Environment

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Coal Ash Material Safety

A Health Risk-Based Evaluation of USGS Coal Ash Data from Five US Power Plants

Supplement

Supplement A

CCP Data Summary Tables from USGS, 2001

Table 9. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for feed coal collected from the Alaska power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg) and selenium (Se) which were analyzed on a whole coal basis. Sulfur (S) is reported in percent. ND, not determined. L, less than value shown. Leaders (---) indicate statistics could not be calculated owing to an insufficient number of analyses above the lower detection limit.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
Ash	12	10.8	10.6	9.77	13	1.08
SiO_2	12	41.4	41.2	36.8	46.3	2.93
Al_2O_3	12	18.3	18.3	17.5	19.2	0.509
CaO	12	19.7	19.6	16.5	22.6	2.14
MgO	12	3.35	3.38	2.77	3.76	0.3
Na_2O	12	0.306	0.318	0.12	0.589	0.13
K_2O	12	1.16	1.14	0.969	1.52	0.154
Fe_2O_3	12	7.37	7.42	6.03	8.19	0.649
TiO_2	12	0.741	0.734	0.681	0.804	0.0377
P_2O_5	12	0.192	0.201	0.114	0.268	0.0501
SO_3	12	4.24	4.31	3.39	4.76	0.404
Parts per million						
As	12	17.4	17.1	15.1	20.8	1.5
Ba	12	5080	5180	4250	5660	495
Be	12	2.52	2.41	1.81	3.33	0.422
Bi	12	0.699	0.677	0.538	0.968	0.135
Cd	12	0.596	0.549	0.46	1.08	0.167
Cl	ND	ND	ND	ND	ND	ND
Co	12	25.4	25.3	22.6	28.6	1.71
Cr	12	150	131	107	384	74.5
Cs	12	5.29	5.24	3.56	7.58	0.941
Cu	12	121	121	100	145	10.7
Ga	12	22.5	23.1	20.2	23.6	1.12
Ge	12	2.67	2.6	1.9	3.26	0.376
Hg	12	0.0538	0.0524	0.0384	0.0696	0.00991
Li	12	22.7	21.5	15.7	35.7	5.2
Mn	12	826	830	519	982	121
Mo	12	8.21	7.97	7.03	9.57	0.893
Nb	12	2.76	2.72	2.26	3.54	0.322
Ni	12	96	95.4	80.9	106	7.22
Pb	12	29.4	29.4	25.7	39.6	3.78
Rb	12	52	51.4	39.4	72.4	8.47
S	12	---	---	---	---	---
Sb	12	6.96	6.88	4.68	11.2	1.71
Sc	12	23.3	23.4	16.2	27.7	3.33
Se	12	0.29	0.28	0.1 L	0.471	0.090
Sr	12	1560	1560	1190	1880	208
Th	12	14.3	14.8	11.2	18.6	1.97
Tl	12	0.545	0.475	0.378	1.09	0.205
U	12	6.22	6.23	4.67	8.73	1.08
V	12	231	228	200	289	25.4
Y	12	32.1	31.7	26.6	42.8	4.29
Zn	12	47.1	46.5	40.2	54.7	4.78

Table 10. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for fly ash hopper collected from the Alaska power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg) and selenium (Se) which were analyzed on a whole coal basis. Sulfur (S) is reported in percent. ND, not determined.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
SiO_2	19	33.4	34.1	28.6	36.6	1.85
Al_2O_3	19	16.5	16.5	15.3	17.7	0.609
CaO	19	26	26.2	23.8	29.2	1.39
MgO	19	4.17	4.15	3.73	4.59	0.242
Na_2O	19	0.473	0.48	0.198	0.81	0.19
K_2O	19	1.19	1.16	1.07	1.37	0.085
Fe_2O_3	19	9.83	9.85	9.1	10.3	0.308
TiO_2	19	0.721	0.724	0.667	0.775	0.0267
P_2O_5	19	0.251	0.236	0.158	0.457	0.085
SO_3	19	4.46	4.34	3.71	5.95	0.688
Parts per million						
As	19	111	100	83.2	204	32.1
Ba	19	6340	6190	5650	7100	496
Be	19	3.12	3.1	2.32	4.61	0.553
Bi	19	5.85	5.32	4.29	10.3	1.64
Cd	19	5.76	4.77	3.96	12.9	2.54
Cl	ND	ND	ND	ND	ND	ND
Co	19	38.8	38.5	34.6	43.4	2.24
Cr	19	173	158	144	418	60.3
Cs	19	6.53	6.28	5.48	8.84	0.893
Cu	19	329	314	270	459	53.3
Ga	19	71.6	70.7	62.9	84.4	5.58
Ge	19	12.2	11.9	9.86	17.7	1.77
Hg	19	3.73	3.74	2.38	4.19	0.390
Li	19	19.9	19.2	9.83	33.3	6.44
Mn	19	1210	1210	987	1390	127
Mo	19	15.6	15	12.8	22.8	2.72
Nb	19	2.73	2.68	2.46	2.96	0.16
Ni	19	146	144	132	162	8.94
Pb	19	248	230	183	424	66.9
Rb	19	58.9	57.1	49.3	75.6	7.12
S	19	1.36	1.32	1.05	1.93	0.241
Sb	19	38.3	32.7	22.2	77.9	15.4
Sc	19	24.6	24	21.4	29	2.45
Se	19	20.1	20.7	13.2	25.3	3.51
Sr	19	1980	1930	1570	2450	269
Th	19	15	14.9	12.9	17.8	1.42
Tl	19	3.66	3.35	2.9	6.61	0.918
U	19	7.19	7.02	6.22	8.83	0.837
V	19	260	256	230	314	21.3
Y	19	42.9	36.9	33.8	116	18.3
Zn	19	343	300	243	715	120

Table 11. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for fly ash last collected from the Alaska power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg) and selenium (Se) which were analyzed on a whole coal basis. Sulfur (S) is reported in percent. L, less than value shown. Leaders (---) indicate statistics could not be calculated owing to an insufficient number of analyses above the lower detection limit. ND, not determined.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
SiO_2	19	36.9	37.1	31.5	43.6	3.5
Al_2O_3	19	17.8	17.8	16.6	18.8	0.635
CaO	19	24.7	24.5	18.9	29.2	2.73
MgO	19	3.91	3.96	3.21	4.46	0.315
Na_2O	19	0.225	0.197	0.109	0.48	0.0958
K_2O	19	0.877	0.85	0.616	1.22	0.168
Fe_2O_3	19	9.16	9.29	7.49	10.4	0.759
TiO_2	19	0.714	0.711	0.641	0.765	0.0346
P_2O_5	19	0.202	0.221	0.131	0.297	0.0463
SO_3	19	0.725	0.724	0.521	0.976	0.127
Parts per million						
As	19	12.9	12.4	10.5	17	1.97
Ba	19	5790	5730	4620	6590	502
Be	19	2.77	2.61	1.92	3.7	0.548
Bi	19	0.293	0.272	0.191	0.443	0.0771
Cd	19	0.29	0.258	0.118	1.05	0.198
Cl	ND	ND	ND	ND	ND	ND
Co	19	32.8	32.7	29.4	36.4	2.2
Cr	19	180	161	145	517	82.1
Cs	19	3.72	3.39	2.35	6.04	0.95
Cu	19	110	107	94.5	134	9.05
Ga	19	19.4	19.1	18	22.3	0.953
Ge	19	1.97	1.88	1.5	2.75	0.322
Hg	19	0.029	0.03	0.01 L	0.0483	0.0132
Li	19	7.23	7.82	1.09	14	3.5
Mn	19	1180	1200	830	1400	133
Mo	19	12.2	12.5	10.3	14.3	1.07
Nb	19	2.69	2.66	2.38	3.55	0.26
Ni	19	139	137	127	154	8.09
Pb	19	13.6	12.4	10.4	22.1	3.4
Rb	19	39.7	36.2	24.5	61.7	10
S	19	---	---	---	---	---
Sb	19	4.44	4.51	3.15	8.01	1.1
Sc	19	22.4	22.7	18.4	27.3	2.07
Se	19	0.923	0.901	0.588	1.45	0.22
Sr	19	1810	1920	1300	2180	280
Th	19	14.6	14.8	11.9	19.3	1.7
Tl	19	0.226	0.215	0.107	0.646	0.122
U	19	6.59	6.66	5.18	9.3	0.923
V	19	246	240	218	381	34.6
Y	19	37.5	37.5	30.9	49.7	4.53
Zn	19	36.8	29.1	23.2	134	25

Table 12. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for fly ash boiler collected from the Alaska power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg) and selenium (Se) which were analyzed on a whole coal basis. Sulfur (S) is reported in percent. L, less than value shown. Leaders (---) indicate statistics could not be calculated owing to an insufficient number of analyses above the lower detection limit. ND, not determined.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
SiO_2	19	40.4	40.4	32.6	45.4	3.04
Al_2O_3	19	18.2	18	16.9	19.5	0.82
CaO	19	21.9	21.2	17.6	28.7	2.55
MgO	19	3.62	3.63	3.11	4.25	0.349
Na_2O	19	0.258	0.22	0.125	0.56	0.122
K_2O	19	0.993	0.993	0.593	1.32	0.169
Fe_2O_3	19	7.98	7.83	6.65	10.1	0.801
TiO_2	19	0.715	0.715	0.673	0.753	0.0236
P_2O_5	19	0.207	0.214	0.125	0.366	0.07
SO_3	19	1.4	1.23	0.642	2.72	0.632
Parts per million						
As	19	13.5	11.2	6.83	33.2	7.08
Ba	19	5220	5320	4290	6200	614
Be	19	2.69	2.61	1.64	3.95	0.652
Bi	19	0.34	0.21	0.1 L	1.21	0.37
Cd	19	0.678	0.285	0.11	3.73	0.979
Cl	ND	ND	ND	ND	ND	ND
Co	19	30.8	30.5	27.7	36.4	2.46
Cr	19	420	341	151	914	223
Cs	19	4.4	4.41	2.56	6.77	1.06
Cu	19	123	123	107	184	17.6
Ga	19	20.8	20.3	18.2	29.6	2.43
Ge	19	2.24	1.96	1.67	5.3	0.854
Hg	19	---	---	---	---	---
Li	19	12.5	8.01	0.501	32.4	10.6
Mn	19	1200	1060	766	2510	468
Mo	19	32.7	33.7	10.7	42.3	7.12
Nb	19	2.81	2.78	2.56	3.25	0.214
Ni	19	232	234	135	288	33.6
Pb	19	15.7	7.83	6.85	63.1	16.3
Rb	19	45.6	46.2	26.9	66.8	9.53
S	19	---	---	0.6 L	1.36	---
Sb	19	6.39	4.68	3.91	17	3.7
Sc	19	21.9	21.8	13.1	25.9	3.02
Se	19	0.87	0.875	0.408	1.28	0.199
Sr	19	1610	1650	1200	2050	263
Th	19	14.5	14.1	12	19.3	2.04
Tl	19	0.379	0.275	0.12	1.38	0.297
U	19	5.28	6.46	0.753	8.67	2.87
V	19	261	234	211	411	61.8
Y	19	35.3	35	29.5	46.9	4.59
Zn	19	38.1	26.6	18.2	169	35.7

Table 13. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for bottom ash collected from the Alaska power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg) and selenium (Se) which were analyzed on a whole coal basis. Sulfur (S) is reported in percent. L, less than value shown. Leaders (---) indicate statistics could not be calculated owing to an insufficient number of analyses above the lower detection limit. ND, not determined.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
SiO_2	19	48.9	48.3	42.7	53.8	3.07
Al_2O_3	19	20.4	20.4	19.3	21.3	0.57
CaO	19	16.1	16	12.3	21.3	2.47
MgO	19	3	2.99	2.5	3.53	0.326
Na_2O	19	0.284	0.263	0.105	0.673	0.165
K_2O	19	1.3	1.31	0.961	1.64	0.169
Fe_2O_3	19	6.24	6.34	5.1	7.96	0.757
TiO_2	19	0.837	0.836	0.763	0.893	0.0344
P_2O_5	19	0.176	0.183	0.0888	0.353	0.0661
SO_3	19	0.15	0.135	0.0773	0.427	0.0749
Parts per million						
As	19	4.01	3.75	0.808	8.49	1.77
Ba	19	4280	4380	3400	5180	510
Be	19	2.34	2.25	1.74	3.67	0.434
Bi	19	---	---	0.1 L	0.118	---
Cd	19	0.17	0.17	0.1 L	0.273	0.050
Cl	ND	ND	ND	ND	ND	ND
Co	19	26.2	26.3	22.4	30.1	1.9
Cr	19	389	349	262	772	129
Cs	19	6.34	6.55	4.1	9.15	1.21
Cu	19	119	119	102	137	8.69
Ga	19	19.8	20	16.7	21.8	1.69
Ge	19	1.41	1.39	0.829	2.02	0.318
Hg	19	0.011	---	0.01 L	0.017	0.0020
Li	19	27.8	28.4	11.1	43.8	7.47
Mn	19	726	730	515	958	102
Mo	19	37.1	35.5	26.3	59.1	7.52
Nb	19	3.17	3.11	2.57	4.02	0.335
Ni	19	233	223	185	340	37.2
Pb	19	3.27	3.06	1.75	5.93	0.995
Rb	19	63.6	64.5	41.8	87.1	11.1
S	19	---	---	---	---	---
Sb	19	3.37	3.33	2.29	4.84	0.654
Sc	19	25.5	25.7	19	28.8	2.25
Se	19	0.201	0.176	0.109	0.396	0.0803
Sr	19	1210	1240	861	1570	205
Th	19	15.3	14.8	11.5	20	2.38
Tl	19	0.262	0.17	0.11	1.22	0.261
U	19	0.977	0.959	0.753	1.38	0.168
V	19	253	243	215	376	38
Y	19	33.9	33.2	28.8	46.2	4.2
Zn	19	27	23.2	19.2	82.3	14.1

Table 14. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for fly/bottom ash mix collected from the Alaska power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg) and selenium (Se) which were analyzed on a whole coal basis. Sulfur (S) is reported in percent. Leaders (---) indicate statistics could not be calculated owing to an insufficient number of analyses above the lower detection limit. ND, not determined.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
SiO_2	19	45.3	45.3	39.9	57.3	3.4
Al_2O_3	19	19.3	19	18.2	23.9	1.23
CaO	19	19.9	19.2	17.2	23.4	1.76
MgO	19	3.37	3.29	2.92	3.78	0.259
Na_2O	19	0.262	0.236	0.148	0.59	0.102
K_2O	19	1.21	1.2	1.09	1.49	0.0776
Fe_2O_3	19	7.72	7.74	6.56	9.22	0.546
TiO_2	19	0.787	0.778	0.745	0.987	0.0501
P_2O_5	19	0.194	0.165	0.128	0.293	0.0585
SO_3	19	1.03	0.883	0.48	1.8	0.374
Parts per million						
As	19	18.8	14.9	7.3	32.9	8.01
Ba	19	4960	4740	4290	5730	450
Be	19	2.34	2.29	1.69	3.16	0.395
Bi	19	0.861	0.629	0.273	1.79	0.479
Cd	19	0.955	0.992	0.38	1.84	0.479
Cl	ND	ND	ND	ND	ND	ND
Co	19	28.8	28.7	24.6	32.6	2.55
Cr	19	408	322	247	925	194
Cs	19	5.61	5.64	4.55	6.15	0.352
Cu	19	153	147	114	197	23.8
Ga	19	26.3	23.9	20.3	34.5	4.32
Ge	19	3.38	2.78	2.13	4.86	1
Hg	19	0.462	0.329	0.123	1.15	0.334
Li	19	23	24.5	13.2	30.4	5.28
Mn	19	873	898	731	966	69.3
Mo	19	34.4	33.4	19.6	45.4	6.61
Nb	19	2.94	2.94	2.44	3.37	0.246
Ni	19	227	226	159	280	31.2
Pb	19	39.1	27.9	14.4	77	20.7
Rb	19	57.6	58.3	49.2	64.8	3.31
S	19	---	---	---	---	---
Sb	19	7.31	7.12	4.21	12.1	2.5
Sc	19	24.5	24.6	20.6	26.5	1.43
Se	19	3.29	2.47	1.25	7.14	1.77
Sr	19	1480	1340	1240	1830	218
Th	19	13.9	13.2	11	17.1	1.86
Tl	19	0.725	0.582	0.312	1.99	0.477
U	19	0.916	0.853	0.682	1.1	0.127
V	19	265	236	203	418	61.4
Y	19	33.3	31.7	27.7	38.4	3.3
Zn	19	76.1	53.5	33.1	233	48

Table 15. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for feed coal collected from the Indiana power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg), selenium (Se), and chlorine (Cl), which were analyzed on a whole coal basis. Sulfur (S) is reported in percent. L, less than value shown.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
Ash	11	8.66	8.71	8.02	9.14	0.32
SiO_2	11	39.9	39.6	37.1	42	1.34
Al_2O_3	11	20.2	20.1	18.8	21.1	0.682
CaO	11	1.43	1.36	1.09	2.02	0.312
MgO	11	0.756	0.739	0.685	0.905	0.0593
Na_2O	11	0.326	0.308	0.228	0.603	0.107
K_2O	11	2.01	2.01	1.85	2.34	0.131
Fe_2O_3	11	26	25.4	23.7	30.5	1.97
TiO_2	11	1.01	1.01	0.954	1.09	0.0352
P_2O_5	11	0.153	0.149	0.121	0.187	0.0201
SO_3	11	2.14	2.16	1.56	2.99	0.494
Parts per million						
As	11	21.3	22.2	0.5 L	28	4.58
Ba	11	341	335	308	396	23.6
Be	11	2.64	2.59	0.5 L	3.22	0.38
Bi	11	0.83	0.813	0.1 L	0.92	0.06
Cd	11	0.82	0.90	0.05	1.05	0.20
Cl	11	59.9	54.5	48.8	99.6	14.6
Co	11	22.1	21.9	1 L	27.7	4.82
Cr	11	98.1	97.9	1 L	117	11.8
Cs	11	3.39	3.28	0.1 L	4.58	0.69
Cu	11	176	173	3 L	215	26.3
Ga	11	36.8	37	0.1 L	51.4	6.47
Ge	11	3.35	3.22	0.1 L	3.83	0.32
Hg	11	0.085	0.091	0.0156	0.101	0.0239
Li	11	29.5	30	8 L	32.8	2.45
Mn	11	161	162	0.5 L	216	40.6
Mo	11	7.11	6.86	0.1 L	9.54	0.96
Nb	11	22.4	21.1	0.2 L	33.5	4.40
Ni	11	67.5	68.9	1 L	81.9	11.5
Pb	11	29.1	26.9	0.2 L	36.8	4.56
Rb	11	32	31.3	0.1 L	40.3	5.04
S	11	3.43	3.38	3.12	4.04	0.249
Sb	11	2.36	2.37	0.2 L	2.68	0.21
Sc	11	23.7	24	1 L	29.8	2.95
Se	11	2.98	2.88	1.99	3.87	0.523
Sr	11	377	357	258	537	75.1
Th	11	19.3	19.4	8 L	22.9	2.28
Tl	11	0.49	0.49	0.1 L	0.574	0.05
U	11	5.93	5.91	0.2 L	6.92	0.55
V	11	287	283	1 L	334	29.2
Y	11	51.4	50.2	0.5 L	64.4	7.49
Zn	11	163	166	2 L	229	43.7

Table 16. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for all economizer fly ash collected from the Indiana power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg), selenium (Se), and chlorine (Cl), which were analyzed on a whole coal basis. Sulfur (S) is reported in percent. L, less than value shown. Leaders (---) indicate statistics could not be calculated owing to an insufficient number of analyses above the lower detection limit.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
SiO_2	11	37.1	37.3	34.4	40	1.55
Al_2O_3	11	18.6	18.3	17.3	19.8	0.846
CaO	11	2.45	2.3	1.87	3.54	0.539
MgO	11	0.759	0.739	0.682	0.88	0.0642
Na_2O	11	0.357	0.364	0.26	0.463	0.067
K_2O	11	1.84	1.83	1.61	2.12	0.158
Fe_2O_3	11	30.3	30.2	26.4	34.5	2.27
TiO_2	11	0.949	0.946	0.783	1.07	0.0891
P_2O_5	11	0.156	0.138	0.114	0.27	0.0515
SO_3	11	1.35	1.34	0.561	1.99	0.505
Parts per million						
As	11	103	100	4.38	240	82.8
Ba	11	354	356	313	394	21.3
Be	11	18.5	18.6	0. 5 L	29.3	9.14
Bi	11	1.28	0.58	0.1 L	7.84	2.24
Cd	11	7.28	2.44	0.298	48.2	13.8
Cl	11	17.8	5.78	1.45	72.5	25.2
Co	11	51.6	54.5	1.95	99.5	24.3
Cr	11	239	167	22.1	741	201
Cs	11	7.77	7.34	0.426	20.7	5.03
Cu	11	156	169	10.8	300	70.4
Ga	11	46.6	30.9	2.15	209	55.1
Ge	11	88.1	73.7	3.56	241	78.2
Hg	11	0.037	0.024	0.01 L	0.132	0.042
Li	11	147	98.5	4	724	195
Mn	11	367	282	224	1040	232
Mo	11	23.9	22.5	2.54	59.1	17.5
Nb	11	31.2	18.8	1.25	177	48.7
Ni	11	245	274	14.5	409	113
Pb	11	82.5	68.4	4.77	277	71.2
Rb	11	102	117	8.34	140	43.3
S	11	1.09	---	0.6 L	1.32	0.11
Sb	11	9.84	7.18	0.455	41.2	11.2
Sc	11	37.5	30.6	1.02	124	30.5
Se	11	3.22	1.3	0.1 L	12.7	3.99
Sr	11	330	294	247	550	87.9
Th	11	35.2	18.8	8 L	205	56.6
Tl	11	9.07	5.71	0.305	42.4	11.9
U	11	15.9	14.8	2.68	43.4	10.4
V	11	322	316	14.3	619	141
Y	11	83.6	77.3	3.81	280	69.4
Zn	11	239	242	40.2	394	101

Table 17. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for air pre heater fly ash collected from the Indiana power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg), selenium (Se), and chlorine (Cl), which were analyzed on a whole coal basis. Sulfur (S) is reported in percent. L, less than value shown. Leaders (---) indicate statistics could not be calculated owing to an insufficient number of analyses above the lower detection limit.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
SiO_2	10	35.4	35.2	31.9	39.2	1.88
Al_2O_3	10	17.6	17.5	16.2	19.5	0.936
CaO	10	2.46	2.36	2.16	3.09	0.282
MgO	10	0.729	0.718	0.669	0.839	0.0465
Na_2O	10	0.38	0.381	0.332	0.437	0.027
K_2O	10	1.81	1.81	1.6	1.97	0.104
Fe_2O_3	10	33.5	33.6	28.3	41.2	3.47
TiO_2	10	0.827	0.798	0.735	0.989	0.0897
P_2O_5	10	0.126	0.111	0.103	0.231	0.04
SO_3	10	1.52	1.35	0.942	2.48	0.496
Parts per million						
As	10	260	113	67.6	1360	392
Ba	10	367	367	346	404	16.2
Be	10	17.6	17.2	12.3	24	3.54
Bi	10	0.602	0.434	0.316	1.92	0.472
Cd	10	9.08	4.91	2.01	33.3	10.8
Cl	10	15.3	10.9	4.81	59.8	15.8
Co	10	47.4	48.3	36.6	61.1	7.11
Cr	10	165	152	103	304	59.5
Cs	10	11.2	7.83	0.1 L	44.6	11.9
Cu	10	151	153	114	200	29.6
Ga	10	27.5	24.2	13.6	57.1	14.1
Ge	10	80.2	61.4	34.7	248	61.8
Hg	10	0.039	0.025	0.016	0.088	0.0244
Li	10	110	108	90.7	153	17.8
Mn	10	300	303	185	379	59.2
Mo	10	37.8	30.2	19.1	101	24.5
Nb	10	14.9	15.4	11.2	17.6	1.96
Ni	10	238	245	173	297	39.8
Pb	10	72.1	60.2	37.7	148	38
Rb	10	112	110	94	132	11.3
S	10	0.88	---	0.6 L	2.28	0.62
Sb	10	11.6	8.22	4.7	36.3	9.47
Sc	10	24.8	25.1	16.3	37.4	6.05
Se	10	10.6	8.21	1.01	29.1	7.94
Sr	10	246	234	211	301	35.6
Th	10	16.2	16.2	13.5	18	1.57
Tl	10	12.4	7.3	4.55	51.2	13.9
U	10	18	13.5	11.2	56.2	13.6
V	10	286	279	198	374	55
Y	10	51.1	50.3	38.9	63.2	7.66
Zn	10	312	192	81.4	1330	373

Table 18. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for all fly ash collected from the Indiana power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg), selenium (Se), and chlorine (Cl), which were analyzed on a whole coal basis. Sulfur (S) is reported in percent. Leaders (---) indicate statistics could not be calculated owing to an insufficient number of analyses above the lower detection limit.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
SiO_2	13	41.1	41	39.9	42.8	0.957
Al_2O_3	13	21.5	21.6	19.8	23.5	0.915
CaO	13	1.46	1.45	1.15	1.75	0.188
MgO	13	0.79	0.784	0.712	0.913	0.0481
Na_2O	13	0.384	0.353	0.271	0.54	0.0876
K_2O	13	2.13	2.11	1.88	2.45	0.134
Fe_2O_3	13	25.7	25.5	22.8	28.5	1.64
TiO_2	13	1.09	1.08	1.02	1.16	0.0441
P_2O_5	13	0.181	0.166	0.151	0.245	0.0324
SO_3	13	0.491	0.486	0.262	1.24	0.256
Parts per million						
As	13	26.1	24	20.2	56.3	9.18
Ba	13	379	375	336	422	28.6
Be	13	5.33	2.75	2.32	32.7	8.26
Bi	13	1.05	0.794	0.672	3.96	0.879
Cd	13	1.15	0.981	0.79	3.29	0.663
Cl	13	4.22	1.81	0.1	19.8	5.6
Co	13	45.3	26.7	22.5	264	65.8
Cr	13	169	96.7	78.2	984	246
Cs	13	6.18	2.93	1.62	43.2	11.2
Cu	13	224	175	156	692	142
Ga	13	59.3	38.9	28.7	309	75.4
Ge	13	11.4	3.9	3.24	88.9	23.6
Hg	13	0.038	0.026	0.013	0.104	0.025
Li	13	68.4	24.8	21.6	560	148
Mn	13	201	161	105	723	159
Mo	13	13.7	6.44	5.32	90.5	23.3
Nb	13	29.8	20.5	17.9	142	33.7
Ni	13	108	67.5	58.2	572	140
Pb	13	50.1	30.7	22.1	293	73.2
Rb	13	83.1	28	16.8	709	188
S	13	---	---	---	---	---
Sb	13	4.12	2.38	1.96	22.4	5.54
Sc	13	42.6	27.4	22.5	227	55.5
Se	13	8.62	6.49	4.06	22.5	5
Sr	13	419	379	319	638	108
Th	13	27.2	20.9	17.5	102	22.6
Tl	13	2.13	0.485	0.382	21	5.67
U	13	8.67	6.45	5.33	34.1	7.68
V	13	420	317	262	1660	375
Y	13	86.1	56.6	50.9	410	97.7
Zn	13	120	88	71.5	478	111

