

UCL Statistics for Data Sets with Non-Detects			
Selected Options			
Computation	ProUCL 5.16/19/17 4:46:43 PM		
From File	ProUCLinput_20-002(d)_0-10.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Monte Carlo Operations	2000		

### Aroclor-1260

General Statistics			
Number of Observations	9	Number of Distinct Observations	9
		Number of Missing Observations	15
Number of Detects	6	Number of Non-Detects	3
Number of Distinct Detects	6	Number of Distinct Non-Detects	3
Minimum Detect	0.0031	Minimum Non-Detect	0.00341
Maximum Detect	0.0263	Maximum Non-Detect	0.00378
Variance Detects	6.9495E-5	Percent Non-Detects	33.33%
Mean Detects	0.0102	SD Detects	0.00834
Median Detects	0.0084	CV Detects	0.821
Skewness Detects	1.906	Kurtosis Detects	4.108
Mean of Logged Detects	-4.825	SD of Logged Detects	0.732

Sample size is small (e.g., <10), if data are collected using ISM approach, you should be guided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistical tests. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). EPC and UCL can be computed using the Nonparametric and All UCL Options commands.

Normal GOF Test on Detects Only			
Shapiro Wilk Test Statistic	0.782	Shapiro Wilk GOF Test	
Shapiro Wilk Critical Value	0.788	Concluded Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.336	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.325	Concluded Data Not Normal at 5% Significance Level	

Nonparametric (KM) Statistics using Normal Critical Values and other Nonparametric Critical Values			
KM Mean	0.0078	1 Standard Error of Mean	0.00257
KM SD	0.00705	95% KM (BCA) UCL	0.0122
95% KM (t) UCL	0.0126	Percentile Bootstrap UCL	0.0122
95% KM (z) UCL	0.012	95% KM Bootstrap t UCL	0.0177
90% KM Chebyshev UCL	0.0155	95% KM Chebyshev UCL	0.019
95% KM Chebyshev UCL	0.0239	99% KM Chebyshev UCL	0.0334

Gamma GOF Tests on Detected Observations Only			
A-D Test Statistic	0.374	Anderson-Darling GOF Test	
5% A-D Critical Value	0.703	Concluded Data do not appear Gamma Distributed at 5% Significance Level	

K-S Test Statistic

0.248

Kolmogorov-Smirnov GOF

5% K-S Critical Value

0.335

appear Gamma Distributed at 5% Sig

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.282	star (bias corrected MLE)	1.252
Theta hat (MLE)	0.00445	star (bias corrected MLE)	0.00811
nu hat (MLE)	27.38	nu star (bias corrected)	15.03
Mean (detects)	0.0102		

Gamma ROS Statistics using Imputed Non-Detects

not be used when data set has > 50% NDs with many tied observations at when kstar of detects is small such as <1.0, especially when the sample si such situations, GROS method may yield incorrect values of UCLs and B` This is especially true when the sample size is small.

d detected data, BTVs and UCLs may be computed using gamma distribu

Minimum	0.0031	Mean	0.0101
Maximum	0.0263	Median	0.01
SD	0.00659	CV	0.653
k hat (MLE)	3.351	star (bias corrected MLE)	2.308
Theta hat (MLE)	0.00301	star (bias corrected MLE)	0.00438
nu hat (MLE)	60.31	nu star (bias corrected)	41.54
Level of Significance ( $\beta$ )	0.0231		
Square Value (41.54, $\alpha$ )	27.77	Square Value (41.54, $\beta$ )	25.42
UCL (use when n>=50)	0.0151	UCL (use when n<50)	0.0165

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0078	SD (KM)	0.00705
Variance (KM)	4.9653E-5	SE of Mean (KM)	0.00257
k hat (KM)	1.225	k star (KM)	0.891
nu hat (KM)	22.06	nu star (KM)	16.04
theta hat (KM)	0.00637	theta star (KM)	0.00875
gamma percentile (KM)	0.0127	gamma percentile (KM)	0.0185
gamma percentile (KM)	0.0243	gamma percentile (KM)	0.0381

Gamma Kaplan-Meier (KM) Statistics

Square Value (16.04, $\alpha$ )	7.988	Square Value (16.04, $\beta$ )	6.825
L-UCL (use when n>=50)	0.0157	M-UCL (use when n<50)	0.0183

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic

0.952

Shapiro Wilk GOF Test

Shapiro Wilk Critical Value

0.788

Data appear Lognormal at 5% Signific

Lilliefors Test Statistic

0.21

Lilliefors GOF Test

% Lilliefors Critical Value

0.325

Data appear Lognormal at 5% Signific

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00763	Mean in Log Scale	-5.203
SD in Original Scale	0.0076	SD in Log Scale	0.81
Assessment of normality of ROS data)	0.0123	Percentile Bootstrap UCL	0.0121
95% BCA Bootstrap UCL	0.0135	95% Bootstrap t UCL	0.0184
95% H-UCL (Log ROS)	0.0172		

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

KM Mean (logged)	-5.142	KM Geo Mean	0.00584
KM SD (logged)	0.706	Critical H Value (KM-Log)	2.63
Standard Error of Mean (logged)	0.258	95% H-UCL (KM -Log)	0.0145
KM SD (logged)	0.706	Critical H Value (KM-Log)	2.63
Standard Error of Mean (logged)	0.258		

DL/2 Statistics			
DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.00737	Mean in Log Scale	-5.32
SD in Original Scale	0.0078	SD in Log Scale	0.942
95% H-Stat UCL (Assumes normality)	0.0122	95% H-Stat UCL	0.0215

DL/2 is not a recommended method, provided for comparisons and historical reference only.

### Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use			
Normal Adjusted Gamma UCL	0.0183	S Adjusted Gamma UCL	0.0165

Guidelines for the selection of a 95% UCL are provided to help the user to select the most appropriate recommendations are based upon data size, data distribution, and skewness. These recommendations are based upon the results of the simulation studies summarized in Singh, 2010. These guidelines will not cover all Real World data sets; for additional insight the user may refer to the literature.

Barium			
General Statistics			
Number of Observations	24	Number of Distinct Observations	24
		Number of Missing Observations	0
Minimum	13.5	Mean	52.63
Maximum	126	Median	51.85
SD	31.3	Std. Error of Mean	6.388
Coefficient of Variation	0.595	Skewness	0.897
Normal GOF Test			
Shapiro Wilk Test Statistic	0.914	Shapiro Wilk GOF Test	
Shapiro Wilk Critical Value	0.916	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.111	Lilliefors GOF Test	
95% Lilliefors Critical Value	0.177	Data appear Normal at 5% Significance Level	

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	63.58	d-CLT UCL (Chen-1995)	64.39
		3-d-t UCL (Johnson-1978)	63.77

Gamma GOF Test

A-D Test Statistic		Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.751	appear Gamma Distributed at 5% Significance	
K-S Test Statistic		Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.179	appear Gamma Distributed at 5% Significance	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.91	3-sigma star (bias corrected MLE)	2.574
Theta hat (MLE)	18.09	3-sigma star (bias corrected MLE)	20.45
nu hat (MLE)	139.7	nu star (bias corrected)	123.5
3-sigma E Mean (bias corrected)	52.63	MLE Sd (bias corrected)	32.81
		Chi Square Value (0.05)	98.87
Adjusted Level of Significance	0.0392	Adjusted Chi Square Value	97.32

Assuming Gamma Distribution

3-sigma UCL (use when n>=50))	65.76	1-sigma UCL (use when n<50)	66.81
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Lognormal GOF Test

Shapiro Wilk Test Statistic		Shapiro Wilk Lognormal GOF Test	
Shapiro Wilk Critical Value	0.916	appear Lognormal at 5% Significance	
Lilliefors Test Statistic		Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.177	appear Lognormal at 5% Significance	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.603	Mean of logged Data	3.782
Maximum of Logged Data	4.836	SD of logged Data	0.64

Assuming Lognormal Distribution

95% H-UCL	71.39	Chebyshev (MVUE) UCL	75.52
Chebyshev (MVUE) UCL	85.58	Chebyshev (MVUE) UCL	99.54
Chebyshev (MVUE) UCL	127		

Nonparametric Distribution Free UCL Statistics

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

Nonparametric Distribution Free UCLs

95% CLT UCL	63.14	95% Jackknife UCL	63.58
Standard Bootstrap UCL	63.05	95% Bootstrap-t UCL	65.23

5% Hall's Bootstrap UCL	65.82	Percentile Bootstrap UCL	63.11
95% BCA Bootstrap UCL	63.64		
ebyshev(Mean, Sd) UCL	71.79	ebyshev(Mean, Sd) UCL	80.48
ebyshev(Mean, Sd) UCL	92.52	ebyshev(Mean, Sd) UCL	116.2

### Suggested UCL to Use

95% Student's-t UCL 63.58

data set follows an approximate (e.g., normal) distribution passing one of the suggested to use a UCL based upon a distribution (e.g., gamma) passing bc

ing the selection of a 95% UCL are provided to help the user to select the n recommendations are based upon data size, data distribution, and skewness are based upon the results of the simulation studies summarized in Singh, will not cover all Real World data sets; for additional insight the user may

## Chromium

### General Statistics

Number of Observations	24	Number of Distinct Observations	22
		Number of Missing Observations	0
Minimum	1.83	Mean	6.055
Maximum	19.1	Median	5.17
SD	4.151	Std. Error of Mean	0.847
Coefficient of Variation	0.685	Skewness	1.929

### Normal GOF Test

Shapiro Wilk Test Statistic	0.785	<b>Shapiro Wilk GOF Test</b>
Shapiro Wilk Critical Value	0.916	data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.241	<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% Student's-t UCL	7.507	d-CLT UCL (Chen-1995)	7.805
		Adjusted-t UCL (Johnson-1978)	7.563

