UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/13/2016 3:00:13 PM
From File	ProUCL input 01-007(a) 0-1, 0-5, 0-10_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Beryllium

General Statistics

Total Number of Observations	14	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	0.4	Mean	1.031
Maximum	3	Median	0.815
SD	0.718	Std. Error of Mean	0.192
Coefficient of Variation	0.696	Skewness	1.893

Normal GOF Test

Shapiro Wilk Test Statistic	0.78	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.874	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.27	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.226	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	1.37	95% Adjusted-CLT UCL (Chen-1995)	1.45
		95% Modified-t UCL (Johnson-1978)	1.386

Gamma GOF Test

A-D Test Statistic	0.591	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.742	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.208	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.23	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.078	k star (bias corrected MLE)	2.466
Theta hat (MLE)	0.335	Theta star (bias corrected MLE)	0.418
nu hat (MLE)	86.2	nu star (bias corrected)	69.06
MLE Mean (bias corrected)	1.031	MLE Sd (bias corrected)	0.656
		Approximate Chi Square Value (0.05)	50.93
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	48.87

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	1.398	95% Adjusted Gamma UCL (use when n<50)	1.457

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.941	**Shapiro Wilk Lognormal GOF Test**

53				5% Shapiro Wilk Critical Value		0.874		Data appear Lognormal at 5% Significance Level				
54				Lilliefors Test Statistic		0.167		**Lilliefors Lognormal GOF Test**				
55				5% Lilliefors Critical Value		0.226		Data appear Lognormal at 5% Significance Level				
56	**Data appear Lognormal at 5% Significance Level**											
57												
58	**Lognormal Statistics**											
59				Minimum of Logged Data		-0.916		Mean of logged Data				-0.141
60				Maximum of Logged Data		1.099		SD of logged Data				0.575
61												
62	**Assuming Lognormal Distribution**											
63				95% H-UCL		1.441		90% Chebyshev (MVUE) UCL				1.493
64				95% Chebyshev (MVUE) UCL		1.712		97.5% Chebyshev (MVUE) UCL				2.015
65				99% Chebyshev (MVUE) UCL		2.611						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
69												
70	**Nonparametric Distribution Free UCLs**											
71				95% CLT UCL		1.346		95% Jackknife UCL				1.37
72				95% Standard Bootstrap UCL		1.34		95% Bootstrap-t UCL				1.643
73				95% Hall's Bootstrap UCL		1.68		95% Percentile Bootstrap UCL				1.365
74				95% BCA Bootstrap UCL		1.445						
75				90% Chebyshev(Mean, Sd) UCL		1.606		95% Chebyshev(Mean, Sd) UCL				1.867
76				97.5% Chebyshev(Mean, Sd) UCL		2.228		99% Chebyshev(Mean, Sd) UCL				2.939
77												
78	**Suggested UCL to Use**											
79				95% Adjusted Gamma UCL		1.457						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												
86												
87	**Chromium**											
88												
89	**General Statistics**											
90				Total Number of Observations		16		Number of Distinct Observations				15
91								Number of Missing Observations				0
92				Minimum		1.33		Mean				8.968
93				Maximum		49.5		Median				6.15
94				SD		12.4		Std. Error of Mean				3.1
95				Coefficient of Variation		1.383		Skewness				2.75
96												
97	**Normal GOF Test**											
98				Shapiro Wilk Test Statistic		0.617		**Shapiro Wilk GOF Test**				
99				5% Shapiro Wilk Critical Value		0.887		Data Not Normal at 5% Significance Level				
100				Lilliefors Test Statistic		0.332		**Lilliefors GOF Test**				
101				5% Lilliefors Critical Value		0.213		Data Not Normal at 5% Significance Level				
102	**Data Not Normal at 5% Significance Level**											
103												
104	**Assuming Normal Distribution**											

