

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.110/13/2016 3:03:35 PM								
5	From File			ProUCL input 01-007(b) 0-1, 0-5, 0-10.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10												
11	Chromium											
12												
13	General Statistics											
14	Total Number of Observations				14		Number of Distinct Observations				13	
15							Number of Missing Observations				0	
16	Minimum				1.33		Mean				5.959	
17	Maximum				41.1		Median				2.5	
18	SD				10.29		Std. Error of Mean				2.749	
19	Coefficient of Variation				1.726		Skewness				3.534	
20												
21	Normal GOF Test											
22	Shapiro Wilk Test Statistic				0.446		Shapiro Wilk GOF Test					
23	5% Shapiro Wilk Critical Value				0.874		Data Not Normal at 5% Significance Level					
24	Lilliefors Test Statistic				0.396		Lilliefors GOF Test					
25	5% Lilliefors Critical Value				0.226		Data Not Normal at 5% Significance Level					
26	Data Not Normal at 5% Significance Level											
27												
28	Assuming Normal Distribution											
29	95% Normal UCL					95% UCLs (Adjusted for Skewness)						
30	95% Student's-t UCL				10.83		95% Adjusted-CLT UCL (Chen-1995)				13.26	
31							95% Modified-t UCL (Johnson-1978)				11.26	
32												
33	Gamma GOF Test											
34	A-D Test Statistic				1.706		Anderson-Darling Gamma GOF Test					
35	5% A-D Critical Value				0.759		Data Not Gamma Distributed at 5% Significance Level					
36	K-S Test Statistic				0.275		Kolmogorov-Smirnov Gamma GOF Test					
37	5% K-S Critical Value				0.235		Data Not Gamma Distributed at 5% Significance Level					
38	Data Not Gamma Distributed at 5% Significance Level											
39												
40	Gamma Statistics											
41	k hat (MLE)				1.032		k star (bias corrected MLE)				0.859	
42	Theta hat (MLE)				5.774		Theta star (bias corrected MLE)				6.942	
43	nu hat (MLE)				28.9		nu star (bias corrected)				24.04	
44	MLE Mean (bias corrected)				5.959		MLE Sd (bias corrected)				6.432	
45						Approximate Chi Square Value (0.05)				13.88		
46	Adjusted Level of Significance				0.0312		Adjusted Chi Square Value				12.86	
47												
48	Assuming Gamma Distribution											
49	95% Approximate Gamma UCL (use when n>=50))				10.32		95% Adjusted Gamma UCL (use when n<50)				11.14	
50												
51	Lognormal GOF Test											
52	Shapiro Wilk Test Statistic				0.817		Shapiro Wilk Lognormal GOF Test					

	A	B	C	D	E	F	G	H	I	J	K	L	
53	5% Shapiro Wilk Critical Value					0.874	Data Not Lognormal at 5% Significance Level						
54	Lilliefors Test Statistic					0.203	Lilliefors Lognormal GOF Test						
55	5% Lilliefors Critical Value					0.226	Data appear Lognormal at 5% Significance Level						
56	Data appear Approximate Lognormal at 5% Significance Level												
57													
58	Lognormal Statistics												
59	Minimum of Logged Data					0.285	Mean of logged Data					1.228	
60	Maximum of Logged Data					3.716	SD of logged Data					0.885	
61													
62	Assuming Lognormal Distribution												
63	95% H-UCL					9.575	90% Chebyshev (MVUE) UCL					8.574	
64	95% Chebyshev (MVUE) UCL					10.25	97.5% Chebyshev (MVUE) UCL					12.58	
65	99% Chebyshev (MVUE) UCL					17.16							
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					10.48	95% Jackknife UCL					10.83	
72	95% Standard Bootstrap UCL					10.43	95% Bootstrap-t UCL					27.69	
73	95% Hall's Bootstrap UCL					26.14	95% Percentile Bootstrap UCL					11.18	
74	95% BCA Bootstrap UCL					14.18							
75	90% Chebyshev(Mean, Sd) UCL					14.21	95% Chebyshev(Mean, Sd) UCL					17.94	
76	97.5% Chebyshev(Mean, Sd) UCL					23.13	99% Chebyshev(Mean, Sd) UCL					33.31	
77													
78	Suggested UCL to Use												
79	95% H-UCL					9.575							
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	ProUCL computes and outputs H-statistic based UCLs for historical reasons only.												
87	H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.												
88	It is therefore recommended to avoid the use of H-statistic based 95% UCLs.												
89	Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.												