### Gamma GOF Test

A-D Test Statistic	0.652	<b>Anderson-Darling Gamma GOF Test</b>
5% A-D Critical Value	0.751	data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.159	<b>Kolmogorov-Smirnov Gamma GOF Test</b>
5% K-S Critical Value	0.179	data appear Gamma Distributed at 5% Significance Level

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

### Gamma Statistics

k hat (MLE)	3.052	star (bias corrected MLE)	2.699
Theta hat (MLE)	1.984	star (bias corrected MLE)	2.244
nu hat (MLE)	146.5	nu star (bias corrected)	129.5
ME Mean (bias corrected)	6.055	MLE Sd (bias corrected)	3.686
		Chi Square Value (0.05)	104.2
Adjusted Level of Significance	0.0392	Adjusted Chi Square Value	102.6

#### Assuming Gamma Distribution

95% UCL (use when n>=50)	7.524	95% UCL (use when n<50)	7.641
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#### Lognormal GOF Test

Shapiro Wilk Test Statistic	0.965	<b>Shapiro Wilk Lognormal GOF Test</b>	
Shapiro Wilk Critical Value	0.916	appear Lognormal at 5% Significance	
Lilliefors Test Statistic	0.12	<b>Lilliefors Lognormal GOF Test</b>	
95% Lilliefors Critical Value	0.177	appear Lognormal at 5% Significance	

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

#### Lognormal Statistics

Minimum of Logged Data	0.604	Mean of logged Data	1.628
Maximum of Logged Data	2.95	SD of logged Data	0.576

#### Assuming Lognormal Distribution

95% H-UCL	7.69	Chebyshev (MVUE) UCL	8.178
Chebyshev (MVUE) UCL	9.18	Chebyshev (MVUE) UCL	10.57
Chebyshev (MVUE) UCL	13.3		

#### Nonparametric Distribution Free UCL Statistics

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

#### Nonparametric Distribution Free UCLs

95% CLT UCL	7.449	95% Jackknife UCL	7.507
Standard Bootstrap UCL	7.44	95% Bootstrap-t UCL	8.139
95% Hall's Bootstrap UCL	8.621	Percentile Bootstrap UCL	7.51
95% BCA Bootstrap UCL	7.65		
Chebyshev(Mean, Sd) UCL	8.597	Chebyshev(Mean, Sd) UCL	9.748
Chebyshev(Mean, Sd) UCL	11.35	Chebyshev(Mean, Sd) UCL	14.48

#### Suggested UCL to Use

95% Adjusted Gamma UCL	7.641
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The selection of a 95% UCL are provided to help the user to select the most appropriate recommendations are based upon data size, data distribution, and skewness. These recommendations are based upon the results of the simulation studies summarized in Singh, et al. (2019). This study will not cover all Real World data sets; for additional insight the user may

General Statistics			
Number of Observations	24	Number of Distinct Observations	24
		Number of Missing Observations	0
Minimum	1.06	Mean	4.917
Maximum	28.7	Median	3.645
SD	5.679	Std. Error of Mean	1.159
Coefficient of Variation	1.155	Skewness	3.524
Normal GOF Test			
Shapiro Wilk Test Statistic	0.581	Shapiro Wilk GOF Test	
Shapiro Wilk Critical Value	0.916	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.296	Lilliefors GOF Test	
95% 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	6.904	Normal-d-CLT UCL (Chen-1995)	7.715
		Normal-d-t UCL (Johnson-1978)	7.043
Gamma GOF Test			
A-D Test Statistic	0.888	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.76	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.18	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.181	Data appear Gamma Distributed at 5% Significance Level	
Detected data follow Appr. Gamma Distribution at 5% Significance Level			
Gamma Statistics			
Gamma k hat (MLE)	1.628	Gamma star (bias corrected MLE)	1.452
Gamma Theta hat (MLE)	3.02	Gamma star (bias corrected MLE)	3.386
Gamma nu hat (MLE)	78.14	Gamma nu star (bias corrected)	69.71
Gamma S.E. Mean (bias corrected)	4.917	Gamma MLE Sd (bias corrected)	4.08
		Chi Square Value (0.05)	51.49
Gamma p-Value at Level of Significance	0.0392	Gamma Adjusted Chi Square Value	50.39
Assuming Gamma Distribution			
Gamma 95% UCL (use when n>=50)	6.657	Gamma 95% UCL (use when n<50)	6.803
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.954	Shapiro Wilk Lognormal GOF Test	
Shapiro Wilk Critical Value	0.916	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.116	Lilliefors Lognormal GOF Test	
95% Lilliefors Critical Value	0.177	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			

Minimum of Logged Data	0.0583	Mean of logged Data	1.255
Maximum of Logged Data	3.357	SD of logged Data	0.768

Assuming Lognormal Distribution			
95% H-UCL	6.756	Chebyshev (MVUE) UCL	7.008
Chebyshev (MVUE) UCL	8.081	Chebyshev (MVUE) UCL	9.571
Chebyshev (MVUE) UCL	12.5		