105	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
106					95% Student's-t UCL	14.4					95% Adjusted-CLT UCL (Chen-1995)	16.34
107											95% Modified-t UCL (Johnson-1978)	14.76
108												
109	**Gamma GOF Test**											
110					A-D Test Statistic	0.916	**Anderson-Darling Gamma GOF Test**					
111					5% A-D Critical Value	0.763	Data Not Gamma Distributed at 5% Significance Level					
112					K-S Test Statistic	0.193	**Kolmogorov-Smirnov Gamma GOF Test**					
113					5% K-S Critical Value	0.221	Detected data appear Gamma Distributed at 5% Significance Level					
114	**Detected data follow Appr. Gamma Distribution at 5% Significance Level**											
115												
116	**Gamma Statistics**											
117					k hat (MLE)	0.997					k star (bias corrected MLE)	0.851
118					Theta hat (MLE)	8.999					Theta star (bias corrected MLE)	10.53
119					nu hat (MLE)	31.89					nu star (bias corrected)	27.24
120					MLE Mean (bias corrected)	8.968					MLE Sd (bias corrected)	9.719
121											Approximate Chi Square Value (0.05)	16.34
122					Adjusted Level of Significance	0.0335					Adjusted Chi Square Value	15.38
123												
124	**Assuming Gamma Distribution**											
125				95% Approximate Gamma UCL (use when n>=50)		14.95					95% Adjusted Gamma UCL (use when n<50)	15.88
126												
127	**Lognormal GOF Test**											
128					Shapiro Wilk Test Statistic	0.915	**Shapiro Wilk Lognormal GOF Test**					
129					5% Shapiro Wilk Critical Value	0.887	Data appear Lognormal at 5% Significance Level					
130					Lilliefors Test Statistic	0.185	**Lilliefors Lognormal GOF Test**					
131					5% Lilliefors Critical Value	0.213	Data appear Lognormal at 5% Significance Level					
132	**Data appear Lognormal at 5% Significance Level**											
133												
134	**Lognormal Statistics**											
135					Minimum of Logged Data	0.285					Mean of logged Data	1.614
136					Maximum of Logged Data	3.902					SD of logged Data	1.046
137												
138	**Assuming Lognormal Distribution**											
139					95% H-UCL	18.36					90% Chebyshev (MVUE) UCL	15.44
140					95% Chebyshev (MVUE) UCL	18.68					97.5% Chebyshev (MVUE) UCL	23.19
141					99% Chebyshev (MVUE) UCL	32.04						
142												
143	**Nonparametric Distribution Free UCL Statistics**											
144	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
145												
146	**Nonparametric Distribution Free UCLs**											
147					95% CLT UCL	14.07					95% Jackknife UCL	14.4
148					95% Standard Bootstrap UCL	13.94					95% Bootstrap-t UCL	25.01
149					95% Hall's Bootstrap UCL	39					95% Percentile Bootstrap UCL	14.36
150					95% BCA Bootstrap UCL	17.05						
151					90% Chebyshev(Mean, Sd) UCL	18.27					95% Chebyshev(Mean, Sd) UCL	22.48
152					97.5% Chebyshev(Mean, Sd) UCL	28.33					99% Chebyshev(Mean, Sd) UCL	39.81
153												
154	**Suggested UCL to Use**											
155					95% Adjusted Gamma UCL	15.88						
156												

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.

Nickel

General Statistics

Total Number of Observations	18	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	0.993	Mean	6.799
Maximum	39.5	Median	3.7
SD	9.658	Std. Error of Mean	2.276
Coefficient of Variation	1.421	Skewness	2.796

Normal GOF Test

Shapiro Wilk Test Statistic	0.59	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.354	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.202	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	10.76	95% Adjusted-CLT UCL (Chen-1995)	12.15
		95% Modified-t UCL (Johnson-1978)	11.01

Gamma GOF Test

A-D Test Statistic	1.224	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.766	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.233	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.209	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.047	k star (bias corrected MLE)	0.909
Theta hat (MLE)	6.494	Theta star (bias corrected MLE)	7.476
nu hat (MLE)	37.69	nu star (bias corrected)	32.74
MLE Mean (bias corrected)	6.799	MLE Sd (bias corrected)	7.129
		Approximate Chi Square Value (0.05)	20.66
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	19.74

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	10.77	95% Adjusted Gamma UCL (use when n<50)	11.28

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.928	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level