90													
91	Selenium												
92													
93	General Statistics												
94	Total Number of Observations					14	Number of Distinct Observations					12	
95	Number of Detects					10	Number of Non-Detects					4	
96	Number of Distinct Detects					8	Number of Distinct Non-Detects					4	
97	Minimum Detect					0.2	Minimum Non-Detect					0.54	
98	Maximum Detect					0.41	Maximum Non-Detect					3.04	
99	Variance Detects					0.00463	Percent Non-Detects					28.57%	
100	Mean Detects					0.281	SD Detects					0.0681	
101	Median Detects					0.27	CV Detects					0.242	
102	Skewness Detects					0.63	Kurtosis Detects					-0.409	
103	Mean of Logged Detects					-1.295	SD of Logged Detects					0.237	
104													

	A	B	C	D	E	F	G	H	I	J	K	L
105	Normal GOF Test on Detects Only											
106	Shapiro Wilk Test Statistic					0.937	Shapiro Wilk GOF Test					
107	5% Shapiro Wilk Critical Value					0.842	Detected Data appear Normal at 5% Significance Level					
108	Lilliefors Test Statistic					0.173	Lilliefors GOF Test					
109	5% Lilliefors Critical Value					0.262	Detected Data appear Normal at 5% Significance Level					
110	Detected Data appear Normal at 5% Significance Level											
111												
112	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
113	KM Mean					0.281	KM Standard Error of Mean					0.0215
114	KM SD					0.0646	95% KM (BCA) UCL					0.315
115	95% KM (t) UCL					0.319	95% KM (Percentile Bootstrap) UCL					0.318
116	95% KM (z) UCL					0.316	95% KM Bootstrap t UCL					0.329
117	90% KM Chebyshev UCL					0.346	95% KM Chebyshev UCL					0.375
118	97.5% KM Chebyshev UCL					0.415	99% KM Chebyshev UCL					0.495
119												
120	Gamma GOF Tests on Detected Observations Only											
121	A-D Test Statistic					0.276	Anderson-Darling GOF Test					
122	5% A-D Critical Value					0.725	Detected data appear Gamma Distributed at 5% Significance Level					
123	K-S Test Statistic					0.184	Kolmogorov-Smirnov GOF					
124	5% K-S Critical Value					0.266	Detected data appear Gamma Distributed at 5% Significance Level					
125	Detected data appear Gamma Distributed at 5% Significance Level											
126												
127	Gamma Statistics on Detected Data Only											
128	k hat (MLE)					19.71	k star (bias corrected MLE)					13.87
129	Theta hat (MLE)					0.0143	Theta star (bias corrected MLE)					0.0203
130	nu hat (MLE)					394.3	nu star (bias corrected)					277.3
131	Mean (detects)					0.281						
132												
133	Gamma ROS Statistics using Imputed Non-Detects											
134	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
135	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)											
136	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
137	This is especially true when the sample size is small.											
138	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
139	Minimum					0.2	Mean					0.28
140	Maximum					0.41	Median					0.277
141	SD					0.0567	CV					0.202
142	k hat (MLE)					27.51	k star (bias corrected MLE)					21.66
143	Theta hat (MLE)					0.0102	Theta star (bias corrected MLE)					0.0129
144	nu hat (MLE)					770.2	nu star (bias corrected)					606.5
145	Adjusted Level of Significance (β)					0.0312						
146	Approximate Chi Square Value (606.49, α)					550.4	Adjusted Chi Square Value (606.49, β)					543.3
147	95% Gamma Approximate UCL (use when n>=50)					0.308	95% Gamma Adjusted UCL (use when n<50)					0.312
148												
149	Estimates of Gamma Parameters using KM Estimates											
150	Mean (KM)					0.281	SD (KM)					0.0646
151	Variance (KM)					0.00417	SE of Mean (KM)					0.0215
152	k hat (KM)					18.94	k star (KM)					14.93
153	nu hat (KM)					530.3	nu star (KM)					418
154	theta hat (KM)					0.0148	theta star (KM)					0.0188
155	80% gamma percentile (KM)					0.34	90% gamma percentile (KM)					0.377
156	95% gamma percentile (KM)					0.41	99% gamma percentile (KM)					0.477

	A	B	C	D	E	F	G	H	I	J	K	L
157												
158	Gamma Kaplan-Meier (KM) Statistics											
159	Approximate Chi Square Value (418.01, α)					371.6	Adjusted Chi Square Value (418.01, β)					365.8
160	95% Gamma Approximate KM-UCL (use when $n \geq 50$)					0.316	95% Gamma Adjusted KM-UCL (use when $n < 50$)					0.321
161												
162	Lognormal GOF Test on Detected Observations Only											
163	Shapiro Wilk Test Statistic					0.954	Shapiro Wilk GOF Test					
164	5% Shapiro Wilk Critical Value					0.842	Detected Data appear Lognormal at 5% Significance Level					
165	Lilliefors Test Statistic					0.17	Lilliefors GOF Test					