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

Nonparametric Distribution Free UCLs			
95% CLT UCL	6.824	95% Jackknife UCL	6.904
Standard Bootstrap UCL	6.779	95% Bootstrap-t UCL	9.843
5% Hall's Bootstrap UCL	15.16	Percentile Bootstrap UCL	6.96
95% BCA Bootstrap UCL	7.753		
Chebyshev(Mean, Sd) UCL	8.395	Chebyshev(Mean, Sd) UCL	9.97
Chebyshev(Mean, Sd) UCL	12.16	Chebyshev(Mean, Sd) UCL	16.45

Suggested UCL to Use			
5% Adjusted Gamma UCL	6.803		

Data set follows an approximate (e.g., normal) distribution passing one of the tests  
 suggested to use a UCL based upon a distribution (e.g., gamma) passing both tests

The following selection of a 95% UCL are provided to help the user to select the most appropriate  
 recommendations are based upon data size, data distribution, and skewness. These  
 recommendations are based upon the results of the simulation studies summarized in Singh, et al.  
 These recommendations will not cover all Real World data sets; for additional insight the user may

Lead			
General Statistics			
Number of Observations	24	Number of Distinct Observations	24
		Number of Missing Observations	0
Minimum	3.14	Mean	8.591
Maximum	13.2	Median	9.5
SD	3.119	Std. Error of Mean	0.637
Coefficient of Variation	0.363	Skewness	-0.409
Normal GOF Test			
Shapiro Wilk Test Statistic	0.924	Shapiro Wilk GOF Test	
Shapiro Wilk Critical Value	0.916	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.167	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.177	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	9.683	d-CLT UCL (Chen-1995)	9.582
		z-d-t UCL (Johnson-1978)	9.674
Gamma GOF Test			
A-D Test Statistic	1.003	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.746	t Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.209	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.178	t Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	6.368	star (bias corrected MLE)	5.6
Theta hat (MLE)	1.349	star (bias corrected MLE)	1.534
nu hat (MLE)	305.7	nu star (bias corrected)	268.8
MLE Mean (bias corrected)	8.591	MLE Sd (bias corrected)	3.63
		Chi Square Value (0.05)	231.8
Adjusted Level of Significance	0.0392	Adjusted Chi Square Value	229.4
Assuming Gamma Distribution			
UCL (use when n>=50))	9.961	Lower UCL (use when n<50)	10.07
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.875	Shapiro Wilk Lognormal GOF Test	
Shapiro Wilk Critical Value	0.916	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.221	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.177	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.144	Mean of logged Data	2.07
Maximum of Logged Data	2.58	SD of logged Data	0.438
Assuming Lognormal Distribution			
95% H-UCL	10.4	Chebyshev (MVUE) UCL	11.09
Chebyshev (MVUE) UCL	12.18	Chebyshev (MVUE) UCL	13.69
Chebyshev (MVUE) UCL	16.65		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	9.639	95% Jackknife UCL	9.683
Standard Bootstrap UCL	9.631	95% Bootstrap-t UCL	9.603
5% Hall's Bootstrap UCL	9.577	Percentile Bootstrap UCL	9.597

95% BCA Bootstrap UCL	9.648		
ebyshev(Mean, Sd) UCL	10.5	ebyshev(Mean, Sd) UCL	11.37
ebyshev(Mean, Sd) UCL	12.57	ebyshev(Mean, Sd) UCL	14.93

### Suggested UCL to Use

95% Student's-t UCL      9.683

ng the selection of a 95% UCL are provided to help the user to select the n  
 ecommendations are based upon data size, data distribution, and skewness  
 are based upon the results of the simulation studies summarized in Singh,  
 will not cover all Real World data sets; for additional insight the user may

ely-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal,  
 en's and Johnson's methods provide adjustments for positively skewed

### Manganese

#### General Statistics

Number of Observations	24	Number of Distinct Observations	23
		Number of Missing Observations	0
Minimum	148	Mean	321.1
Maximum	494	Median	341
SD	100.6	Std. Error of Mean	20.53
Coefficient of Variation	0.313	Skewness	-0.164

#### Normal GOF Test

Shapiro Wilk Test Statistic	0.962	<b>Shapiro Wilk GOF Test</b>	
Shapiro Wilk Critical Value	0.916	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.112	<b>Lilliefors GOF Test</b>	
5% Lilliefors Critical Value	0.177	Data appear Normal at 5% Significance Level	

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

#### Assuming Normal Distribution

##### 95% Normal UCL

95% Student's-t UCL	356.3	<b>95% UCLs (Adjusted for Skewness)</b>	
		Standard-CLT UCL (Chen-1995)	354.1
		Standard-t UCL (Johnson-1978)	356.2

#### Gamma GOF Test

A-D Test Statistic	0.502	<b>Anderson-Darling Gamma GOF Test</b>	
5% A-D Critical Value	0.745	Data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.151	<b>Kolmogorov-Smirnov Gamma GOF Test</b>	
5% K-S Critical Value	0.178	Data appear Gamma Distributed at 5% Significance Level	

