

UCL Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.16/19/17 4:45:03 PM
From File	ProUCLinput_20-002(d)_0-1.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Barium

General Statistics

Total Number of Observations	8	Number of Distinct Obse	8
		Number of Missing Obse	0
Minimum	24.7	Mean	58.14
Maximum	86.7	Median	58.4
SD	21.64	Std. Error of Mean	7.65
Coefficient of Variation	0.372	Skewness	-0.211

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.959	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.818	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.181	Lilliefors GOF Test
5% Lilliefors Critical Value	0.283	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	72.63	95% Adjusted-CLT UC 70.11
		95% Modified-t UCL (J) 72.54

Gamma GOF Test

A-D Test Statistic	0.263	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.717	Detected data appear Gamma Distributed at 5% Significance
K-S Test Statistic	0.191	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.295	Detected data appear Gamma Distributed at 5% Significance

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.09	k star (bias corrected ML)	4.514
Theta hat (MLE)	8.2	Theta star (bias corrected)	12.88
nu hat (MLE)	113.4	nu star (bias corrected)	72.23
MLE Mean (bias corrected)	58.14	MLE Sd (bias corrected)	27.36
		Approximate Chi Square	53.66
Adjusted Level of Significance	0.0195	Adjusted Chi Square Val	49.63

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	78.26	95% Adjusted Gamma	84.61
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Lognormal GOF Test

Shapiro Wilk Test Statistic	0.93	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.818	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.169	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.283	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.207	Mean of logged Data	3.991
Maximum of Logged Data	4.462	SD of logged Data	0.427

Assuming Lognormal Distribution

95% H-UCL	84.97	90% Chebyshev (MVU	85.23
95% Chebyshev (MVUE) UCL	97.33	97.5% Chebyshev (MVL	114.1
99% Chebyshev (MVUE) UCL	147.1		

Nonparametric Distribution Free UCL Statistics

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

Nonparametric Distribution Free UCLs

95% CLT UCL	70.72	95% Jackknife UCL	72.63
95% Standard Bootstrap UCL	69.94	95% Bootstrap-t UCL	73.19
95% Hall's Bootstrap UCL	69.49	95% Percentile Bootstr	70.2
95% BCA Bootstrap UCL	70.13		
90% Chebyshev(Mean, Sd) UCL	81.09	95% Chebyshev(Mean	91.49
97.5% Chebyshev(Mean, Sd) UCL	105.9	99% Chebyshev(Mean	134.3

Suggested UCL to Use

95% Student's-t UCL	72.63
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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.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positively skewed data sets.

Chromium

General Statistics

Total Number of Observations	8	Number of Distinct Obse	8
		Number of Missing Obse	0
Minimum	2.56	Mean	8.939
Maximum	19.1	Median	6.16
SD	5.867	Std. Error of Mean	2.074
Coefficient of Variation	0.656	Skewness	0.823

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.

For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).

Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.884	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.818	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.291	Lilliefors GOF Test
5% Lilliefors Critical Value	0.283	Data Not 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	12.87	95% Adjusted-CLT UC 13
		95% Modified-t UCL (J 12.97

Gamma GOF Test

A-D Test Statistic	0.367	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.722	Detected data appear Gamma Distributed at 5% Significance	
K-S Test Statistic	0.245	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.297	Detected data appear Gamma Distributed at 5% Significance	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.717	k star (bias corrected ML	1.781
Theta hat (MLE)	3.29	Theta star (bias correcte	5.018
nu hat (MLE)	43.47	nu star (bias corrected)	28.5
MLE Mean (bias corrected)	8.939	MLE Sd (bias corrected)	6.698
		Approximate Chi Square	17.32
Adjusted Level of Significance	0.0195	Adjusted Chi Square Val	15.16

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when $n \geq 50$)	14.71	95% Adjusted Gamma	16.81
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Lognormal GOF Test

Shapiro Wilk Test Statistic	0.948	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.818	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.203	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.283	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.94	Mean of logged Data	1.995
Maximum of Logged Data	2.95	SD of logged Data	0.679

Assuming Lognormal Distribution

95% H-UCL	18.48	90% Chebyshev (MVU	15.51
95% Chebyshev (MVUE) UCL	18.48	97.5% Chebyshev (MVL	22.6
99% Chebyshev (MVUE) UCL	30.69		

Nonparametric Distribution Free UCL Statistics

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

Nonparametric Distribution Free UCLs

95% CLT UCL	12.35	95% Jackknife UCL	12.87
95% Standard Bootstrap UCL	12.11	95% Bootstrap-t UCL	14.63
95% Hall's Bootstrap UCL	12.35	95% Percentile Bootstr	12.3
95% BCA Bootstrap UCL	12.54		
90% Chebyshev(Mean, Sd) UCL	15.16	95% Chebyshev(Mean	17.98
97.5% Chebyshev(Mean, Sd) UCL	21.89	99% Chebyshev(Mean	29.58

Suggested UCL to Use

95% Student's-t UCL	12.87
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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.