209				Lilliefors Test Statistic	0.147	**Lilliefors Lognormal GOF Test**						
210				5% Lilliefors Critical Value	0.202	Data appear Lognormal at 5% Significance Level						
211	**Data appear Lognormal at 5% Significance Level**											
212												
213	**Lognormal Statistics**											
214				Minimum of Logged Data	-0.00702	Mean of logged Data	1.368					
215				Maximum of Logged Data	3.676	SD of logged Data	0.97					
216												
217	**Assuming Lognormal Distribution**											
218				95% H-UCL	11.58	90% Chebyshev (MVUE) UCL	10.67					
219				95% Chebyshev (MVUE) UCL	12.75	97.5% Chebyshev (MVUE) UCL	15.64					
220				99% Chebyshev (MVUE) UCL	21.32							
221												
222	**Nonparametric Distribution Free UCL Statistics**											
223	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
224												
225	**Nonparametric Distribution Free UCLs**											
226				95% CLT UCL	10.54	95% Jackknife UCL	10.76					
227				95% Standard Bootstrap UCL	10.37	95% Bootstrap-t UCL	19.3					
228				95% Hall's Bootstrap UCL	25.71	95% Percentile Bootstrap UCL	10.78					
229				95% BCA Bootstrap UCL	12.4							
230				90% Chebyshev(Mean, Sd) UCL	13.63	95% Chebyshev(Mean, Sd) UCL	16.72					
231				97.5% Chebyshev(Mean, Sd) UCL	21.02	99% Chebyshev(Mean, Sd) UCL	29.45					
232												
233	**Suggested UCL to Use**											
234				95% H-UCL	11.58							
235												
236	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
237	Recommendations are based upon data size, data distribution, and skewness.											
238	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
239	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
240												
241	**ProUCL computes and outputs H-statistic based UCLs for historical reasons only.**											
242	**H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.**											
243	**It is therefore recommended to avoid the use of H-statistic based 95% UCLs.**											
244	**Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.**											
245												
246	**Selenium**											
247												
248	**General Statistics**											
249				Total Number of Observations	14	Number of Distinct Observations	12					
250				Number of Detects	10	Number of Non-Detects	4					
251				Number of Distinct Detects	8	Number of Distinct Non-Detects	4					
252				Minimum Detect	0.18	Minimum Non-Detect	0.51					
253				Maximum Detect	0.41	Maximum Non-Detect	0.6					
254				Variance Detects	0.00464	Percent Non-Detects	28.57%					
255				Mean Detects	0.292	SD Detects	0.0681					
256				Median Detects	0.31	CV Detects	0.233					
257				Skewness Detects	-0.162	Kurtosis Detects	-0.0925					
258				Mean of Logged Detects	-1.258	SD of Logged Detects	0.249					
259												
260	**Normal GOF Test on Detects Only**											

261				Shapiro Wilk Test Statistic	0.945	**Shapiro Wilk GOF Test**						
262				5% Shapiro Wilk Critical Value	0.842	Detected Data appear Normal at 5% Significance Level						
263				Lilliefors Test Statistic	0.204	**Lilliefors GOF Test**						
264				5% Lilliefors Critical Value	0.262	Detected Data appear Normal at 5% Significance Level						
265				**Detected Data appear Normal at 5% Significance Level**								
266												
267				**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**								
268				KM Mean	0.292	KM Standard Error of Mean	0.0215					
269				KM SD	0.0646	95% KM (BCA) UCL	0.325					
270				95% KM (t) UCL	0.33	95% KM (Percentile Bootstrap) UCL	0.326					
271				95% KM (z) UCL	0.327	95% KM Bootstrap t UCL	0.331					
272				90% KM Chebyshev UCL	0.357	95% KM Chebyshev UCL	0.386					
273				97.5% KM Chebyshev UCL	0.427	99% KM Chebyshev UCL	0.506					
274												
275				**Gamma GOF Tests on Detected Observations Only**								
276				A-D Test Statistic	0.464	**Anderson-Darling GOF Test**						
277				5% A-D Critical Value	0.725	Detected data appear Gamma Distributed at 5% Significance Level						
278				K-S Test Statistic	0.233	**Kolmogorov-Smirnov GOF**						
279				5% K-S Critical Value	0.266	Detected data appear Gamma Distributed at 5% Significance Level						
280				**Detected data appear Gamma Distributed at 5% Significance Level**								
281												
282				**Gamma Statistics on Detected Data Only**								
283				k hat (MLE)	18.99	k star (bias corrected MLE)	13.36					
284				Theta hat (MLE)	0.0154	Theta star (bias corrected MLE)	0.0219					
285				nu hat (MLE)	379.8	nu star (bias corrected)	267.2					
286				Mean (detects)	0.292							
287												
288				**Gamma ROS Statistics using Imputed Non-Detects**								
289				GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs								
290				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)								
291				For such situations, GROS method may yield incorrect values of UCLs and BTVs								
292				This is especially true when the sample size is small.								
293				For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates								
294				Minimum	0.18	Mean	0.291					
295				Maximum	0.41	Median	0.289					
296				SD	0.0567	CV	0.195					
297				k hat (MLE)	26.5	k star (bias corrected MLE)	20.87					
298				Theta hat (MLE)	0.011	Theta star (bias corrected MLE)	0.0139					
299				nu hat (MLE)	741.9	nu star (bias corrected)	584.3					
300				Adjusted Level of Significance (β)	0.0312							
301				Approximate Chi Square Value (584.27, α)	529.2	Adjusted Chi Square Value (584.27, β)	522.2					
302				95% Gamma Approximate UCL (use when n>=50)	0.321	95% Gamma Adjusted UCL (use when n<50)	0.325					
303												
304				**Estimates of Gamma Parameters using KM Estimates**								
305				Mean (KM)	0.292	SD (KM)	0.0646					
306				Variance (KM)	0.00418	SE of Mean (KM)	0.0215					
307				k hat (KM)	20.42	k star (KM)	16.09					
308				nu hat (KM)	571.7	nu star (KM)	450.5					
309				theta hat (KM)	0.0143	theta star (KM)	0.0181					
310				80% gamma percentile (KM)	0.351	90% gamma percentile (KM)	0.388					
311				95% gamma percentile (KM)	0.421	99% gamma percentile (KM)	0.487					
312												