Table 19. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for feed coal collected from the New Mexico power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg), selenium (Se), and chlorine (Cl), which were analyzed on a whole coal basis. Sulfur (S) is reported in percent.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
Ash	17	25.4	25.5	23.8	26.8	0.808
SiO_2	17	62.6	62.8	57.7	65.4	1.79
Al_2O_3	17	24.7	24.7	23.4	26.3	0.966
CaO	17	2.87	2.84	1.86	3.44	0.4
MgO	17	0.763	0.722	0.59	1.07	0.131
Na_2O	17	1.22	1.23	1.06	1.38	0.107
K_2O	17	0.844	0.786	0.605	1.31	0.231
Fe_2O_3	17	3.84	3.78	3.34	4.84	0.422
TiO_2	17	0.856	0.853	0.738	0.918	0.0389
P_2O_5	17	0.152	0.152	0.0902	0.206	0.034
SO_3	17	2.34	2.38	0.917	2.85	0.454
Parts per million						
As	17	11.3	10.4	8.77	16.7	2.28
Ba	17	1590	1600	1160	2010	301
Be	17	4.71	4.68	3.85	6.21	0.587
Bi	17	1.51	1.56	1.12	1.72	0.177
Cd	17	0.324	0.322	0.194	0.402	0.0541
Cl	17	110	116	57	187	37.9
Co	17	9.2	8.67	8.05	11.6	1.02
Cr	17	30.8	28.5	26.4	38.7	3.9
Cs	17	3.33	2.53	2.3	7.18	1.67
Cu	17	52.6	50.9	45.2	86.2	9.14
Ga	17	32.5	32.9	29.3	35.1	1.61
Ge	17	7.57	7.09	5.71	10.7	1.34
Hg	17	0.0889	0.0913	0.0655	0.115	0.0144
Li	17	102	103	77	125	14.9
Mn	17	193	196	127	227	25.5
Mo	17	6.77	6.69	5.83	7.89	0.548
Nb	17	15.9	15.9	14.3	17.7	0.905
Ni	17	40.8	39.4	34	54.6	5.55
Pb	17	46.2	46.8	38.5	51.3	3.6
Rb	17	41.3	34.1	29.1	75.7	16.1
S	17	0.789	0.768	0.679	0.965	0.086
Sb	17	2.37	2.28	1.97	3.13	0.337
Sc	17	12.3	11.9	10.9	14.2	1.03
Se	17	1.66	1.68	1.3	1.92	0.169
Sr	17	385	394	301	487	58.9
Th	17	25.6	25.2	22.8	29	1.53
Tl	17	1.12	0.933	0.522	2.43	0.566
U	17	11.2	11.1	10	12.5	0.657
V	17	85.5	82.9	73.3	101	7.96
Y	17	30.7	30.6	28.2	35.1	1.83
Zn	17	61.6	59.6	55	79.1	7.28

Table 20. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for bottom ash collected from the New Mexico power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg), selenium (Se), and chlorine (Cl), which were analyzed on a whole coal basis. Sulfur (S) is reported in percent. L, less than value shown. Leaders (---) indicate statistics could not be calculated owing to an insufficient number of analyses above the lower detection limit.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
SiO_2	18	64.8	64.9	62.8	67.4	1.06
Al_2O_3	18	24.1	24.1	22.8	25.7	0.687
CaO	18	2.95	2.96	2.18	3.57	0.364
MgO	18	0.735	0.678	0.64	0.987	0.114
Na_2O	18	1.04	1.04	0.884	1.19	0.0954
K_2O	18	0.871	0.794	0.656	1.27	0.2
Fe_2O_3	18	4.36	4.24	3.41	5.77	0.701
TiO_2	18	0.821	0.822	0.792	0.838	0.0122
P_2O_5	18	0.123	0.132	0.0779	0.154	0.0248
SO_3	18	0.122	0.117	0.063	0.221	0.0444
Parts per million						
As	18	3.05	2.18	1.24	18.1	3.8
Ba	18	1420	1440	983	2000	277
Be	18	4.16	4.09	3.41	5.33	0.566
Bi	18	---	---	---	---	---
Cd	18	---	---	---	---	---
Cl	18	24.7	22.2	17.4	42.9	6.78
Co	18	8.58	8.41	7.29	10.6	1.02
Cr	18	22.3	20.7	17.5	30.1	3.83
Cs	18	3.53	2.68	2.42	6.78	1.51
Cu	18	42.9	42.5	40.4	47.5	1.69
Ga	18	18.1	18	16.7	21	0.869
Ge	18	2.22	2.17	1.73	3.28	0.456
Hg	18	0.0208	0.005	0.01L	0.155	0.0423
Li	18	98.4	97.8	82.6	120	10
Mn	18	238	240	159	308	35.6
Mo	18	2.71	2.71	2.15	3.64	0.395
Nb	18	14.3	14.4	13.3	15.9	0.595
Ni	18	35.8	34.9	28.8	49.5	5.83
Pb	18	19.2	19.2	16.5	23	1.67
Rb	18	43.6	36.7	31	71.6	14.4
S	18	---	---	---	---	---
Sb	18	0.623	0.61	0.401	0.911	0.169
Sc	18	12.4	12	11.1	14.3	0.98
Se	18	0.207	0.186	0.1L	0.626	0.132
Sr	18	329	339	270	408	39.1
Th	18	25.3	25.1	23.7	29	1.36
Tl	18	0.446	0.144	0.1L	1.96	0.61
U	18	9.66	9.37	9.03	11	0.573
V	18	77.5	74.1	69.4	95.5	7.79
Y	18	30.1	29.3	27.8	33.9	1.8
Zn	18	32.4	31.1	26.5	53.2	6.18

Table 21. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for fly ash north collected from the New Mexico power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg), selenium (Se), and chlorine (Cl), which were analyzed on a whole coal basis. Sulfur (S) is reported in percent. Leaders (---) indicate statistics could not be calculated owing to an insufficient number of analyses above the lower detection limit.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
SiO_2	17	64.7	64.1	62.3	67.4	1.66
Al_2O_3	17	25.4	25.5	24.4	26.1	0.49
CaO	17	2.73	2.82	2.08	3.02	0.256
MgO	17	0.768	0.732	0.657	0.988	0.0945
Na_2O	17	1.19	1.15	1.03	1.34	0.0971
K_2O	17	0.869	0.792	0.654	1.27	0.189
Fe_2O_3	17	3.53	3.51	3.11	4.23	0.305
TiO_2	17	0.89	0.889	0.843	0.949	0.0268
P_2O_5	17	0.147	0.15	0.0893	0.176	0.023
SO_3	17	0.060	---	0.05 L	0.115	0.020
Parts per million						
As	17	10.2	9.64	5.69	16.9	2.81
Ba	17	1490	1510	1050	1820	210
Be	17	5.09	5.06	4	6.66	0.795
Bi	17	1.28	1.17	0.743	2.16	0.337
Cd	17	0.293	0.296	0.182	0.389	0.0553
Cl	17	3.09	3.14	1.13	5.48	1.2
Co	17	10.4	9.42	7.57	14.5	2.33
Cr	17	28.6	25.4	21.6	39.2	5.99
Cs	17	3.68	3.03	2.49	7.37	1.47
Cu	17	54.6	55.6	48.9	63.3	4.07
Ga	17	30.5	29.9	23.7	42.9	4.72
Ge	17	6.82	6.32	3.98	10.1	1.75
Hg	17	0.0954	0.0983	0.0484	0.183	0.0315
Li	17	103	100	88.8	125	10.4
Mn	17	197	202	146	223	19.5
Mo	17	5.85	5.63	4.62	7.76	0.94
Nb	17	16.2	16.1	14.5	19.7	1.25
Ni	17	33.4	31.3	18.1	70.8	11.6
Pb	17	44	43.1	33.2	63.6	7.34
Rb	17	44	38.7	31	74.2	13.1
S	17	---	---	---	---	---
Sb	17	2.17	2	1.29	3.12	0.551
Sc	17	13.2	12.9	12.1	15.6	0.963
Se	17	3.84	3.91	3.29	4.46	0.313
Sr	17	374	368	305	451	46.9
Th	17	27.3	27	24.9	30.5	1.44
Tl	17	1.04	1.02	0.307	2.15	0.584
U	17	11.3	11.1	10	13.3	0.879
V	17	94	92.4	81.1	108	9.63
Y	17	32.8	32.3	29.3	37.3	2.39
Zn	17	73.7	61.6	41.5	277	53.2

Table 22. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for fly ash south collected from the New Mexico power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg), selenium (Se), and chlorine (Cl), which were analyzed on a whole coal basis. Sulfur (S) is reported in percent. L, less than value shown. Leaders (---) indicate statistics could not be calculated owing to an insufficient number of analyses above the lower detection limit.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
SiO_2	17	64.6	64.4	61.6	66.3	1.05
Al_2O_3	17	25.5	25.5	24.3	26.4	0.551
CaO	17	2.88	2.79	2.26	3.48	0.322
MgO	17	0.759	0.733	0.634	1	0.0942
Na_2O	17	1.17	1.19	0.957	1.28	0.1
K_2O	17	0.868	0.823	0.666	1.25	0.171
Fe_2O_3	17	3.63	3.67	2.84	4.25	0.381
TiO_2	17	0.886	0.883	0.848	0.918	0.0187
P_2O_5	17	0.145	0.147	0.0898	0.176	0.0227
SO_3	17	0.060	---	0.05 L	0.0715	0.010
Parts per million						
As	17	10.6	10.6	7.52	14.1	1.52
Ba	17	1500	1560	1140	1820	211
Be	17	4.92	4.82	4.04	5.8	0.584
Bi	17	1.13	1.15	0.852	1.37	0.157
Cd	17	0.273	0.273	0.173	0.356	0.0465
Cl	17	3.73	3.35	0.1L	12.5	2.84
Co	17	12.8	12.4	10.4	16	1.5
Cr	17	31.6	30.1	25.8	39.9	4.5
Cs	17	3.77	3.15	2.68	7.61	1.4
Cu	17	52.9	52.3	49	60.7	2.96
Ga	17	27.9	28	23.6	33.8	2.68
Ge	17	5.95	5.83	3.81	8.19	1.17
Hg	17	0.0388	0.0311	0.0212	0.0904	0.018
Li	17	105	104	85	124	10.4
Mn	17	217	218	168	249	20.4
Mo	17	5.26	5.26	4.27	6.93	0.625
Nb	17	15.9	15.9	14.7	17.2	0.732
Ni	17	19.5	19.3	15.8	23.8	2.54
Pb	17	40.5	41.1	33	48	4.34
Rb	17	42.6	36.8	30.5	75	12.6
S	17	---	---	---	---	---
Sb	17	2.05	2.1	1.48	2.87	0.329
Sc	17	11.6	11.6	10.4	13.4	0.884
Se	17	3.89	3.94	3.06	4.48	0.403
Sr	17	375	380	304	450	46.5
Th	17	27.2	27.1	25.3	29.2	1.13
Tl	17	1.13	1.04	0.729	1.85	0.344
U	17	10.8	10.6	9.84	11.9	0.61
V	17	93.7	92.1	83.3	108	7.6
Y	17	32.1	31.8	28.8	36	2.08
Zn	17	57	57	43.3	71.9	5.66

Table 23. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for fly ash coarse collected from the New Mexico power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg), selenium (Se), and chlorine (Cl), which were analyzed on a whole coal basis. Sulfur (S) is reported in percent. Leaders (---) indicate statistics could not be calculated owing to an insufficient number of analyses above the lower detection limit.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
SiO_2		62.5	61.9	59.7	66.3	1.96
Al_2O_3	16	23.5	23.6	22.5	24.3	0.557
CaO	16	2.99	3.01	2.48	3.4	0.295
MgO	16	0.642	0.625	0.569	0.768	0.0607
Na_2O	16	0.954	0.937	0.847	1.05	0.0579
K_2O	16	0.795	0.763	0.648	1.02	0.112
Fe_2O_3	16	3.95	3.96	2.94	4.93	0.509
TiO_2	16	0.787	0.795	0.693	0.829	0.0332
P_2O_5	16	0.129	0.129	0.103	0.151	0.0149
SO_3	16	---	---	---	---	---
Parts per million						
As	16	6.88	6.74	5.77	9.81	0.966
Ba	16	1430	1410	992	1850	241
Be	16	3.98	3.9	3.32	4.72	0.368
Bi	16	0.609	0.619	0.465	0.795	0.0845
Cd	16	0.16	0.159	0.12	0.222	0.0258
Cl	16	3.62	3.25	1.1	6.21	1.46
Co	16	11.9	11.7	10.9	13.4	0.762
Cr	16	26.5	26.3	23.1	31	2.38
Cs	16	3.41	3.02	2.67	5.23	0.875
Cu	16	45.3	45.2	43.1	48.9	1.64
Ga	16	18.3	18.3	16.7	21.8	1.26
Ge	16	3.61	3.45	2.8	4.84	0.568
Hg	16	0.108	0.0902	0.0318	0.26	0.0601
Li	16	97.3	96.5	85.4	114	7.12
Mn	16	303	303	271	328	15.9
Mo	16	3.79	3.76	3.33	4.98	0.394
Nb	16	13.5	13.5	12.4	14.2	0.49
Ni	16	19.6	19.3	15	24	2.34
Pb	16	23.6	23.9	19.8	27.6	1.99
Rb	16	40.2	36.5	31.4	57.8	8.46
S	16	---	---	---	---	---
Sb	16	1.23	1.23	1.05	1.5	0.139
Sc	16	9.83	9.69	9.19	10.7	0.487
Se	16	4.46	4.26	3.06	6.31	0.786
Sr	16	305	303	251	360	27.6
Th	16	24.6	24.3	23	27.2	1
Tl	16	0.697	0.61	0.478	1.99	0.359
U	16	9.45	9.49	8.88	10	0.322
V	16	83.3	82.9	76.8	91.2	3.99
Y	16	28.5	28.6	27	30.6	0.903
Zn	16	28.7	29	22.6	35.7	2.66

Table 24. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for fly ash product collected from the New Mexico power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg), selenium (Se), and chlorine (Cl), which were analyzed on a whole coal basis. Sulfur (S) is reported in percent. L, less than value shown. Leaders (---) indicate statistics could not be calculated owing to an insufficient number of analyses above the lower detection limit.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
SiO_2	16	62.8	62.9	60.8	63.7	0.782
Al_2O_3	16	26	26.1	25	26.5	0.45
CaO	16	2.62	2.63	2.37	2.9	0.179
MgO	16	0.821	0.793	0.743	0.98	0.0743
Na_2O	16	1.31	1.29	1.22	1.45	0.0732
K_2O	16	0.89	0.854	0.704	1.14	0.146
Fe_2O_3	16	3.57	3.48	3.23	4.01	0.253
TiO_2	16	0.938	0.934	0.915	0.974	0.0148
P_2O_5	16	0.183	0.186	0.145	0.207	0.0194
SO_3	16	0.07	0.06	0.05 L	0.106	0.01
Parts per million						
As	16	19.6	19.1	16.8	22.2	1.58
Ba	16	1660	1660	1230	1950	178
Be	16	5.75	5.66	5.06	6.69	0.472
Bi	16	2.16	2.16	1.85	2.46	0.174
Cd	16	0.528	0.509	0.42	0.68	0.0799
Cl	16	3.37	2.54	0.1L	8.58	2.47
Co	16	15.8	15.4	14.5	18.3	1.18
Cr	16	37.7	36.1	33.7	45.9	3.68
Cs	16	3.97	3.5	2.9	6.16	1.09
Cu	16	65	65.1	60.8	68.7	2.4
Ga	16	42.4	42.8	39.2	44.5	1.68
Ge	16	10.1	9.62	8.7	11.9	1.06
Hg	16	0.138	0.119	0.0648	0.263	0.0673
Li	16	102	102	91.8	116	6.26
Mn	16	198	194	180	222	10.7
Mo	16	8.63	8.59	7.94	9.35	0.44
Nb	16	17.5	17.6	16.6	18.2	0.465
Ni	16	19.9	20	17.3	22.9	1.5
Pb	16	61.9	62.6	53.8	67.5	4.09
Rb	16	44	40	33.2	64.7	10.2
S	16	---	---	---	---	---
Sb	16	3.27	3.14	2.79	3.78	0.317
Sc	16	12.6	12.4	11.8	13.9	0.679
Se	16	8.39	8.67	1.03	12.2	2.86
Sr	16	402	396	345	476	29.8
Th	16	28	27.8	26.9	30	0.731
Tl	16	1.55	1.33	1.07	2.9	0.458
U	16	12.7	12.7	12	13.5	0.413
V	16	114	112	106	128	6.04
Y	16	34.3	34.1	32.2	36.7	1.37
Zn	16	77.7	78.9	70.4	83.5	4.15

Table 25. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for barge coal collected from the Ohio power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg), selenium (Se), and chlorine (Cl), which were analyzed on a whole coal basis. Sulfur (S) is reported in percent.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
Ash	15	9.86	9.91	8.51	11.2	0.913
SiO_2	15	41.3	40.4	36.7	46	3.11
Al_2O_3	15	19.4	19.5	17.8	20.7	0.829
CaO	15	2.49	2.51	2.22	2.78	0.163
MgO	15	0.637	0.646	0.563	0.704	0.0475
Na_2O	15	0.418	0.407	0.327	0.53	0.0659
K_2O	15	1.42	1.38	1.18	1.74	0.204
Fe_2O_3	15	25.7	26	20.9	31	3.52
TiO_2	15	0.832	0.83	0.713	0.953	0.0715
P_2O_5	15	0.248	0.213	0.183	0.336	0.0597
SO_3	15	2.87	3.7	1.12	4.46	1.44
Parts per million						
As	15	71.8	71.1	49.8	108	15.5
Ba	15	534	539	385	659	98.6
Be	15	9.55	9.4	7.93	11.1	1.13
Bi	15	1.19	1.14	0.971	1.56	0.18
Cd	15	0.926	0.865	0.716	1.25	0.18
Cl	15	470	469	327	602	96
Co	15	35.5	34.8	30.1	43.3	3.58
Cr	15	157	157	130	195	18.5
Cs	15	7.04	7.01	5.45	10.2	1.13
Cu	15	70.8	71.4	60.7	88.4	8.11
Ga	15	40.4	40.8	32.7	52.2	4.87
Ge	15	42.1	41.8	30.3	58	10.4
Hg	15	0.097	0.086	0.073	0.139	0.0224
Li	15	118	104	91.5	158	24.1
Mn	15	243	234	179	309	45
Mo	15	11	10.2	8.23	15.2	1.95
Nb	15	24	24.1	19.6	31.8	3.05
Ni	15	96	94.4	81.4	119	10.9
Pb	15	42.3	41.1	35.2	53	5.22
Rb	15	88.6	86.5	65.5	137	17
S	15	3.77	3.71	2.96	4.32	0.43
Sb	15	2.43	2.39	1.71	3.36	0.474
Sc	15	27.3	26	20.9	34.2	3.39
Se	15	1.8	1.68	0.87	2.47	0.466
Sr	15	685	674	513	913	134
Th	15	17.4	16.9	14.5	20.8	1.81
Tl	15	5.88	5.73	4.02	8.21	1.36
U	15	7.83	7.95	5.54	10.4	1.44
V	15	251	268	194	323	37.9
Y	15	50	48.2	42.7	60.3	5.84
Zn	15	132	124	110	162	19

Table 26. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for feed coal collected from the Ohio power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg), selenium (Se), and chlorine (Cl), which were analyzed on a whole coal basis. Sulfur (S) is reported in percent.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
Ash	16	9.86	9.75	9.12	11.2	0.598
SiO_2	16	41	41.1	37.9	45.3	2.05
Al_2O_3	16	18.9	18.9	17.9	19.7	0.564
CaO	16	2.47	2.51	1.79	2.84	0.292
MgO	16	0.645	0.648	0.59	0.693	0.0333
Na_2O	16	0.422	0.431	0.288	0.558	0.0745
K_2O	16	1.48	1.5	1.25	1.65	0.14
Fe_2O_3	16	25.1	24.2	21.4	30	2.86
TiO_2	16	0.912	0.918	0.797	1.03	0.0663
P_2O_5	16	0.248	0.252	0.165	0.341	0.0529
SO_3	16	3.99	4.16	0.864	4.79	0.915
Parts per million						
As	16	67	66.3	53.2	84.3	9.34
Ba	16	557	560	425	674	69.9
Be	16	9.96	9.13	7.92	14.4	2.03
Bi	16	1.07	1.03	0.81	1.44	0.178
Cd	16	0.779	0.778	0.572	0.914	0.1
Cl	16	530	554	413	616	75.3
Co	16	31.1	31.3	26	35.3	2.49
Cr	16	140	141	113	169	13.1
Cs	16	6.06	5.96	5.27	8.14	0.735
Cu	16	66.9	64.5	54.2	79.8	8.04
Ga	16	36.3	36.2	30.7	44.7	3.3
Ge	16	36.1	36.5	23.1	43.9	5.74
Hg	16	0.115	0.111	0.105	0.146	0.0114
Li	16	100	100	84.6	118	10.6
Mn	16	236	251	161	366	52
Mo	16	11	10.1	8.85	15.6	2.29
Nb	16	20.5	19.9	16.3	26.2	2.47
Ni	16	87.6	87.7	76.5	103	7.01
Pb	16	38.2	37.9	34.4	44	2.48
Rb	16	78.3	77.1	66.8	103	9.35
S	16	3.73	3.86	0.918	4.39	0.794
Sb	16	2.26	2.17	1.71	3.84	0.498
Sc	16	25.3	25.1	21.7	30.9	2.63
Se	16	2.03	1.89	1.22	3.76	0.592
Sr	16	726	729	513	966	125
Th	16	15.8	15.8	14.8	18	0.767
Tl	16	5.31	5.37	4.37	7.13	0.732
U	16	6.88	6.89	5.8	7.91	0.679
V	16	220	222	180	269	20.4
Y	16	44.9	44.3	39.6	52.5	4.26
Zn	16	113	115	91	134	10.5

Table 27. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for pulverized coal collected from the Ohio power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg), selenium (Se), and chlorine (Cl), which were analyzed on a whole coal basis. Sulfur (S) is reported in percent.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
Ash	15	9.64	9.69	8.53	10.4	0.497
SiO_2	15	42.5	42.7	38.5	45.8	2.05
Al_2O_3	15	19.9	19.7	19	21.8	0.715
CaO	15	2.53	2.58	2.1	2.82	0.182
MgO	15	0.654	0.662	0.55	0.717	0.0414
Na_2O	15	0.437	0.451	0.342	0.532	0.0523
K_2O	15	1.49	1.49	1.13	1.71	0.172
Fe_2O_3	15	23.7	23.7	20.2	30.1	3.18
TiO_2	15	0.86	0.9	0.698	0.993	0.0991
P_2O_5	15	0.271	0.27	0.185	0.327	0.0407
SO_3	15	2.38	3.21	0.75	3.74	1.24
Parts per million						
As	15	90.3	91.8	71.4	103	7.83
Ba	15	546	551	398	678	75.6
Be	15	12.4	12.4	10.8	13.6	0.779
Bi	15	1.52	1.46	1.39	1.92	0.134
Cd	15	1.14	1.08	0.94	1.42	0.148
Cl	15	507	502	373	591	68.7
Co	15	44.5	44.1	41.4	51.1	2.69
Cr	15	193	195	177	208	10.6
Cs	15	8.55	9.05	5.44	9.88	1.09
Cu	15	86.1	85.1	79	97.6	4.64
Ga	15	52.4	52.2	49	56.8	2.88
Ge	15	53	51.4	40.6	66.3	7.91
Hg	15	0.11	0.11	0.095	0.131	0.0099
Li	15	145	138	128	178	16
Mn	15	297	299	246	380	32.7
Mo	15	13.5	13	11.8	16.4	1.42
Nb	15	30.6	30.5	26.4	34	2.07
Ni	15	112	110	105	123	5.74
Pb	15	53.9	53	50.7	59.5	2.6
Rb	15	113	118	66.5	142	18.1
S	15	3.48	3.34	3.1	4.6	0.445
Sb	15	3.1	3	2.3	5.14	0.658
Sc	15	36.6	37	29.5	39.5	2.61
Se	15	1.56	1.65	0.811	2.07	0.341
Sr	15	725	724	551	918	106
Th	15	22.7	22.5	20.4	25.1	1.23
Tl	15	6.84	6.73	5.24	8.52	1.07
U	15	9.66	9.53	8.16	11.4	0.928
V	15	339	334	299	377	24.6
Y	15	63.4	63.5	56	72.3	3.99
Zn	15	169	164	153	214	16.2

Table 28. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for bottom ash collected from the Ohio power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg), selenium (Se), and chlorine (Cl), which were analyzed on a whole coal basis. Sulfur (S) is reported in percent. L, less than value shown. Leaders (---) indicate statistics could not be calculated owing to an insufficient number of analyses above the lower detection limit.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
SiO_2	15	40	39.5	38.7	45.2	1.66
Al_2O_3	15	17.6	17.6	17.1	18.1	0.259
CaO	15	2.32	2.29	2.14	2.88	0.176
MgO	15	0.594	0.594	0.558	0.645	0.0218
Na_2O	15	0.317	0.32	0.281	0.375	0.023
K_2O	15	1.29	1.28	1.24	1.34	0.0281
Fe_2O_3	15	29.9	30.2	26.8	31.7	1.42
TiO_2	15	0.895	0.899	0.842	0.966	0.0312
P_2O_5	15	0.169	0.17	0.151	0.185	0.00993
SO_3	15	0.197	0.176	0.127	0.378	0.0629
Parts per million						
As	15	5.98	5.27	3.6	12.9	2.75
Ba	15	492	491	474	518	11.3
Be	15	9.02	8.84	7.72	10.3	0.825
Bi	15	0.283	0.249	0.216	0.634	0.105
Cd	15	0.12	0.12	0.1 L	0.169	0.02
Cl	15	20.9	13.8	2.18	61.1	18.5
Co	15	36.2	36.2	34.5	37.7	0.835
Cr	15	377	374	266	461	44.9
Cs	15	5.38	5.39	4.94	5.64	0.187
Cu	15	61.4	60.9	54	69.1	4
Ga	15	20.6	20.7	19.5	22.1	0.784
Ge	15	12.2	12.2	10.9	13.8	0.744
Hg	15	0.0022	---	0.01L	0.0207	0.00822
Li	15	92.8	92.5	86.4	98.6	3.33
Mn	15	321	320	0.5 L	347	14.8
Mo	15	8.12	8.17	6.31	10.2	1.05
Nb	15	21	20.8	19.7	24.6	1.14
Ni	15	202	207	162	240	19.5
Pb	15	17.4	15	13.9	40	6.62
Rb	15	74.1	74.2	69	78.2	2.33
S	15	---	---	---	---	---
Sb	15	1.29	1.02	0.867	3.2	0.645
Sc	15	25.9	26	24	31.5	1.8
Se	15	0.20	---	0.1 L	0.755	0.17
Sr	15	601	615	554	636	29.2
Th	15	16.1	16.1	15.3	17.3	0.511
Tl	15	0.554	0.55	0.446	0.684	0.0547
U	15	5.75	5.63	5.27	7.08	0.435
V	15	209	211	192	221	9.19
Y	15	52.5	52.9	48.1	55.8	2.36
Zn	15	61.2	61.2	55.9	72.9	3.88

Table 29. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for economizer fly ash collected from the Ohio power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg), selenium (Se), and chlorine (Cl), which were analyzed on a whole coal basis. Sulfur (S) is reported in percent. L, less than value shown. Leaders (---) indicate statistics could not be calculated owing to an insufficient number of analyses above the lower detection limit.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
SiO_2	15	39.9	39.6	36.8	43	1.82
Al_2O_3	15	17.8	17.9	15.9	19.6	1.17
CaO	15	2.85	2.84	2.37	3.23	0.207
MgO	15	0.617	0.621	0.559	0.665	0.0336
Na_2O	15	0.336	0.353	0.251	0.428	0.0519
K_2O	15	1.26	1.25	1.16	1.41	0.0921
Fe_2O_3	15	30.1	31.4	22.5	36.3	4.51
TiO_2	15	0.901	0.897	0.794	1	0.0582
P_2O_5	15	0.228	0.23	0.176	0.276	0.0243
SO_3	15	0.581	0.569	0.257	1.07	0.256
Parts per million						
As	15	70.3	41.6	16.2	275	73.1
Ba	15	508	513	462	573	30.6
Be	15	9.75	9.01	8.15	12.3	1.39
Bi	15	0.661	0.56	0.402	1.66	0.327
Cd	15	0.795	0.403	0.267	3.22	0.861
Cl	15	6.05	4.13	0.85	27.9	6.48
Co	15	36.6	36.6	34.9	38.6	0.971
Cr	15	266	264	216	441	53.3
Cs	15	5.29	5.37	4.83	5.74	0.281
Cu	15	61	60.5	54.8	68.2	4.53
Ga	15	28.7	28.9	24.6	31.6	1.97
Ge	15	27.3	27.5	17.8	51.7	8.2
Hg	15	0.0029	---	0.01 L	0.025	0.0105
Li	15	91.3	91.3	78.8	101	6.66
Mn	15	326	321	272	449	44.1
Mo	15	7.55	8.02	5.42	10.1	1.34
Nb	15	21.3	21.5	19.2	23.5	1.28
Ni	15	151	154	132	171	11.5
Pb	15	24.4	20.4	17.8	56.8	10.5
Rb	15	71.3	73.5	63.4	78.8	4.56
S	15	---	---	---	---	---
Sb	15	2.33	1.73	1.24	6.95	1.46
Sc	15	26.1	27	22.9	29.1	2.12
Se	15	0.18	0.13	0.1 L	0.363	0.08
Sr	15	652	650	528	771	68.9
Th	15	16.3	16.5	15.1	17.2	0.761
Tl	15	2.26	1.66	0.978	5.7	1.54
U	15	6.54	6.7	5.45	7.64	0.621
V	15	222	222	204	245	10.3
Y	15	53.4	53	51	58.4	2.21
Zn	15	81.1	80.90	68.60	106	9.29