Copper

General Statistics

Total Number of Observations	8	Number of Distinct Obse	8
		Number of Missing Obse	0

Minimum	2.27	Mean	8.72
Maximum	28.7	Median	5.28
SD	8.695	Std. Error of Mean	3.074
Coefficient of Variation	0.997	Skewness	2.152

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.727	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.818	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.272	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.283	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	14.54	95% Adjusted-CLT UC	16.28
		95% Modified-t UCL (J	14.93

Gamma GOF Test

A-D Test Statistic	0.468	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.727	Detected data appear Gamma Distributed at 5% Significance	
K-S Test Statistic	0.245	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.298	Detected data appear Gamma Distributed at 5% Significance	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.711	k star (bias corrected ML	1.153
Theta hat (MLE)	5.096	Theta star (bias correcte	7.564
nu hat (MLE)	27.38	nu star (bias corrected)	18.45
MLE Mean (bias corrected)	8.72	MLE Sd (bias corrected)	8.121
		Approximate Chi Square	9.714
Adjusted Level of Significance	0.0195	Adjusted Chi Square Val	8.161

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	16.56	95% Adjusted Gamma	19.71
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Lognormal GOF Test

Shapiro Wilk Test Statistic	0.949	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.818	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.199	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.283	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.82	Mean of logged Data	1.846
Maximum of Logged Data	3.357	SD of logged Data	0.803

Assuming Lognormal Distribution

95% H-UCL	21.49	90% Chebyshev (MVU	15.56
95% Chebyshev (MVUE) UCL	18.84	97.5% Chebyshev (MVL	23.39
99% Chebyshev (MVUE) UCL	32.32		

Nonparametric Distribution Free UCL Statistics

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

Nonparametric Distribution Free UCLs

95% CLT UCL	13.78	95% Jackknife UCL	14.54
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95% Standard Bootstrap UCL	13.39	95% Bootstrap-t UCL	27.45
95% Hall's Bootstrap UCL	34.77	95% Percentile Bootstr	14.09
95% BCA Bootstrap UCL	16.02		
90% Chebyshev(Mean, Sd) UCL	17.94	95% Chebyshev(Mean	22.12
97.5% Chebyshev(Mean, Sd) UCL	27.92	99% Chebyshev(Mean	39.31

Suggested UCL to Use

95% Student's-t UCL 14.54

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	8	Number of Distinct Obse	8
		Number of Missing Obse	0
Minimum	6.57	Mean	10.11
Maximum	13.2	Median	9.675
SD	2.074	Std. Error of Mean	0.733
Coefficient of Variation	0.205	Skewness	-0.186

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.

For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).

Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.963	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.818	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.19	Lilliefors GOF Test
5% Lilliefors Critical Value	0.283	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	11.5	95% Adjusted-CLT UC 11.26
		95% Modified-t UCL (J 11.49

Gamma GOF Test

A-D Test Statistic	0.292	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.716	Detected data appear Gamma Distributed at 5% Significance
K-S Test Statistic	0.167	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.294	Detected data appear Gamma Distributed at 5% Significance

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	25.56	k star (bias corrected ML	16.06
Theta hat (MLE)	0.396	Theta star (bias correcte	0.63
nu hat (MLE)	408.9	nu star (bias corrected)	256.9
MLE Mean (bias corrected)	10.11	MLE Sd (bias corrected)	2.523
		Approximate Chi Square	220.8
Adjusted Level of Significance	0.0195	Adjusted Chi Square Val	212.3

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when $n \geq 50$)

11.76

95% Adjusted Gamma

12.23

Lognormal GOF Test

Shapiro Wilk Test Statistic
5% Shapiro Wilk Critical Value
Lilliefors Test Statistic
5% Lilliefors Critical Value

0.94
0.818
0.174
0.283

Shapiro Wilk Lognormal GOF Test

Data appear Lognormal at 5% Significance Level
Lilliefors Lognormal GOF Test
Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data
Maximum of Logged Data

1.883
2.58

Mean of logged Data
SD of logged Data

2.294
0.216

Assuming Lognormal Distribution

95% H-UCL
95% Chebyshev (MVUE) UCL
99% Chebyshev (MVUE) UCL

11.91
13.5
17.84

90% Chebyshev (MVU)
97.5% Chebyshev (MVL)

12.45
14.96

Nonparametric Distribution Free UCL Statistics

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

Nonparametric Distribution Free UCLs

95% CLT UCL
95% Standard Bootstrap UCL
95% Hall's Bootstrap UCL
95% BCA Bootstrap UCL
90% Chebyshev(Mean, Sd) UCL
97.5% Chebyshev(Mean, Sd) UCL

11.32
11.23
11.45
11.16
12.31
14.69

95% Jackknife UCL
95% Bootstrap-t UCL
95% Percentile Bootstr
95% Chebyshev(Mean
99% Chebyshev(Mean

11.5
11.45
11.21
13.31
17.41

Suggested UCL to Use

95% Student's-t UCL

11.5

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

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

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

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

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positively skewed data sets.