313	**Gamma Kaplan-Meier (KM) Statistics**											
314					Approximate Chi Square Value (450.52, α)		402.3		Adjusted Chi Square Value (450.52, β)			396.3
315					95% Gamma Approximate KM-UCL (use when n>=50)		0.327		95% Gamma Adjusted KM-UCL (use when n<50)			0.332
316												
317	**Lognormal GOF Test on Detected Observations Only**											
318					Shapiro Wilk Test Statistic		0.922		**Shapiro Wilk GOF Test**			
319					5% Shapiro Wilk Critical Value		0.842		Detected Data appear Lognormal at 5% Significance Level			
320					Lilliefors Test Statistic		0.236		**Lilliefors GOF Test**			
321					5% Lilliefors Critical Value		0.262		Detected Data appear Lognormal at 5% Significance Level			
322	**Detected Data appear Lognormal at 5% Significance Level**											
323												
324	**Lognormal ROS Statistics Using Imputed Non-Detects**											
325					Mean in Original Scale		0.29		Mean in Log Scale			-1.258
326					SD in Original Scale		0.0568		SD in Log Scale			0.207
327					95% t UCL (assumes normality of ROS data)		0.317		95% Percentile Bootstrap UCL			0.314
328					95% BCA Bootstrap UCL		0.314		95% Bootstrap t UCL			0.315
329					95% H-UCL (Log ROS)		0.323					
330												
331	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
332					KM Mean (logged)		-1.258		KM Geo Mean			0.284
333					KM SD (logged)		0.236		95% Critical H Value (KM-Log)			1.844
334					KM Standard Error of Mean (logged)		0.0787		95% H-UCL (KM -Log)			0.33
335					KM SD (logged)		0.236		95% Critical H Value (KM-Log)			1.844
336					KM Standard Error of Mean (logged)		0.0787					
337												
338	**DL/2 Statistics**											
339					**DL/2 Normal**				**DL/2 Log-Transformed**			
340					Mean in Original Scale		0.286		Mean in Log Scale			-1.27
341					SD in Original Scale		0.0582		SD in Log Scale			0.211
342					95% t UCL (Assumes normality)		0.314		95% H-Stat UCL			0.319
343	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
344												
345	**Nonparametric Distribution Free UCL Statistics**											
346	**Detected Data appear Normal Distributed at 5% Significance Level**											
347												
348	**Suggested UCL to Use**											
349					95% KM (t) UCL		0.33					
350												
351	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
352	Recommendations are based upon data size, data distribution, and skewness.											
353	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
354	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
355												
356												
357	**Zinc**											
358												
359	**General Statistics**											
360					Total Number of Observations		12		Number of Distinct Observations			12
361									Number of Missing Observations			0
362					Minimum		16.6		Mean			35.53
363					Maximum		69.1		Median			32
364					SD		14.79		Std. Error of Mean			4.269