Table 30. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for fly ash collected from the Ohio power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg), selenium (Se), and chlorine (Cl), which were analyzed on a whole coal basis. Sulfur (S) is reported in percent.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
SiO_2	13	41.7	42	38.2	43.8	1.68
Al_2O_3	13	18.2	18.5	15.7	19	0.859
CaO	13	2.32	2.41	1.86	2.58	0.23
MgO	13	0.631	0.632	0.566	0.678	0.0293
Na_2O	13	1.75	1.74	1.42	2.15	0.198
K_2O	13	1.47	1.45	1.32	1.65	0.0992
Fe_2O_3	13	26.9	25.8	24	34.8	2.88
TiO_2	13	0.959	0.969	0.87	1	0.0414
P_2O_5	13	0.218	0.217	0.178	0.252	0.0191
SO_3	13	2.46	2.48	1.96	2.91	0.239
Parts per million						
As	13	59	60.3	33.7	93.8	14.8
Ba	13	530	518	464	608	49.4
Be	13	11.3	11.7	8.03	15.4	2.01
Bi	13	0.997	1.02	0.431	1.48	0.291
Cd	13	0.736	0.789	0.312	0.963	0.172
Cl	13	669	680	394	1270	229
Co	13	36.1	32.6	27.6	46.4	6.62
Cr	13	148	133	118	181	26.2
Cs	13	7.21	6.8	5.6	8.72	1.09
Cu	13	85.2	77.8	55.1	193	35
Ga	13	36.3	34.5	22	47.4	7.51
Ge	13	31.3	31.8	14.4	42.1	7.82
Hg	13	0.0322	0.0318	0.0167	0.0561	0.0109
Li	13	110	97.9	74	140	22.4
Mn	13	253	236	193	333	51.5
Mo	13	10.5	10.6	7.15	18.4	2.69
Nb	13	25.6	22.4	19.2	33	5.02
Ni	13	98	102	79.5	123	14.2
Pb	13	39.1	41.8	21.4	50.4	7.42
Rb	13	92.9	85.8	73.1	115	15
S	13	0.524	0.617	0.3	0.723	0.187
Sb	13	2.05	1.95	0.982	5.3	1.04
Sc	13	28.7	26.8	19.8	37	5.89
Se	13	4.13	4.11	3.49	5.47	0.539
Sr	13	667	648	587	763	49.5
Th	13	18.2	16.2	13.9	23	3.33
Tl	13	3.43	3.37	1.06	6.13	1.13
U	13	7.66	7.3	5.2	9.58	1.51
V	13	248	229	179	317	47.4
Y	13	59.1	55	48	76.7	9.89
Zn	13	111	111	62.7	141	21.9

Table 31. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for pyrite rejects collected from the Ohio power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg), selenium (Se), and chlorine (Cl), which were analyzed on a whole coal basis. Sulfur (S) is reported in percent. L, less than value shown. Leaders (---) indicate statistics could not be calculated owing to an insufficient number of analyses above the lower detection limit.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
SiO_2	16	22.8	22.8	10.7	41.1	6.25
Al_2O_3	16	6.62	6.11	3.12	14.9	2.74
CaO	16	19.8	16.1	2.51	47.2	12.7
MgO	16	1.62	1.54	0.189	3.37	0.979
Na_2O	16	0.139	0.125	0.0467	0.383	0.072
K_2O	16	0.597	0.546	0.301	1.68	0.316
Fe_2O_3	16	30.9	29.8	9.23	74.2	15.5
TiO_2	16	0.292	0.269	0.126	0.551	0.126
P_2O_5	16	0.201	0.145	0.103	0.861	0.183
SO_3	16	8.58	8.96	1.29	15.3	4.59
Parts per million						
As	16	348	321	50.2	982	235
Ba	16	261	244	107	601	124
Be	16	2.9	3.08	1.18	4.55	0.98
Bi	16	0.40	0.32	0.1 L	0.951	0.24
Cd	16	0.817	0.741	0.534	1.48	0.249
Cl	16	170	165	113	327	55.2
Co	16	23	21.2	12.6	36.9	8.04
Cr	16	336	315	141	639	146
Cs	16	2.63	2.29	0.836	8.26	1.71
Cu	16	66.1	62.6	25.2	150	31.4
Ga	16	11.2	11	4.23	28.9	5.93
Ge	16	7.16	6.71	1.45	13.8	4.16
Hg	16	1.75	1.125	0.091	6.82	1.676
Li	16	40.2	35.9	17.7	89.6	18.1
Mn	16	---	---	---	---	---
Mo	16	21.9	22.4	6.83	38.6	10.7
Nb	16	12	8.93	4.72	48.8	10.5
Ni	16	172	170	72.3	325	67.1
Pb	16	41.1	38.4	7.38	142	32.4
Rb	16	37.8	34.5	14.6	123	25.2
S	16	9.18	7.59	0.6 L	28.5	6.40
Sb	16	2.98	3.25	0.722	6.12	1.57
Sc	16	11.2	10.1	4.58	23.8	5.39
Se	16	8.73	6.89	1.8	18.3	5.2
Sr	16	357	351	89.6	553	109
Th	16	9.31	---	8 L	16.9	2.45
Tl	16	17	13	1.16	62.5	14.7
U	16	4.34	4.86	1.3	5.29	1.04
V	16	84.9	84.9	28.8	159	32
Y	16	17.8	15.7	6.09	43.4	9.9
Zn	16	68.4	56.4	29	163	35.8

Table 32. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for feed coal collected from the Wyoming power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg), selenium (Se), and chlorine (Cl), which were analyzed on a whole coal basis. Sulfur (S) is reported in percent.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
Ash	18	10.9	10.5	8.52	16.8	1.99
SiO_2	18	34.9	34.6	26.9	47.9	4.57
Al_2O_3	18	18	17.7	15.5	21.6	1.52
CaO	18	15.2	15.2	9.1	19.5	2.71
MgO	18	3.5	3.36	2.32	4.56	0.6
Na_2O	18	0.483	0.262	0.148	1.19	0.392
K_2O	18	0.455	0.419	0.262	0.883	0.143
Fe_2O_3	18	4.2	4.18	2.92	6.32	0.894
TiO_2	18	1.34	1.26	1.01	2.39	0.303
P_2O_5	18	0.501	0.51	0.272	0.693	0.109
SO_3	18	20.6	20.2	12.9	27.7	3.38
Parts per million						
As	18	38.5	37	25.7	59.9	8.31
Ba	18	3330	3210	1500	6010	1120
Be	18	24.9	28	3.05	36	10.4
Bi	18	1.37	1.18	0.919	3.24	0.589
Cd	18	6.36	1.84	0.95	47.7	11.6
Cl	18	60.7	29.4	12.2	380	92.9
Co	18	95.2	97.6	39.5	132	26.3
Cr	18	190	152	88.3	441	107
Cs	18	12.9	14.4	2.95	16.1	3.92
Cu	18	151	149	118	191	22.5
Ga	18	46.3	47.9	30.2	55.2	8.48
Ge	18	128	138	2.78	272	70
Hg	18	0.151	0.158	0.016	0.237	0.060
Li	18	88.1	97.9	33	122	26.9
Mn	18	209	187	145	369	61.8
Mo	18	31	29.8	5.1	69.2	17.1
Nb	18	44.5	43.6	36.5	52.9	3.91
Ni	18	204	197	64.9	335	56.7
Pb	18	87.4	94.4	24.3	121	30.2
Rb	18	129	131	37.5	230	40.5
S	18	0.842	0.838	0.704	1.05	0.0938
Sb	18	9.18	6.31	1.68	35.6	8.58
Sc	18	34.8	37.2	20.9	43.3	6.89
Se	18	1.22	1.21	0.773	1.92	0.253
Sr	18	2440	2430	1410	3250	430
Th	18	17.5	17.4	15.4	19.6	1.44
Tl	18	17.8	14.5	0.862	54.6	15
U	18	17.1	13.8	7.17	38.4	8.83
V	18	265	254	197	345	45.2
Y	18	35	30.9	20.3	62.7	12.5
Zn	18	357	325	168	516	105

Table 33. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for pulverized coal collected from the Wyoming power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg), selenium (Se), and chlorine (Cl), which were analyzed on a whole coal basis. Sulfur (S) is reported in percent. L, less than value shown.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
Ash	15	9.01	9.06	8.65	9.33	0.196
SiO_2	15	33.7	33.6	32.6	35	0.745
Al_2O_3	15	17.6	17.4	16.8	18.6	0.573
CaO	15	16.2	16.1	14.8	17.8	0.752
MgO	15	3.79	3.8	3.52	4.12	0.171
Na_2O	15	0.3	0.246	0.21	0.718	0.126
K_2O	15	0.4	0.397	0.358	0.432	0.0193
Fe_2O_3	15	4.61	4.48	3.85	6.37	0.637
TiO_2	15	1.27	1.27	1.21	1.35	0.0374
P_2O_5	15	0.522	0.532	0.463	0.564	0.0282
SO_3	15	22	21.8	20.4	23.5	0.846
Parts per million						
As	15	39.2	39.8	19.4	53.8	10.9
Ba	15	3540	3520	3330	3910	169
Be	15	29	28	0.5 L	37.2	5.46
Bi	15	1.24	1.19	0.941	2.18	0.29
Cd	15	1.99	2.21	0.878	2.54	0.504
Cl	15	12.8	10.4	5.72	48.9	10.4
Co	15	94.6	108	1.08	120	37.8
Cr	15	138	155	3.41	183	54.2
Cs	15	14.9	16.9	0.6	20.4	5.91
Cu	15	137	152	3.82	222	57.8
Ga	15	50.5	47.9	30	75	12.3
Ge	15	120	129	3.34	175	52.7
Hg	15	0.16	0.159	0.135	0.186	0.0171
Li	15	109	107	8 L	128	8.71
Mn	15	167	166	146	211	16.7
Mo	15	29.2	31.2	7.18	37.8	9.11
Nb	15	41.5	46.6	5.57	51.3	14.7
Ni	15	161	181	4.8	202	63.1
Pb	15	108	114	34.3	155	32.4
Rb	15	119	132	31.4	145	35.9
S	15	0.805	0.805	0.772	0.849	0.0212
Sb	15	7.23	7.57	3	13.1	2.32
Sc	15	40.1	38.3	34.1	48.3	4.6
Se	15	1.21	1.16	0.988	1.58	0.163
Sr	15	2630	2640	2340	2910	141
Th	15	18	18.1	14.7	21.3	1.68
Tl	15	14.8	16.9	1.08	20.6	5.6
U	15	13.9	11.8	8.78	25.5	4.82
V	15	305	298	272	399	30.8
Y	15	32.6	31.7	26	44.1	4.22
Zn	15	384	389	275	595	72.7

Table 34. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for bottom ash collected from the Wyoming power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg), selenium (Se), and chlorine (Cl), which were analyzed on a whole coal basis. Sulfur (S) is reported in percent. L, less than value shown.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
SiO_2	15	43.3	43.6	40.4	45.6	1.34
Al_2O_3	15	20	19.7	18.4	21.4	0.847
CaO	15	16.3	16.3	15	17.5	0.701
MgO	15	3.81	3.84	3.27	4.03	0.2
Na_2O	15	0.266	0.219	0.178	0.753	0.139
K_2O	15	0.423	0.422	0.344	0.502	0.0399
Fe_2O_3	15	9.75	9.34	7.21	14.6	1.93
TiO_2	15	1.51	1.52	1.38	1.64	0.0674
P_2O_5	15	0.446	0.445	0.412	0.49	0.021
SO_3	15	0.503	0.449	0.0502	0.998	0.308
Parts per million						
As	15	6.48	6.65	4.99	7.73	0.815
Ba	15	2750	2790	2440	2990	165
Be	15	3.36	3.37	2.99	3.78	0.272
Bi	15	0.222	0.226	0.147	0.268	0.0304
Cd	15	0.20	0.170	0.1 L	0.425	0.090
Cl	15	92.8	102	10.9	173	51.8
Co	15	46	46.1	36.6	55	5
Cr	15	76.2	74.6	62.8	89.9	9.4
Cs	15	5.02	5.01	3.82	5.94	0.558
Cu	15	130	133	110	148	10.8
Ga	15	18	17.9	14.7	20.6	1.55
Ge	15	1.46	1.45	1.23	1.63	0.124
Hg	15	0.0248	0.0187	0.01 L	0.111	0.0307
Li	15	34.9	35.4	29.5	39.3	3.03
Mn	15	250	265	145	282	43.3
Mo	15	3.19	3.21	3	3.37	0.116
Nb	15	44.4	44.8	42	47.9	1.62
Ni	15	93.9	77.3	65.3	255	48.6
Pb	15	9.26	9.52	7.59	10.5	1.02
Rb	15	45.4	44.4	35.4	54	5.04
S	15	0.3	0.3	0.3	0.3	0
Sb	15	0.746	0.773	0.568	1.05	0.122
Sc	15	25.2	25.3	19.4	30.9	3.49
Se	15	0.58	0.40	0.1 L	1.28	0.360
Sr	15	2540	2560	2370	2680	82
Th	15	17.9	18.2	16.6	19.2	0.787
Tl	15	0.166	0.159	0.102	0.294	0.0498
U	15	8.98	8.95	8.44	9.55	0.351
V	15	411	347	279	591	120
Y	15	50.7	51.4	46.7	56.7	3.05
Zn	15	84.9	74	51.7	152	30.7

Table 35. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for economizer fly ash collected from the Wyoming power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg), selenium (Se), and chlorine (Cl), which were analyzed on a whole coal basis. Sulfur (S) is reported in percent. L, less than value shown. Leaders (---) indicate statistics could not be calculated owing to an insufficient number of analyses above the lower detection limit.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
SiO_2	16	42.8	42.8	41.2	44	0.75
Al_2O_3	16	20.7	20.7	20.1	21.6	0.398
CaO	16	19.2	19.1	18.3	19.7	0.361
MgO	16	4.46	4.46	4.3	4.58	0.0772
Na_2O	16	0.261	0.231	0.193	0.491	0.094
K_2O	16	0.439	0.443	0.407	0.453	0.0126
Fe_2O_3	16	5.47	5.54	4.66	6.44	0.509
TiO_2	16	1.6	1.61	1.54	1.65	0.0383
P_2O_5	16	0.509	0.507	0.495	0.533	0.0108
SO_3	16	0.954	0.931	0.767	1.36	0.14
Parts per million						
As	16	14.4	14.6	13.3	15.5	0.672
Ba	16	2880	2880	2770	3050	68.6
Be	16	3.89	3.88	3.56	4.33	0.212
Bi	16	0.618	0.599	0.468	0.808	0.0917
Cd	16	0.449	0.375	0.208	1.26	0.26
Cl	16	2.28	1.75	0.1	6.31	1.92
Co	16	50.2	51.1	33.9	55	4.73
Cr	16	95.1	93	66.1	159	18.7
Cs	16	5.37	5.38	4.73	5.73	0.239
Cu	16	170	175	132	188	13.5
Ga	16	29	29	22.6	32.7	2.5
Ge	16	2.73	2.75	2.42	3.05	0.183
Hg	16	0.031	0.025	0.01 L	0.101	0.0282
Li	16	36.1	36.7	28.6	38.2	2.16
Mn	16	152	152	132	200	15.6
Mo	16	5.4	5.16	4.72	9.45	1.11
Nb	16	57.3	57.8	45.9	61.1	3.8
Ni	16	120	92.7	52.7	235	71.7
Pb	16	16.1	16.2	12.8	18.3	1.36
Rb	16	68.7	70.4	42.6	75.8	7.49
S	16	---	---	---	---	---
Sb	16	1.39	1.39	1.23	1.54	0.0973
Sc	16	28.4	28.7	21.6	30.7	2.07
Se	16	0.18	0.16	0.1 L	0.526	0.100
Sr	16	2990	2990	2850	3140	88.2
Th	16	23.9	24.3	19.3	25.2	1.33
Tl	16	0.234	0.21	0.155	0.442	0.073
U	16	13.3	13.6	9.84	14.2	0.969
V	16	302	287	256	549	67.4
Y	16	45.8	37.8	34.4	67.4	13
Zn	16	134	122	73.4	180	29.3

Table 36. Descriptive statistics of ash yield and contents of selected major, minor, and trace elements for fly ash collected from the Wyoming power plant.
[All analyses are in percent or parts per million and are reported on an as-determined ash basis except for mercury (Hg), selenium (Se), and chlorine (Cl), which were analyzed on a whole coal basis. Sulfur (S) is reported in percent.]

	Number of samples	Mean	Median	Range		Standard deviation
				Minimum	Maximum	
Percent						
SiO_2	15	29	28.9	27.5	31.1	0.971
Al_2O_3	15	15.6	15.7	14.7	16.3	0.46
CaO	15	26.3	26.3	24.9	27.3	0.661
MgO	15	3.34	3.36	3.2	3.47	0.093
Na_2O	15	0.543	0.531	0.463	0.73	0.0642
K_2O	15	0.398	0.398	0.37	0.429	0.0151
Fe_2O_3	15	3.32	3.34	2.87	3.57	0.172
TiO_2	15	1.14	1.14	1.06	1.21	0.0387
P_2O_5	15	0.462	0.459	0.44	0.486	0.0142
SO_3	15	19.2	19.2	17.8	20.3	0.646
Parts per million						
As	15	19.4	20	14.6	22	1.85
Ba	15	3170	3170	2980	3370	84.1
Be	15	2.71	2.74	2.07	3.1	0.239
Bi	15	1.18	1.2	1.04	1.35	0.0917
Cd	15	0.804	0.814	0.699	0.895	0.0613
Cl	15	1080	1050	903	1630	171
Co	15	38.7	39.4	31.4	43.5	3.18
Cr	15	83.6	82.4	54.1	102	10.6
Cs	15	4.57	4.5	4.11	5.7	0.427
Cu	15	149	144	118	171	14.1
Ga	15	29.6	28.8	24.5	34	2.64
Ge	15	2.91	2.91	2.42	3.26	0.237
Hg	15	0.604	0.695	0.021	0.971	0.349
Li	15	29.2	29	21.8	32.9	2.68
Mn	15	215	229	145	283	43.2
Mo	15	5.69	5.78	4.95	6.09	0.293
Nb	15	34.6	34.3	30.7	41.7	3.4
Ni	15	158	158	106	180	17
Pb	15	28.4	28.2	25	33.1	2.03
Rb	15	41.9	39.5	36.4	60.6	7.47
S	15	5.67	5.9	0.727	6.89	1.42
Sb	15	1.92	1.91	1.65	2.11	0.153
Sc	15	25.5	25.5	18.1	29.7	3.07
Se	15	12.4	12.3	11.2	13.5	0.68
Sr	15	2290	2290	2180	2400	58.1
Th	15	14	14.2	11.4	16.8	1.49
Tl	15	0.594	0.593	0.472	0.747	0.0678
U	15	8.75	8.45	7.29	11.2	1.12
V	15	312	317	218	376	46
Y	15	42.6	42.6	34.6	50.3	4.07
Zn	15	135	136	87.9	186	27

Supplement B

USEPA RSL Equations for Residential Soil Exposure

Supplement B - Table 1
USEPA RSL Residential Soil Default Generic Exposure Factors
Coal Ash Material Safety - A Health Risk-Based Evaluation
American Coal Ash Association

Symbol	Definition (units)	Default
	Toxicity Values	
RfD_o	Chronic Oral Reference Dose (mg/kg-day)	Contaminant-specific
RfC	Chronic Inhalation Reference Concentration (mg/m^3)	Contaminant-specific
CSF_o	Chronic oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Contaminant-specific
IUR	Chronic Inhalation Unit Risk $(\mu g/m^3)^{-1}$	Contaminant-specific
	Miscellaneous Variables	
TR	target risk	1×10^{-6}
THQ	target hazard quotient	1
AT_r	Averaging time - resident (days/year)	365
LT	Lifetime (years)	70
	Ingestion, and Dermal Contact Rates	
IRS_c	Resident Soil Ingestion Rate - Child (mg/day)	200
IRS_a	Resident Soil Ingestion Rate - Adult (mg/day)	100
IFS_{adj}	Resident Soil Ingestion Rate - Age-adjusted (mg-year/kg-day)	114
$IFSM_{adj}$	Resident Mutagenic Soil Ingestion Rate - Age-adjusted (mg-year/kg-day)	489.5
IRS_{0-2}	Soil Ingestion Rate - Age-segment 0-2 (mg/day)	200
IRS_{2-6}	Soil Ingestion Rate - Age-segment 2-6 (mg/day)	200
IRS_{6-16}	Soil Ingestion Rate - Age-segment 6-16 (mg/day)	100
IRS_{16-30}	Soil Ingestion Rate - Age-segment 16-30 (mg/day)	100
BW_c	Resident Body Weight - child (kg)	15
BW_a	Resident Body Weight - adult (kg)	70
SA_c	Resident soil surface area - child (cm^2)	2800
SA_a	Resident soil surface area - adult (cm^2)	5700
AF_c	Resident soil adherence factor - child (mg/cm^2)	0.2
AF_a	Resident soil adherence factor - adult (mg/cm^2)	0.07
ABS_d	Fraction of contaminant absorbed dermally from soil (unitless)	Contaminant-specific
GIABS	Fraction of contaminant absorbed in gastrointestinal tract (unitless) Note: if the GIABS is >50% then it is set to 100% for the calculation of dermal toxicity values.	Contaminant-specific
	Exposure Frequency, Exposure Duration, and Exposure Time Variables	
EF_r	Resident Exposure Frequency (days/yr)	350
ED_r	Resident Exposure Duration (yr)	30
ED_c	Resident Exposure Duration - child (yr)	6
ED_a	Resident Exposure Duration - adult (yr) = EDr - EDc	24
ET_{ra}	Resident Air Exposure Time (hours/day)	24
ET_{rs}	Resident Soil Exposure Time (hours/day)	24
ED_{0-2}	Exposure Duration - age segment 0-2 (yr)	Site-specific (or 350)
ED_{2-6}	Exposure Duration - age segment 2-6 (yr)	Site-specific (or 350)
ED_{6-16}	Exposure Duration - age segment 6-16 (yr)	Site-specific (or 350)
ED_{16-30}	Exposure Duration - age segment 16-30 (yr)	Site-specific (or 350)
	Particulate Emission Factor Variables	
PEF_w	Particulate Emission Factor - Minneapolis (m^3/kg)	1.36×10^9(region-specific)
V	Fraction of Vegetative Cover (unitless)	0.5
	Volatilization Factor	
VF_s	Volatilization Factor - Los Angeles (m^3/kg)	Not applicable to constituents in CCPs

Source:
USEPA. 2012c. Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites – User's Guide. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

Supplement B - Table 2
USEPA RSL Equations for Residential Soil Exposure – Noncarinogens
Coal Ash Material Safety - A Health Risk-Based Evaluation
American Coal Ash Association

Residential Soil Land Use Equations – Noncarcinogens

[Child Only Scenario]

Incidental Ingestion of Soil:

$$SL_{res\text{-}sol\text{-}nc\text{-}ing}\left(\frac{mg}{kg}\right)=\frac{THQ\times AT_r\left(\frac{365\ days}{year}\times ED_c\left(6\ years\right)\right)\times BW_c\left(15\ Kg\right)}{EF_r\left(\frac{350\ days}{year}\right)\times ED_c\left(6\ year\right)\times\frac{1}{RfD_o\left(\frac{mg}{Kg\text{-}day}\right)}\times IRS_c\left(\frac{200\ mg}{day}\right)\times\frac{10^{-6}Kg}{1\ mg}}$$

Inhalation of Particulates Emitted from Soil:

$$SL_{res\text{-}sol\text{-}nc\text{-}inh}\left(\frac{mg}{kg}\right)=\frac{THQ\times AT_r\left(\frac{365\ days}{year}\times ED_c\left(6\ years\right)\right)}{EF_r\left(\frac{350\ days}{year}\right)\times ED_c\left(6\ year\right)\times ET_{rs}\left(\frac{24\ hours}{day}\right)\times\left(\frac{1\ day}{24\ hours}\right)\times\frac{1}{RfC\left(\frac{mg}{m^3}\right)}\times\left(\frac{1}{VF_s\left(\frac{m^3}{Kg}\right)}+\frac{1}{PEF_w\left(\frac{m^3}{Kg}\right)}\right)}$$

Dermal Contact with Soil:

$$SL_{res\text{-}sol\text{-}nc\text{-}der}\left(\frac{mg}{kg}\right)=\frac{THQ\times AT_r\left(\frac{365\ days}{year}\times ED_c\left(6\ years\right)\right)\times BW_c\left(15\ Kg\right)}{EF_r\left(\frac{350\ days}{year}\right)\times ED_c\left(6\ year\right)\times\frac{1}{\left(RfD_o\left(\frac{mg}{Kg\text{-}day}\right)\times GIABS\right)}\times SA_c\left(\frac{2800\ cm^2}{day}\right)\times AF_c\left(\frac{0.2\ mg}{cm^2}\right)\times ABS_d\times\frac{10^{-6}Kg}{1\ mg}}$$

Total (Ingestion + Inhalation + Dermal):

$$SL_{res\text{-}sol\text{-}nc\text{-}tot}\left(\frac{mg}{kg}\right)=\frac{1}{\frac{1}{SL_{res\text{-}sol\text{-}nc\text{-}ing}}+\frac{1}{SL_{res\text{-}sol\text{-}nc\text{-}der}}+\frac{1}{SL_{res\text{-}sol\text{-}nc\text{-}inh}}}$$

Source: USEPA. 2012c. Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites – User's Guide. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

Supplement B - Table 3
USEPA RSL Equations for Residential Soil Exposure – Potential Carcinogens
Coal Ash Material Safety - A Health Risk-Based Evaluation
American Coal Ash Association

Residential Soil Land Use Equations – Potential Carcinogens

[Child and Adult Scenarios]

Incidental Ingestion of Soil:

$$SL_{res\text{-}sol\text{-}ca\text{-}ing}\left(mg/kg\right)=\frac{TR\times AT_r\left(\frac{365\ days}{year}\times LT\ (70\ years)\right)}{CSF_o\left(\frac{mg}{Kg\text{-}day}\right)^{-1}\times EF_r\left(\frac{350\ days}{year}\right)\times IFS_{adj}\left(\frac{114\ mg\text{-}Year}{Kg\text{-}day}\right)\times\left(\frac{10^{-6}Kg}{mg}\right)}$$

where:

$$IFS_{adj}\left(\frac{114\ mg\ Year}{Kg\text{-}day}\right)=\frac{ED_c\ (6\ years)\times IRS_c\left(\frac{200\ mg}{day}\right)}{BW_c\ (15\ Kg)}+\frac{ED_a-ED_c\ (24\ years)\times IRS_a\left(\frac{100\ mg}{day}\right)}{BW_a\ (70\ Kg)}$$

Inhalation of Particulates Emitted from Soil:

$$SL_{res\text{-}sol\text{-}ca\text{-}inh}\left(mg/kg\right)=\frac{TR\times AT_r\left(\frac{365\ days}{year}\times LT\ (70\ years)\right)}{IUR\left(\mu g/m^3\right)^{-1}\times\left(\frac{1000\ \mu g}{mg}\right)\times EF_r\left(\frac{350\ days}{year}\right)\times\left(\frac{1}{VF_s\left(\frac{m^3}{Kg}\right)}+\frac{1}{PEF_w\left(\frac{m^3}{Kg}\right)}\right)\times ED_r\ (30\ years)\times ET_{rs}\left(\frac{24\ hours}{day}\right)\times\left(\frac{1\ day}{24\ hours}\right)}$$