166	5% Lilliefors Critical Value					0.262	Detected Data appear Lognormal at 5% Significance Level					
167	Detected Data appear Lognormal at 5% Significance Level											
168												
169	Lognormal ROS Statistics Using Imputed Non-Detects											
170	Mean in Original Scale					0.279	Mean in Log Scale					-1.295
171	SD in Original Scale					0.0567	SD in Log Scale					0.197
172	95% t UCL (assumes normality of ROS data)					0.306	95% Percentile Bootstrap UCL					0.302
173	95% BCA Bootstrap UCL					0.306	95% Bootstrap t UCL					0.31
174	95% H-UCL (Log ROS)					0.308						
175												
176	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
177	KM Mean (logged)					-1.295	KM Geo Mean					0.274
178	KM SD (logged)					0.225	95% Critical H Value (KM-Log)					1.835
179	KM Standard Error of Mean (logged)					0.0749	95% H-UCL (KM -Log)					0.315
180	KM SD (logged)					0.225	95% Critical H Value (KM-Log)					1.835
181	KM Standard Error of Mean (logged)					0.0749						
182												
183	DL/2 Statistics											
184	DL/2 Normal						DL/2 Log-Transformed					
185	Mean in Original Scale					0.452	Mean in Log Scale					-1.054
186	SD in Original Scale					0.442	SD in Log Scale					0.646
187	95% t UCL (Assumes normality)					0.662	95% H-Stat UCL					0.645
188	DL/2 is not a recommended method, provided for comparisons and historical reasons											
189												
190	Nonparametric Distribution Free UCL Statistics											
191	Detected Data appear Normal Distributed at 5% Significance Level											
192												
193	Suggested UCL to Use											
194	95% KM (t) UCL					0.319						
195												
196	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
197	Recommendations are based upon data size, data distribution, and skewness.											
198	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
199	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
200												
201	Plutonium-239/240											
202												
203	General Statistics											
204	Total Number of Observations					14	Number of Distinct Observations					14
205	Number of Detects					11	Number of Non-Detects					3
206	Number of Distinct Detects					11	Number of Distinct Non-Detects					3
207	Minimum Detect					0.471	Minimum Non-Detect					0.033
208	Maximum Detect					20.1	Maximum Non-Detect					0.142

	A	B	C	D	E	F	G	H	I	J	K	L
209	Variance Detects					32.07	Percent Non-Detects					21.43%
210	Mean Detects					5.536	SD Detects					5.663
211	Median Detects					3.76	CV Detects					1.023
212	Skewness Detects					1.893	Kurtosis Detects					4.164
213	Mean of Logged Detects					1.24	SD of Logged Detects					1.08
214												
215	Normal GOF Test on Detects Only											
216	Shapiro Wilk Test Statistic					0.796	Shapiro Wilk GOF Test					
217	5% Shapiro Wilk Critical Value					0.85	Detected Data Not Normal at 5% Significance Level					
218	Lilliefors Test Statistic					0.246	Lilliefors GOF Test					
219	5% Lilliefors Critical Value					0.251	Detected Data appear Normal at 5% Significance Level					
220	Detected Data appear Approximate Normal at 5% Significance Level											
221												
222	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
223	KM Mean					4.357	KM Standard Error of Mean					1.484
224	KM SD					5.292	95% KM (BCA) UCL					7.192
225	95% KM (t) UCL					6.984	95% KM (Percentile Bootstrap) UCL					6.972
226	95% KM (z) UCL					6.797	95% KM Bootstrap t UCL					8.848
227	90% KM Chebyshev UCL					8.808	95% KM Chebyshev UCL					10.82
228	97.5% KM Chebyshev UCL					13.62	99% KM Chebyshev UCL					19.12
229												
230	Gamma GOF Tests on Detected Observations Only											
231	A-D Test Statistic					0.231	Anderson-Darling GOF Test					
232	5% A-D Critical Value					0.748	Detected data appear Gamma Distributed at 5% Significance Level					
233	K-S Test Statistic					0.15	Kolmogorov-Smimov GOF					
234	5% K-S Critical Value					0.261	Detected data appear Gamma Distributed at 5% Significance Level					
235	Detected data appear Gamma Distributed at 5% Significance Level											
236												
237	Gamma Statistics on Detected Data Only											
238	k hat (MLE)					1.201	k star (bias corrected MLE)					0.934
239	Theta hat (MLE)					4.611	Theta star (bias corrected MLE)					5.929
240	nu hat (MLE)					26.41	nu star (bias corrected)					20.54
241	Mean (detects)					5.536						
242												
243	Gamma ROS Statistics using Imputed Non-Detects											
244	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
245	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)											
