hat (MLE)	19.3	nu star (bias corrected)	14.2
Mean (detects)	1.255		

#### 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	0.108	Mean	0.635
Maximum	2.31	Median	0.262
SD	0.723	CV	1.139
k hat (MLE)	1.143	k star (bias corrected ML	1.028
Theta hat (MLE)	0.555	Theta star (bias correcte	0.617
nu hat (MLE)	54.88	nu star (bias corrected)	49.35
Adjusted Level of Signific	0.0392		

Approximate Chi Square	34.22	Adjusted Chi Square Val	33.34
95% Gamma Approxima	0.915	95% Gamma Adjusted U	0.939

### Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.55	SD (KM)	0.754
Variance (KM)	0.568	SE of Mean (KM)	0.163
k hat (KM)	0.532	k star (KM)	0.493
nu hat (KM)	25.53	nu star (KM)	23.68
theta hat (KM)	1.033	theta star (KM)	1.115
80% gamma percentile (	0.902	90% gamma percentile (	1.492
95% gamma percentile (	2.122	99% gamma percentile (	3.675

### Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square	13.6	Adjusted Chi Square Val	13.07
95% Gamma Approxirr	0.957	95% Gamma Adjusted	0.996

### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statist	0.734	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical	0.829	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.302	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Valu	0.274	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	0.578	Mean in Log Scale	-1.217
SD in Original Scale	0.754	SD in Log Scale	1.07
95% t UCL (assumes r	0.842	95% Percentile Bootstr	0.836
95% BCA Bootstrap UCL	0.873	95% Bootstrap t UCL	0.937
95% H-UCL (Log ROS	0.945		

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

KM Mean (logged)	-1.412	KM Geo Mean	0.244
KM SD (logged)	1.159	95% Critical H Value (t	2.76
KM Standard Error of Me	0.256	95% H-UCL (KM -Log)	0.929
KM SD (logged)	1.159	95% Critical H Value (t	2.76
KM Standard Error of Me	0.256		

### DL/2 Statistics

<b>DL/2 Normal</b>		<b>DL/2 Log-Transformed</b>	
Mean in Original Scale	0.595	Mean in Log Scale	-1.152
SD in Original Scale	0.746	SD in Log Scale	1.065
95% t UCL (Assumes r	0.856	95% H-Stat UCL	0.999

### 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	0.83
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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	24	Number of Distinct Observations	24
Number of Detects	11	Number of Non-Detects	13
Number of Distinct Detects	11	Number of Distinct Non-Detects	13
Minimum Detect	0.0587	Minimum Non-Detect	0
Maximum Detect	0.119	Maximum Non-Detect	0.0611
Variance Detects	2.6784E-4	Percent Non-Detects	54.17%
Mean Detects	0.0775	SD Detects	0.0164
Median Detects	0.0756	CV Detects	0.211
Skewness Detects	1.685	Kurtosis Detects	3.989

**Normal GOF Test on Detects Only**

Shapiro Wilk Test Statist	0.853	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical	0.85	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.219	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.251	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	0.0357	KM Standard Error of Mean	0.00859
KM SD	0.04	95% KM (BCA) UCL	0.0597
95% KM (t) UCL	0.0504	95% KM (Percentile Bootstrap) UCL	0.0567
95% KM (z) UCL	0.0498	95% KM Bootstrap t UCL	0.05
90% KM Chebyshev UCL	0.0615	95% KM Chebyshev UCL	0.0732
97.5% KM Chebyshev UCL	0.0894	99% KM Chebyshev UCL	0.121

**Gamma GOF Tests on Detected Observations Only**

A-D Test Statistic	0.418	<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	0.185	<b>Kolmogorov-Smirnov GOF</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 on Detected Data Only**

k hat (MLE)	28.21	k star (bias corrected MLE)	20.58
Theta hat (MLE)	0.00275	Theta star (bias corrected MLE)	0.00376
nu hat (MLE)	620.7	nu star (bias corrected)	452.8

Mean (detects) 0.0775

### Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0357	SD (KM)	0.04
Variance (KM)	0.0016	SE of Mean (KM)	0.00859
k hat (KM)	0.797	k star (KM)	0.725
nu hat (KM)	38.24	nu star (KM)	34.8
theta hat (KM)	0.0448	theta star (KM)	0.0492
80% gamma percentile (	0.0586	90% gamma percentile (	0.0889
95% gamma percentile (	0.12	99% gamma percentile (	0.194

### Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Signific	0.0392
Approximate Chi Square	22.3	Adjusted Chi Square Val	21.6
95% Gamma Approxirr	0.0557	95% Gamma Adjusted	0.0575

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

### DL/2 Statistics

Mean in Original Scale	0.0453	SD in Original Scale	0.0327
95% t UCL (Assumes r	0.0567		

**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 0.0504

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.