Dermal Contact with Soil:

$$SL_{res\text{-}sol\text{-}ca\text{-}der}\left(mg/kg\right)=\frac{TR\times AT_r\left(\frac{365\ days}{year}\times LT\ (70\ years)\right)}{\left(\frac{CSF_o\left(\frac{mg}{Kg\text{-}day}\right)^{-1}}{GIABS}\right)\times EF_r\left(\frac{350\ days}{year}\right)\times DFS_{adj}\left(\frac{361\ mg\text{-}Year}{Kg\text{-}day}\right)\times ABS_d\times\left(\frac{10^{-6}Kg}{mg}\right)}$$

where:

$$DFS_{adj}\left(\frac{361\ mg\text{-}Year}{Kg\text{-}day}\right)=\frac{ED_c\ (6\ years)\times SA_c\left(\frac{2800\ cm^2}{day}\right)\times AF_c\left(\frac{0.2\ mg}{cm^2}\right)}{BW_c\ (15\ Kg)}+\frac{ED_a-ED_c\ (24\ years)\times SA_a\left(\frac{5700\ cm^2}{day}\right)\times AF_a\left(\frac{0.07\ mg}{cm^2}\right)}{BW_a\ (70\ Kg)}$$

Total (Ingestion + Inhalation + Dermal):

$$SL_{res\text{-}sol\text{-}ca\text{-}tot}\left(mg/kg\right)=\frac{1}{\frac{1}{SL_{res\text{-}sol\text{-}ca\text{-}ing}}+\frac{1}{SL_{res\text{-}sol\text{-}ca\text{-}der}}+\frac{1}{SL_{res\text{-}sol\text{-}ca\text{-}inh}}}$$

Source: USEPA. 2012c. Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites – User's Guide. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

Supplement B - Table 4
USEPA RSL Equations for Residential Soil Exposure –
Potential Carcinogens with Mutagenic Mode of Action
Coal Ash Material Safety - A Health Risk-Based Evaluation
American Coal Ash Association

Residential Soil Land Use Equations – Potential Carcinogens with Mutagenic Mode of Action [Child and Adult Scenarios]

Incidental Ingestion of Soil:

$$SL_{res\text{-}sol\text{-}mu\text{-}ing}\left(\frac{mg}{kg}\right)=\frac{TR\times AT_r\left(\frac{365\ days}{year}\times LT\left(70\ years\right)\right)}{CSF_0\left(\frac{mg}{Kg\text{-}day}\right)^{-1}\times EF_r\left(\frac{350\ days}{year}\right)\times IFSM_{adj}\left(\frac{489.5\ mg\text{-}Year}{Kg\text{-}day}\right)\times\left(\frac{10^{-6}Kg}{mg}\right)}$$

where:

$$IFSM_{adj}\left(\frac{489.5\ mg\text{-}Year}{Kg\text{-}day}\right)=\frac{ED_{0\text{-}2}\left(yr\right)\times IRS_c\left(\frac{200\ mg}{day}\right)\times 10}{BW_c\left(15\ Kg\right)}+\frac{ED_{2\text{-}6}\left(yr\right)\times IRS_c\left(\frac{200\ mg}{day}\right)\times 3}{BW_c\left(15\ Kg\right)}+\frac{ED_{6\text{-}16}\left(yr\right)\times IRS_a\left(\frac{100\ mg}{day}\right)\times 3}{BW_a\left(70\ Kg\right)}+\frac{ED_{16\text{-}30}\left(yr\right)\times IRS_a\left(\frac{100\ mg}{day}\right)\times 1}{BW_a\left(70\ Kg\right)}$$

Inhalation of Particulates Emitted from Soil:

$$SL_{res\text{-}sol\text{-}mu\text{-}inh}\left(\frac{mg}{kg}\right)=\frac{TR\times AT_r\left(\frac{365\ days}{year}\times LT\left(70\ years\right)\right)}{EF_r\left(\frac{350\ days}{year}\right)\times ET_{ra}\left(\frac{24\ hours}{day}\right)\times\left(\frac{1\ day}{24\ hours}\right)\times\left(\frac{1000\ \mu g}{mg}\right)\times\left[\left(\left(ED_{0\text{-}2}\left(yrs\right)\times IUR\left(\frac{\mu g}{m^3}\right)^{-1}\times 10\right)+\left(ED_{2\text{-}6}\left(yrs\right)\times IUR\left(\frac{\mu g}{m^3}\right)^{-1}\times 3\right)+\left(ED_{6\text{-}16}\left(yrs\right)\times IUR\left(\frac{\mu g}{m^3}\right)^{-1}\times 3\right)+\left(ED_{16\text{-}30}\left(yrs\right)\times IUR\left(\frac{\mu g}{m^3}\right)^{-1}\times 1\right)\right)\times\left(\frac{1}{VF_c\left(\frac{m^3}{Kg}\right)}+\frac{1}{PEF_w\left(\frac{m^3}{Kg}\right)}\right)\right]}$$

Dermal Contact with Soil:

$$SL_{res\text{-}sol\text{-}mu\text{-}der}\left(\frac{mg}{kg}\right)=\frac{TR\times AT_r\left(\frac{365\ days}{year}\times LT\left(70\ years\right)\right)}{\left(\frac{CSF_0\left(\frac{mg}{Kg\text{-}day}\right)^{-1}}{GIABS}\right)\times EF_r\left(\frac{350\ days}{year}\right)\times DFSM_{adj}\left(\frac{1445\ mg\text{-}Year}{Kg\text{-}day}\right)\times ABS_d\times\left(\frac{10^{-6}Kg}{mg}\right)}$$

where:

$$DFSM_{adj}\left(\frac{1445\ mg\text{-}Year}{Kg\text{-}day}\right)=\frac{ED_{0\text{-}2}\left(yr\right)\times AF_c\left(\frac{0.2\ mg}{cm^2}\right)\times SA_c\left(\frac{2800\ cm^2}{day}\right)\times 10}{BW_c\left(15\ Kg\right)}+\frac{ED_{2\text{-}6}\left(yr\right)\times AF_c\left(\frac{0.2\ mg}{cm^2}\right)\times SA_c\left(\frac{2800\ cm^2}{day}\right)\times 3}{BW_c\left(15\ Kg\right)}+\frac{ED_{6\text{-}16}\left(yr\right)\times AF_a\left(\frac{0.07\ mg}{cm^2}\right)\times SA_a\left(\frac{5700\ cm^2}{day}\right)\times 3}{BW_a\left(70\ Kg\right)}+\frac{ED_{16\text{-}30}\left(yr\right)\times AF_a\left(\frac{0.07\ mg}{cm^2}\right)\times SA_a\left(\frac{5700\ cm^2}{day}\right)\times 1}{BW_a\left(70\ Kg\right)}$$

Total:

$$SL_{res\text{-}sol\text{-}mu\text{-}tot}\left(\frac{mg}{kg}\right)=\frac{1}{\frac{1}{SL_{res\text{-}sol\text{-}mu\text{-}ing}}+\frac{1}{SL_{res\text{-}sol\text{-}mu\text{-}der}}+\frac{1}{SL_{res\text{-}sol\text{-}mu\text{-}inh}}}$$

Source: USEPA. 2012c. Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites – User's Guide. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

Supplement C

ProUCL Output

General UCL Statistics for Full Data Sets

User Selected Options

From File	Sheet1_a.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Alaska Power Plant Fly+Bottom Ash

As_ppm

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	19

Raw Statistics		**Log-transformed Statistics**	
Minimum	7.3	Minimum of Log Data	1.988
Maximum	32.9	Maximum of Log Data	3.493
Mean	18.77	Mean of log Data	2.843
Geometric Mean	17.17	SD of log Data	0.439
Median	14.9		
SD	8.01		
Std. Error of Mean	1.838		
Coefficient of Variation	0.427		
Skewness	0.44		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.898	Shapiro Wilk Test Statistic	0.935
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	21.95	95% H-UCL	23.13
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	27.28
95% Adjusted-CLT UCL (Chen-1995)	21.99	97.5% Chebyshev (MVUE) UCL	30.94
95% Modified-t UCL (Johnson-1978)	21.99	99% Chebyshev (MVUE) UCL	38.15

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	4.902	Data appear Gamma Distributed at 5% Significance Level
Theta Star	3.829	
MLE of Mean	18.77	
MLE of Standard Deviation	8.477	
nu star	186.3	
Approximate Chi Square Value (.05)	155.7	**Nonparametric Statistics**
Adjusted Level of Significance	0.0369	95% CLT UCL 21.79
Adjusted Chi Square Value	153.3	95% Jackknife UCL 21.95
		95% Standard Bootstrap UCL 21.71
Anderson-Darling Test Statistic	0.643	95% Bootstrap-t UCL 22.22
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL 21.73
Kolmogorov-Smirnov Test Statistic	0.179	95% Percentile Bootstrap UCL 21.83
Kolmogorov-Smirnov 5% Critical Value	0.199	95% BCA Bootstrap UCL 21.63
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 26.78
		97.5% Chebyshev(Mean, Sd) UCL 30.24
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 37.05
95% Approximate Gamma UCL (Use when n >= 40)	22.45	
95% Adjusted Gamma UCL (Use when n < 40)	22.81	

Potential UCL to Use		Use 95% Approximate Gamma UCL	22.45

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Ba_ppm

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	19

Raw Statistics		Log-transformed Statistics	
Minimum	4290	Minimum of Log Data	8.364
Maximum	5730	Maximum of Log Data	8.653
Mean	4959	Mean of log Data	8.505
Geometric Mean	4940	SD of log Data	0.0903
Median	4740		
SD	449.9		
Std. Error of Mean	103.2		
Coefficient of Variation	0.0907		
Skewness	0.238		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.926	Shapiro Wilk Test Statistic	0.929
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	5138	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	5408
95% Adjusted-CLT UCL (Chen-1995)	5135	97.5% Chebyshev (MVUE) UCL	5602
95% Modified-t UCL (Johnson-1978)	5139	99% Chebyshev (MVUE) UCL	5983

Gamma Distribution Test		Data Distribution
k star (bias corrected)	108.8	Data appear Normal at 5% Significance Level
Theta Star	45.56	
MLE of Mean	4959	
MLE of Standard Deviation	475.4	
nu star	4136	
Approximate Chi Square Value (.05)	3988	**Nonparametric Statistics**
Adjusted Level of Significance	0.0369	95% CLT UCL 5129
Adjusted Chi Square Value	3975	95% Jackknife UCL 5138
		95% Standard Bootstrap UCL 5123
Anderson-Darling Test Statistic	0.627	95% Bootstrap-t UCL 5146
Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL 5135
Kolmogorov-Smirnov Test Statistic	0.211	95% Percentile Bootstrap UCL 5121
Kolmogorov-Smirnov 5% Critical Value	0.198	95% BCA Bootstrap UCL 5119
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 5409
		97.5% Chebyshev(Mean, Sd) UCL 5604
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 5986
95% Approximate Gamma UCL (Use when n >= 40)	5144	
95% Adjusted Gamma UCL (Use when n < 40)	5161	

Potential UCL to Use	Use 95% Student's-t UCL 5138

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Be_ppm

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	19

Raw Statistics		Log-transformed Statistics	
Minimum	1.69	Minimum of Log Data	0.525
Maximum	3.16	Maximum of Log Data	1.151
Mean	2.338	Mean of log Data	0.836
Geometric Mean	2.307	SD of log Data	0.168
Median	2.29		
SD	0.395		
Std. Error of Mean	0.0905		
Coefficient of Variation	0.169		
Skewness	0.425		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.966	Shapiro Wilk Test Statistic	0.977
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	2.495	95% H-UCL	2.509
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2.732
95% Adjusted-CLT UCL (Chen-1995)	2.496	97.5% Chebyshev (MVUE) UCL	2.902
95% Modified-t UCL (Johnson-1978)	2.496	99% Chebyshev (MVUE) UCL	3.237

Gamma Distribution Test		Data Distribution
k star (bias corrected)	31.7	Data appear Normal at 5% Significance Level
Theta Star	0.0738	
MLE of Mean	2.338	
MLE of Standard Deviation	0.415	
nu star	1205	
Approximate Chi Square Value (.05)	1125	**Nonparametric Statistics**
Adjusted Level of Significance	0.0369	95% CLT UCL 2.487
Adjusted Chi Square Value	1118	95% Jackknife UCL 2.495
		95% Standard Bootstrap UCL 2.481
Anderson-Darling Test Statistic	0.23	95% Bootstrap-t UCL 2.507
Anderson-Darling 5% Critical Value	0.74	95% Hall's Bootstrap UCL 2.502
Kolmogorov-Smirnov Test Statistic	0.109	95% Percentile Bootstrap UCL 2.486
Kolmogorov-Smirnov 5% Critical Value	0.198	95% BCA Bootstrap UCL 2.505
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 2.732
		97.5% Chebyshev(Mean, Sd) UCL 2.903
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 3.239
95% Approximate Gamma UCL (Use when n >= 40)	2.503	
95% Adjusted Gamma UCL (Use when n < 40)	2.518	

Potential UCL to Use	Use 95% Student's-t UCL 2.495

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Cd_ppm

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	18

Raw Statistics		Log-transformed Statistics	
Minimum	0.38	Minimum of Log Data	-0.968
Maximum	1.84	Maximum of Log Data	0.61
Mean	0.955	Mean of log Data	-0.177
Geometric Mean	0.838	SD of log Data	0.536
Median	0.992		
SD	0.479		
Std. Error of Mean	0.11		
Coefficient of Variation	0.502		
Skewness	0.365		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.898	Shapiro Wilk Test Statistic	0.896
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	1.145	95% H-UCL	1.253
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1.495
95% Adjusted-CLT UCL (Chen-1995)	1.145	97.5% Chebyshev (MVUE) UCL	1.726
95% Modified-t UCL (Johnson-1978)	1.147	99% Chebyshev (MVUE) UCL	2.181

Gamma Distribution Test		Data Distribution
k star (bias corrected)	3.402	Data do not follow a Discernable Distribution (0.05)
Theta Star	0.281	
MLE of Mean	0.955	
MLE of Standard Deviation	0.518	
nu star	129.3	
Approximate Chi Square Value (.05)	104	**Nonparametric Statistics**
Adjusted Level of Significance	0.0369	95% CLT UCL 1.136
Adjusted Chi Square Value	102	95% Jackknife UCL 1.145
		95% Standard Bootstrap UCL 1.132
Anderson-Darling Test Statistic	0.818	95% Bootstrap-t UCL 1.152
Anderson-Darling 5% Critical Value	0.745	95% Hall's Bootstrap UCL 1.133
Kolmogorov-Smirnov Test Statistic	0.219	95% Percentile Bootstrap UCL 1.134
Kolmogorov-Smirnov 5% Critical Value	0.199	95% BCA Bootstrap UCL 1.137
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 1.434
		97.5% Chebyshev(Mean, Sd) UCL 1.641
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 2.049
95% Approximate Gamma UCL (Use when n >= 40)	1.187	
95% Adjusted Gamma UCL (Use when n < 40)	1.21	

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	1.434

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Co_ppm

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	16

Raw Statistics		Log-transformed Statistics	
Minimum	24.6	Minimum of Log Data	3.203
Maximum	32.6	Maximum of Log Data	3.484
Mean	28.78	Mean of log Data	3.356
Geometric Mean	28.68	SD of log Data	0.09
Median	28.7		
SD	2.555		
Std. Error of Mean	0.586		
Coefficient of Variation	0.0887		
Skewness	-0.23		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.917	Shapiro Wilk Test Statistic	0.912
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	29.8	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	31.38
95% Adjusted-CLT UCL (Chen-1995)	29.72	97.5% Chebyshev (MVUE) UCL	32.5
95% Modified-t UCL (Johnson-1978)	29.8	99% Chebyshev (MVUE) UCL	34.71

Gamma Distribution Test		Data Distribution
k star (bias corrected)	110.9	Data appear Normal at 5% Significance Level
Theta Star	0.259	
MLE of Mean	28.78	
MLE of Standard Deviation	2.733	
nu star	4216	
Approximate Chi Square Value (.05)	4066	**Nonparametric Statistics**
Adjusted Level of Significance	0.0369	95% CLT UCL 29.75
Adjusted Chi Square Value	4053	95% Jackknife UCL 29.8
		95% Standard Bootstrap UCL 29.72
Anderson-Darling Test Statistic	0.672	95% Bootstrap-t UCL 29.8
Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL 29.7
Kolmogorov-Smirnov Test Statistic	0.167	95% Percentile Bootstrap UCL 29.74
Kolmogorov-Smirnov 5% Critical Value	0.198	95% BCA Bootstrap UCL 29.68
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 31.34
		97.5% Chebyshev(Mean, Sd) UCL 32.44
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 34.62
95% Approximate Gamma UCL (Use when n >= 40)	29.85	
95% Adjusted Gamma UCL (Use when n < 40)	29.94	

Potential UCL to Use	Use 95% Student's-t UCL 29.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Cr_ppm

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	17

Raw Statistics		**Log-transformed Statistics**	
Minimum	247	Minimum of Log Data	5.509
Maximum	925	Maximum of Log Data	6.83
Mean	407.5	Mean of log Data	5.93
Geometric Mean	376.1	SD of log Data	0.384
Median	322		
SD	193.8		
Std. Error of Mean	44.46		
Coefficient of Variation	0.476		
Skewness	1.778		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.719	Shapiro Wilk Test Statistic	0.817
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	484.6	95% H-UCL	481
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	561.1
95% Adjusted-CLT UCL (Chen-1995)	500	97.5% Chebyshev (MVUE) UCL	629.4
95% Modified-t UCL (Johnson-1978)	487.6	99% Chebyshev (MVUE) UCL	763.7

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	5.41	Data do not follow a Discernable Distribution (0.05)
Theta Star	75.33	
MLE of Mean	407.5	
MLE of Standard Deviation	175.2	
nu star	205.6	
Approximate Chi Square Value (.05)	173.4	**Nonparametric Statistics**
Adjusted Level of Significance	0.0369	95% CLT UCL 480.7
Adjusted Chi Square Value	170.8	95% Jackknife UCL 484.6
		95% Standard Bootstrap UCL 479
Anderson-Darling Test Statistic	1.791	95% Bootstrap-t UCL 521.7
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL 479.9
Kolmogorov-Smirnov Test Statistic	0.261	95% Percentile Bootstrap UCL 482.8
Kolmogorov-Smirnov 5% Critical Value	0.199	95% BCA Bootstrap UCL 492.2
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 601.3
		97.5% Chebyshev(Mean, Sd) UCL 685.2
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 849.9
95% Approximate Gamma UCL (Use when n >= 40)	483.2	
95% Adjusted Gamma UCL (Use when n < 40)	490.5	

Potential UCL to Use		Use 95% Student's-t UCL	484.6
		or 95% Modified-t UCL	487.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Cu_ppm

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	17

Raw Statistics		Log-transformed Statistics	
Minimum	114	Minimum of Log Data	4.736
Maximum	197	Maximum of Log Data	5.283
Mean	153	Mean of log Data	5.019
Geometric Mean	151.3	SD of log Data	0.156
Median	147		
SD	23.79		
Std. Error of Mean	5.459		
Coefficient of Variation	0.156		
Skewness	0.178		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.942	Shapiro Wilk Test Statistic	0.946
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	162.5	95% H-UCL	163.3
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	177
95% Adjusted-CLT UCL (Chen-1995)	162.2	97.5% Chebyshev (MVUE) UCL	187.3
95% Modified-t UCL (Johnson-1978)	162.5	99% Chebyshev (MVUE) UCL	207.7

Gamma Distribution Test		Data Distribution
k star (bias corrected)	36.79	Data appear Normal at 5% Significance Level
Theta Star	4.159	
MLE of Mean	153	
MLE of Standard Deviation	25.22	
nu star	1398	
Approximate Chi Square Value (.05)	1312	**Nonparametric Statistics**
Adjusted Level of Significance	0.0369	95% CLT UCL 162
Adjusted Chi Square Value	1305	95% Jackknife UCL 162.5
		95% Standard Bootstrap UCL 161.8
Anderson-Darling Test Statistic	0.558	95% Bootstrap-t UCL 162.7
Anderson-Darling 5% Critical Value	0.74	95% Hall's Bootstrap UCL 161.5
Kolmogorov-Smirnov Test Statistic	0.175	95% Percentile Bootstrap UCL 161.8
Kolmogorov-Smirnov 5% Critical Value	0.198	95% BCA Bootstrap UCL 162
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 176.8
		97.5% Chebyshev(Mean, Sd) UCL 187.1
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 207.3
95% Approximate Gamma UCL (Use when n >= 40)	163	
95% Adjusted Gamma UCL (Use when n < 40)	163.9	

Potential UCL to Use		Use 95% Student's-t UCL	162.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Hg_ppm

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	19

Raw Statistics		Log-transformed Statistics	
Minimum	0.123	Minimum of Log Data	-2.096
Maximum	1.15	Maximum of Log Data	0.14
Mean	0.462	Mean of log Data	-0.997
Geometric Mean	0.369	SD of log Data	0.678
Median	0.329		
SD	0.334		
Std. Error of Mean	0.0767		
Coefficient of Variation	0.723		
Skewness	1.141		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.817	Shapiro Wilk Test Statistic	0.938
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	0.595	95% H-UCL	0.66
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.787
95% Adjusted-CLT UCL (Chen-1995)	0.61	97.5% Chebyshev (MVUE) UCL	0.93
95% Modified-t UCL (Johnson-1978)	0.598	99% Chebyshev (MVUE) UCL	1.21

Gamma Distribution Test		Data Distribution
k star (bias corrected)	2.033	Data appear Gamma Distributed at 5% Significance Level
Theta Star	0.227	
MLE of Mean	0.462	
MLE of Standard Deviation	0.324	
nu star	77.26	
Approximate Chi Square Value (.05)	58.01	**Nonparametric Statistics**
Adjusted Level of Significance	0.0369	95% CLT UCL 0.588
Adjusted Chi Square Value	56.56	95% Jackknife UCL 0.595
		95% Standard Bootstrap UCL 0.588
Anderson-Darling Test Statistic	0.739	95% Bootstrap-t UCL 0.638
Anderson-Darling 5% Critical Value	0.75	95% Hall's Bootstrap UCL 0.588
Kolmogorov-Smirnov Test Statistic	0.187	95% Percentile Bootstrap UCL 0.592
Kolmogorov-Smirnov 5% Critical Value	0.201	95% BCA Bootstrap UCL 0.605
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 0.796
		97.5% Chebyshev(Mean, Sd) UCL 0.941
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 1.225
95% Approximate Gamma UCL (Use when n >= 40)	0.615	
95% Adjusted Gamma UCL (Use when n < 40)	0.631	

Potential UCL to Use	Use 95% Approximate Gamma UCL 0.615

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Li_ppm

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	18

Raw Statistics		Log-transformed Statistics	
Minimum	13.2	Minimum of Log Data	2.58
Maximum	30.4	Maximum of Log Data	3.414
Mean	22.96	Mean of log Data	3.105
Geometric Mean	22.32	SD of log Data	0.254
Median	24.5		
SD	5.278		
Std. Error of Mean	1.211		
Coefficient of Variation	0.23		
Skewness	-0.507		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.934	Shapiro Wilk Test Statistic	0.899
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	25.06	95% H-UCL	25.69
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	28.9
95% Adjusted-CLT UCL (Chen-1995)	24.8	97.5% Chebyshev (MVUE) UCL	31.45
95% Modified-t UCL (Johnson-1978)	25.04	99% Chebyshev (MVUE) UCL	36.46

Gamma Distribution Test		Data Distribution
k star (bias corrected)	14.97	Data appear Normal at 5% Significance Level
Theta Star	1.534	
MLE of Mean	22.96	
MLE of Standard Deviation	5.934	
nu star	569	
Approximate Chi Square Value (.05)	514.7	**Nonparametric Statistics**
Adjusted Level of Significance	0.0369	95% CLT UCL 24.95
Adjusted Chi Square Value	510.2	95% Jackknife UCL 25.06
		95% Standard Bootstrap UCL 24.92
Anderson-Darling Test Statistic	0.65	95% Bootstrap-t UCL 24.88
Anderson-Darling 5% Critical Value	0.74	95% Hall's Bootstrap UCL 24.79
Kolmogorov-Smirnov Test Statistic	0.17	95% Percentile Bootstrap UCL 24.85
Kolmogorov-Smirnov 5% Critical Value	0.198	95% BCA Bootstrap UCL 24.79
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 28.24
		97.5% Chebyshev(Mean, Sd) UCL 30.53
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 35.01
95% Approximate Gamma UCL (Use when n >= 40)	25.39	
95% Adjusted Gamma UCL (Use when n < 40)	25.61	

Potential UCL to Use	Use 95% Student's-t UCL 25.06

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Mn_ppm

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	19

Raw Statistics		Log-transformed Statistics	
Minimum	731	Minimum of Log Data	6.594
Maximum	966	Maximum of Log Data	6.873
Mean	873	Mean of log Data	6.769
Geometric Mean	870.3	SD of log Data	0.0821
Median	898		
SD	69.29		
Std. Error of Mean	15.9		
Coefficient of Variation	0.0794		
Skewness	-0.786		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.921	Shapiro Wilk Test Statistic	0.905
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	900.6	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	944.8
95% Adjusted-CLT UCL (Chen-1995)	896.1	97.5% Chebyshev (MVUE) UCL	975.9
95% Modified-t UCL (Johnson-1978)	900.1	99% Chebyshev (MVUE) UCL	1037

Gamma Distribution Test		Data Distribution
k star (bias corrected)	135.1	Data appear Normal at 5% Significance Level
Theta Star	6.463	
MLE of Mean	873	
MLE of Standard Deviation	75.11	
nu star	5133	
Approximate Chi Square Value (.05)	4968	**Nonparametric Statistics**
Adjusted Level of Significance	0.0369	95% CLT UCL 899.1
Adjusted Chi Square Value	4953	95% Jackknife UCL 900.6
		95% Standard Bootstrap UCL 898.6
Anderson-Darling Test Statistic	0.595	95% Bootstrap-t UCL 898.6
Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL 895.7
Kolmogorov-Smirnov Test Statistic	0.176	95% Percentile Bootstrap UCL 897.9
Kolmogorov-Smirnov 5% Critical Value	0.198	95% BCA Bootstrap UCL 895.6
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 942.3
		97.5% Chebyshev(Mean, Sd) UCL 972.3
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 1031
95% Approximate Gamma UCL (Use when n >= 40)	902.1	
95% Adjusted Gamma UCL (Use when n < 40)	904.7	

Potential UCL to Use	Use 95% Student's-t UCL 900.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Mo_ppm

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	19

Raw Statistics		Log-transformed Statistics	
Minimum	19.6	Minimum of Log Data	2.976
Maximum	45.4	Maximum of Log Data	3.816
Mean	34.35	Mean of log Data	3.518
Geometric Mean	33.71	SD of log Data	0.205
Median	33.4		
SD	6.606		
Std. Error of Mean	1.515		
Coefficient of Variation	0.192		
Skewness	-0.18		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.971	Shapiro Wilk Test Statistic	0.945
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	36.98	95% H-UCL	37.52
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	41.47
95% Adjusted-CLT UCL (Chen-1995)	36.78	97.5% Chebyshev (MVUE) UCL	44.53
95% Modified-t UCL (Johnson-1978)	36.97	99% Chebyshev (MVUE) UCL	50.55

Gamma Distribution Test		Data Distribution
k star (bias corrected)	22.45	Data appear Normal at 5% Significance Level
Theta Star	1.53	
MLE of Mean	34.35	
MLE of Standard Deviation	7.251	
nu star	853	
Approximate Chi Square Value (.05)	786.2	**Nonparametric Statistics**
Adjusted Level of Significance	0.0369	95% CLT UCL 36.85
Adjusted Chi Square Value	780.6	95% Jackknife UCL 36.98
		95% Standard Bootstrap UCL 36.72
Anderson-Darling Test Statistic	0.267	95% Bootstrap-t UCL 36.87
Anderson-Darling 5% Critical Value	0.74	95% Hall's Bootstrap UCL 36.79
Kolmogorov-Smirnov Test Statistic	0.0971	95% Percentile Bootstrap UCL 36.77
Kolmogorov-Smirnov 5% Critical Value	0.198	95% BCA Bootstrap UCL 36.69
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 40.96
		97.5% Chebyshev(Mean, Sd) UCL 43.82
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 49.43
95% Approximate Gamma UCL (Use when n >= 40)	37.27	
95% Adjusted Gamma UCL (Use when n < 40)	37.54	

Potential UCL to Use	Use 95% Student's-t UCL 36.98

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Ni_ppm

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	19

Raw Statistics		Log-transformed Statistics	
Minimum	159	Minimum of Log Data	5.069
Maximum	280	Maximum of Log Data	5.635
Mean	226.8	Mean of log Data	5.415
Geometric Mean	224.7	SD of log Data	0.143
Median	226		
SD	31.21		
Std. Error of Mean	7.159		
Coefficient of Variation	0.138		
Skewness	-0.274		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.977	Shapiro Wilk Test Statistic	0.959
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	239.3	95% H-UCL	240.8
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	259.4
95% Adjusted-CLT UCL (Chen-1995)	238.1	97.5% Chebyshev (MVUE) UCL	273.5
95% Modified-t UCL (Johnson-1978)	239.2	99% Chebyshev (MVUE) UCL	301.2