Uranium-234

General Statistics

Total Number of Observations
Minimum
Maximum
SD
Coefficient of Variation

8
0.688
15
4.839
1.53

Number of Distinct Obse
Number of Missing Obse
Mean
Median
Std. Error of Mean
Skewness

8
0
3.162
1.3
1.711
2.708

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.

For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).

Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic
5% Shapiro Wilk Critical Value
Lilliefors Test Statistic
5% Lilliefors Critical Value

0.534
0.818
0.386
0.283

Shapiro Wilk GOF Test

Data Not Normal at 5% Significance Level
Lilliefors GOF Test
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

6.403

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UC 7.726

95% Modified-t UCL (J 6.676

Gamma GOF Test

A-D Test Statistic

1.278

Anderson-Darling Gamma GOF Test

5% A-D Critical Value

0.735

Data Not Gamma Distributed at 5% Significance Level

K-S Test Statistic

0.382

Kolmogorov-Smirnov Gamma GOF Test

5% K-S Critical Value

0.301

Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)

1.028

k star (bias corrected ML 0.726

Theta hat (MLE)

3.076

Theta star (bias corrected 4.356

nu hat (MLE)

16.45

nu star (bias corrected) 11.62

MLE Mean (bias corrected)

3.162

MLE Sd (bias corrected) 3.711

Approximate Chi Square 4.975

Adjusted Level of Significance

0.0195

Adjusted Chi Square Val 3.933

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when $n \geq 50$)

7.383

95% Adjusted Gamma

9.338

Lognormal GOF Test

Shapiro Wilk Test Statistic

0.78

Shapiro Wilk Lognormal GOF Test

5% Shapiro Wilk Critical Value

0.818

Data Not Lognormal at 5% Significance Level

Lilliefors Test Statistic

0.333

Lilliefors Lognormal GOF Test

5% Lilliefors Critical Value

0.283

Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data

-0.374

Mean of logged Data 0.592

Maximum of Logged Data

2.708

SD of logged Data 0.953

Assuming Lognormal Distribution

95% H-UCL

9.369

90% Chebyshev (MVU

5.374

95% Chebyshev (MVUE) UCL

6.61

97.5% Chebyshev (MVL

8.326

99% Chebyshev (MVUE) UCL

11.7

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL

5.976

95% Jackknife UCL

6.403

95% Standard Bootstrap UCL

5.821

95% Bootstrap-t UCL

43.62

95% Hall's Bootstrap UCL

36.86

95% Percentile Bootstr

6.394

95% BCA Bootstrap UCL

8.164

90% Chebyshev(Mean, Sd) UCL

8.294

95% Chebyshev(Mean

10.62

97.5% Chebyshev(Mean, Sd) UCL

13.85

99% Chebyshev(Mean

20.18

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL

10.62

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.

General Statistics

Total Number of Observations	8	Number of Distinct Obse	8
Number of Detects	7	Number of Non-Detects	1
Number of Distinct Detects	7	Number of Distinct Non-I	1
Minimum Detect	0.0652	Minimum Non-Detect	0.0716
Maximum Detect	0.775	Maximum Non-Detect	0.0716
Variance Detects	0.0671	Percent Non-Detects	12.5%
Mean Detects	0.192	SD Detects	0.259
Median Detects	0.0923	CV Detects	1.347
Skewness Detects	2.56	Kurtosis Detects	6.633
Mean of Logged Detects	-2.096	SD of Logged Detects	0.868

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.56	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.803	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.404	Lilliefors GOF Test
5% Lilliefors Critical Value	0.304	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	0.177	KM Standard Error of Me	0.0871
KM SD	0.228	95% KM (BCA) UCL	0.346
95% KM (t) UCL	0.342	95% KM (Percentile Bc	0.34
95% KM (z) UCL	0.32	95% KM Bootstrap t U	1.762
90% KM Chebyshev UCL	0.438	95% KM Chebyshev UCL	0.556
97.5% KM Chebyshev UCL	0.721	99% KM Chebyshev UCL	1.043

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.118	Anderson-Darling GOF Test
5% A-D Critical Value	0.724	Detected Data Not Gamma Distributed at 5% Significance Le
K-S Test Statistic	0.331	Kolmogorov-Smirnov GOF
5% K-S Critical Value	0.318	Detected Data Not Gamma Distributed at 5% Significance Le

