UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/13/2016 2:30:32 PM
From File	ProUCL input 01-006(b) 0-1, 0-5, 0-10_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Plutonium-238

General Statistics

Total Number of Observations	35	Number of Distinct Observations	33
Number of Detects	6	Number of Non-Detects	29
Number of Distinct Detects	6	Number of Distinct Non-Detects	27
Minimum Detect	0.0175	Minimum Non-Detect	-0.017
Maximum Detect	0.0684	Maximum Non-Detect	0.34
Variance Detects	3.0114E-4	Percent Non-Detects	82.86%
Mean Detects	0.0385	SD Detects	0.0174
Median Detects	0.0371	CV Detects	0.451
Skewness Detects	0.936	Kurtosis Detects	1.559

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.947	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.224	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.325	Detected Data appear Normal at 5% Significance Level
Detected Data appear Normal at 5% Significance Level		

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	-0.00721	KM Standard Error of Mean	0.00416
KM SD	0.0222	95% KM (BCA) UCL	0.00542
95% KM (t) UCL	-1.698E-4	95% KM (Percentile Bootstrap) UCL	0.00299
95% KM (z) UCL	-3.617E-4	95% KM Bootstrap t UCL	-0.00317
90% KM Chebyshev UCL	0.00528	95% KM Chebyshev UCL	0.0109
97.5% KM Chebyshev UCL	0.0188	99% KM Chebyshev UCL	0.0342

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.185	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.698	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.166	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.333	Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level		

Gamma Statistics on Detected Data Only

k hat (MLE)	6.015	k star (bias corrected MLE)	3.119
Theta hat (MLE)	0.00639	Theta star (bias corrected MLE)	0.0123
nu hat (MLE)	72.18	nu star (bias corrected)	37.42
Mean (detects)	0.0385		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	-0.00721	SD (KM)	0.0222

	A	B	C	D	E	F	G	H	I	J	K	L
53					Variance (KM)	4.9140E-4				SE of Mean (KM)		0.00416
54					k hat (KM)	0.106				k star (KM)		0.116
55					nu hat (KM)	7.409				nu star (KM)		8.107
56					theta hat (KM)	-0.0681				theta star (KM)		-0.0623
57			80% gamma percentile (KM)			-0.00607			90% gamma percentile (KM)			-0.0202
58			95% gamma percentile (KM)			-0.0413			99% gamma percentile (KM)			-0.106
59												
60					Gamma Kaplan-Meier (KM) Statistics							
61									Adjusted Level of Significance (β)			0.0425
62			Approximate Chi Square Value (8.11, α)			2.797			Adjusted Chi Square Value (8.11, β)			2.651
63		95% Gamma Approximate KM-UCL (use when n>=50)				-0.0209			95% Gamma Adjusted KM-UCL (use when n<50)			-0.0221
64												
65				Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution								
66					KM Mean (logged)	N/A					KM Geo Mean	N/A
67					KM SD (logged)	N/A				95% Critical H Value (KM-Log)		N/A
68			KM Standard Error of Mean (logged)			N/A				95% H-UCL (KM -Log)		N/A
69					KM SD (logged)	N/A				95% Critical H Value (KM-Log)		N/A
70			KM Standard Error of Mean (logged)			N/A						
71												
72					DL/2 Statistics							
73					Mean in Original Scale	0.0122					SD in Original Scale	0.0318
74				95% t UCL (Assumes normality)		0.0213						
75				DL/2 is not a recommended method, provided for comparisons and historical reasons								
76												
77					Nonparametric Distribution Free UCL Statistics							
78				Detected Data appear Normal Distributed at 5% Significance Level								
79												
80					Suggested UCL to Use							
81					95% KM (t) UCL	-1.698E-4						
82												
83		Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.										
84				Recommendations are based upon data size, data distribution, and skewness.								
85			These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).										
86		However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.										
87												
88	Plutonium-239/240											
89												
90					General Statistics							
91			Total Number of Observations			35			Number of Distinct Observations			34
92				Number of Detects		34				Number of Non-Detects		1
93			Number of Distinct Detects			33			Number of Distinct Non-Detects			1
94				Minimum Detect		0.0618				Minimum Non-Detect		0.00861
95				Maximum Detect		24.4				Maximum Non-Detect		0.00861
96				Variance Detects		24.17				Percent Non-Detects		2.857%
97				Mean Detects		3.494					SD Detects	4.917
98				Median Detects		1.63					CV Detects	1.407
99				Skewness Detects		2.732					Kurtosis Detects	9.334
100				Mean of Logged Detects		0.385				SD of Logged Detects		1.431
101												
102					Normal GOF Test on Detects Only							
103			Shapiro Wilk Test Statistic			0.686			Shapiro Wilk GOF Test			
104			5% Shapiro Wilk Critical Value			0.933			Detected Data Not Normal at 5% Significance Level			