365				Coefficient of Variation	0.416						Skewness	1.135
366												
367					**Normal GOF Test**							
368				Shapiro Wilk Test Statistic	0.882	**Shapiro Wilk GOF Test**						
369				5% Shapiro Wilk Critical Value	0.859	Data appear Normal at 5% Significance Level						
370				Lilliefors Test Statistic	0.278	**Lilliefors GOF Test**						
371				5% Lilliefors Critical Value	0.243	Data Not Normal at 5% Significance Level						
372					**Data appear Approximate Normal at 5% Significance Level**							
373												
374					**Assuming Normal Distribution**							
375				**95% Normal UCL**				**95% UCLs (Adjusted for Skewness)**				
376				95% Student's-t UCL	43.19			95% Adjusted-CLT UCL (Chen-1995)	44.04			
377								95% Modified-t UCL (Johnson-1978)	43.43			
378												
379					**Gamma GOF Test**							
380				A-D Test Statistic	0.503	**Anderson-Darling Gamma GOF Test**						
381				5% A-D Critical Value	0.731	Detected data appear Gamma Distributed at 5% Significance Level						
382				K-S Test Statistic	0.23	**Kolmogorov-Smirnov Gamma GOF Test**						
383				5% K-S Critical Value	0.246	Detected data appear Gamma Distributed at 5% Significance Level						
384					**Detected data appear Gamma Distributed at 5% Significance Level**							
385												
386					**Gamma Statistics**							
387				k hat (MLE)	6.921			k star (bias corrected MLE)	5.246			
388				Theta hat (MLE)	5.133			Theta star (bias corrected MLE)	6.772			
389				nu hat (MLE)	166.1			nu star (bias corrected)	125.9			
390				MLE Mean (bias corrected)	35.53			MLE Sd (bias corrected)	15.51			
391								Approximate Chi Square Value (0.05)	101			
392				Adjusted Level of Significance	0.029			Adjusted Chi Square Value	97.59			
393												
394					**Assuming Gamma Distribution**							
395				95% Approximate Gamma UCL (use when n>=50))	44.29			95% Adjusted Gamma UCL (use when n<50)	45.83			
396												
397					**Lognormal GOF Test**							
398				Shapiro Wilk Test Statistic	0.943	**Shapiro Wilk Lognormal GOF Test**						
399				5% Shapiro Wilk Critical Value	0.859	Data appear Lognormal at 5% Significance Level						
400				Lilliefors Test Statistic	0.205	**Lilliefors Lognormal GOF Test**						
401				5% Lilliefors Critical Value	0.243	Data appear Lognormal at 5% Significance Level						
402					**Data appear Lognormal at 5% Significance Level**							
403												
404					**Lognormal Statistics**							
405				Minimum of Logged Data	2.809			Mean of logged Data	3.496			
406				Maximum of Logged Data	4.236			SD of logged Data	0.4			
407												
408					**Assuming Lognormal Distribution**							
409				95% H-UCL	45.61			90% Chebyshev (MVUE) UCL	47.96			
410				95% Chebyshev (MVUE) UCL	53.61			97.5% Chebyshev (MVUE) UCL	61.45			
411				99% Chebyshev (MVUE) UCL	76.85							
412												
413					**Nonparametric Distribution Free UCL Statistics**							
414					**Data appear to follow a Discernible Distribution at 5% Significance Level**							
415												
416					**Nonparametric Distribution Free UCLs**							

