UCL Statistics for Data Sets with Non-Detects

Plutonium-238

General Statistics

Total Number of Observations	70	Number of Distinct Observations	64
Number of Detects	9	Number of Non-Detects	61
Number of Distinct Detects	9	Number of Distinct Non-Detects	55
Minimum Detect	0.0175	Minimum Non-Detect	-0.017
Maximum Detect	0.0684	Maximum Non-Detect	0.34
Variance Detects	3.0503E-4	Percent Non-Detects	87.14%
Mean Detects	0.0392	SD Detects	0.0175
Median Detects	0.0389	CV Detects	0.446
Skewness Detects	0.588	Kurtosis Detects	-0.476

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.93	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.185	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Detected Data appear Normal at 5% Significance Level
Detected Data appear Normal at 5% Significance Level		

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

KM Mean	-0.00966	KM Standard Error of Mean	0.00253
KM SD	0.0198	95% KM (BCA) UCL	2.5704E-4
95% KM (t) UCL	-0.00544	95% KM (Percentile Bootstrap) UCL	-9.373E-4
95% KM (z) UCL	-0.00549	95% KM Bootstrap t UCL	-0.00571
90% KM Chebyshev UCL	-0.00206	95% KM Chebyshev UCL	0.00139
97.5% KM Chebyshev UCL	0.00617	99% KM Chebyshev UCL	0.0156

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.231	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.723	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.134	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.28	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)	5.603	k star (bias corrected MLE)	3.809
Theta hat (MLE)	0.007	Theta star (bias corrected MLE)	0.0103
nu hat (MLE)	100.8	nu star (bias corrected)	68.57
Mean (detects)	0.0392		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	-0.00966	SD (KM)	0.0198

	A	B	C	D	E	F	G	H	I	J	K	L
53					Variance (KM)	3.9377E-4				SE of Mean (KM)		0.00253
54					k hat (KM)	0.237				k star (KM)		0.236
55					nu hat (KM)	33.19				nu star (KM)		33.1
56					theta hat (KM)	-0.0408				theta star (KM)		-0.0409
57			80% gamma percentile (KM)			-0.0137			90% gamma percentile (KM)			-0.0291
58			95% gamma percentile (KM)			-0.0475			99% gamma percentile (KM)			-0.097
59												
60					Gamma Kaplan-Meier (KM) Statistics							
61									Adjusted Level of Significance (β)			0.0466
62			Approximate Chi Square Value (33.10, α)			20.94			Adjusted Chi Square Value (33.10, β)			20.74
63		95% Gamma Approximate KM-UCL (use when n>=50)				-0.0153			95% Gamma Adjusted KM-UCL (use when n<50)			-0.0154
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	0.00848				SD in Original Scale		0.0243
74				Mean in Original Scale 95% t UCL (Assumes normality)		0.0133						
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	-0.00544						
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			70			Number of Distinct Observations			69
92				Number of Detects		66				Number of Non-Detects		4
93				Number of Distinct Detects		65			Number of Distinct Non-Detects			4
94					Minimum Detect	0.0583				Minimum Non-Detect		0.00237
95					Maximum Detect	24.4				Maximum Non-Detect		0.024
96					Variance Detects	23.02				Percent Non-Detects		5.714%
97					Mean Detects	2.888				SD Detects		4.798
98					Median Detects	0.79				CV Detects		1.661
99					Skewness Detects	3.082				Kurtosis Detects		10.97
100				Mean of Logged Detects		-0.0278				SD of Logged Detects		1.563
101												
102					Normal GOF Test on Detects Only							
103				Shapiro Wilk Test Statistic		0.607		**Normal GOF Test on Detected Observations Only**				
104					5% Shapiro Wilk P Value	0		Detected Data Not Normal at 5% Significance Level				