	Lilliefors Test Statistic	0.243	Lilliefors GOF Test		
	5% Lilliefors Critical Value	0.15	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	3.395	KM Standard Error of Mean	0.825
	KM SD	4.809	95% KM (BCA) UCL	4.799
	95% KM (t) UCL	4.79	95% KM (Percentile Bootstrap) UCL	4.951
	95% KM (z) UCL	4.752	95% KM Bootstrap t UCL	5.617
	90% KM Chebyshev UCL	5.87	95% KM Chebyshev UCL	6.991
	97.5% KM Chebyshev UCL	8.548	99% KM Chebyshev UCL	11.6
	Gamma GOF Tests on Detected Observations Only			
	A-D Test Statistic	0.668	**Anderson-Darling GOF Test**	
	5% A-D Critical Value	0.793	Detected data appear Gamma Distributed at 5% Significance Level	
	K-S Test Statistic	0.154	**Kolmogorov-Smirnov GOF**	
	5% K-S Critical Value	0.157	Detected data appear Gamma Distributed at 5% Significance Level	
	Detected data appear Gamma Distributed at 5% Significance Level			
	Gamma Statistics on Detected Data Only			
	k hat (MLE)	0.698	k star (bias corrected MLE)	0.656
	Theta hat (MLE)	5.005	Theta star (bias corrected MLE)	5.325
	nu hat (MLE)	47.48	nu star (bias corrected)	44.62
	Mean (detects)	3.494		
	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	3.395
	Maximum	24.4	Median	1.59
	SD	4.879	CV	1.437
	k hat (MLE)	0.627	k star (bias corrected MLE)	0.592
	Theta hat (MLE)	5.417	Theta star (bias corrected MLE)	5.734
	nu hat (MLE)	43.87	nu star (bias corrected)	41.45
	Adjusted Level of Significance (β)	0.0425		
	Approximate Chi Square Value (41.45, α)	27.69	Adjusted Chi Square Value (41.45, β)	27.16
	95% Gamma Approximate UCL (use when n>=50)	5.081	95% Gamma Adjusted UCL (use when n<50)	5.181
	Estimates of Gamma Parameters using KM Estimates			
	Mean (KM)	3.395	SD (KM)	4.809
	Variance (KM)	23.13	SE of Mean (KM)	0.825
	k hat (KM)	0.498	k star (KM)	0.475
	nu hat (KM)	34.88	nu star (KM)	33.22
	theta hat (KM)	6.813	theta star (KM)	7.153
	80% gamma percentile (KM)	5.561	90% gamma percentile (KM)	9.283
	95% gamma percentile (KM)	13.28	99% gamma percentile (KM)	23.18
	Gamma Kaplan-Meier (KM) Statistics			
	Approximate Chi Square Value (33.22, α)	21.04	Adjusted Chi Square Value (33.22, β)	20.58

	A	B	C	D	E	F	G	H	I	J	K	L
157	95% Gamma Approximate KM-UCL (use when n>=50)					5.359	95% Gamma Adjusted KM-UCL (use when n<50)					5.479
158												
159	**Lognormal GOF Test on Detected Observations Only**											
160	Shapiro Wilk Test Statistic					0.971	**Shapiro Wilk GOF Test**					
161	5% Shapiro Wilk Critical Value					0.933	Detected Data appear Lognormal at 5% Significance Level					
162	Lilliefors Test Statistic					0.118	**Lilliefors GOF Test**					
163	5% Lilliefors Critical Value					0.15	Detected Data appear Lognormal at 5% Significance Level					
164	**Detected Data appear Lognormal at 5% Significance Level**											
165												
166	**Lognormal ROS Statistics Using Imputed Non-Detects**											
167	Mean in Original Scale					3.396	Mean in Log Scale					0.282
168	SD in Original Scale					4.879	SD in Log Scale					1.537
169	95% t UCL (assumes normality of ROS data)					4.79	95% Percentile Bootstrap UCL					4.802
170	95% BCA Bootstrap UCL					5.182	95% Bootstrap t UCL					5.7
171	95% H-UCL (Log ROS)					10.01						
172												
173	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
174	KM Mean (logged)					0.238	KM Geo Mean					1.269
175	KM SD (logged)					1.632	95% Critical H Value (KM-Log)					3.325
176	KM Standard Error of Mean (logged)					0.28	95% H-UCL (KM -Log)					12.19
177	KM SD (logged)					1.632	95% Critical H Value (KM-Log)					3.325
178	KM Standard Error of Mean (logged)					0.28						
179												
180	**DL/2 Statistics**											
181	**DL/2 Normal**						**DL/2 Log-Transformed**					
182	Mean in Original Scale					3.395	Mean in Log Scale					0.219
183	SD in Original Scale					4.88	SD in Log Scale					1.72
184	95% t UCL (Assumes normality)					4.789	95% H-Stat UCL					15.15
185	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
186												
187	**Nonparametric Distribution Free UCL Statistics**											
188	**Detected Data appear Gamma Distributed at 5% Significance Level**											
189												
190	**Suggested UCL to Use**											
191	Adjusted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1)					5.479						
192												
193	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
194	Recommendations are based upon data size, data distribution, and skewness.											
195	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
196	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
197												