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

#### Gamma Statistics

Gamma k hat (MLE)	9.393	Gamma k star (bias corrected MLE)	8.247
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Theta hat (MLE)	34.18	star (bias corrected MLE)	38.93
nu hat (MLE)	450.9	nu star (bias corrected)	395.8
ME Mean (bias corrected)	321.1	MLE Sd (bias corrected)	111.8
		Chi Square Value (0.05)	350.7
Adjusted Level of Significance	0.0392	Adjusted Chi Square Value	347.8

#### Assuming Gamma Distribution

UCL (use when n>=50))	362.4	Gamma UCL (use when n<50)	365.5
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#### Lognormal GOF Test

Shapiro Wilk Test Statistic	0.928	<b>Shapiro Wilk Lognormal GOF Test</b>
Shapiro Wilk Critical Value	0.916	appear Lognormal at 5% Significance
Lilliefors Test Statistic	0.163	<b>Lilliefors Lognormal GOF Test</b>
95% Lilliefors Critical Value	0.177	appear Lognormal at 5% Significance

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

#### Lognormal Statistics

Minimum of Logged Data	4.997	Mean of logged Data	5.718
Maximum of Logged Data	6.203	SD of logged Data	0.35

#### Assuming Lognormal Distribution

95% H-UCL	370.4	Chebyshev (MVUE) UCL	393
Chebyshev (MVUE) UCL	425	Chebyshev (MVUE) UCL	469.3
Chebyshev (MVUE) UCL	556.5		

#### Nonparametric Distribution Free UCL Statistics

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

#### Nonparametric Distribution Free UCLs

95% CLT UCL	354.9	95% Jackknife UCL	356.3
Standard Bootstrap UCL	354.1	95% Bootstrap-t UCL	356.3
95% Hall's Bootstrap UCL	353.5	Percentile Bootstrap UCL	354.4
95% BCA Bootstrap UCL	352.9		
Chebyshev(Mean, Sd) UCL	382.7	Chebyshev(Mean, Sd) UCL	410.6
Chebyshev(Mean, Sd) UCL	449.3	Chebyshev(Mean, Sd) UCL	525.4

#### Suggested UCL to Use

95% Student's-t UCL	356.3
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Guidelines for the selection of a 95% UCL are provided to help the user to select the most appropriate UCL. The recommendations are based upon data size, data distribution, and skewness. The recommendations are based upon the results of the simulation studies summarized in Singh, et al. (2010). The recommendations will not cover all Real World data sets; for additional insight the user may refer to the literature.

**For highly-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, etc.) are recommended. Chen's and Johnson's methods provide adjustments for positively skewed data.**

## Perchlorate

### General Statistics

Number of Observations	24	Number of Distinct Observations	22
Number of Detects	8	Number of Non-Detects	16
Number of Distinct Detects	8	Number of Distinct Non-Detects	14
Minimum Detect	6.6200E-4	Minimum Non-Detect	0.00203
Maximum Detect	0.00254	Maximum Non-Detect	0.00234
Variance Detects	5.1514E-7	Percent Non-Detects	66.67%
Mean Detects	0.00131	SD Detects	7.1773E-4
Median Detects	9.7550E-4	CV Detects	0.547
Skewness Detects	0.819	Kurtosis Detects	-0.998
Mean of Logged Detects	-6.76	SD of Logged Detects	0.527

### Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.845	<b>Shapiro Wilk GOF Test</b>
Shapiro Wilk Critical Value	0.818	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.278	<b>Lilliefors GOF Test</b>
95% Lilliefors Critical Value	0.283	Data appear Normal at 5% Significance Level

### Detected Data appear Normal at 5% Significance Level

### Kolmogorov-Smirnov (KM) Statistics using Normal Critical Values and other Nonparametric

KM Mean	0.0012	1 Standard Error of Mean	2.1007E-4
KM SD	5.8023E-4	95% KM (BCA) UCL	0.00154
95% KM (t) UCL	0.00156	Percentile Bootstrap UCL	0.00155
95% KM (z) UCL	0.00154	95% KM Bootstrap t UCL	0.00196
90% KM Chebyshev UCL	0.00183	95% KM Chebyshev UCL	0.00211
95% KM Chebyshev UCL	0.00251	99% KM Chebyshev UCL	0.00329

### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.553	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.719	Data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.246	<b>Kolmogorov-Smirnov GOF Test</b>
5% K-S Critical Value	0.295	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)	4.158	kstar (bias corrected MLE)	2.682
Theta hat (MLE)	3.1583E-4	theta star (bias corrected MLE)	4.8962E-4
nu hat (MLE)	66.52	nu star (bias corrected)	42.91
Mean (detects)	0.00131		

### Gamma ROS Statistics using Imputed Non-Detects

Gamma ROS should not be used when data set has > 50% NDs with many tied observations at the detection limit. When kstar of detects is small such as <1.0, especially when the sample size is small, in such situations, GROS method may yield incorrect values of UCLs and Bias Correction Factors. This is especially true when the sample size is small.