	A	B	C	D	E	F	G	H	I	J	K	L
105				Lilliefors Test Statistic		0.278			**Lilliefors GOF Test**			
106				5% Lilliefors Critical Value		0.109			Detected Data Not Normal at 5% Significance Level			
107					**Detected Data Not Normal at 5% Significance Level**							
108												
109				**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**								
110					KM Mean	2.723				KM Standard Error of Mean		0.563
111					KM SD	4.671				95% KM (BCA) UCL		3.711
112					95% KM (t) UCL	3.661			95% KM (Percentile Bootstrap) UCL			3.661
113					95% KM (z) UCL	3.649				95% KM Bootstrap t UCL		4.07
114				90% KM Chebyshev UCL		4.411				95% KM Chebyshev UCL		5.176
115				97.5% KM Chebyshev UCL		6.237				99% KM Chebyshev UCL		8.321
116												
117				**Gamma GOF Tests on Detected Observations Only**								
118					A-D Test Statistic	1.679			**Anderson-Darling GOF Test**			
119				5% A-D Critical Value		0.81		Detected Data Not Gamma Distributed at 5% Significance Level				
120					K-S Test Statistic	0.159			**Kolmogorov-Smirnov GOF**			
121				5% K-S Critical Value		0.116		Detected Data Not Gamma Distributed at 5% Significance Level				
122					**Detected Data Not Gamma Distributed at 5% Significance Level**							
123												
124				**Gamma Statistics on Detected Data Only**								
125					k hat (MLE)	0.572				k star (bias corrected MLE)		0.556
126					Theta hat (MLE)	5.051				Theta star (bias corrected MLE)		5.196
127					nu hat (MLE)	75.47				nu star (bias corrected)		73.38
128					Mean (detects)	2.888						
129												
130				**Gamma ROS Statistics using Imputed Non-Detects**								
131			GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs									
132		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)										
133				For such situations, GROS method may yield incorrect values of UCLs and BTVs								
134					This is especially true when the sample size is small.							
135		For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates										
136					Minimum	0.01				Mean		2.724
137					Maximum	24.4				Median		0.702
138					SD	4.705				CV		1.727
139					k hat (MLE)	0.493				k star (bias corrected MLE)		0.481
140					Theta hat (MLE)	5.525				Theta star (bias corrected MLE)		5.658
141					nu hat (MLE)	69.01				nu star (bias corrected)		67.39
142			Adjusted Level of Significance (β)			0.0466						
143			Approximate Chi Square Value (67.39, α)			49.5			Adjusted Chi Square Value (67.39, β)			49.18
144		95% Gamma Approximate UCL (use when n>=50)				3.708			95% Gamma Adjusted UCL (use when n<50)			3.733
145												
146				**Estimates of Gamma Parameters using KM Estimates**								
147					Mean (KM)	2.723				SD (KM)		4.671
148					Variance (KM)	21.82				SE of Mean (KM)		0.563
149					k hat (KM)	0.34				k star (KM)		0.335
150					nu hat (KM)	47.58				nu star (KM)		46.87
151					theta hat (KM)	8.013				theta star (KM)		8.134
152				80% gamma percentile (KM)		4.278				90% gamma percentile (KM)		7.916
153				95% gamma percentile (KM)		12.02				99% gamma percentile (KM)		22.54
154												
155				**Gamma Kaplan-Meier (KM) Statistics**								
156		Approximate Chi Square Value (46.87, α)				32.16			Adjusted Chi Square Value (46.87, β)			31.91

	A	B	C	D	E	F	G	H	I	J	K	L
157	95% Gamma Approximate KM-UCL (use when n>=50)					3.969	95% Gamma Adjusted KM-UCL (use when n<50)					4.001
158												
159	Lognormal GOF Test on Detected Observations Only											
160	Shapiro Wilk Approximate Test Statistic					0.96	Shapiro Wilk GOF Test					
161	5% Shapiro Wilk P Value					0.0828	Detected Data appear Lognormal at 5% Significance Level					
162	Lilliefors Test Statistic					0.0822	Lilliefors GOF Test					
163	5% Lilliefors Critical Value					0.109	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					2.725	Mean in Log Scale					-0.236
168	SD in Original Scale					4.704	SD in Log Scale					1.74
169	95% t UCL (assumes normality of ROS data)					3.662	95% Percentile Bootstrap UCL					3.722
170	95% BCA Bootstrap UCL					3.917	95% Bootstrap t UCL					4.082
171	95% H-UCL (Log ROS)					6.156						
172												
173	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
174	KM Mean (logged)					-0.372	KM Geo Mean					0.69
175	KM SD (logged)					2.054	95% Critical H Value (KM-Log)					2.935
176	KM Standard Error of Mean (logged)					0.247	95% H-UCL (KM -Log)					11.74
177	KM SD (logged)					2.054	95% Critical H Value (KM-Log)					2.935
178	KM Standard Error of Mean (logged)					0.247						
179												
180	DL/2 Statistics											
181	DL/2 Normal						DL/2 Log-Transformed					
182	Mean in Original Scale					2.724	Mean in Log Scale					-0.328
183	SD in Original Scale					4.705	SD in Log Scale					1.964
184	95% t UCL (Assumes normality)					3.661	95% H-Stat UCL					9.734
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 Lognormal Distributed at 5% Significance Level											
189												
190	Suggested UCL to Use											
191	KM H-UCL					11.74						
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.											
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197												