Gamma Distribution Test		Data Distribution
k star (bias corrected)	44.91	Data appear Normal at 5% Significance Level
Theta Star	5.051	
MLE of Mean	226.8	
MLE of Standard Deviation	33.85	
nu star	1707	
Approximate Chi Square Value (.05)	1612	**Nonparametric Statistics**
Adjusted Level of Significance	0.0369	95% CLT UCL 238.6
Adjusted Chi Square Value	1604	95% Jackknife UCL 239.3
		95% Standard Bootstrap UCL 238.2
Anderson-Darling Test Statistic	0.269	95% Bootstrap-t UCL 238.7
Anderson-Darling 5% Critical Value	0.74	95% Hall's Bootstrap UCL 238.2
Kolmogorov-Smirnov Test Statistic	0.127	95% Percentile Bootstrap UCL 237.9
Kolmogorov-Smirnov 5% Critical Value	0.198	95% BCA Bootstrap UCL 237.8
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 258
		97.5% Chebyshev(Mean, Sd) UCL 271.6
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 298.1
95% Approximate Gamma UCL (Use when n >= 40)	240.2	
95% Adjusted Gamma UCL (Use when n < 40)	241.4	

Potential UCL to Use	Use 95% Student's-t UCL 239.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Pb_ppm

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	19

Raw Statistics		Log-transformed Statistics	
Minimum	14.4	Minimum of Log Data	2.667
Maximum	77	Maximum of Log Data	4.344
Mean	39.08	Mean of log Data	3.529
Geometric Mean	34.08	SD of log Data	0.541
Median	27.9		
SD	20.74		
Std. Error of Mean	4.759		
Coefficient of Variation	0.531		
Skewness	0.536		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.874	Shapiro Wilk Test Statistic	0.911
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	47.34	95% H-UCL	51.23
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	61.15
95% Adjusted-CLT UCL (Chen-1995)	47.54	97.5% Chebyshev (MVUE) UCL	70.68
95% Modified-t UCL (Johnson-1978)	47.43	99% Chebyshev (MVUE) UCL	89.41

Gamma Distribution Test		Data Distribution
k star (bias corrected)	3.243	Data appear Lognormal at 5% Significance Level
Theta Star	12.05	
MLE of Mean	39.08	
MLE of Standard Deviation	21.7	
nu star	123.3	
Approximate Chi Square Value (.05)	98.61	**Nonparametric Statistics**
Adjusted Level of Significance	0.0369	95% CLT UCL 46.91
Adjusted Chi Square Value	96.69	95% Jackknife UCL 47.34
		95% Standard Bootstrap UCL 46.92
Anderson-Darling Test Statistic	0.85	95% Bootstrap-t UCL 48.03
Anderson-Darling 5% Critical Value	0.746	95% Hall's Bootstrap UCL 47.05
Kolmogorov-Smirnov Test Statistic	0.211	95% Percentile Bootstrap UCL 46.95
Kolmogorov-Smirnov 5% Critical Value	0.199	95% BCA Bootstrap UCL 47.18
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 59.83
		97.5% Chebyshev(Mean, Sd) UCL 68.8
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 86.43
95% Approximate Gamma UCL (Use when n >= 40)	48.85	
95% Adjusted Gamma UCL (Use when n < 40)	49.82	

Potential UCL to Use		Use 95% H-UCL	51.23

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sb_ppm

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	19

Raw Statistics		Log-transformed Statistics	
Minimum	4.21	Minimum of Log Data	1.437
Maximum	12.1	Maximum of Log Data	2.493
Mean	7.305	Mean of log Data	1.933
Geometric Mean	6.909	SD of log Data	0.344
Median	7.12		
SD	2.502		
Std. Error of Mean	0.574		
Coefficient of Variation	0.342		
Skewness	0.426		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.911	Shapiro Wilk Test Statistic	0.918
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	8.301	95% H-UCL	8.535
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	9.863
95% Adjusted-CLT UCL (Chen-1995)	8.309	97.5% Chebyshev (MVUE) UCL	10.97
95% Modified-t UCL (Johnson-1978)	8.31	99% Chebyshev (MVUE) UCL	13.14

Gamma Distribution Test		Data Distribution
k star (bias corrected)	7.716	Data appear Normal at 5% Significance Level
Theta Star	0.947	
MLE of Mean	7.305	
MLE of Standard Deviation	2.63	
nu star	293.2	
Approximate Chi Square Value (.05)	254.6	**Nonparametric Statistics**
Adjusted Level of Significance	0.0369	95% CLT UCL 8.249
Adjusted Chi Square Value	251.4	95% Jackknife UCL 8.301
		95% Standard Bootstrap UCL 8.22
Anderson-Darling Test Statistic	0.671	95% Bootstrap-t UCL 8.358
Anderson-Darling 5% Critical Value	0.741	95% Hall's Bootstrap UCL 8.258
Kolmogorov-Smirnov Test Statistic	0.216	95% Percentile Bootstrap UCL 8.219
Kolmogorov-Smirnov 5% Critical Value	0.199	95% BCA Bootstrap UCL 8.287
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 9.807
		97.5% Chebyshev(Mean, Sd) UCL 10.89
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 13.02
95% Approximate Gamma UCL (Use when n >= 40)	8.415	
95% Adjusted Gamma UCL (Use when n < 40)	8.52	

Potential UCL to Use		Use 95% Student's-t UCL	8.301

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Se_ppm

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	19

Raw Statistics		Log-transformed Statistics	
Minimum	1.25	Minimum of Log Data	0.223
Maximum	7.14	Maximum of Log Data	1.966
Mean	3.291	Mean of log Data	1.061
Geometric Mean	2.89	SD of log Data	0.518
Median	2.47		
SD	1.775		
Std. Error of Mean	0.407		
Coefficient of Variation	0.539		
Skewness	0.892		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.875	Shapiro Wilk Test Statistic	0.939
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	3.996	95% H-UCL	4.231
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	5.04
95% Adjusted-CLT UCL (Chen-1995)	4.049	97.5% Chebyshev (MVUE) UCL	5.802
95% Modified-t UCL (Johnson-1978)	4.01	99% Chebyshev (MVUE) UCL	7.3

Gamma Distribution Test		Data Distribution
k star (bias corrected)	3.413	Data appear Gamma Distributed at 5% Significance Level
Theta Star	0.964	
MLE of Mean	3.291	
MLE of Standard Deviation	1.781	
nu star	129.7	
Approximate Chi Square Value (.05)	104.4	**Nonparametric Statistics**
Adjusted Level of Significance	0.0369	95% CLT UCL 3.96
Adjusted Chi Square Value	102.4	95% Jackknife UCL 3.996
		95% Standard Bootstrap UCL 3.933
Anderson-Darling Test Statistic	0.642	95% Bootstrap-t UCL 4.093
Anderson-Darling 5% Critical Value	0.745	95% Hall's Bootstrap UCL 4.009
Kolmogorov-Smirnov Test Statistic	0.173	95% Percentile Bootstrap UCL 3.948
Kolmogorov-Smirnov 5% Critical Value	0.199	95% BCA Bootstrap UCL 3.959
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 5.065
		97.5% Chebyshev(Mean, Sd) UCL 5.833
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 7.341
95% Approximate Gamma UCL (Use when n >= 40)	4.088	
95% Adjusted Gamma UCL (Use when n < 40)	4.167	

Potential UCL to Use	Use 95% Approximate Gamma UCL 4.088

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sr_ppm

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	15

Raw Statistics		**Log-transformed Statistics**	
Minimum	1240	Minimum of Log Data	7.123
Maximum	1830	Maximum of Log Data	7.512
Mean	1479	Mean of log Data	7.289
Geometric Mean	1464	SD of log Data	0.146
Median	1340		
SD	218.4		
Std. Error of Mean	50.1		
Coefficient of Variation	0.148		
Skewness	0.284		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.845	Shapiro Wilk Test Statistic	0.844
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	1566	95% H-UCL	1572
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1696
95% Adjusted-CLT UCL (Chen-1995)	1565	97.5% Chebyshev (MVUE) UCL	1790
95% Modified-t UCL (Johnson-1978)	1566	99% Chebyshev (MVUE) UCL	1974

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	41.41	Data do not follow a Discernable Distribution (0.05)
Theta Star	35.71	
MLE of Mean	1479	
MLE of Standard Deviation	229.8	
nu star	1574	
Approximate Chi Square Value (.05)	1483	
Adjusted Level of Significance	0.0369	
Adjusted Chi Square Value	1475	
Anderson-Darling Test Statistic	1.326	
Anderson-Darling 5% Critical Value	0.74	
Kolmogorov-Smirnov Test Statistic	0.263	
Kolmogorov-Smirnov 5% Critical Value	0.198	
Data not Gamma Distributed at 5% Significance Level		

Nonparametric Statistics	
95% CLT UCL	1561
95% Jackknife UCL	1566
95% Standard Bootstrap UCL	1562
95% Bootstrap-t UCL	1566
95% Hall's Bootstrap UCL	1560
95% Percentile Bootstrap UCL	1559
95% BCA Bootstrap UCL	1565
95% Chebyshev(Mean, Sd) UCL	1697
97.5% Chebyshev(Mean, Sd) UCL	1792
99% Chebyshev(Mean, Sd) UCL	1977

Assuming Gamma Distribution	
95% Approximate Gamma UCL (Use when n >= 40)	1570
95% Adjusted Gamma UCL (Use when n < 40)	1578

Potential UCL to Use	
Use 95% Student's-t UCL	1566
or 95% Modified-t UCL	1566

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Tl_ppm

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	19

Raw Statistics		Log-transformed Statistics	
Minimum	0.312	Minimum of Log Data	-1.165
Maximum	1.99	Maximum of Log Data	0.688
Mean	0.725	Mean of log Data	-0.484
Geometric Mean	0.616	SD of log Data	0.56
Median	0.582		
SD	0.477		
Std. Error of Mean	0.11		
Coefficient of Variation	0.658		
Skewness	1.741		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.774	Shapiro Wilk Test Statistic	0.909
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	0.915	95% H-UCL	0.948
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1.132
95% Adjusted-CLT UCL (Chen-1995)	0.952	97.5% Chebyshev (MVUE) UCL	1.313
95% Modified-t UCL (Johnson-1978)	0.922	99% Chebyshev (MVUE) UCL	1.669

Gamma Distribution Test		Data Distribution
k star (bias corrected)	2.76	Data Follow Appr. Gamma Distribution at 5% Significance Level
Theta Star	0.263	
MLE of Mean	0.725	
MLE of Standard Deviation	0.436	
nu star	104.9	
Approximate Chi Square Value (.05)	82.24	**Nonparametric Statistics**
Adjusted Level of Significance	0.0369	95% CLT UCL 0.905
Adjusted Chi Square Value	80.49	95% Jackknife UCL 0.915
		95% Standard Bootstrap UCL 0.903
Anderson-Darling Test Statistic	0.803	95% Bootstrap-t UCL 1.042
Anderson-Darling 5% Critical Value	0.747	95% Hall's Bootstrap UCL 1.886
Kolmogorov-Smirnov Test Statistic	0.178	95% Percentile Bootstrap UCL 0.911
Kolmogorov-Smirnov 5% Critical Value	0.2	95% BCA Bootstrap UCL 0.941
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 1.202
		97.5% Chebyshev(Mean, Sd) UCL 1.409
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 1.815
95% Approximate Gamma UCL (Use when n >= 40)	0.925	
95% Adjusted Gamma UCL (Use when n < 40)	0.945	

Potential UCL to Use	Use 95% Approximate Gamma UCL 0.925

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U_ppm

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	17

Raw Statistics		Log-transformed Statistics	
Minimum	0.682	Minimum of Log Data	-0.383
Maximum	1.1	Maximum of Log Data	0.0953
Mean	0.916	Mean of log Data	-0.0968
Geometric Mean	0.908	SD of log Data	0.141
Median	0.853		
SD	0.127		
Std. Error of Mean	0.0292		
Coefficient of Variation	0.139		
Skewness	0.0015		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.914	Shapiro Wilk Test Statistic	0.918
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	0.967	95% H-UCL	0.972
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1.046
95% Adjusted-CLT UCL (Chen-1995)	0.964	97.5% Chebyshev (MVUE) UCL	1.102
95% Modified-t UCL (Johnson-1978)	0.967	99% Chebyshev (MVUE) UCL	1.212

Gamma Distribution Test		Data Distribution
k star (bias corrected)	45.41	Data appear Normal at 5% Significance Level
Theta Star	0.0202	
MLE of Mean	0.916	
MLE of Standard Deviation	0.136	
nu star	1726	
Approximate Chi Square Value (.05)	1630	**Nonparametric Statistics**
Adjusted Level of Significance	0.0369	95% CLT UCL 0.964
Adjusted Chi Square Value	1622	95% Jackknife UCL 0.967
		95% Standard Bootstrap UCL 0.962
Anderson-Darling Test Statistic	0.768	95% Bootstrap-t UCL 0.97
Anderson-Darling 5% Critical Value	0.74	95% Hall's Bootstrap UCL 0.964
Kolmogorov-Smirnov Test Statistic	0.208	95% Percentile Bootstrap UCL 0.961
Kolmogorov-Smirnov 5% Critical Value	0.198	95% BCA Bootstrap UCL 0.963
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 1.044
		97.5% Chebyshev(Mean, Sd) UCL 1.099
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 1.207
95% Approximate Gamma UCL (Use when n >= 40)	0.97	
95% Adjusted Gamma UCL (Use when n < 40)	0.975	

Potential UCL to Use	Use 95% Student's-t UCL 0.967

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

V_ppm

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	16

Raw Statistics		Log-transformed Statistics	
Minimum	203	Minimum of Log Data	5.313
Maximum	418	Maximum of Log Data	6.035
Mean	265.5	Mean of log Data	5.56
Geometric Mean	259.8	SD of log Data	0.205
Median	236		
SD	61.38		
Std. Error of Mean	14.08		
Coefficient of Variation	0.231		
Skewness	1.573		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.712	Shapiro Wilk Test Statistic	0.751
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	289.9	95% H-UCL	289.1
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	319.6
95% Adjusted-CLT UCL (Chen-1995)	294.1	97.5% Chebyshev (MVUE) UCL	343.2
95% Modified-t UCL (Johnson-1978)	290.7	99% Chebyshev (MVUE) UCL	389.5

Gamma Distribution Test		Data Distribution
k star (bias corrected)	19.75	Data do not follow a Discernable Distribution (0.05)
Theta Star	13.44	
MLE of Mean	265.5	
MLE of Standard Deviation	59.74	
nu star	750.4	
Approximate Chi Square Value (.05)	687.8	**Nonparametric Statistics**
Adjusted Level of Significance	0.0369	95% CLT UCL 288.6
Adjusted Chi Square Value	682.6	95% Jackknife UCL 289.9
		95% Standard Bootstrap UCL 288
Anderson-Darling Test Statistic	2.488	95% Bootstrap-t UCL 303
Anderson-Darling 5% Critical Value	0.74	95% Hall's Bootstrap UCL 287.9
Kolmogorov-Smirnov Test Statistic	0.324	95% Percentile Bootstrap UCL 289.6
Kolmogorov-Smirnov 5% Critical Value	0.198	95% BCA Bootstrap UCL 295.1
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 326.9
		97.5% Chebyshev(Mean, Sd) UCL 353.4
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 405.6
95% Approximate Gamma UCL (Use when n >= 40)	289.6	
95% Adjusted Gamma UCL (Use when n < 40)	291.8	

Potential UCL to Use		Use 95% Student's-t UCL	289.9
		or 95% Modified-t UCL	290.7

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	19

Raw Statistics

Minimum	33.1
Maximum	233
Mean	76.12
Geometric Mean	66.58
Median	53.5
SD	48.02
Std. Error of Mean	11.02
Coefficient of Variation	0.631
Skewness	2.228

Log-transformed Statistics

Minimum of Log Data	3.5
Maximum of Log Data	5.451
Mean of log Data	4.198
SD of log Data	0.495

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.746
Shapiro Wilk Critical Value	0.901

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.914
Shapiro Wilk Critical Value	0.901

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	95.22

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	100.3
95% Modified-t UCL (Johnson-1978)	96.16

Assuming Lognormal Distribution

95% H-UCL	95.13
95% Chebyshev (MVUE) UCL	113.1
97.5% Chebyshev (MVUE) UCL	129.6
99% Chebyshev (MVUE) UCL	162.2

Gamma Distribution Test

k star (bias corrected)	3.315
Theta Star	22.96
MLE of Mean	76.12
MLE of Standard Deviation	41.8
nu star	126
Approximate Chi Square Value (.05)	101.1
Adjusted Level of Significance	0.0369
Adjusted Chi Square Value	99.11
Anderson-Darling Test Statistic	0.976
Anderson-Darling 5% Critical Value	0.745
Kolmogorov-Smirnov Test Statistic	0.212
Kolmogorov-Smirnov 5% Critical Value	0.199

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL (Use when n >= 40)	94.89
95% Adjusted Gamma UCL (Use when n < 40)	96.75

Data Distribution

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	94.24
95% Jackknife UCL	95.22
95% Standard Bootstrap UCL	93.52
95% Bootstrap-t UCL	110.1
95% Hall's Bootstrap UCL	166.5
95% Percentile Bootstrap UCL	94.1
95% BCA Bootstrap UCL	99.86
95% Chebyshev(Mean, Sd) UCL	124.1
97.5% Chebyshev(Mean, Sd) UCL	144.9
99% Chebyshev(Mean, Sd) UCL	185.7

Potential UCL to Use

Use 95% Student's-t UCL	95.22
or 95% Modified-t UCL	96.16
or 95% H-UCL	95.13

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Full Data Sets

User Selected Options

From File	ProUCL input Indiana.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Indiana Power Plant Fly Ash

As_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	20.2	Minimum of Log Data	3.006
Maximum	56.3	Maximum of Log Data	4.031
Mean	26.13	Mean of log Data	3.227
Geometric Mean	25.2	SD of log Data	0.249
Median	24		
SD	9.176		
Std. Error of Mean	2.545		
Coefficient of Variation	0.351		
Skewness	3.449		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.459	Shapiro Wilk Test Statistic	0.55
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	30.67	95% H-UCL	29.74
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	33.81
95% Adjusted-CLT UCL (Chen-1995)	32.92	97.5% Chebyshev (MVUE) UCL	37.22
95% Modified-t UCL (Johnson-1978)	31.07	99% Chebyshev (MVUE) UCL	43.91

Gamma Distribution Test		Data Distribution
k star (bias corrected)	10.84	Data do not follow a Discernable Distribution (0.05)
Theta Star	2.411	
MLE of Mean	26.13	
MLE of Standard Deviation	7.938	
nu star	281.8	
Approximate Chi Square Value (.05)	243.9	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 30.32
Adjusted Chi Square Value	238.9	95% Jackknife UCL 30.67
		95% Standard Bootstrap UCL 30.24
Anderson-Darling Test Statistic	2.659	95% Bootstrap-t UCL 47.17
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 52.34
Kolmogorov-Smirnov Test Statistic	0.435	95% Percentile Bootstrap UCL 31.18
Kolmogorov-Smirnov 5% Critical Value	0.236	95% BCA Bootstrap UCL 33.67
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 37.22
		97.5% Chebyshev(Mean, Sd) UCL 42.02
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 51.45
95% Approximate Gamma UCL (Use when n >= 40)	30.19	
95% Adjusted Gamma UCL (Use when n < 40)	30.82	

Potential UCL to Use		Use 95% Student's-t UCL	30.67
		or 95% Modified-t UCL	31.07

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Ba_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	12

Raw Statistics		**Log-transformed Statistics**	
Minimum	336	Minimum of Log Data	5.817
Maximum	422	Maximum of Log Data	6.045
Mean	379.5	Mean of log Data	5.936
Geometric Mean	378.5	SD of log Data	0.0753
Median	375		
SD	28.64		
Std. Error of Mean	7.944		
Coefficient of Variation	0.0755		
Skewness	0.177		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.932	Shapiro Wilk Test Statistic	0.935
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	393.6	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	414
95% Adjusted-CLT UCL (Chen-1995)	392.9	97.5% Chebyshev (MVUE) UCL	429
95% Modified-t UCL (Johnson-1978)	393.7	99% Chebyshev (MVUE) UCL	458.4

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	146.9	Data appear Normal at 5% Significance Level
Theta Star	2.583	
MLE of Mean	379.5	
MLE of Standard Deviation	31.31	
nu star	3820	
Approximate Chi Square Value (.05)	3677	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 392.5
Adjusted Chi Square Value	3657	95% Jackknife UCL 393.6
		95% Standard Bootstrap UCL 392.4
Anderson-Darling Test Statistic	0.399	95% Bootstrap-t UCL 394.4
Anderson-Darling 5% Critical Value	0.732	95% Hall's Bootstrap UCL 391.5
Kolmogorov-Smirnov Test Statistic	0.158	95% Percentile Bootstrap UCL 391.2
Kolmogorov-Smirnov 5% Critical Value	0.236	95% BCA Bootstrap UCL 392.2
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 414.1
		97.5% Chebyshev(Mean, Sd) UCL 429.1
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 458.5
95% Approximate Gamma UCL (Use when n >= 40)	394.2	
95% Adjusted Gamma UCL (Use when n < 40)	396.3	

Potential UCL to Use		Use 95% Student's-t UCL	393.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Be_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	2.32	Minimum of Log Data	0.842
Maximum	32.7	Maximum of Log Data	3.487
Mean	5.328	Mean of log Data	1.271
Geometric Mean	3.566	SD of log Data	0.701
Median	2.75		
SD	8.264		
Std. Error of Mean	2.292		
Coefficient of Variation	1.551		
Skewness	3.547		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.381	Shapiro Wilk Test Statistic	0.555
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	9.413	95% H-UCL	7.372
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	8.414
95% Adjusted-CLT UCL (Chen-1995)	11.51	97.5% Chebyshev (MVUE) UCL	10.13
95% Modified-t UCL (Johnson-1978)	9.789	99% Chebyshev (MVUE) UCL	13.49

Gamma Distribution Test		Data Distribution
k star (bias corrected)	1.119	Data do not follow a Discernable Distribution (0.05)
Theta Star	4.761	
MLE of Mean	5.328	
MLE of Standard Deviation	5.036	
nu star	29.1	
Approximate Chi Square Value (.05)	17.78	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 9.098
Adjusted Chi Square Value	16.53	95% Jackknife UCL 9.413
		95% Standard Bootstrap UCL 8.9
Anderson-Darling Test Statistic	3.017	95% Bootstrap-t UCL 60.69
Anderson-Darling 5% Critical Value	0.752	95% Hall's Bootstrap UCL 31.65
Kolmogorov-Smirnov Test Statistic	0.403	95% Percentile Bootstrap UCL 9.822
Kolmogorov-Smirnov 5% Critical Value	0.241	95% BCA Bootstrap UCL 12.33
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 15.32
		97.5% Chebyshev(Mean, Sd) UCL 19.64
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 28.13
95% Approximate Gamma UCL (Use when n >= 40)	8.717	
95% Adjusted Gamma UCL (Use when n < 40)	9.376	

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	15.32

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Cd_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	0.79	Minimum of Log Data	-0.236
Maximum	3.29	Maximum of Log Data	1.191
Mean	1.152	Mean of log Data	0.0554
Geometric Mean	1.057	SD of log Data	0.375
Median	0.981		
SD	0.663		
Std. Error of Mean	0.184		
Coefficient of Variation	0.575		
Skewness	3.245		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.521	Shapiro Wilk Test Statistic	0.681
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	1.48	95% H-UCL	1.405
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1.647
95% Adjusted-CLT UCL (Chen-1995)	1.631	97.5% Chebyshev (MVUE) UCL	1.871
95% Modified-t UCL (Johnson-1978)	1.507	99% Chebyshev (MVUE) UCL	2.312

Gamma Distribution Test		Data Distribution
k star (bias corrected)	4.641	Data do not follow a Discernable Distribution (0.05)
Theta Star	0.248	
MLE of Mean	1.152	
MLE of Standard Deviation	0.535	
nu star	120.7	
Approximate Chi Square Value (.05)	96.31	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 1.455
Adjusted Chi Square Value	93.21	95% Jackknife UCL 1.48
		95% Standard Bootstrap UCL 1.436
Anderson-Darling Test Statistic	1.873	95% Bootstrap-t UCL 2.586
Anderson-Darling 5% Critical Value	0.736	95% Hall's Bootstrap UCL 2.817
Kolmogorov-Smirnov Test Statistic	0.327	95% Percentile Bootstrap UCL 1.494
Kolmogorov-Smirnov 5% Critical Value	0.237	95% BCA Bootstrap UCL 1.685
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 1.954
		97.5% Chebyshev(Mean, Sd) UCL 2.3
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 2.982
95% Approximate Gamma UCL (Use when n >= 40)	1.444	
95% Adjusted Gamma UCL (Use when n < 40)	1.492	

Potential UCL to Use		
	Use 95% Student's-t UCL	1.48
	or 95% Modified-t UCL	1.507

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Co_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	11

Raw Statistics		**Log-transformed Statistics**	
Minimum	22.5	Minimum of Log Data	3.114
Maximum	264	Maximum of Log Data	5.576
Mean	45.31	Mean of log Data	3.468
Geometric Mean	32.08	SD of log Data	0.642
Median	26.7		
SD	65.79		
Std. Error of Mean	18.25		
Coefficient of Variation	1.452		
Skewness	3.591		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.349	Shapiro Wilk Test Statistic	0.453
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	77.83	95% H-UCL	60.32
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	70.01
95% Adjusted-CLT UCL (Chen-1995)	94.74	97.5% Chebyshev (MVUE) UCL	83.55
95% Modified-t UCL (Johnson-1978)	80.86	99% Chebyshev (MVUE) UCL	110.1

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	1.278	Data do not follow a Discernable Distribution (0.05)
Theta Star	35.44	
MLE of Mean	45.31	
MLE of Standard Deviation	40.07	
nu star	33.24	
Approximate Chi Square Value (.05)	21.05	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 75.32
Adjusted Chi Square Value	19.68	95% Jackknife UCL 77.83
		95% Standard Bootstrap UCL 74.22
Anderson-Darling Test Statistic	3.648	95% Bootstrap-t UCL 822.4
Anderson-Darling 5% Critical Value	0.749	95% Hall's Bootstrap UCL 469.3
Kolmogorov-Smirnov Test Statistic	0.456	95% Percentile Bootstrap UCL 81.06
Kolmogorov-Smirnov 5% Critical Value	0.241	95% BCA Bootstrap UCL 100.5
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 124.8
		97.5% Chebyshev(Mean, Sd) UCL 159.3
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 226.8
95% Approximate Gamma UCL (Use when n >= 40)	71.52	
95% Adjusted Gamma UCL (Use when n < 40)	76.51	

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	124.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Cr_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		**Log-transformed Statistics**	
Minimum	78.2	Minimum of Log Data	4.359
Maximum	984	Maximum of Log Data	6.892
Mean	169.1	Mean of log Data	4.776
Geometric Mean	118.7	SD of log Data	0.66
Median	96.7		
SD	245.7		
Std. Error of Mean	68.13		
Coefficient of Variation	1.453		
Skewness	3.565		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.375	Shapiro Wilk Test Statistic	0.54
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	290.5	95% H-UCL	229.4
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	265
95% Adjusted-CLT UCL (Chen-1995)	353.1	97.5% Chebyshev (MVUE) UCL	317.1
95% Modified-t UCL (Johnson-1978)	301.8	99% Chebyshev (MVUE) UCL	419.4

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	1.249	Data do not follow a Discernable Distribution (0.05)
Theta Star	135.3	
MLE of Mean	169.1	
MLE of Standard Deviation	151.3	
nu star	32.49	
Approximate Chi Square Value (.05)	20.46	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 281.2
Adjusted Chi Square Value	19.11	95% Jackknife UCL 290.5
		95% Standard Bootstrap UCL 278.2
Anderson-Darling Test Statistic	3.08	95% Bootstrap-t UCL 1356
Anderson-Darling 5% Critical Value	0.75	95% Hall's Bootstrap UCL 1076
Kolmogorov-Smirnov Test Statistic	0.392	95% Percentile Bootstrap UCL 302
Kolmogorov-Smirnov 5% Critical Value	0.241	95% BCA Bootstrap UCL 371.7
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 466.1
		97.5% Chebyshev(Mean, Sd) UCL 594.6
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 847
95% Approximate Gamma UCL (Use when n >= 40)	268.5	
95% Adjusted Gamma UCL (Use when n < 40)	287.5	