d detected data, BTVs and UCLs may be computed using gamma distribu			
Minimum	6.6200E-4	Mean	0.0071
Maximum	0.01	Median	0.01
SD	0.0042	CV	0.591
k hat (MLE)	1.472	star (bias corrected MLE)	1.316
Theta hat (MLE)	0.00483	star (bias corrected MLE)	0.0054
nu hat (MLE)	70.67	nu star (bias corrected)	63.17
Level of Significance ( $\beta$ )	0.0392		
Square Value (63.17, $\alpha$ )	45.89	Square Value (63.17, $\beta$ )	44.85
3 $\sigma$ UCL (use when n $\geq$ 50)	0.00978	3 $\sigma$ UCL (use when n<50)	0.01

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0012	SD (KM)	5.8023E-4
Variance (KM)	3.3667E-7	SE of Mean (KM)	2.1007E-4
k hat (KM)	4.251	k star (KM)	3.747
nu hat (KM)	204	nu star (KM)	179.9
theta hat (KM)	2.8143E-4	theta star (KM)	3.1925E-4
5 gamma percentile (KM)	0.00166	5 gamma percentile (KM)	0.00202
95 gamma percentile (KM)	0.00236	95 gamma percentile (KM)	0.00308

Gamma Kaplan-Meier (KM) Statistics

Square Value (179.86, $\alpha$ )	149.8	Square Value (179.86, $\beta$ )	147.9
L-UCL (use when n $\geq$ 50)	0.00144	M-UCL (use when n<50)	0.00145

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.881	Shapiro Wilk GOF Test	
Shapiro Wilk Critical Value	0.818	Data appear Lognormal at 5% Signific	
Lilliefors Test Statistic	0.213	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.283	Data appear Lognormal at 5% Signific	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00112	Mean in Log Scale	-6.842
SD in Original Scale	4.2775E-4	SD in Log Scale	0.309
Normality of ROS data)	0.00127	Percentile Bootstrap UCL	0.00127
95% BCA Bootstrap UCL	0.00132	95% Bootstrap t UCL	0.00137
95% H-UCL (Log ROS)	0.00126		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-6.835	KM Geo Mean	0.00108
KM SD (logged)	0.45	Critical H Value (KM-Log)	1.937
Standard Error of Mean (logged)	0.168	95% H-UCL (KM -Log)	0.00143
KM SD (logged)	0.45	Critical H Value (KM-Log)	1.937
Standard Error of Mean (logged)	0.168		

DL/2 Statistics

DL/2 Normal	DL/2 Log-Transformed
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Mean in Original Scale	0.00117	Mean in Log Scale	-6.799
SD in Original Scale	4.1105E-4	SD in Log Scale	0.294
UCL (Assumes normality)	0.00131	95% H-Stat UCL	0.0013
not a recommended method, provided for comparisons and historical			

Nonparametric Distribution Free UCL Statistics			
Detected Data appear Normal Distributed at 5% Significance Level			
Suggested UCL to Use			
95% KM (t) UCL	0.00156		

The selection of a 95% UCL are provided to help the user to select the n  
 ecommendations are based upon data size, data distribution, and skewness  
 are based upon the results of the simulation studies summarized in Singh,  
 will not cover all Real World data sets; for additional insight the user may

## Uranium-234

General Statistics			
Number of Observations	24	Number of Distinct Observations	23
		Number of Missing Observations	0
Minimum	0.685	Mean	1.819
Maximum	15	Median	1.195
SD	2.847	Std. Error of Mean	0.581
Coefficient of Variation	1.565	Skewness	4.696

Normal GOF Test		
Shapiro Wilk Test Statistic	0.32	Shapiro Wilk GOF Test
Shapiro Wilk Critical Value	0.916	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.449	Lilliefors GOF Test
95% 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	2.815	Adjusted CLT UCL (Chen-1995)	3.37
		Adjusted t UCL (Johnson-1978)	2.908

Gamma GOF Test		
A-D Test Statistic	4.403	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.759	t Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.381	Imogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.181	t Gamma Distributed at 5% Significance Level
Data Not Gamma Distributed at 5% Significance Level		

Gamma Statistics			
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k hat (MLE)	1.691	star (bias corrected MLE)	1.507
Theta hat (MLE)	1.076	star (bias corrected MLE)	1.207
nu hat (MLE)	81.15	nu star (bias corrected)	72.34
E Mean (bias corrected)	1.819	MLE Sd (bias corrected)	1.482
		Chi Square Value (0.05)	53.75
ted Level of Significance	0.0392	ljusted Chi Square Value	52.63

#### Assuming Gamma Distribution

UCL (use when n>=50))	2.448	1a UCL (use when n<50)	2.5
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#### Lognormal GOF Test

hapiro Wilk Test Statistic	0.644	<b>Shapiro Wilk Lognormal GOF Test</b>	
Shapiro Wilk Critical Value	0.916	a Not Lognormal at 5% Significance L	
Lilliefors Test Statistic	0.297	<b>Lilliefors Lognormal GOF Test</b>	
% Lilliefors Critical Value	0.177	a Not Lognormal at 5% Significance L	