417					95% CLT UCL	42.55					95% Jackknife UCL	43.19
418					95% Standard Bootstrap UCL	42.19					95% Bootstrap-t UCL	46.2
419					95% Hall's Bootstrap UCL	46.99					95% Percentile Bootstrap UCL	42.72
420					95% BCA Bootstrap UCL	43.98						
421					90% Chebyshev(Mean, Sd) UCL	48.33					95% Chebyshev(Mean, Sd) UCL	54.13
422					97.5% Chebyshev(Mean, Sd) UCL	62.19					99% Chebyshev(Mean, Sd) UCL	78
423												
424					**Suggested UCL to Use**							
425					95% Student's-t UCL	43.19						
426												
427	When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test											
428	When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL											
429												
430	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
431	Recommendations are based upon data size, data distribution, and skewness.											
432	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
433	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
434												
435	**Bis(2-ethylhexyl)phthalate**											
436												
437	**General Statistics**											
438					Total Number of Observations	20					Number of Distinct Observations	17
439					Number of Detects	7					Number of Non-Detects	13
440					Number of Distinct Detects	7					Number of Distinct Non-Detects	10
441					Minimum Detect	0.14					Minimum Non-Detect	0.33
442					Maximum Detect	1.7					Maximum Non-Detect	0.394
443					Variance Detects	0.339					Percent Non-Detects	65%
444					Mean Detects	1.034					SD Detects	0.583
445					Median Detects	1.2					CV Detects	0.563
446					Skewness Detects	-0.497					Kurtosis Detects	-1.098
447					Mean of Logged Detects	-0.212					SD of Logged Detects	0.896
448												
449	**Normal GOF Test on Detects Only**											
450					Shapiro Wilk Test Statistic	0.941					**Shapiro Wilk GOF Test**	
451					5% Shapiro Wilk Critical Value	0.803					Detected Data appear Normal at 5% Significance Level	
452					Lilliefors Test Statistic	0.183					**Lilliefors GOF Test**	
453					5% Lilliefors Critical Value	0.304					Detected Data appear Normal at 5% Significance Level	
454	**Detected Data appear Normal at 5% Significance Level**											
455												
456	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**											
457					KM Mean	0.453					KM Standard Error of Mean	0.129
458					KM SD	0.533					95% KM (BCA) UCL	0.773
459					95% KM (t) UCL	0.675					95% KM (Percentile Bootstrap) UCL	0.729
460					95% KM (z) UCL	0.665					95% KM Bootstrap t UCL	0.671
461					90% KM Chebyshev UCL	0.839					95% KM Chebyshev UCL	1.014
462					97.5% KM Chebyshev UCL	1.256					99% KM Chebyshev UCL	1.733
463												
464	**Gamma GOF Tests on Detected Observations Only**											
465					A-D Test Statistic	0.453					**Anderson-Darling GOF Test**	
466					5% A-D Critical Value	0.714					Detected data appear Gamma Distributed at 5% Significance Level	
467					K-S Test Statistic	0.245					**Kolmogorov-Smirnov GOF**	
468					5% K-S Critical Value	0.315					Detected data appear Gamma Distributed at 5% Significance Level	

	A	B	C	D	E	F	G	H	I	J	K	L
469	**Detected data appear Gamma Distributed at 5% Significance Level**											
470												
471	**Gamma Statistics on Detected Data Only**											
472					k hat (MLE)	2.19			k star (bias corrected MLE)	1.346		
473					Theta hat (MLE)	0.472			Theta star (bias corrected MLE)	0.768		
474					nu hat (MLE)	30.65			nu star (bias corrected)	18.85		
475					Mean (detects)	1.034						
476												
477	**Gamma ROS Statistics using Imputed Non-Detects**											
478	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
479	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)											
480	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
481	This is especially true when the sample size is small.											
482	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
483					Minimum	0.01			Mean	0.429		
484					Maximum	1.7			Median	0.0821		
485					SD	0.567			CV	1.322		
486					k hat (MLE)	0.647			k star (bias corrected MLE)	0.583		
487					Theta hat (MLE)	0.663			Theta star (bias corrected MLE)	0.735		
488					nu hat (MLE)	25.88			nu star (bias corrected)	23.33		
489					Adjusted Level of Significance (β)	0.038						
490					Approximate Chi Square Value (23.33, α)	13.34			Adjusted Chi Square Value (23.33, β)	12.74		
491					95% Gamma Approximate UCL (use when n>=50)	0.75			95% Gamma Adjusted UCL (use when n<50)	0.785		
492												
493	**Estimates of Gamma Parameters using KM Estimates**											
494					Mean (KM)	0.453			SD (KM)	0.533		
495					Variance (KM)	0.284			SE of Mean (KM)	0.129		
496					k hat (KM)	0.723			k star (KM)	0.648		
497					nu hat (KM)	28.93			nu star (KM)	25.92		
498					theta hat (KM)	0.626			theta star (KM)	0.699		
499					80% gamma percentile (KM)	0.746			90% gamma percentile (KM)	1.158		
500					95% gamma percentile (KM)	1.585			99% gamma percentile (KM)	2.613		
501												
502	**Gamma Kaplan-Meier (KM) Statistics**											
503					Approximate Chi Square Value (25.92, α)	15.32			Adjusted Chi Square Value (25.92, β)	14.68		
504					95% Gamma Approximate KM-UCL (use when n>=50)	0.767			95% Gamma Adjusted KM-UCL (use when n<50)	0.8		
505												
506	**Lognormal GOF Test on Detected Observations Only**											
507					Shapiro Wilk Test Statistic	0.83			**Shapiro Wilk GOF Test**			
508					5% Shapiro Wilk Critical Value	0.803			Detected Data appear Lognormal at 5% Significance Level			
509					Lilliefors Test Statistic	0.241			**Lilliefors GOF Test**			
510					5% Lilliefors Critical Value	0.304			Detected Data appear Lognormal at 5% Significance Level			
511	**Detected Data appear Lognormal at 5% Significance Level**											
512												
513	**Lognormal ROS Statistics Using Imputed Non-Detects**											
514					Mean in Original Scale	0.467			Mean in Log Scale	-1.294		
515					SD in Original Scale	0.54			SD in Log Scale	0.996		
516					95% t UCL (assumes normality of ROS data)	0.676			95% Percentile Bootstrap UCL	0.675		
517					95% BCA Bootstrap UCL	0.706			95% Bootstrap t UCL	0.759		
518					95% H-UCL (Log ROS)	0.821						
519												
520	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											