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	466.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Cu_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		**Log-transformed Statistics**	
Minimum	156	Minimum of Log Data	5.05
Maximum	692	Maximum of Log Data	6.54
Mean	223.8	Mean of log Data	5.315
Geometric Mean	203.3	SD of log Data	0.385
Median	175		
SD	142.4		
Std. Error of Mean	39.49		
Coefficient of Variation	0.636		
Skewness	3.457		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.446	Shapiro Wilk Test Statistic	0.578
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	294.2	95% H-UCL	273.2
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	320.7
95% Adjusted-CLT UCL (Chen-1995)	329.3	97.5% Chebyshev (MVUE) UCL	365.3
95% Modified-t UCL (Johnson-1978)	300.5	99% Chebyshev (MVUE) UCL	452.9

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	4.175	Data do not follow a Discernable Distribution (0.05)
Theta Star	53.62	
MLE of Mean	223.8	
MLE of Standard Deviation	109.6	
nu star	108.5	
Approximate Chi Square Value (.05)	85.49	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 288.8
Adjusted Chi Square Value	82.58	95% Jackknife UCL 294.2
		95% Standard Bootstrap UCL 287.2
Anderson-Darling Test Statistic	2.523	95% Bootstrap-t UCL 647.2
Anderson-Darling 5% Critical Value	0.736	95% Hall's Bootstrap UCL 567.4
Kolmogorov-Smirnov Test Statistic	0.351	95% Percentile Bootstrap UCL 300.2
Kolmogorov-Smirnov 5% Critical Value	0.237	95% BCA Bootstrap UCL 344.2
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 396
		97.5% Chebyshev(Mean, Sd) UCL 470.5
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 616.8
95% Approximate Gamma UCL (Use when n >= 40)	284.2	
95% Adjusted Gamma UCL (Use when n < 40)	294.2	

Potential UCL to Use	Use 95% Student's-t UCL 294.2
	or 95% Modified-t UCL 300.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Hg_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.0127	Minimum of Log Data	-4.366
Maximum	0.104	Maximum of Log Data	-2.263
Mean	0.0376	Mean of log Data	-3.436
Geometric Mean	0.0322	SD of log Data	0.556
Median	0.0264		
SD	0.0247		
Std. Error of Mean	0.00685		
Coefficient of Variation	0.657		
Skewness	1.868		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.796	Shapiro Wilk Test Statistic	0.953
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.0498	95% H-UCL	0.0533
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.0628
95% Adjusted-CLT UCL (Chen-1995)	0.0527	97.5% Chebyshev (MVUE) UCL	0.074
95% Modified-t UCL (Johnson-1978)	0.0504	99% Chebyshev (MVUE) UCL	0.0958

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	2.642	Data appear Gamma Distributed at 5% Significance Level
Theta Star	0.0142	
MLE of Mean	0.0376	
MLE of Standard Deviation	0.0231	
nu star	68.7	
Approximate Chi Square Value (.05)	50.62	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 0.0489
Adjusted Chi Square Value	48.42	95% Jackknife UCL 0.0498
		95% Standard Bootstrap UCL 0.0485
Anderson-Darling Test Statistic	0.558	95% Bootstrap-t UCL 0.0595
Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL 0.0634
Kolmogorov-Smirnov Test Statistic	0.204	95% Percentile Bootstrap UCL 0.0495
Kolmogorov-Smirnov 5% Critical Value	0.238	95% BCA Bootstrap UCL 0.0518
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 0.0675
		97.5% Chebyshev(Mean, Sd) UCL 0.0804
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 0.106
95% Approximate Gamma UCL (Use when n >= 40)	0.0511	
95% Adjusted Gamma UCL (Use when n < 40)	0.0534	

Potential UCL to Use		Use 95% Approximate Gamma UCL	0.0511

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Li_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		**Log-transformed Statistics**	
Minimum	21.6	Minimum of Log Data	3.073
Maximum	560	Maximum of Log Data	6.328
Mean	68.38	Mean of log Data	3.511
Geometric Mean	33.49	SD of log Data	0.88
Median	24.8		
SD	148		
Std. Error of Mean	41.04		
Coefficient of Variation	2.164		
Skewness	3.585		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.349	Shapiro Wilk Test Statistic	0.514
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	141.5	95% H-UCL	96.63
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	101.3
95% Adjusted-CLT UCL (Chen-1995)	179.5	97.5% Chebyshev (MVUE) UCL	124.6
95% Modified-t UCL (Johnson-1978)	148.3	99% Chebyshev (MVUE) UCL	170.3

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	0.688	Data do not follow a Discernable Distribution (0.05)
Theta Star	99.37	
MLE of Mean	68.38	
MLE of Standard Deviation	82.43	
nu star	17.89	
Approximate Chi Square Value (.05)	9.312	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 135.9
Adjusted Chi Square Value	8.443	95% Jackknife UCL 141.5
		95% Standard Bootstrap UCL 132.7
Anderson-Darling Test Statistic	3.431	95% Bootstrap-t UCL 2159
Anderson-Darling 5% Critical Value	0.766	95% Hall's Bootstrap UCL 1047
Kolmogorov-Smirnov Test Statistic	0.427	95% Percentile Bootstrap UCL 149.8
Kolmogorov-Smirnov 5% Critical Value	0.245	95% BCA Bootstrap UCL 192
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 247.2
		97.5% Chebyshev(Mean, Sd) UCL 324.6
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 476.7
95% Approximate Gamma UCL (Use when n >= 40)	131.4	
95% Adjusted Gamma UCL (Use when n < 40)	144.9	

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	247.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Mn_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	12

Raw Statistics		**Log-transformed Statistics**	
Minimum	105	Minimum of Log Data	4.654
Maximum	723	Maximum of Log Data	6.583
Mean	200.8	Mean of log Data	5.163
Geometric Mean	174.7	SD of log Data	0.457
Median	161		
SD	158.8		
Std. Error of Mean	44.04		
Coefficient of Variation	0.791		
Skewness	3.454		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.459	Shapiro Wilk Test Statistic	0.661
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	279.3	95% H-UCL	254.7
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	300.9
95% Adjusted-CLT UCL (Chen-1995)	318.3	97.5% Chebyshev (MVUE) UCL	347.9
95% Modified-t UCL (Johnson-1978)	286.3	99% Chebyshev (MVUE) UCL	440.3

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	2.942	Data do not follow a Discernable Distribution (0.05)
Theta Star	68.24	
MLE of Mean	200.8	
MLE of Standard Deviation	117	
nu star	76.5	
Approximate Chi Square Value (.05)	57.35	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 273.2
Adjusted Chi Square Value	54.99	95% Jackknife UCL 279.3
		95% Standard Bootstrap UCL 271.1
Anderson-Darling Test Statistic	2.215	95% Bootstrap-t UCL 581.6
Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL 631.6
Kolmogorov-Smirnov Test Statistic	0.361	95% Percentile Bootstrap UCL 285.8
Kolmogorov-Smirnov 5% Critical Value	0.238	95% BCA Bootstrap UCL 332.5
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 392.8
		97.5% Chebyshev(Mean, Sd) UCL 475.8
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 639
95% Approximate Gamma UCL (Use when n >= 40)	267.8	
95% Adjusted Gamma UCL (Use when n < 40)	279.3	

Potential UCL to Use		Use 95% Student's-t UCL	279.3
		or 95% Modified-t UCL	286.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Mo_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		**Log-transformed Statistics**	
Minimum	5.32	Minimum of Log Data	1.671
Maximum	90.5	Maximum of Log Data	4.505
Mean	13.74	Mean of log Data	2.133
Geometric Mean	8.439	SD of log Data	0.775
Median	6.44		
SD	23.29		
Std. Error of Mean	6.459		
Coefficient of Variation	1.695		
Skewness	3.492		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.391	Shapiro Wilk Test Statistic	0.562
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	25.25	95% H-UCL	19.85
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	22.01
95% Adjusted-CLT UCL (Chen-1995)	31.05	97.5% Chebyshev (MVUE) UCL	26.75
95% Modified-t UCL (Johnson-1978)	26.3	99% Chebyshev (MVUE) UCL	36.05

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	0.946	Data do not follow a Discernable Distribution (0.05)
Theta Star	14.52	
MLE of Mean	13.74	
MLE of Standard Deviation	14.13	
nu star	24.61	
Approximate Chi Square Value (.05)	14.31	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 24.37
Adjusted Chi Square Value	13.2	95% Jackknife UCL 25.25
		95% Standard Bootstrap UCL 24.02
Anderson-Darling Test Statistic	3.034	95% Bootstrap-t UCL 252.4
Anderson-Darling 5% Critical Value	0.755	95% Hall's Bootstrap UCL 116.7
Kolmogorov-Smirnov Test Statistic	0.421	95% Percentile Bootstrap UCL 26.18
Kolmogorov-Smirnov 5% Critical Value	0.242	95% BCA Bootstrap UCL 33.13
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 41.9
		97.5% Chebyshev(Mean, Sd) UCL 54.08
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 78.01
95% Approximate Gamma UCL (Use when n >= 40)	23.63	
95% Adjusted Gamma UCL (Use when n < 40)	25.61	

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	41.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Ni_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	12

Raw Statistics		**Log-transformed Statistics**	
Minimum	58.2	Minimum of Log Data	4.064
Maximum	572	Maximum of Log Data	6.349
Mean	107.9	Mean of log Data	4.393
Geometric Mean	80.88	SD of log Data	0.6
Median	67.5		
SD	139.7		
Std. Error of Mean	38.76		
Coefficient of Variation	1.295		
Skewness	3.579		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.362	Shapiro Wilk Test Statistic	0.48
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	177	95% H-UCL	142.6
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	166.9
95% Adjusted-CLT UCL (Chen-1995)	212.8	97.5% Chebyshev (MVUE) UCL	197.9
95% Modified-t UCL (Johnson-1978)	183.4	99% Chebyshev (MVUE) UCL	258.8

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	1.5	Data do not follow a Discernable Distribution (0.05)
Theta Star	71.94	
MLE of Mean	107.9	
MLE of Standard Deviation	88.11	
nu star	39	
Approximate Chi Square Value (.05)	25.7	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 171.7
Adjusted Chi Square Value	24.17	95% Jackknife UCL 177
		95% Standard Bootstrap UCL 169.5
Anderson-Darling Test Statistic	3.409	95% Bootstrap-t UCL 1291
Anderson-Darling 5% Critical Value	0.745	95% Hall's Bootstrap UCL 613
Kolmogorov-Smirnov Test Statistic	0.432	95% Percentile Bootstrap UCL 184.1
Kolmogorov-Smirnov 5% Critical Value	0.24	95% BCA Bootstrap UCL 224.3
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 276.8
		97.5% Chebyshev(Mean, Sd) UCL 349.9
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 493.5
95% Approximate Gamma UCL (Use when n >= 40)	163.8	
95% Adjusted Gamma UCL (Use when n < 40)	174.2	

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	276.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Pb_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	22.1	Minimum of Log Data	3.096
Maximum	293	Maximum of Log Data	5.68
Mean	50.15	Mean of log Data	3.559
Geometric Mean	35.12	SD of log Data	0.661
Median	30.7		
SD	73.18		
Std. Error of Mean	20.3		
Coefficient of Variation	1.459		
Skewness	3.569		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.377	Shapiro Wilk Test Statistic	0.558
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	86.32	95% H-UCL	68
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	78.55
95% Adjusted-CLT UCL (Chen-1995)	105	97.5% Chebyshev (MVUE) UCL	94
95% Modified-t UCL (Johnson-1978)	89.67	99% Chebyshev (MVUE) UCL	124.3

Gamma Distribution Test		Data Distribution
k star (bias corrected)	1.244	Data do not follow a Discernable Distribution (0.05)
Theta Star	40.33	
MLE of Mean	50.15	
MLE of Standard Deviation	44.97	
nu star	32.33	
Approximate Chi Square Value (.05)	20.34	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 83.53
Adjusted Chi Square Value	18.99	95% Jackknife UCL 86.32
		95% Standard Bootstrap UCL 81.46
Anderson-Darling Test Statistic	3.012	95% Bootstrap-t UCL 489.9
Anderson-Darling 5% Critical Value	0.75	95% Hall's Bootstrap UCL 265.7
Kolmogorov-Smirnov Test Statistic	0.388	95% Percentile Bootstrap UCL 90.11
Kolmogorov-Smirnov 5% Critical Value	0.241	95% BCA Bootstrap UCL 111.2
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 138.6
		97.5% Chebyshev(Mean, Sd) UCL 176.9
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 252.1
95% Approximate Gamma UCL (Use when n >= 40)	79.73	
95% Adjusted Gamma UCL (Use when n < 40)	85.38	

Potential UCL to Use	Use 95% Chebyshev (Mean, Sd) UCL 138.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sb_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	1.96	Minimum of Log Data	0.673
Maximum	22.4	Maximum of Log Data	3.109
Mean	4.115	Mean of log Data	1.089
Geometric Mean	2.973	SD of log Data	0.651
Median	2.38		
SD	5.541		
Std. Error of Mean	1.537		
Coefficient of Variation	1.347		
Skewness	3.501		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.405	Shapiro Wilk Test Statistic	0.584
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	6.855	95% H-UCL	5.663
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	6.559
95% Adjusted-CLT UCL (Chen-1995)	8.238	97.5% Chebyshev (MVUE) UCL	7.838
95% Modified-t UCL (Johnson-1978)	7.103	99% Chebyshev (MVUE) UCL	10.35

Gamma Distribution Test		Data Distribution
k star (bias corrected)	1.347	Data do not follow a Discernable Distribution (0.05)
Theta Star	3.055	
MLE of Mean	4.115	
MLE of Standard Deviation	3.546	
nu star	35.03	
Approximate Chi Square Value (.05)	22.49	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 6.643
Adjusted Chi Square Value	21.06	95% Jackknife UCL 6.855
		95% Standard Bootstrap UCL 6.598
Anderson-Darling Test Statistic	2.78	95% Bootstrap-t UCL 24.31
Anderson-Darling 5% Critical Value	0.748	95% Hall's Bootstrap UCL 22.01
Kolmogorov-Smirnov Test Statistic	0.403	95% Percentile Bootstrap UCL 7.055
Kolmogorov-Smirnov 5% Critical Value	0.24	95% BCA Bootstrap UCL 8.772
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 10.81
		97.5% Chebyshev(Mean, Sd) UCL 13.71
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 19.41
95% Approximate Gamma UCL (Use when n >= 40)	6.41	
95% Adjusted Gamma UCL (Use when n < 40)	6.844	

Potential UCL to Use	Use 95% Chebyshev (Mean, Sd) UCL 10.81

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Se_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		**Log-transformed Statistics**	
Minimum	4.06	Minimum of Log Data	1.401
Maximum	22.5	Maximum of Log Data	3.114
Mean	8.622	Mean of log Data	2.039
Geometric Mean	7.683	SD of log Data	0.47
Median	6.49		
SD	4.998		
Std. Error of Mean	1.386		
Coefficient of Variation	0.58		
Skewness	2.055		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.773	Shapiro Wilk Test Statistic	0.928
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	11.09	95% H-UCL	11.37
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	13.44
95% Adjusted-CLT UCL (Chen-1995)	11.75	97.5% Chebyshev (MVUE) UCL	15.58
95% Modified-t UCL (Johnson-1978)	11.22	99% Chebyshev (MVUE) UCL	19.78

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	3.508	Data appear Gamma Distributed at 5% Significance Level
Theta Star	2.458	
MLE of Mean	8.622	
MLE of Standard Deviation	4.604	
nu star	91.21	
Approximate Chi Square Value (.05)	70.18	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 10.9
Adjusted Chi Square Value	67.56	95% Jackknife UCL 11.09
		95% Standard Bootstrap UCL 10.84
Anderson-Darling Test Statistic	0.619	95% Bootstrap-t UCL 13.63
Anderson-Darling 5% Critical Value	0.737	95% Hall's Bootstrap UCL 21.53
Kolmogorov-Smirnov Test Statistic	0.201	95% Percentile Bootstrap UCL 11.06
Kolmogorov-Smirnov 5% Critical Value	0.238	95% BCA Bootstrap UCL 11.81
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 14.66
		97.5% Chebyshev(Mean, Sd) UCL 17.28
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 22.41
95% Approximate Gamma UCL (Use when n >= 40)	11.2	
95% Adjusted Gamma UCL (Use when n < 40)	11.64	

Potential UCL to Use	Use 95% Approximate Gamma UCL 11.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sr_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	319	Minimum of Log Data	5.765
Maximum	638	Maximum of Log Data	6.458
Mean	418.7	Mean of log Data	6.01
Geometric Mean	407.3	SD of log Data	0.238
Median	379		
SD	108.2		
Std. Error of Mean	30.02		
Coefficient of Variation	0.259		
Skewness	1.184		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.834	Shapiro Wilk Test Statistic	0.876
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	472.2	95% H-UCL	476
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	538.9
95% Adjusted-CLT UCL (Chen-1995)	478.6	97.5% Chebyshev (MVUE) UCL	591.2
95% Modified-t UCL (Johnson-1978)	473.8	99% Chebyshev (MVUE) UCL	694

Gamma Distribution Test		Data Distribution
k star (bias corrected)	14.14	Data appear Gamma Distributed at 5% Significance Level
Theta Star	29.6	
MLE of Mean	418.7	
MLE of Standard Deviation	111.3	
nu star	367.8	
Approximate Chi Square Value (.05)	324.3	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 468.1
Adjusted Chi Square Value	318.5	95% Jackknife UCL 472.2
		95% Standard Bootstrap UCL 464.7
Anderson-Darling Test Statistic	0.702	95% Bootstrap-t UCL 492.7
Anderson-Darling 5% Critical Value	0.733	95% Hall's Bootstrap UCL 500.3
Kolmogorov-Smirnov Test Statistic	0.22	95% Percentile Bootstrap UCL 468.8
Kolmogorov-Smirnov 5% Critical Value	0.236	95% BCA Bootstrap UCL 478.1
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 549.5
		97.5% Chebyshev(Mean, Sd) UCL 606.2
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 717.4
95% Approximate Gamma UCL (Use when n >= 40)	474.8	
95% Adjusted Gamma UCL (Use when n < 40)	483.4	

Potential UCL to Use	Use 95% Approximate Gamma UCL 474.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Tl_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.382	Minimum of Log Data	-0.962
Maximum	21	Maximum of Log Data	3.045
Mean	2.133	Mean of log Data	-0.353
Geometric Mean	0.703	SD of log Data	1.065
Median	0.485		
SD	5.674		
Std. Error of Mean	1.574		
Coefficient of Variation	2.66		
Skewness	3.595		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.338	Shapiro Wilk Test Statistic	0.521
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	4.938	95% H-UCL	3.083
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2.793
95% Adjusted-CLT UCL (Chen-1995)	6.398	97.5% Chebyshev (MVUE) UCL	3.498
95% Modified-t UCL (Johnson-1978)	5.199	99% Chebyshev (MVUE) UCL	4.881

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	0.484	Data do not follow a Discernable Distribution (0.05)
Theta Star	4.411	
MLE of Mean	2.133	
MLE of Standard Deviation	3.067	
nu star	12.57	
Approximate Chi Square Value (.05)	5.608	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 4.721
Adjusted Chi Square Value	4.96	95% Jackknife UCL 4.938
		95% Standard Bootstrap UCL 4.581
Anderson-Darling Test Statistic	3.565	95% Bootstrap-t UCL 128.4
Anderson-Darling 5% Critical Value	0.785	95% Hall's Bootstrap UCL 65.6
Kolmogorov-Smirnov Test Statistic	0.447	95% Percentile Bootstrap UCL 5.256
Kolmogorov-Smirnov 5% Critical Value	0.249	95% BCA Bootstrap UCL 6.87
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 8.992
		97.5% Chebyshev(Mean, Sd) UCL 11.96
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 17.79
95% Approximate Gamma UCL (Use when n >= 40)	4.783	
95% Adjusted Gamma UCL (Use when n < 40)	5.408	

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	8.992

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	5.33	Minimum of Log Data	1.673
Maximum	34.1	Maximum of Log Data	3.529
Mean	8.666	Mean of log Data	2
Geometric Mean	7.39	SD of log Data	0.473
Median	6.45		
SD	7.679		
Std. Error of Mean	2.13		
Coefficient of Variation	0.886		
Skewness	3.545		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.396	Shapiro Wilk Test Statistic	0.523
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	12.46	95% H-UCL	10.98
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	12.97
95% Adjusted-CLT UCL (Chen-1995)	14.41	97.5% Chebyshev (MVUE) UCL	15.04
95% Modified-t UCL (Johnson-1978)	12.81	99% Chebyshev (MVUE) UCL	19.11

Gamma Distribution Test		Data Distribution
k star (bias corrected)	2.587	Data do not follow a Discernable Distribution (0.05)
Theta Star	3.35	
MLE of Mean	8.666	
MLE of Standard Deviation	5.388	
nu star	67.25	
Approximate Chi Square Value (.05)	49.38	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 12.17
Adjusted Chi Square Value	47.2	95% Jackknife UCL 12.46
		95% Standard Bootstrap UCL 12.05
Anderson-Darling Test Statistic	3.019	95% Bootstrap-t UCL 43.65
Anderson-Darling 5% Critical Value	0.739	95% Hall's Bootstrap UCL 33.65
Kolmogorov-Smirnov Test Statistic	0.398	95% Percentile Bootstrap UCL 12.84
Kolmogorov-Smirnov 5% Critical Value	0.238	95% BCA Bootstrap UCL 15.19
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 17.95
		97.5% Chebyshev(Mean, Sd) UCL 21.97
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 29.86
95% Approximate Gamma UCL (Use when n >= 40)	11.8	
95% Adjusted Gamma UCL (Use when n < 40)	12.35	

Potential UCL to Use	
Use 95% Student's-t UCL	12.46
or 95% Modified-t UCL	12.81

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

V_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	262	Minimum of Log Data	5.568
Maximum	1660	Maximum of Log Data	7.415
Mean	419.6	Mean of log Data	5.876
Geometric Mean	356.2	SD of log Data	0.481
Median	317		
SD	375.4		
Std. Error of Mean	104.1		
Coefficient of Variation	0.895		
Skewness	3.517		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.412	Shapiro Wilk Test Statistic	0.558
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	605.2	95% H-UCL	534.7
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	632.1
95% Adjusted-CLT UCL (Chen-1995)	699.4	97.5% Chebyshev (MVUE) UCL	734.2
95% Modified-t UCL (Johnson-1978)	622.1	99% Chebyshev (MVUE) UCL	934.8

Gamma Distribution Test		Data Distribution
k star (bias corrected)	2.52	Data do not follow a Discernable Distribution (0.05)
Theta Star	166.5	
MLE of Mean	419.6	
MLE of Standard Deviation	264.3	
nu star	65.53	
Approximate Chi Square Value (.05)	47.9	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 590.9
Adjusted Chi Square Value	45.76	95% Jackknife UCL 605.2
		95% Standard Bootstrap UCL 584.3
Anderson-Darling Test Statistic	2.779	95% Bootstrap-t UCL 1937
Anderson-Darling 5% Critical Value	0.739	95% Hall's Bootstrap UCL 1455
Kolmogorov-Smirnov Test Statistic	0.37	95% Percentile Bootstrap UCL 625.5
Kolmogorov-Smirnov 5% Critical Value	0.238	95% BCA Bootstrap UCL 741.2
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 873.4
		97.5% Chebyshev(Mean, Sd) UCL 1070
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 1456
95% Approximate Gamma UCL (Use when n >= 40)	574	
95% Adjusted Gamma UCL (Use when n < 40)	600.9	

Potential UCL to Use		Use 95% Student's-t UCL	605.2
		or 95% Modified-t UCL	622.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Zn_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	122	Minimum of Log Data	4.804
Maximum	848	Maximum of Log Data	6.743
Mean	238.2	Mean of log Data	5.326
Geometric Mean	205.6	SD of log Data	0.48
Median	183		
SD	188.7		
Std. Error of Mean	52.33		
Coefficient of Variation	0.792		
Skewness	3.268		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.514	Shapiro Wilk Test Statistic	0.731
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	331.5	95% H-UCL	308.1
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	364.2
95% Adjusted-CLT UCL (Chen-1995)	375	97.5% Chebyshev (MVUE) UCL	423
95% Modified-t UCL (Johnson-1978)	339.4	99% Chebyshev (MVUE) UCL	538.4

Gamma Distribution Test		Data Distribution
k star (bias corrected)	2.78	Data do not follow a Discernable Distribution (0.05)
Theta Star	85.69	
MLE of Mean	238.2	
MLE of Standard Deviation	142.9	
nu star	72.28	
Approximate Chi Square Value (.05)	53.7	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 324.3
Adjusted Chi Square Value	51.43	95% Jackknife UCL 331.5
		95% Standard Bootstrap UCL 322.4
Anderson-Darling Test Statistic	1.837	95% Bootstrap-t UCL 679.4
Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL 728.2
Kolmogorov-Smirnov Test Statistic	0.342	95% Percentile Bootstrap UCL 331.1
Kolmogorov-Smirnov 5% Critical Value	0.238	95% BCA Bootstrap UCL 397.4
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 466.3
		97.5% Chebyshev(Mean, Sd) UCL 565
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 758.9
95% Approximate Gamma UCL (Use when n >= 40)	320.6	
95% Adjusted Gamma UCL (Use when n < 40)	334.8	

Potential UCL to Use		Use 95% Student's-t UCL	331.5
		or 95% Modified-t UCL	339.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Full Data Sets

User Selected Options

From File	ProUCLinputNewMexico.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

As_ppm

General Statistics

Number of Valid Observations	16	Number of Distinct Observations	13

Raw Statistics		**Log-transformed Statistics**	
Minimum	16.8	Minimum of Log Data	2.821
Maximum	22.2	Maximum of Log Data	3.1
Mean	19.58	Mean of log Data	2.972
Geometric Mean	19.52	SD of log Data	0.0804
Median	19.1		
SD	1.582		
Std. Error of Mean	0.395		
Coefficient of Variation	0.0808		
Skewness	0.258		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.928	Shapiro Wilk Test Statistic	0.932
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	20.27	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	21.3
95% Adjusted-CLT UCL (Chen-1995)	20.26	97.5% Chebyshev (MVUE) UCL	22.04
95% Modified-t UCL (Johnson-1978)	20.28	99% Chebyshev (MVUE) UCL	23.5

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	133.8	Data appear Normal at 5% Significance Level
Theta Star	0.146	
MLE of Mean	19.58	
MLE of Standard Deviation	1.693	
nu star	4283	
Approximate Chi Square Value (.05)	4131	**Nonparametric Statistics**
Adjusted Level of Significance	0.0335	95% CLT UCL 20.23
Adjusted Chi Square Value	4115	95% Jackknife UCL 20.27
		95% Standard Bootstrap UCL 20.21
Anderson-Darling Test Statistic	0.555	95% Bootstrap-t UCL 20.32
Anderson-Darling 5% Critical Value	0.736	95% Hall's Bootstrap UCL 20.27
Kolmogorov-Smirnov Test Statistic	0.165	95% Percentile Bootstrap UCL 20.21
Kolmogorov-Smirnov 5% Critical Value	0.214	95% BCA Bootstrap UCL 20.23
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 21.3
		97.5% Chebyshev(Mean, Sd) UCL 22.05
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 23.52
95% Approximate Gamma UCL (Use when n >= 40)	20.3	
95% Adjusted Gamma UCL (Use when n < 40)	20.38	

Potential UCL to Use		Use 95% Student's-t UCL	20.27

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Ba_ppm

General Statistics

Number of Valid Observations	16	Number of Distinct Observations	16

Raw Statistics		Log-transformed Statistics	
Minimum	1230	Minimum of Log Data	7.115
Maximum	1950	Maximum of Log Data	7.576
Mean	1664	Mean of log Data	7.411
Geometric Mean	1654	SD of log Data	0.112
Median	1655		
SD	177.7		
Std. Error of Mean	44.42		
Coefficient of Variation	0.107		
Skewness	-0.598		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.953	Shapiro Wilk Test Statistic	0.925
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	1742	95% H-UCL	1751
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1867
95% Adjusted-CLT UCL (Chen-1995)	1730	97.5% Chebyshev (MVUE) UCL	1955
95% Modified-t UCL (Johnson-1978)	1741	99% Chebyshev (MVUE) UCL	2127