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

#### Lognormal Statistics

Minimum of Logged Data	-0.378	Mean of logged Data	0.274
Maximum of Logged Data	2.708	SD of logged Data	0.601

#### Assuming Lognormal Distribution

95% H-UCL	2.043	Chebyshev (MVUE) UCL	2.169
Chebyshev (MVUE) UCL	2.444	Chebyshev (MVUE) UCL	2.826
Chebyshev (MVUE) UCL	3.576		

#### Nonparametric Distribution Free UCL Statistics

#### Data do not follow a Discernible Distribution (0.05)

#### Nonparametric Distribution Free UCLs

95% CLT UCL	2.775	95% Jackknife UCL	2.815
Standard Bootstrap UCL	2.776	95% Bootstrap-t UCL	10.17
5% Hall's Bootstrap UCL	8.567	Percentile Bootstrap UCL	2.926
95% BCA Bootstrap UCL	3.62		
Chebyshev(Mean, Sd) UCL	3.562	Chebyshev(Mean, Sd) UCL	4.352
Chebyshev(Mean, Sd) UCL	5.448	Chebyshev(Mean, Sd) UCL	7.601

#### Suggested UCL to Use

Chebyshev (Mean, Sd) UCL	4.352
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ing the selection of a 95% UCL are provided to help the user to select the n  
recommendations are based upon data size, data distribution, and skewnes  
are based upon the results of the simulation studies summarized in Singh,  
will not cover all Real World data sets; for additional insight the user may

General Statistics			
Number of Observations	24	Number of Distinct Observations	24
Number of Detects	17	Number of Non-Detects	7
Number of Distinct Detects	17	Number of Distinct Non-Detects	7
Minimum Detect	0.0652	Minimum Non-Detect	0.0227
Maximum Detect	0.775	Maximum Non-Detect	0.0716
Variance Detects	0.0278	Percent Non-Detects	29.17%
Mean Detects	0.135	SD Detects	0.167
Median Detects	0.0923	CV Detects	1.236
Skewness Detects	3.973	Kurtosis Detects	16.1
Mean of Logged Detects	-2.259	SD of Logged Detects	0.568

#### Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.384	<b>Shapiro Wilk GOF Test</b>
Shapiro Wilk Critical Value	0.892	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.392	<b>Lilliefors GOF Test</b>
95% Lilliefors Critical Value	0.207	Detected Data Not Normal at 5% Significance Level

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

#### Empirical (KM) Statistics using Normal Critical Values and other Nonparametric

KM Mean	0.103	1 Standard Error of Mean	0.0305
KM SD	0.145	95% KM (BCA) UCL	0.168
95% KM (t) UCL	0.156	Percentile Bootstrap) UCL	0.159
95% KM (z) UCL	0.153	95% KM Bootstrap t UCL	0.256
90% KM Chebyshev UCL	0.195	95% KM Chebyshev UCL	0.236
95% KM Chebyshev UCL	0.294	99% KM Chebyshev UCL	0.407

#### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.966	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.749	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.364	<b>Kolmogorov-Smirnov GOF</b>
5% K-S Critical Value	0.212	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)	2.104	kstar (bias corrected MLE)	1.772
Theta hat (MLE)	0.0642	theta star (bias corrected MLE)	0.0762
nu hat (MLE)	71.54	nu star (bias corrected)	60.25
Mean (detects)	0.135		

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

Should not be used when data set has > 50% NDs with many tied observations at zero or when kstar of detects is small such as <1.0, especially when the sample size is small. In such situations, GROS method may yield incorrect values of UCLs and BTVs.

This is especially true when the sample size is small.

For detected data, BTVs and UCLs may be computed using gamma distribution.

Minimum	0.01	Mean	0.0985
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Maximum	0.775	Median	0.0813
SD	0.151	CV	1.53
k hat (MLE)	0.931	star (bias corrected MLE)	0.842
Theta hat (MLE)	0.106	star (bias corrected MLE)	0.117
nu hat (MLE)	44.67	nu star (bias corrected)	40.42
Level of Significance ( $\beta$ )	0.0392		
Square Value (40.42, $\alpha$ )	26.85	Square Value (40.42, $\beta$ )	26.07
UCL (use when $n \geq 50$ )	0.148	UCL (use when $n < 50$ )	0.153

#### Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.103	SD (KM)	0.145
Variance (KM)	0.021	SE of Mean (KM)	0.0305
k hat (KM)	0.506	k star (KM)	0.471
nu hat (KM)	24.29	nu star (KM)	22.59
theta hat (KM)	0.204	theta star (KM)	0.219
gamma percentile (KM)	0.169	gamma percentile (KM)	0.283
gamma percentile (KM)	0.405	gamma percentile (KM)	0.708

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

Square Value (22.59, $\alpha$ )	12.78	Square Value (22.59, $\beta$ )	12.26
L-UCL (use when $n \geq 50$ )	0.182	M-UCL (use when $n < 50$ )	0.19

#### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.644	Shapiro Wilk GOF Test	
Shapiro Wilk Critical Value	0.892	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.313	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.207	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	0.106	Mean in Log Scale	-2.57
SD in Original Scale	0.147	SD in Log Scale	0.687
normality of ROS data)	0.157	Percentile Bootstrap UCL	0.163
95% BCA Bootstrap UCL	0.198	95% Bootstrap t UCL	0.281
95% H-UCL (Log ROS)	0.132		

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

KM Mean (logged)	-2.681	KM Geo Mean	0.0685
KM SD (logged)	0.819	Critical H Value (KM-Log)	2.314
Standard Error of Mean (logged)	0.175	95% H-UCL (KM -Log)	0.142
KM SD (logged)	0.819	Critical H Value (KM-Log)	2.314
Standard Error of Mean (logged)	0.175		

#### DL/2 Statistics

##### DL/2 Normal

##### DL/2 Log-Transformed

Mean in Original Scale	0.102	Mean in Log Scale	-2.74
SD in Original Scale	0.149	SD in Log Scale	0.938

UCL (Assumes normality) 0.154 95% H-Stat UCL 0.162  
 not a recommended method, provided for comparisons and historical

### Nonparametric Distribution Free UCL Statistics

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

#### Suggested UCL to Use

% KM (Chebyshev) UCL 0.236

ing the selection of a 95% UCL are provided to help the user to select the n  
 ecommendations are based upon data size, data distribution, and skewness  
 are based upon the results of the simulation studies summarized in Singh,  
 will not cover all Real World data sets; for additional insight the user may

### Uranium-238

#### General Statistics

Number of Observations	24	Number of Distinct Observations	21
		Number of Missing Observations	0
Minimum	0.717	Mean	1.843
Maximum	15.4	Median	1.235
SD	2.921	Std. Error of Mean	0.596
Coefficient of Variation	1.585	Skewness	4.731

#### Normal GOF Test

Shapiro Wilk Test Statistic	0.309	<b>Shapiro Wilk GOF Test</b>
Shapiro Wilk Critical Value	0.916	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.47	<b>Lilliefors GOF Test</b>
% 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% Student's-t UCL	2.865	<b>95% UCLs (Adjusted for Skewness)</b>	
		Adjusted-CLT UCL (Chen-1995)	3.439
		Adjusted-t UCL (Johnson-1978)	2.961

#### Gamma GOF Test

A-D Test Statistic	4.686	<b>Anderson-Darling Gamma GOF Test</b>
5% A-D Critical Value	0.759	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.431	<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)	1.693	Star (bias corrected MLE)	1.509
Theta hat (MLE)	1.088	Star (bias corrected MLE)	1.221

nu hat (MLE)	81.28	nu star (bias corrected)	72.45
MLE Mean (bias corrected)	1.843	MLE Sd (bias corrected)	1.5
		Chi Square Value (0.05)	53.85
Adjusted Level of Significance	0.0392	Adjusted Chi Square Value	52.72

### Assuming Gamma Distribution

UCL (use when n>=50))	2.479	Gamma UCL (use when n<50)	2.532
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### Lognormal GOF Test

Shapiro Wilk Test Statistic	0.613	<b>Shapiro Wilk Lognormal GOF Test</b>	
Shapiro Wilk Critical Value	0.916	α Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.361	<b>Lilliefors Lognormal GOF Test</b>	
95% Lilliefors Critical Value	0.177	α Not Lognormal at 5% Significance Level	

### Data Not Lognormal at 5% Significance Level

### Lognormal Statistics

Minimum of Logged Data	-0.333	Mean of logged Data	0.288
Maximum of Logged Data	2.734	SD of logged Data	0.593

### Assuming Lognormal Distribution

95% H-UCL	2.052	Chebyshev (MVUE) UCL	2.18
Chebyshev (MVUE) UCL	2.453	Chebyshev (MVUE) UCL	2.833
Chebyshev (MVUE) UCL	3.578		

### Nonparametric Distribution Free UCL Statistics

### Data do not follow a Discernible Distribution (0.05)

### Nonparametric Distribution Free UCLs

95% CLT UCL	2.824	95% Jackknife UCL	2.865
Standard Bootstrap UCL	2.796	95% Bootstrap-t UCL	11.28
95% Hall's Bootstrap UCL	9.366	Percentile Bootstrap UCL	3.003
95% BCA Bootstrap UCL	3.788		
Chebyshev(Mean, Sd) UCL	3.631	Chebyshev(Mean, Sd) UCL	4.442
Chebyshev(Mean, Sd) UCL	5.566	Chebyshev(Mean, Sd) UCL	7.775

### Suggested UCL to Use

Chebyshev (Mean, Sd) UCL	4.442
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The selection of a 95% UCL are provided to help the user to select the most appropriate recommendations are based upon data size, data distribution, and skewness. These recommendations are based upon the results of the simulation studies summarized in Singh, et al. (2018). This will not cover all Real World data sets; for additional insight the user may