521				KM Mean (logged)	-1.352					KM Geo Mean	0.259
522				KM SD (logged)	0.97					95% Critical H Value (KM-Log)	2.591
523				KM Standard Error of Mean (logged)	0.234					95% H-UCL (KM -Log)	0.737
524				KM SD (logged)	0.97					95% Critical H Value (KM-Log)	2.591
525				KM Standard Error of Mean (logged)	0.234						
526											
527					**DL/2 Statistics**						
528				**DL/2 Normal**						**DL/2 Log-Transformed**	
529				Mean in Original Scale	0.476					Mean in Log Scale	-1.205
530				SD in Original Scale	0.533					SD in Log Scale	0.902
531				95% t UCL (Assumes normality)	0.682					95% H-Stat UCL	0.755
532				**DL/2 is not a recommended method, provided for comparisons and historical reasons**							
533											
534					**Nonparametric Distribution Free UCL Statistics**						
535					**Detected Data appear Normal Distributed at 5% Significance Level**						
536											
537					**Suggested UCL to Use**						
538				95% KM (t) UCL	0.675						
539											
540					Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.						
541					Recommendations are based upon data size, data distribution, and skewness.						
542					These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).						
543					However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.						
544											
545	**Plutonium-239/240**										
546											
547					**General Statistics**						
548				Total Number of Observations	36					Number of Distinct Observations	36
549				Number of Detects	34					Number of Non-Detects	2
550				Number of Distinct Detects	34					Number of Distinct Non-Detects	2
551				Minimum Detect	0.101					Minimum Non-Detect	0.0308
552				Maximum Detect	25.6					Maximum Non-Detect	0.037
553				Variance Detects	57.29					Percent Non-Detects	5.556%
554				Mean Detects	6.004					SD Detects	7.569
555				Median Detects	3.075					CV Detects	1.261
556				Skewness Detects	1.467					Kurtosis Detects	1.05
557				Mean of Logged Detects	0.709					SD of Logged Detects	1.725
558											
559					**Normal GOF Test on Detects Only**						
560				Shapiro Wilk Test Statistic	0.752					**Shapiro Wilk GOF Test**	
561				5% Shapiro Wilk Critical Value	0.933					Detected Data Not Normal at 5% Significance Level	
562				Lilliefors Test Statistic	0.218					**Lilliefors GOF Test**	
563				5% Lilliefors Critical Value	0.15					Detected Data Not Normal at 5% Significance Level	
564					**Detected Data Not Normal at 5% Significance Level**						
565											
566					**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**						
567				KM Mean	5.672					KM Standard Error of Mean	1.248
568				KM SD	7.375					95% KM (BCA) UCL	7.91
569				95% KM (t) UCL	7.78					95% KM (Percentile Bootstrap) UCL	7.718
570				95% KM (z) UCL	7.724					95% KM Bootstrap t UCL	8.269
571				90% KM Chebyshev UCL	9.415					95% KM Chebyshev UCL	11.11
572				97.5% KM Chebyshev UCL	13.46					99% KM Chebyshev UCL	18.09