246	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
247	This is especially true when the sample size is small.											
248	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
249	Minimum					0.01	Mean					4.352
250	Maximum					20.1	Median					2.69
251	SD					5.496	CV					1.263
252	k hat (MLE)					0.437	k star (bias corrected MLE)					0.391
253	Theta hat (MLE)					9.95	Theta star (bias corrected MLE)					11.12
254	nu hat (MLE)					12.25	nu star (bias corrected)					10.96
255	Adjusted Level of Significance (β)					0.0312						
256	Approximate Chi Square Value (10.96, α)					4.548	Adjusted Chi Square Value (10.96, β)					4.014
257	95% Gamma Approximate UCL (use when n>=50)					10.48	95% Gamma Adjusted UCL (use when n<50)					11.88
258												
259	Estimates of Gamma Parameters using KM Estimates											
260	Mean (KM)					4.357	SD (KM)					5.292

	A	B	C	D	E	F	G	H	I	J	K	L
261	Variance (KM)					28.01	SE of Mean (KM)					1.484
262	k hat (KM)					0.678	k star (KM)					0.58
263	nu hat (KM)					18.98	nu star (KM)					16.24
264	theta hat (KM)					6.429	theta star (KM)					7.51
265	80% gamma percentile (KM)					7.182	90% gamma percentile (KM)					11.42
266	95% gamma percentile (KM)					15.87	99% gamma percentile (KM)					26.67
267												
268	Gamma Kaplan-Meier (KM) Statistics											
269	Approximate Chi Square Value (16.24, α)					8.135	Adjusted Chi Square Value (16.24, β)					7.385
270	95% Gamma Approximate KM-UCL (use when $n \geq 50$)					8.701	95% Gamma Adjusted KM-UCL (use when $n < 50$)					9.585
271												
272	Lognormal GOF Test on Detected Observations Only											
273	Shapiro Wilk Test Statistic					0.976	Shapiro Wilk GOF Test					
274	5% Shapiro Wilk Critical Value					0.85	Detected Data appear Lognormal at 5% Significance Level					
275	Lilliefors Test Statistic					0.141	Lilliefors GOF Test					
276	5% Lilliefors Critical Value					0.251	Detected Data appear Lognormal at 5% Significance Level					
277	Detected Data appear Lognormal at 5% Significance Level											
278												
279	Lognormal ROS Statistics Using Imputed Non-Detects											
280	Mean in Original Scale					4.409	Mean in Log Scale					0.699
281	SD in Original Scale					5.449	SD in Log Scale					1.434
282	95% t UCL (assumes normality of ROS data)					6.988	95% Percentile Bootstrap UCL					6.872
283	95% BCA Bootstrap UCL					7.8	95% Bootstrap t UCL					8.834
284	95% H-UCL (Log ROS)					23.21						
285												
286	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
287	KM Mean (logged)					0.244	KM Geo Mean					1.276
288	KM SD (logged)					2.116	95% Critical H Value (KM-Log)					4.909
289	KM Standard Error of Mean (logged)					0.593	95% H-UCL (KM -Log)					213.2
290	KM SD (logged)					2.116	95% Critical H Value (KM-Log)					4.909
291	KM Standard Error of Mean (logged)					0.593						
292												
293	DL/2 Statistics											
294	DL/2 Normal						DL/2 Log-Transformed					
295	Mean in Original Scale					4.358	Mean in Log Scale					0.218
296	SD in Original Scale					5.492	SD in Log Scale					2.262
297	95% t UCL (Assumes normality)					6.957	95% H-Stat UCL					420.9
298	DL/2 is not a recommended method, provided for comparisons and historical reasons											
299												
300	Nonparametric Distribution Free UCL Statistics											
301	Detected Data appear Approximate Normal Distributed at 5% Significance Level											
302												
303	Suggested UCL to Use											
304	95% KM (t) UCL					6.984						
305												
306	When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test											
307	When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL											
308												
309	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
310	Recommendations are based upon data size, data distribution, and skewness.											
311	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
312	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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313												