Gamma Distribution Test		Data Distribution
k star (bias corrected)	71.87	Data appear Normal at 5% Significance Level
Theta Star	23.15	
MLE of Mean	1664	
MLE of Standard Deviation	196.2	
nu star	2300	
Approximate Chi Square Value (.05)	2190	**Nonparametric Statistics**
Adjusted Level of Significance	0.0335	95% CLT UCL 1737
Adjusted Chi Square Value	2177	95% Jackknife UCL 1742
		95% Standard Bootstrap UCL 1734
Anderson-Darling Test Statistic	0.364	95% Bootstrap-t UCL 1737
Anderson-Darling 5% Critical Value	0.736	95% Hall's Bootstrap UCL 1741
Kolmogorov-Smirnov Test Statistic	0.142	95% Percentile Bootstrap UCL 1736
Kolmogorov-Smirnov 5% Critical Value	0.214	95% BCA Bootstrap UCL 1724
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 1857
		97.5% Chebyshev(Mean, Sd) UCL 1941
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 2106
95% Approximate Gamma UCL (Use when n >= 40)	1748	
95% Adjusted Gamma UCL (Use when n < 40)	1757	

Potential UCL to Use		Use 95% Student's-t UCL	1742

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Be_ppm

General Statistics

Number of Valid Observations	16	Number of Distinct Observations	16

Raw Statistics		Log-transformed Statistics	
Minimum	5.06	Minimum of Log Data	1.621
Maximum	6.69	Maximum of Log Data	1.901
Mean	5.745	Mean of log Data	1.745
Geometric Mean	5.727	SD of log Data	0.0811
Median	5.66		
SD	0.472		
Std. Error of Mean	0.118		
Coefficient of Variation	0.0822		
Skewness	0.559		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.951	Shapiro Wilk Test Statistic	0.961
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	5.952	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	6.253
95% Adjusted-CLT UCL (Chen-1995)	5.957	97.5% Chebyshev (MVUE) UCL	6.473
95% Modified-t UCL (Johnson-1978)	5.955	99% Chebyshev (MVUE) UCL	6.904

Gamma Distribution Test		Data Distribution
k star (bias corrected)	130.9	Data appear Normal at 5% Significance Level
Theta Star	0.0439	
MLE of Mean	5.745	
MLE of Standard Deviation	0.502	
nu star	4187	
Approximate Chi Square Value (.05)	4038	**Nonparametric Statistics**
Adjusted Level of Significance	0.0335	95% CLT UCL 5.939
Adjusted Chi Square Value	4021	95% Jackknife UCL 5.952
		95% Standard Bootstrap UCL 5.936
Anderson-Darling Test Statistic	0.275	95% Bootstrap-t UCL 5.959
Anderson-Darling 5% Critical Value	0.736	95% Hall's Bootstrap UCL 5.976
Kolmogorov-Smirnov Test Statistic	0.145	95% Percentile Bootstrap UCL 5.947
Kolmogorov-Smirnov 5% Critical Value	0.214	95% BCA Bootstrap UCL 5.959
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 6.26
		97.5% Chebyshev(Mean, Sd) UCL 6.483
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 6.92
95% Approximate Gamma UCL (Use when n >= 40)	5.958	
95% Adjusted Gamma UCL (Use when n < 40)	5.982	

Potential UCL to Use		Use 95% Student's-t UCL	5.952

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Cd_ppm

General Statistics

Number of Valid Observations	16	Number of Distinct Observations	16

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.42	Minimum of Log Data	-0.868
Maximum	0.68	Maximum of Log Data	-0.386
Mean	0.528	Mean of log Data	-0.649
Geometric Mean	0.522	SD of log Data	0.149
Median	0.509		
SD	0.0799		
Std. Error of Mean	0.02		
Coefficient of Variation	0.151		
Skewness	0.441		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.945	Shapiro Wilk Test Statistic	0.955
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.563	95% H-UCL	0.566
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.614
95% Adjusted-CLT UCL (Chen-1995)	0.563	97.5% Chebyshev (MVUE) UCL	0.651
95% Modified-t UCL (Johnson-1978)	0.563	99% Chebyshev (MVUE) UCL	0.725

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	38.71	Data appear Normal at 5% Significance Level
Theta Star	0.0136	
MLE of Mean	0.528	
MLE of Standard Deviation	0.0848	
nu star	1239	
Approximate Chi Square Value (.05)	1158	**Nonparametric Statistics**
Adjusted Level of Significance	0.0335	95% CLT UCL 0.561
Adjusted Chi Square Value	1149	95% Jackknife UCL 0.563
		95% Standard Bootstrap UCL 0.559
Anderson-Darling Test Statistic	0.317	95% Bootstrap-t UCL 0.567
Anderson-Darling 5% Critical Value	0.735	95% Hall's Bootstrap UCL 0.562
Kolmogorov-Smirnov Test Statistic	0.139	95% Percentile Bootstrap UCL 0.56
Kolmogorov-Smirnov 5% Critical Value	0.214	95% BCA Bootstrap UCL 0.561
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 0.615
		97.5% Chebyshev(Mean, Sd) UCL 0.653
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 0.727
95% Approximate Gamma UCL (Use when n >= 40)	0.565	
95% Adjusted Gamma UCL (Use when n < 40)	0.569	

Potential UCL to Use		Use 95% Student's-t UCL	0.563

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Co_ppm

General Statistics

Number of Valid Observations	16	Number of Distinct Observations	14

Raw Statistics		**Log-transformed Statistics**	
Minimum	14.5	Minimum of Log Data	2.674
Maximum	18.3	Maximum of Log Data	2.907
Mean	15.84	Mean of log Data	2.76
Geometric Mean	15.8	SD of log Data	0.0727
Median	15.35		
SD	1.182		
Std. Error of Mean	0.296		
Coefficient of Variation	0.0746		
Skewness	0.906		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.87	Shapiro Wilk Test Statistic	0.88
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	16.36	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	17.1
95% Adjusted-CLT UCL (Chen-1995)	16.4	97.5% Chebyshev (MVUE) UCL	17.64
95% Modified-t UCL (Johnson-1978)	16.37	99% Chebyshev (MVUE) UCL	18.71

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	161.3	Data Follow Appr. Gamma Distribution at 5% Significance Level
Theta Star	0.0982	
MLE of Mean	15.84	
MLE of Standard Deviation	1.247	
nu star	5163	
Approximate Chi Square Value (.05)	4997	**Nonparametric Statistics**
Adjusted Level of Significance	0.0335	95% CLT UCL 16.33
Adjusted Chi Square Value	4978	95% Jackknife UCL 16.36
		95% Standard Bootstrap UCL 16.32
Anderson-Darling Test Statistic	0.889	95% Bootstrap-t UCL 16.47
Anderson-Darling 5% Critical Value	0.736	95% Hall's Bootstrap UCL 16.36
Kolmogorov-Smirnov Test Statistic	0.211	95% Percentile Bootstrap UCL 16.31
Kolmogorov-Smirnov 5% Critical Value	0.214	95% BCA Bootstrap UCL 16.36
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 17.13
		97.5% Chebyshev(Mean, Sd) UCL 17.69
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 18.78
95% Approximate Gamma UCL (Use when n >= 40)	16.37	
95% Adjusted Gamma UCL (Use when n < 40)	16.43	

Potential UCL to Use		Use 95% Approximate Gamma UCL	16.37

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Cr_ppm

General Statistics

Number of Valid Observations	16	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	33.7	Minimum of Log Data	3.517
Maximum	45.9	Maximum of Log Data	3.826
Mean	37.68	Mean of log Data	3.625
Geometric Mean	37.51	SD of log Data	0.0942
Median	36.1		
SD	3.682		
Std. Error of Mean	0.92		
Coefficient of Variation	0.0977		
Skewness	1.025		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.869	Shapiro Wilk Test Statistic	0.884
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	39.29	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	41.54
95% Adjusted-CLT UCL (Chen-1995)	39.44	97.5% Chebyshev (MVUE) UCL	43.22
95% Modified-t UCL (Johnson-1978)	39.33	99% Chebyshev (MVUE) UCL	46.51

Gamma Distribution Test		Data Distribution
k star (bias corrected)	95.49	Data do not follow a Discernable Distribution (0.05)
Theta Star	0.395	
MLE of Mean	37.68	
MLE of Standard Deviation	3.855	
nu star	3056	
Approximate Chi Square Value (.05)	2928	**Nonparametric Statistics**
Adjusted Level of Significance	0.0335	95% CLT UCL 39.19
Adjusted Chi Square Value	2914	95% Jackknife UCL 39.29
		95% Standard Bootstrap UCL 39.12
Anderson-Darling Test Statistic	0.845	95% Bootstrap-t UCL 39.72
Anderson-Darling 5% Critical Value	0.736	95% Hall's Bootstrap UCL 39.5
Kolmogorov-Smirnov Test Statistic	0.258	95% Percentile Bootstrap UCL 39.21
Kolmogorov-Smirnov 5% Critical Value	0.214	95% BCA Bootstrap UCL 39.34
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 41.69
		97.5% Chebyshev(Mean, Sd) UCL 43.42
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 46.83
95% Approximate Gamma UCL (Use when n >= 40)	39.31	
95% Adjusted Gamma UCL (Use when n < 40)	39.51	

Potential UCL to Use	
Use 95% Student's-t UCL	39.29
or 95% Modified-t UCL	39.33

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Cu_ppm

General Statistics

Number of Valid Observations	16	Number of Distinct Observations	16

Raw Statistics		**Log-transformed Statistics**	
Minimum	60.8	Minimum of Log Data	4.108
Maximum	68.7	Maximum of Log Data	4.23
Mean	65.01	Mean of log Data	4.174
Geometric Mean	64.96	SD of log Data	0.037
Median	65.05		
SD	2.396		
Std. Error of Mean	0.599		
Coefficient of Variation	0.0369		
Skewness	-0.142		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.963	Shapiro Wilk Test Statistic	0.961
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	66.06	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	67.63
95% Adjusted-CLT UCL (Chen-1995)	65.97	97.5% Chebyshev (MVUE) UCL	68.76
95% Modified-t UCL (Johnson-1978)	66.05	99% Chebyshev (MVUE) UCL	70.99

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	635.6	Data appear Normal at 5% Significance Level
Theta Star	0.102	
MLE of Mean	65.01	
MLE of Standard Deviation	2.579	
nu star	20339	
Approximate Chi Square Value (.05)	20008	
Adjusted Level of Significance	0.0335	
Adjusted Chi Square Value	19971	
Anderson-Darling Test Statistic	0.267	
Anderson-Darling 5% Critical Value	0.736	
Kolmogorov-Smirnov Test Statistic	0.141	
Kolmogorov-Smirnov 5% Critical Value	0.214	
Data appear Gamma Distributed at 5% Significance Level		

Nonparametric Statistics	
95% CLT UCL	65.99
95% Jackknife UCL	66.06
95% Standard Bootstrap UCL	65.98
95% Bootstrap-t UCL	65.99
95% Hall's Bootstrap UCL	65.97
95% Percentile Bootstrap UCL	65.96
95% BCA Bootstrap UCL	65.96
95% Chebyshev(Mean, Sd) UCL	67.62
97.5% Chebyshev(Mean, Sd) UCL	68.75
99% Chebyshev(Mean, Sd) UCL	70.97

Assuming Gamma Distribution	
95% Approximate Gamma UCL (Use when n >= 40)	66.08
95% Adjusted Gamma UCL (Use when n < 40)	66.2

Potential UCL to Use	Use 95% Student's-t UCL 66.06

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Hg_ppm

General Statistics

Number of Valid Observations	16	Number of Distinct Observations	16

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.0648	Minimum of Log Data	-2.736
Maximum	0.263	Maximum of Log Data	-1.336
Mean	0.138	Mean of log Data	-2.09
Geometric Mean	0.124	SD of log Data	0.487
Median	0.119		
SD	0.0673		
Std. Error of Mean	0.0168		
Coefficient of Variation	0.487		
Skewness	0.644		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.893	Shapiro Wilk Test Statistic	0.924
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.168	95% H-UCL	0.18
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.214
95% Adjusted-CLT UCL (Chen-1995)	0.169	97.5% Chebyshev (MVUE) UCL	0.246
95% Modified-t UCL (Johnson-1978)	0.168	99% Chebyshev (MVUE) UCL	0.31

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	3.842	Data appear Normal at 5% Significance Level
Theta Star	0.036	
MLE of Mean	0.138	
MLE of Standard Deviation	0.0705	
nu star	122.9	
Approximate Chi Square Value (.05)	98.33	**Nonparametric Statistics**
Adjusted Level of Significance	0.0335	95% CLT UCL 0.166
Adjusted Chi Square Value	95.83	95% Jackknife UCL 0.168
		95% Standard Bootstrap UCL 0.165
Anderson-Darling Test Statistic	0.476	95% Bootstrap-t UCL 0.17
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL 0.166
Kolmogorov-Smirnov Test Statistic	0.152	95% Percentile Bootstrap UCL 0.165
Kolmogorov-Smirnov 5% Critical Value	0.216	95% BCA Bootstrap UCL 0.168
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 0.211
		97.5% Chebyshev(Mean, Sd) UCL 0.243
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 0.305
95% Approximate Gamma UCL (Use when n >= 40)	0.173	
95% Adjusted Gamma UCL (Use when n < 40)	0.177	

Potential UCL to Use		Use 95% Student's-t UCL	0.168

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Li_ppm

General Statistics

Number of Valid Observations	16	Number of Distinct Observations	14

Raw Statistics		Log-transformed Statistics	
Minimum	91.8	Minimum of Log Data	4.52
Maximum	116	Maximum of Log Data	4.754
Mean	101.9	Mean of log Data	4.622
Geometric Mean	101.7	SD of log Data	0.0609
Median	102		
SD	6.259		
Std. Error of Mean	1.565		
Coefficient of Variation	0.0614		
Skewness	0.456		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.978	Shapiro Wilk Test Statistic	0.985
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	104.7	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	108.7
95% Adjusted-CLT UCL (Chen-1995)	104.7	97.5% Chebyshev (MVUE) UCL	111.6
95% Modified-t UCL (Johnson-1978)	104.7	99% Chebyshev (MVUE) UCL	117.4

Gamma Distribution Test		Data Distribution
k star (bias corrected)	232.6	Data appear Normal at 5% Significance Level
Theta Star	0.438	
MLE of Mean	101.9	
MLE of Standard Deviation	6.682	
nu star	7444	
Approximate Chi Square Value (.05)	7244	**Nonparametric Statistics**
Adjusted Level of Significance	0.0335	95% CLT UCL 104.5
Adjusted Chi Square Value	7222	95% Jackknife UCL 104.7
		95% Standard Bootstrap UCL 104.4
Anderson-Darling Test Statistic	0.141	95% Bootstrap-t UCL 104.8
Anderson-Darling 5% Critical Value	0.736	95% Hall's Bootstrap UCL 105.2
Kolmogorov-Smirnov Test Statistic	0.087	95% Percentile Bootstrap UCL 104.4
Kolmogorov-Smirnov 5% Critical Value	0.214	95% BCA Bootstrap UCL 104.5
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 108.7
		97.5% Chebyshev(Mean, Sd) UCL 111.7
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 117.5
95% Approximate Gamma UCL (Use when n >= 40)	104.7	
95% Adjusted Gamma UCL (Use when n < 40)	105	

Potential UCL to Use		Use 95% Student's-t UCL	104.7

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Mn_ppm

General Statistics

Number of Valid Observations	16	Number of Distinct Observations	14

Raw Statistics		**Log-transformed Statistics**	
Minimum	180	Minimum of Log Data	5.193
Maximum	222	Maximum of Log Data	5.403
Mean	197.5	Mean of log Data	5.284
Geometric Mean	197.2	SD of log Data	0.0534
Median	193.5		
SD	10.68		
Std. Error of Mean	2.671		
Coefficient of Variation	0.0541		
Skewness	0.688		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.939	Shapiro Wilk Test Statistic	0.946
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	202.2	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	209
95% Adjusted-CLT UCL (Chen-1995)	202.4	97.5% Chebyshev (MVUE) UCL	214
95% Modified-t UCL (Johnson-1978)	202.3	99% Chebyshev (MVUE) UCL	223.7

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	301.8	Data appear Normal at 5% Significance Level
Theta Star	0.654	
MLE of Mean	197.5	
MLE of Standard Deviation	11.37	
nu star	9657	
Approximate Chi Square Value (.05)	9430	**Nonparametric Statistics**
Adjusted Level of Significance	0.0335	95% CLT UCL 201.9
Adjusted Chi Square Value	9404	95% Jackknife UCL 202.2
		95% Standard Bootstrap UCL 201.8
Anderson-Darling Test Statistic	0.478	95% Bootstrap-t UCL 202.5
Anderson-Darling 5% Critical Value	0.736	95% Hall's Bootstrap UCL 203.1
Kolmogorov-Smirnov Test Statistic	0.19	95% Percentile Bootstrap UCL 201.9
Kolmogorov-Smirnov 5% Critical Value	0.214	95% BCA Bootstrap UCL 201.9
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 209.1
		97.5% Chebyshev(Mean, Sd) UCL 214.2
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 224.1
95% Approximate Gamma UCL (Use when n >= 40)	202.3	
95% Adjusted Gamma UCL (Use when n < 40)	202.8	

Potential UCL to Use		Use 95% Student's-t UCL	202.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Mo_ppm

General Statistics

Number of Valid Observations	16	Number of Distinct Observations	15

Raw Statistics		**Log-transformed Statistics**	
Minimum	7.94	Minimum of Log Data	2.072
Maximum	9.35	Maximum of Log Data	2.235
Mean	8.632	Mean of log Data	2.154
Geometric Mean	8.621	SD of log Data	0.051
Median	8.59		
SD	0.44		
Std. Error of Mean	0.11		
Coefficient of Variation	0.051		
Skewness	0.0645		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.959	Shapiro Wilk Test Statistic	0.96
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	8.825	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	9.112
95% Adjusted-CLT UCL (Chen-1995)	8.815	97.5% Chebyshev (MVUE) UCL	9.319
95% Modified-t UCL (Johnson-1978)	8.825	99% Chebyshev (MVUE) UCL	9.727

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	333.8	Data appear Normal at 5% Significance Level
Theta Star	0.0259	
MLE of Mean	8.632	
MLE of Standard Deviation	0.472	
nu star	10682	
Approximate Chi Square Value (.05)	10443	**Nonparametric Statistics**
Adjusted Level of Significance	0.0335	95% CLT UCL 8.813
Adjusted Chi Square Value	10416	95% Jackknife UCL 8.825
		95% Standard Bootstrap UCL 8.808
Anderson-Darling Test Statistic	0.242	95% Bootstrap-t UCL 8.831
Anderson-Darling 5% Critical Value	0.736	95% Hall's Bootstrap UCL 8.816
Kolmogorov-Smirnov Test Statistic	0.113	95% Percentile Bootstrap UCL 8.809
Kolmogorov-Smirnov 5% Critical Value	0.214	95% BCA Bootstrap UCL 8.805
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 9.111
		97.5% Chebyshev(Mean, Sd) UCL 9.319
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 9.726
95% Approximate Gamma UCL (Use when n >= 40)	8.83	
95% Adjusted Gamma UCL (Use when n < 40)	8.852	

Potential UCL to Use	Use 95% Student's-t UCL 8.825

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Ni_ppm

General Statistics

Number of Valid Observations	16	Number of Distinct Observations	15

Raw Statistics		**Log-transformed Statistics**	
Minimum	17.3	Minimum of Log Data	2.851
Maximum	22.9	Maximum of Log Data	3.131
Mean	19.88	Mean of log Data	2.987
Geometric Mean	19.83	SD of log Data	0.0753
Median	20		
SD	1.501		
Std. Error of Mean	0.375		
Coefficient of Variation	0.0755		
Skewness	0.249		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.985	Shapiro Wilk Test Statistic	0.988
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	20.54	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	21.51
95% Adjusted-CLT UCL (Chen-1995)	20.52	97.5% Chebyshev (MVUE) UCL	22.22
95% Modified-t UCL (Johnson-1978)	20.54	99% Chebyshev (MVUE) UCL	23.61

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	152.9	Data appear Normal at 5% Significance Level
Theta Star	0.13	
MLE of Mean	19.88	
MLE of Standard Deviation	1.608	
nu star	4892	
Approximate Chi Square Value (.05)	4731	**Nonparametric Statistics**
Adjusted Level of Significance	0.0335	95% CLT UCL 20.5
Adjusted Chi Square Value	4713	95% Jackknife UCL 20.54
		95% Standard Bootstrap UCL 20.48
Anderson-Darling Test Statistic	0.143	95% Bootstrap-t UCL 20.56
Anderson-Darling 5% Critical Value	0.736	95% Hall's Bootstrap UCL 20.53
Kolmogorov-Smirnov Test Statistic	0.105	95% Percentile Bootstrap UCL 20.49
Kolmogorov-Smirnov 5% Critical Value	0.214	95% BCA Bootstrap UCL 20.48
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 21.52
		97.5% Chebyshev(Mean, Sd) UCL 22.23
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 23.62
95% Approximate Gamma UCL (Use when n >= 40)	20.56	
95% Adjusted Gamma UCL (Use when n < 40)	20.64	

Potential UCL to Use	Use 95% Student's-t UCL 20.54

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Pb_ppm

General Statistics

Number of Valid Observations	16	Number of Distinct Observations	16

Raw Statistics		**Log-transformed Statistics**	
Minimum	53.8	Minimum of Log Data	3.985
Maximum	67.5	Maximum of Log Data	4.212
Mean	61.88	Mean of log Data	4.123
Geometric Mean	61.75	SD of log Data	0.0669
Median	62.55		
SD	4.088		
Std. Error of Mean	1.022		
Coefficient of Variation	0.0661		
Skewness	-0.337		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.961	Shapiro Wilk Test Statistic	0.956
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	63.67	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	66.4
95% Adjusted-CLT UCL (Chen-1995)	63.47	97.5% Chebyshev (MVUE) UCL	68.35
95% Modified-t UCL (Johnson-1978)	63.66	99% Chebyshev (MVUE) UCL	72.19

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	195.3	Data appear Normal at 5% Significance Level
Theta Star	0.317	
MLE of Mean	61.88	
MLE of Standard Deviation	4.428	
nu star	6250	
Approximate Chi Square Value (.05)	6067	
Adjusted Level of Significance	0.0335	
Adjusted Chi Square Value	6047	
Anderson-Darling Test Statistic	0.256	
Anderson-Darling 5% Critical Value	0.736	
Kolmogorov-Smirnov Test Statistic	0.132	
Kolmogorov-Smirnov 5% Critical Value	0.214	
Data appear Gamma Distributed at 5% Significance Level		

Nonparametric Statistics	
95% CLT UCL	63.56
95% Jackknife UCL	63.67
95% Standard Bootstrap UCL	63.49
95% Bootstrap-t UCL	63.58
95% Hall's Bootstrap UCL	63.45
95% Percentile Bootstrap UCL	63.52
95% BCA Bootstrap UCL	63.49
95% Chebyshev(Mean, Sd) UCL	66.34
97.5% Chebyshev(Mean, Sd) UCL	68.26
99% Chebyshev(Mean, Sd) UCL	72.05

Assuming Gamma Distribution	
95% Approximate Gamma UCL (Use when n >= 40)	63.75
95% Adjusted Gamma UCL (Use when n < 40)	63.96

Potential UCL to Use	Use 95% Student's-t UCL 63.67

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Sb_ppm

General Statistics

Number of Valid Observations	16	Number of Distinct Observations	16

Raw Statistics		**Log-transformed Statistics**	
Minimum	2.79	Minimum of Log Data	1.026
Maximum	3.78	Maximum of Log Data	1.33
Mean	3.266	Mean of log Data	1.179
Geometric Mean	3.252	SD of log Data	0.0956
Median	3.14		
SD	0.317		
Std. Error of Mean	0.0792		
Coefficient of Variation	0.097		
Skewness	0.461		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.893	Shapiro Wilk Test Statistic	0.903
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	3.405	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	3.607
95% Adjusted-CLT UCL (Chen-1995)	3.406	97.5% Chebyshev (MVUE) UCL	3.754
95% Modified-t UCL (Johnson-1978)	3.407	99% Chebyshev (MVUE) UCL	4.044

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	94.09	Data appear Normal at 5% Significance Level
Theta Star	0.0347	
MLE of Mean	3.266	
MLE of Standard Deviation	0.337	
nu star	3011	
Approximate Chi Square Value (.05)	2884	
Adjusted Level of Significance	0.0335	
Adjusted Chi Square Value	2870	
Anderson-Darling Test Statistic	0.808	
Anderson-Darling 5% Critical Value	0.736	
Kolmogorov-Smirnov Test Statistic	0.252	
Kolmogorov-Smirnov 5% Critical Value	0.214	
Data not Gamma Distributed at 5% Significance Level		

Nonparametric Statistics	
95% CLT UCL	3.396
95% Jackknife UCL	3.405
95% Standard Bootstrap UCL	3.396
95% Bootstrap-t UCL	3.423
95% Hall's Bootstrap UCL	3.393
95% Percentile Bootstrap UCL	3.4
95% BCA Bootstrap UCL	3.396
95% Chebyshev(Mean, Sd) UCL	3.611
97.5% Chebyshev(Mean, Sd) UCL	3.761
99% Chebyshev(Mean, Sd) UCL	4.054

Assuming Gamma Distribution	
95% Approximate Gamma UCL (Use when n >= 40)	3.409
95% Adjusted Gamma UCL (Use when n < 40)	3.426

Potential UCL to Use	Use 95% Student's-t UCL 3.405

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Se_ppm

General Statistics

Number of Valid Observations	16	Number of Distinct Observations	16

Raw Statistics		Log-transformed Statistics	
Minimum	1.03	Minimum of Log Data	0.0296
Maximum	12.2	Maximum of Log Data	2.501
Mean	8.39	Mean of log Data	2.022
Geometric Mean	7.55	SD of log Data	0.586
Median	8.67		
SD	2.863		
Std. Error of Mean	0.716		
Coefficient of Variation	0.341		
Skewness	-1.025		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.922	Shapiro Wilk Test Statistic	0.667
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	9.645	95% H-UCL	12.4
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	14.75
95% Adjusted-CLT UCL (Chen-1995)	9.371	97.5% Chebyshev (MVUE) UCL	17.3
95% Modified-t UCL (Johnson-1978)	9.614	99% Chebyshev (MVUE) UCL	22.31

Gamma Distribution Test		Data Distribution
k star (bias corrected)	4.024	Data appear Normal at 5% Significance Level
Theta Star	2.085	
MLE of Mean	8.39	
MLE of Standard Deviation	4.183	
nu star	128.8	
Approximate Chi Square Value (.05)	103.6	**Nonparametric Statistics**
Adjusted Level of Significance	0.0335	95% CLT UCL 9.567
Adjusted Chi Square Value	101	95% Jackknife UCL 9.645
		95% Standard Bootstrap UCL 9.482
Anderson-Darling Test Statistic	1.12	95% Bootstrap-t UCL 9.469
Anderson-Darling 5% Critical Value	0.741	95% Hall's Bootstrap UCL 9.454
Kolmogorov-Smirnov Test Statistic	0.234	95% Percentile Bootstrap UCL 9.493
Kolmogorov-Smirnov 5% Critical Value	0.216	95% BCA Bootstrap UCL 9.375
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 11.51
		97.5% Chebyshev(Mean, Sd) UCL 12.86
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 15.51
95% Approximate Gamma UCL (Use when n >= 40)	10.43	
95% Adjusted Gamma UCL (Use when n < 40)	10.7	

Potential UCL to Use	Use 95% Student's-t UCL 9.645

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Sr_ppm

General Statistics

Number of Valid Observations	16	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	345	Minimum of Log Data	5.844
Maximum	476	Maximum of Log Data	6.165
Mean	402.1	Mean of log Data	5.994
Geometric Mean	401.1	SD of log Data	0.0728
Median	396		
SD	29.79		
Std. Error of Mean	7.447		
Coefficient of Variation	0.0741		
Skewness	0.772		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.933	Shapiro Wilk Test Statistic	0.947
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	415.1	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	434
95% Adjusted-CLT UCL (Chen-1995)	415.8	97.5% Chebyshev (MVUE) UCL	447.8
95% Modified-t UCL (Johnson-1978)	415.4	99% Chebyshev (MVUE) UCL	475