	A	B	C	D	E	F	G	H	I	J	K	L
573												
574	**Gamma GOF Tests on Detected Observations Only**											
575					A-D Test Statistic	0.895	**Anderson-Darling GOF Test**					
576					5% A-D Critical Value	0.805	Detected Data Not Gamma Distributed at 5% Significance Level					
577					K-S Test Statistic	0.172	**Kolmogorov-Smirnov GOF**					
578					5% K-S Critical Value	0.159	Detected Data Not Gamma Distributed at 5% Significance Level					
579	**Detected Data Not Gamma Distributed at 5% Significance Level**											
580												
581	**Gamma Statistics on Detected Data Only**											
582					k hat (MLE)	0.574	k star (bias corrected MLE)					0.543
583					Theta hat (MLE)	10.46	Theta star (bias corrected MLE)					11.06
584					nu hat (MLE)	39.03	nu star (bias corrected)					36.92
585					Mean (detects)	6.004						
586												
587	**Gamma ROS Statistics using Imputed Non-Detects**											
588	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
589	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)											
590	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
591	This is especially true when the sample size is small.											
592	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
593					Minimum	0.01	Mean					5.671
594					Maximum	25.6	Median					1.95
595					SD	7.48	CV					1.319
596					k hat (MLE)	0.483	k star (bias corrected MLE)					0.461
597					Theta hat (MLE)	11.74	Theta star (bias corrected MLE)					12.29
598					nu hat (MLE)	34.79	nu star (bias corrected)					33.22
599					Adjusted Level of Significance (β)	0.0428						
600					Approximate Chi Square Value (33.22, α)	21.04	Adjusted Chi Square Value (33.22, β)					20.6
601					95% Gamma Approximate UCL (use when n>=50)	8.952	95% Gamma Adjusted UCL (use when n<50)					9.144
602												
603	**Estimates of Gamma Parameters using KM Estimates**											
604					Mean (KM)	5.672	SD (KM)					7.375
605					Variance (KM)	54.39	SE of Mean (KM)					1.248
606					k hat (KM)	0.592	k star (KM)					0.561
607					nu hat (KM)	42.59	nu star (KM)					40.37
608					theta hat (KM)	9.589	theta star (KM)					10.12
609					80% gamma percentile (KM)	9.345	90% gamma percentile (KM)					14.97
610					95% gamma percentile (KM)	20.91	99% gamma percentile (KM)					35.36
611												
612	**Gamma Kaplan-Meier (KM) Statistics**											
613					Approximate Chi Square Value (40.37, α)	26.81	Adjusted Chi Square Value (40.37, β)					26.31
614					95% Gamma Approximate KM-UCL (use when n>=50)	8.54	95% Gamma Adjusted KM-UCL (use when n<50)					8.703
615												
616	**Lognormal GOF Test on Detected Observations Only**											
617					Shapiro Wilk Test Statistic	0.915	**Shapiro Wilk GOF Test**					
618					5% Shapiro Wilk Critical Value	0.933	Detected Data Not Lognormal at 5% Significance Level					
619					Lilliefors Test Statistic	0.16	**Lilliefors GOF Test**					
620					5% Lilliefors Critical Value	0.15	Detected Data Not Lognormal at 5% Significance Level					
621	**Detected Data Not Lognormal at 5% Significance Level**											
622												
623	**Lognormal ROS Statistics Using Imputed Non-Detects**											
624					Mean in Original Scale	5.672	Mean in Log Scale					0.485

625					SD in Original Scale	7.479					SD in Log Scale	1.919
626					95% t UCL (assumes normality of ROS data)	7.778					95% Percentile Bootstrap UCL	7.727
627					95% BCA Bootstrap UCL	7.956					95% Bootstrap t UCL	8.401
628					95% H-UCL (Log ROS)	32.86						
629												
630	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
631					KM Mean (logged)	0.476					KM Geo Mean	1.61
632					KM SD (logged)	1.91					95% Critical H Value (KM-Log)	3.584
633					KM Standard Error of Mean (logged)	0.323					95% H-UCL (KM -Log)	31.72
634					KM SD (logged)	1.91					95% Critical H Value (KM-Log)	3.584
635					KM Standard Error of Mean (logged)	0.323						
636												
637	**DL/2 Statistics**											
638	**DL/2 Normal**						**DL/2 Log-Transformed**					
639					Mean in Original Scale	5.671					Mean in Log Scale	0.443
640					SD in Original Scale	7.48					SD in Log Scale	2.011
641					95% t UCL (Assumes normality)	7.777					95% H-Stat UCL	41.8
642	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
643												
644	**Nonparametric Distribution Free UCL Statistics**											
645	**Data do not follow a Discernible Distribution at 5% Significance Level**											
646												
647	**Suggested UCL to Use**											
648					95% KM (Chebyshev) UCL	11.11						
649												
650	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
651	Recommendations are based upon data size, data distribution, and skewness.											
652	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
653	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
654												