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.258	k star (bias corrected ML	0.814
Theta hat (MLE)	0.153	Theta star (bias correcte	0.236
nu hat (MLE)	17.61	nu star (bias corrected)	11.4
Mean (detects)	0.192		

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	0.17
Maximum	0.775	Median	0.0845
SD	0.248	CV	1.465
k hat (MLE)	0.918	k star (bias corrected ML	0.657
Theta hat (MLE)	0.185	Theta star (bias correcte	0.258
nu hat (MLE)	14.7	nu star (bias corrected)	10.52
Adjusted Level of Significance (β)	0.0195		
Approximate Chi Square Value (10.52, α)	4.268	Adjusted Chi Square Val	3.321
95% Gamma Approximate UCL (use when $n \geq 50$)	0.418	95% Gamma Adjusted U	0.537

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.177	SD (KM)	0.228
Variance (KM)	0.052	SE of Mean (KM)	0.0871
k hat (KM)	0.6	k star (KM)	0.458
nu hat (KM)	9.601	nu star (KM)	7.334
theta hat (KM)	0.294	theta star (KM)	0.385
80% gamma percentile (KM)	0.289	90% gamma percentile (0.487
95% gamma percentile (KM)	0.7	99% gamma percentile (1.23

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (7.33, α)	2.356	Adjusted Chi Square Val	1.707
95% Gamma Approximate KM-UCL (use when $n \geq 50$)	0.55	95% Gamma Adjusted	0.759

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.753	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.803	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.282	Lilliefors GOF Test
5% Lilliefors Critical Value	0.304	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.175	Mean in Log Scale	-2.203
SD in Original Scale	0.245	SD in Log Scale	0.859
95% t UCL (assumes normality of ROS data)	0.339	95% Percentile Bootstr	0.343
95% BCA Bootstrap UCL	0.431	95% Bootstrap t UCL	1.546
95% H-UCL (Log ROS)	0.436		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.171	KM Geo Mean	0.114
KM SD (logged)	0.778	95% Critical H Value (t	2.903
KM Standard Error of Mean (logged)	0.297	95% H-UCL (KM -Log)	0.363
KM SD (logged)	0.778	95% Critical H Value (t	2.903
KM Standard Error of Mean (logged)	0.297		

DL/2 Statistics

DL/2 Normal

Mean in Original Scale	0.173	Mean in Log Scale	-2.25
SD in Original Scale	0.246	SD in Log Scale	0.915
95% t UCL (Assumes normality)	0.338	95% H-Stat UCL	0.487

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

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL	0.363
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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	8	Number of Distinct Obse	8
		Number of Missing Obse	0
Minimum	0.771	Mean	3.216
Maximum	15.4	Median	1.375

SD	4.969	Std. Error of Mean	1.757
Coefficient of Variation	1.545	Skewness	2.73

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.523	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.818	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.39	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.283	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	6.545	95% Adjusted-CLT UC	7.918
		95% Modified-t UCL (J	6.827

Gamma GOF Test

A-D Test Statistic	1.357	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.735	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.395	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.301	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.032	k star (bias corrected ML	0.728
Theta hat (MLE)	3.117	Theta star (bias correcte	4.416
nu hat (MLE)	16.51	nu star (bias corrected)	11.65
MLE Mean (bias corrected)	3.216	MLE Sd (bias corrected)	3.769
		Approximate Chi Square	4.999
Adjusted Level of Significance	0.0195	Adjusted Chi Square Val	3.955

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	7.497	95% Adjusted Gamma	9.477
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Lognormal GOF Test

Shapiro Wilk Test Statistic	0.754	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.818	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.353	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.283	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.26	Mean of logged Data	0.611
Maximum of Logged Data	2.734	SD of logged Data	0.94

Assuming Lognormal Distribution

95% H-UCL	9.182	90% Chebyshev (MVU	5.387
95% Chebyshev (MVUE) UCL	6.618	97.5% Chebyshev (MVL	8.326
99% Chebyshev (MVUE) UCL	11.68		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	6.106	95% Jackknife UCL	6.545
95% Standard Bootstrap UCL	5.861	95% Bootstrap-t UCL	46.79
95% Hall's Bootstrap UCL	43.11	95% Percentile Bootstr	6.594

95% BCA Bootstrap UCL	8.318		
90% Chebyshev(Mean, Sd) UCL	8.487	95% Chebyshev(Mean	10.87
97.5% Chebyshev(Mean, Sd) UCL	14.19	99% Chebyshev(Mean	20.7

Suggested UCL to Use	
95% Chebyshev (Mean, Sd) UCL	10.87

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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