Gamma Distribution Test		Data Distribution
k star (bias corrected)	161.9	Data appear Normal at 5% Significance Level
Theta Star	2.484	
MLE of Mean	402.1	
MLE of Standard Deviation	31.6	
nu star	5180	
Approximate Chi Square Value (.05)	5013	**Nonparametric Statistics**
Adjusted Level of Significance	0.0335	95% CLT UCL 414.3
Adjusted Chi Square Value	4995	95% Jackknife UCL 415.1
		95% Standard Bootstrap UCL 414.3
Anderson-Darling Test Statistic	0.469	95% Bootstrap-t UCL 417.6
Anderson-Darling 5% Critical Value	0.736	95% Hall's Bootstrap UCL 421.8
Kolmogorov-Smirnov Test Statistic	0.145	95% Percentile Bootstrap UCL 414.8
Kolmogorov-Smirnov 5% Critical Value	0.214	95% BCA Bootstrap UCL 415.9
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 434.5
		97.5% Chebyshev(Mean, Sd) UCL 448.6
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 476.2
95% Approximate Gamma UCL (Use when n >= 40)	415.4	
95% Adjusted Gamma UCL (Use when n < 40)	416.9	

Potential UCL to Use	Use 95% Student's-t UCL 415.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General Statistics

Number of Valid Observations	16	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	1.07	Minimum of Log Data	0.0677
Maximum	2.9	Maximum of Log Data	1.065
Mean	1.548	Mean of log Data	0.402
Geometric Mean	1.495	SD of log Data	0.26
Median	1.33		
SD	0.458		
Std. Error of Mean	0.114		
Coefficient of Variation	0.296		
Skewness	1.797		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.807	Shapiro Wilk Test Statistic	0.892
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	1.748	95% H-UCL	1.75
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1.985
95% Adjusted-CLT UCL (Chen-1995)	1.791	97.5% Chebyshev (MVUE) UCL	2.175
95% Modified-t UCL (Johnson-1978)	1.757	99% Chebyshev (MVUE) UCL	2.55

Gamma Distribution Test		Data Distribution
k star (bias corrected)	12.04	Data appear Lognormal at 5% Significance Level
Theta Star	0.129	
MLE of Mean	1.548	
MLE of Standard Deviation	0.446	
nu star	385.3	
Approximate Chi Square Value (.05)	340.8	**Nonparametric Statistics**
Adjusted Level of Significance	0.0335	95% CLT UCL 1.736
Adjusted Chi Square Value	336.1	95% Jackknife UCL 1.748
		95% Standard Bootstrap UCL 1.731
Anderson-Darling Test Statistic	0.784	95% Bootstrap-t UCL 1.837
Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL 1.997
Kolmogorov-Smirnov Test Statistic	0.247	95% Percentile Bootstrap UCL 1.733
Kolmogorov-Smirnov 5% Critical Value	0.215	95% BCA Bootstrap UCL 1.793
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 2.046
		97.5% Chebyshev(Mean, Sd) UCL 2.262
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 2.686
95% Approximate Gamma UCL (Use when n >= 40)	1.75	
95% Adjusted Gamma UCL (Use when n < 40)	1.774	

Potential UCL to Use	
Use 95% Student's-t UCL	1.748
or 95% Modified-t UCL	1.757
or 95% H-UCL	1.75

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General Statistics

Number of Valid Observations	16	Number of Distinct Observations	10

Raw Statistics		Log-transformed Statistics	
Minimum	12	Minimum of Log Data	2.485
Maximum	13.5	Maximum of Log Data	2.603
Mean	12.7	Mean of log Data	2.541
Geometric Mean	12.69	SD of log Data	0.0323
Median	12.7		
SD	0.413		
Std. Error of Mean	0.103		
Coefficient of Variation	0.0325		
Skewness	0.519		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.948	Shapiro Wilk Test Statistic	0.954
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	12.88	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	13.15
95% Adjusted-CLT UCL (Chen-1995)	12.88	97.5% Chebyshev (MVUE) UCL	13.34
95% Modified-t UCL (Johnson-1978)	12.88	99% Chebyshev (MVUE) UCL	13.72

Gamma Distribution Test		Data Distribution
k star (bias corrected)	826.2	Data appear Normal at 5% Significance Level
Theta Star	0.0154	
MLE of Mean	12.7	
MLE of Standard Deviation	0.442	
nu star	26439	
Approximate Chi Square Value (.05)	26062	**Nonparametric Statistics**
Adjusted Level of Significance	0.0335	95% CLT UCL 12.87
Adjusted Chi Square Value	26019	95% Jackknife UCL 12.88
		95% Standard Bootstrap UCL 12.87
Anderson-Darling Test Statistic	0.332	95% Bootstrap-t UCL 12.89
Anderson-Darling 5% Critical Value	0.736	95% Hall's Bootstrap UCL 12.94
Kolmogorov-Smirnov Test Statistic	0.122	95% Percentile Bootstrap UCL 12.88
Kolmogorov-Smirnov 5% Critical Value	0.214	95% BCA Bootstrap UCL 12.89
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 13.15
		97.5% Chebyshev(Mean, Sd) UCL 13.34
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 13.73
95% Approximate Gamma UCL (Use when n >= 40)	12.88	
95% Adjusted Gamma UCL (Use when n < 40)	12.9	

Potential UCL to Use	Use 95% Student's-t UCL 12.88

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

V_ppm

General Statistics

Number of Valid Observations	16	Number of Distinct Observations	10

Raw Statistics		Log-transformed Statistics	
Minimum	106	Minimum of Log Data	4.663
Maximum	128	Maximum of Log Data	4.852
Mean	113.9	Mean of log Data	4.734
Geometric Mean	113.7	SD of log Data	0.0521
Median	111.5		
SD	6.043		
Std. Error of Mean	1.511		
Coefficient of Variation	0.0531		
Skewness	0.938		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.905	Shapiro Wilk Test Statistic	0.915
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	116.5	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	120.3
95% Adjusted-CLT UCL (Chen-1995)	116.7	97.5% Chebyshev (MVUE) UCL	123.1
95% Modified-t UCL (Johnson-1978)	116.6	99% Chebyshev (MVUE) UCL	128.6

Gamma Distribution Test		Data Distribution
k star (bias corrected)	316	Data appear Normal at 5% Significance Level
Theta Star	0.36	
MLE of Mean	113.9	
MLE of Standard Deviation	6.406	
nu star	10112	
Approximate Chi Square Value (.05)	9880	**Nonparametric Statistics**
Adjusted Level of Significance	0.0335	95% CLT UCL 116.4
Adjusted Chi Square Value	9853	95% Jackknife UCL 116.5
		95% Standard Bootstrap UCL 116.3
Anderson-Darling Test Statistic	0.65	95% Bootstrap-t UCL 117
Anderson-Darling 5% Critical Value	0.736	95% Hall's Bootstrap UCL 117
Kolmogorov-Smirnov Test Statistic	0.186	95% Percentile Bootstrap UCL 116.2
Kolmogorov-Smirnov 5% Critical Value	0.214	95% BCA Bootstrap UCL 116.4
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 120.5
		97.5% Chebyshev(Mean, Sd) UCL 123.3
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 128.9
95% Approximate Gamma UCL (Use when n >= 40)	116.6	
95% Adjusted Gamma UCL (Use when n < 40)	116.9	

Potential UCL to Use		Use 95% Student's-t UCL	116.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Zn_ppm

General Statistics

Number of Valid Observations	16	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	70.4	Minimum of Log Data	4.254
Maximum	83.5	Maximum of Log Data	4.425
Mean	77.67	Mean of log Data	4.351
Geometric Mean	77.56	SD of log Data	0.0542
Median	78.85		
SD	4.155		
Std. Error of Mean	1.039		
Coefficient of Variation	0.0535		
Skewness	-0.46		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.934	Shapiro Wilk Test Statistic	0.929
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	79.49	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	82.26
95% Adjusted-CLT UCL (Chen-1995)	79.25	97.5% Chebyshev (MVUE) UCL	84.24
95% Modified-t UCL (Johnson-1978)	79.47	99% Chebyshev (MVUE) UCL	88.14

Gamma Distribution Test		Data Distribution
k star (bias corrected)	298	Data appear Normal at 5% Significance Level
Theta Star	0.261	
MLE of Mean	77.67	
MLE of Standard Deviation	4.5	
nu star	9535	
Approximate Chi Square Value (.05)	9309	**Nonparametric Statistics**
Adjusted Level of Significance	0.0335	95% CLT UCL 79.38
Adjusted Chi Square Value	9283	95% Jackknife UCL 79.49
		95% Standard Bootstrap UCL 79.33
Anderson-Darling Test Statistic	0.447	95% Bootstrap-t UCL 79.43
Anderson-Darling 5% Critical Value	0.736	95% Hall's Bootstrap UCL 79.15
Kolmogorov-Smirnov Test Statistic	0.17	95% Percentile Bootstrap UCL 79.31
Kolmogorov-Smirnov 5% Critical Value	0.214	95% BCA Bootstrap UCL 79.26
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 82.2
		97.5% Chebyshev(Mean, Sd) UCL 84.16
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 88
95% Approximate Gamma UCL (Use when n >= 40)	79.55	
95% Adjusted Gamma UCL (Use when n < 40)	79.77	

Potential UCL to Use		Use 95% Student's-t UCL	79.49

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

General UCL Statistics for Full Data Sets

User Selected Options

From File	ProUCLinputOhio.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

As_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	33.7	Minimum of Log Data	3.517
Maximum	93.8	Maximum of Log Data	4.541
Mean	59.04	Mean of log Data	4.048
Geometric Mean	57.31	SD of log Data	0.258
Median	60.3		
SD	14.75		
Std. Error of Mean	4.091		
Coefficient of Variation	0.25		
Skewness	0.52		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.92	Shapiro Wilk Test Statistic	0.923
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	66.33	95% H-UCL	68.14
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	77.68
95% Adjusted-CLT UCL (Chen-1995)	66.4	97.5% Chebyshev (MVUE) UCL	85.73
95% Modified-t UCL (Johnson-1978)	66.43	99% Chebyshev (MVUE) UCL	101.5

Gamma Distribution Test		Data Distribution
k star (bias corrected)	13.12	Data appear Normal at 5% Significance Level
Theta Star	4.501	
MLE of Mean	59.04	
MLE of Standard Deviation	16.3	
nu star	341.1	
Approximate Chi Square Value (.05)	299.3	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 65.77
Adjusted Chi Square Value	293.7	95% Jackknife UCL 66.33
		95% Standard Bootstrap UCL 65.4
Anderson-Darling Test Statistic	0.517	95% Bootstrap-t UCL 66.55
Anderson-Darling 5% Critical Value	0.733	95% Hall's Bootstrap UCL 68.53
Kolmogorov-Smirnov Test Statistic	0.176	95% Percentile Bootstrap UCL 65.72
Kolmogorov-Smirnov 5% Critical Value	0.236	95% BCA Bootstrap UCL 65.59
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 76.87
		97.5% Chebyshev(Mean, Sd) UCL 84.59
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 99.75
95% Approximate Gamma UCL (Use when n >= 40)	67.28	
95% Adjusted Gamma UCL (Use when n < 40)	68.56	

Potential UCL to Use		Use 95% Student's-t UCL	66.33

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Ba_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		**Log-transformed Statistics**	
Minimum	464	Minimum of Log Data	6.14
Maximum	608	Maximum of Log Data	6.41
Mean	530.2	Mean of log Data	6.269
Geometric Mean	528.1	SD of log Data	0.0922
Median	518		
SD	49.44		
Std. Error of Mean	13.71		
Coefficient of Variation	0.0932		
Skewness	0.416		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.92	Shapiro Wilk Test Statistic	0.929
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	554.7	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	589.4
95% Adjusted-CLT UCL (Chen-1995)	554.5	97.5% Chebyshev (MVUE) UCL	615
95% Modified-t UCL (Johnson-1978)	554.9	99% Chebyshev (MVUE) UCL	665.2

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	97.5	Data appear Normal at 5% Significance Level
Theta Star	5.438	
MLE of Mean	530.2	
MLE of Standard Deviation	53.7	
nu star	2535	
Approximate Chi Square Value (.05)	2419	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 552.8
Adjusted Chi Square Value	2403	95% Jackknife UCL 554.7
		95% Standard Bootstrap UCL 551.9
Anderson-Darling Test Statistic	0.416	95% Bootstrap-t UCL 555.7
Anderson-Darling 5% Critical Value	0.732	95% Hall's Bootstrap UCL 552.6
Kolmogorov-Smirnov Test Statistic	0.173	95% Percentile Bootstrap UCL 552
Kolmogorov-Smirnov 5% Critical Value	0.236	95% BCA Bootstrap UCL 551.5
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 590
		97.5% Chebyshev(Mean, Sd) UCL 615.9
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 666.7
95% Approximate Gamma UCL (Use when n >= 40)	555.7	
95% Adjusted Gamma UCL (Use when n < 40)	559.4	

Potential UCL to Use		Use 95% Student's-t UCL	554.7

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Be_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	8.03	Minimum of Log Data	2.083
Maximum	15.4	Maximum of Log Data	2.734
Mean	11.26	Mean of log Data	2.407
Geometric Mean	11.1	SD of log Data	0.179
Median	11.7		
SD	2.01		
Std. Error of Mean	0.557		
Coefficient of Variation	0.178		
Skewness	0.385		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.961	Shapiro Wilk Test Statistic	0.968
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	12.25	95% H-UCL	12.38
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	13.71
95% Adjusted-CLT UCL (Chen-1995)	12.24	97.5% Chebyshev (MVUE) UCL	14.77
95% Modified-t UCL (Johnson-1978)	12.26	99% Chebyshev (MVUE) UCL	16.84

Gamma Distribution Test		Data Distribution
k star (bias corrected)	26.35	Data appear Normal at 5% Significance Level
Theta Star	0.427	
MLE of Mean	11.26	
MLE of Standard Deviation	2.194	
nu star	685	
Approximate Chi Square Value (.05)	625.3	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 12.18
Adjusted Chi Square Value	617.1	95% Jackknife UCL 12.25
		95% Standard Bootstrap UCL 12.14
Anderson-Darling Test Statistic	0.284	95% Bootstrap-t UCL 12.35
Anderson-Darling 5% Critical Value	0.733	95% Hall's Bootstrap UCL 12.4
Kolmogorov-Smirnov Test Statistic	0.149	95% Percentile Bootstrap UCL 12.15
Kolmogorov-Smirnov 5% Critical Value	0.236	95% BCA Bootstrap UCL 12.16
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 13.69
		97.5% Chebyshev(Mean, Sd) UCL 14.74
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 16.81
95% Approximate Gamma UCL (Use when n >= 40)	12.34	
95% Adjusted Gamma UCL (Use when n < 40)	12.5	

Potential UCL to Use	Use 95% Student's-t UCL 12.25

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Cd_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.312	Minimum of Log Data	-1.165
Maximum	0.963	Maximum of Log Data	-0.0377
Mean	0.736	Mean of log Data	-0.341
Geometric Mean	0.711	SD of log Data	0.292
Median	0.789		
SD	0.172		
Std. Error of Mean	0.0476		
Coefficient of Variation	0.233		
Skewness	-1.218		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.895	Shapiro Wilk Test Statistic	0.787
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.821	95% H-UCL	0.871
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1.003
95% Adjusted-CLT UCL (Chen-1995)	0.797	97.5% Chebyshev (MVUE) UCL	1.117
95% Modified-t UCL (Johnson-1978)	0.818	99% Chebyshev (MVUE) UCL	1.341

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	11.67	Data appear Normal at 5% Significance Level
Theta Star	0.0631	
MLE of Mean	0.736	
MLE of Standard Deviation	0.215	
nu star	303.3	
Approximate Chi Square Value (.05)	264	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 0.814
Adjusted Chi Square Value	258.7	95% Jackknife UCL 0.821
		95% Standard Bootstrap UCL 0.811
Anderson-Darling Test Statistic	0.804	95% Bootstrap-t UCL 0.806
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 0.8
Kolmogorov-Smirnov Test Statistic	0.202	95% Percentile Bootstrap UCL 0.807
Kolmogorov-Smirnov 5% Critical Value	0.236	95% BCA Bootstrap UCL 0.795
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 0.943
		97.5% Chebyshev(Mean, Sd) UCL 1.033
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 1.21
95% Approximate Gamma UCL (Use when n >= 40)	0.845	
95% Adjusted Gamma UCL (Use when n < 40)	0.862	

Potential UCL to Use	Use 95% Student's-t UCL 0.821

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Co_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	12

Raw Statistics		**Log-transformed Statistics**	
Minimum	27.6	Minimum of Log Data	3.318
Maximum	46.4	Maximum of Log Data	3.837
Mean	36.09	Mean of log Data	3.571
Geometric Mean	35.54	SD of log Data	0.183
Median	32.6		
SD	6.624		
Std. Error of Mean	1.837		
Coefficient of Variation	0.184		
Skewness	0.26		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.9	Shapiro Wilk Test Statistic	0.906
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	39.37	95% H-UCL	39.78
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	44.1
95% Adjusted-CLT UCL (Chen-1995)	39.26	97.5% Chebyshev (MVUE) UCL	47.57
95% Modified-t UCL (Johnson-1978)	39.39	99% Chebyshev (MVUE) UCL	54.38

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	25.02	Data appear Normal at 5% Significance Level
Theta Star	1.442	
MLE of Mean	36.09	
MLE of Standard Deviation	7.215	
nu star	650.6	
Approximate Chi Square Value (.05)	592.5	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 39.11
Adjusted Chi Square Value	584.5	95% Jackknife UCL 39.37
		95% Standard Bootstrap UCL 39.01
Anderson-Darling Test Statistic	0.599	95% Bootstrap-t UCL 39.66
Anderson-Darling 5% Critical Value	0.733	95% Hall's Bootstrap UCL 38.9
Kolmogorov-Smirnov Test Statistic	0.234	95% Percentile Bootstrap UCL 39.05
Kolmogorov-Smirnov 5% Critical Value	0.236	95% BCA Bootstrap UCL 39.16
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 44.1
		97.5% Chebyshev(Mean, Sd) UCL 47.56
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 54.37
95% Approximate Gamma UCL (Use when n >= 40)	39.64	
95% Adjusted Gamma UCL (Use when n < 40)	40.17	

Potential UCL to Use		Use 95% Student's-t UCL	39.37

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Cr_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	11

Raw Statistics		Log-transformed Statistics	
Minimum	118	Minimum of Log Data	4.771
Maximum	181	Maximum of Log Data	5.198
Mean	147.8	Mean of log Data	4.981
Geometric Mean	145.6	SD of log Data	0.177
Median	133		
SD	26.22		
Std. Error of Mean	7.273		
Coefficient of Variation	0.177		
Skewness	0.218		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.803	Shapiro Wilk Test Statistic	0.808
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	160.7	95% H-UCL	162.3
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	179.4
95% Adjusted-CLT UCL (Chen-1995)	160.2	97.5% Chebyshev (MVUE) UCL	193.1
95% Modified-t UCL (Johnson-1978)	160.8	99% Chebyshev (MVUE) UCL	220

Gamma Distribution Test		Data Distribution
k star (bias corrected)	26.77	Data do not follow a Discernable Distribution (0.05)
Theta Star	5.52	
MLE of Mean	147.8	
MLE of Standard Deviation	28.56	
nu star	696.1	
Approximate Chi Square Value (.05)	635.9	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 159.7
Adjusted Chi Square Value	627.7	95% Jackknife UCL 160.7
		95% Standard Bootstrap UCL 159.5
Anderson-Darling Test Statistic	1.197	95% Bootstrap-t UCL 161.3
Anderson-Darling 5% Critical Value	0.733	95% Hall's Bootstrap UCL 158.4
Kolmogorov-Smirnov Test Statistic	0.248	95% Percentile Bootstrap UCL 159.7
Kolmogorov-Smirnov 5% Critical Value	0.236	95% BCA Bootstrap UCL 159.9
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 179.5
		97.5% Chebyshev(Mean, Sd) UCL 193.2
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 220.1
95% Approximate Gamma UCL (Use when n >= 40)	161.8	
95% Adjusted Gamma UCL (Use when n < 40)	163.9	

Potential UCL to Use	
Use 95% Student's-t UCL	160.7
or 95% Modified-t UCL	160.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Cu_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		**Log-transformed Statistics**	
Minimum	55.1	Minimum of Log Data	4.009
Maximum	193	Maximum of Log Data	5.263
Mean	85.22	Mean of log Data	4.391
Geometric Mean	80.73	SD of log Data	0.315
Median	77.8		
SD	35.05		
Std. Error of Mean	9.72		
Coefficient of Variation	0.411		
Skewness	2.737		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.678	Shapiro Wilk Test Statistic	0.845
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	102.5	95% H-UCL	101
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	117
95% Adjusted-CLT UCL (Chen-1995)	109.1	97.5% Chebyshev (MVUE) UCL	131.1
95% Modified-t UCL (Johnson-1978)	103.8	99% Chebyshev (MVUE) UCL	158.7

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	7.291	Data Follow Appr. Gamma Distribution at 5% Significance Level
Theta Star	11.69	
MLE of Mean	85.22	
MLE of Standard Deviation	31.56	
nu star	189.6	
Approximate Chi Square Value (.05)	158.7	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 101.2
Adjusted Chi Square Value	154.7	95% Jackknife UCL 102.5
		95% Standard Bootstrap UCL 100.3
Anderson-Darling Test Statistic	0.928	95% Bootstrap-t UCL 123.2
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 172
Kolmogorov-Smirnov Test Statistic	0.23	95% Percentile Bootstrap UCL 101.9
Kolmogorov-Smirnov 5% Critical Value	0.237	95% BCA Bootstrap UCL 110.3
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 127.6
		97.5% Chebyshev(Mean, Sd) UCL 145.9
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 181.9
95% Approximate Gamma UCL (Use when n >= 40)	101.8	
95% Adjusted Gamma UCL (Use when n < 40)	104.4	

Potential UCL to Use		Use 95% Approximate Gamma UCL	101.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Hg_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	12

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.0167	Minimum of Log Data	-4.092
Maximum	0.0561	Maximum of Log Data	-2.881
Mean	0.0322	Mean of log Data	-3.487
Geometric Mean	0.0306	SD of log Data	0.338
Median	0.0318		
SD	0.0109		
Std. Error of Mean	0.00303		
Coefficient of Variation	0.339		
Skewness	0.718		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.952	Shapiro Wilk Test Statistic	0.981
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.0376	95% H-UCL	0.0392
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.0456
95% Adjusted-CLT UCL (Chen-1995)	0.0379	97.5% Chebyshev (MVUE) UCL	0.0514
95% Modified-t UCL (Johnson-1978)	0.0377	99% Chebyshev (MVUE) UCL	0.0627

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	7.513	Data appear Normal at 5% Significance Level
Theta Star	0.00429	
MLE of Mean	0.0322	
MLE of Standard Deviation	0.0118	
nu star	195.4	
Approximate Chi Square Value (.05)	164	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 0.0372
Adjusted Chi Square Value	159.9	95% Jackknife UCL 0.0376
		95% Standard Bootstrap UCL 0.037
Anderson-Darling Test Statistic	0.205	95% Bootstrap-t UCL 0.0386
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 0.039
Kolmogorov-Smirnov Test Statistic	0.145	95% Percentile Bootstrap UCL 0.0374
Kolmogorov-Smirnov 5% Critical Value	0.237	95% BCA Bootstrap UCL 0.0374
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 0.0455
		97.5% Chebyshev(Mean, Sd) UCL 0.0512
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 0.0624
95% Approximate Gamma UCL (Use when n >= 40)	0.0384	
95% Adjusted Gamma UCL (Use when n < 40)	0.0394	

Potential UCL to Use	Use 95% Student's-t UCL 0.0376

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Li_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	74	Minimum of Log Data	4.304
Maximum	140	Maximum of Log Data	4.942
Mean	110	Mean of log Data	4.681
Geometric Mean	107.9	SD of log Data	0.207
Median	97.9		
SD	22.43		
Std. Error of Mean	6.222		
Coefficient of Variation	0.204		
Skewness	0.133		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.871	Shapiro Wilk Test Statistic	0.883
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	121.1	95% H-UCL	123
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	137.7
95% Adjusted-CLT UCL (Chen-1995)	120.5	97.5% Chebyshev (MVUE) UCL	149.6
95% Modified-t UCL (Johnson-1978)	121.2	99% Chebyshev (MVUE) UCL	173.1

Gamma Distribution Test		Data Distribution
k star (bias corrected)	19.9	Data appear Normal at 5% Significance Level
Theta Star	5.529	
MLE of Mean	110	
MLE of Standard Deviation	24.67	
nu star	517.4	
Approximate Chi Square Value (.05)	465.7	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 120.3
Adjusted Chi Square Value	458.7	95% Jackknife UCL 121.1
		95% Standard Bootstrap UCL 119.9
Anderson-Darling Test Statistic	0.805	95% Bootstrap-t UCL 121.9
Anderson-Darling 5% Critical Value	0.733	95% Hall's Bootstrap UCL 119.4
Kolmogorov-Smirnov Test Statistic	0.236	95% Percentile Bootstrap UCL 120.2
Kolmogorov-Smirnov 5% Critical Value	0.236	95% BCA Bootstrap UCL 119.4
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 137.2
		97.5% Chebyshev(Mean, Sd) UCL 148.9
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 171.9
95% Approximate Gamma UCL (Use when n >= 40)	122.3	
95% Adjusted Gamma UCL (Use when n < 40)	124.1	

Potential UCL to Use		Use 95% Student's-t UCL	121.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Mn_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		**Log-transformed Statistics**	
Minimum	193	Minimum of Log Data	5.263
Maximum	333	Maximum of Log Data	5.808
Mean	252.8	Mean of log Data	5.514
Geometric Mean	248.2	SD of log Data	0.2
Median	236		
SD	51.54		
Std. Error of Mean	14.29		
Coefficient of Variation	0.204		
Skewness	0.466		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.889	Shapiro Wilk Test Statistic	0.904
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	278.3	95% H-UCL	281.4
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	314.2
95% Adjusted-CLT UCL (Chen-1995)	278.3	97.5% Chebyshev (MVUE) UCL	340.8
95% Modified-t UCL (Johnson-1978)	278.6	99% Chebyshev (MVUE) UCL	393.1

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	20.72	Data appear Normal at 5% Significance Level
Theta Star	12.2	
MLE of Mean	252.8	
MLE of Standard Deviation	55.54	
nu star	538.8	
Approximate Chi Square Value (.05)	486	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 276.4
Adjusted Chi Square Value	478.8	95% Jackknife UCL 278.3
		95% Standard Bootstrap UCL 275.3
Anderson-Darling Test Statistic	0.534	95% Bootstrap-t UCL 280.9
Anderson-Darling 5% Critical Value	0.733	95% Hall's Bootstrap UCL 276.2
Kolmogorov-Smirnov Test Statistic	0.179	95% Percentile Bootstrap UCL 275.1
Kolmogorov-Smirnov 5% Critical Value	0.236	95% BCA Bootstrap UCL 277.5
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 315.2
		97.5% Chebyshev(Mean, Sd) UCL 342.1
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 395.1
95% Approximate Gamma UCL (Use when n >= 40)	280.3	
95% Adjusted Gamma UCL (Use when n < 40)	284.5	

Potential UCL to Use	Use 95% Student's-t UCL 278.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Mo_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	12

Raw Statistics		**Log-transformed Statistics**	
Minimum	7.15	Minimum of Log Data	1.967
Maximum	18.4	Maximum of Log Data	2.912
Mean	10.47	Mean of log Data	2.324
Geometric Mean	10.21	SD of log Data	0.223
Median	10.6		
SD	2.687		
Std. Error of Mean	0.745		
Coefficient of Variation	0.257		
Skewness	2.233		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.744	Shapiro Wilk Test Statistic	0.853
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	11.8	95% H-UCL	11.79
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	13.28
95% Adjusted-CLT UCL (Chen-1995)	12.19	97.5% Chebyshev (MVUE) UCL	14.5
95% Modified-t UCL (Johnson-1978)	11.88	99% Chebyshev (MVUE) UCL	16.91

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	15.64	Data do not follow a Discernable Distribution (0.05)
Theta Star	0.67	
MLE of Mean	10.47	
MLE of Standard Deviation	2.648	
nu star	406.6	
Approximate Chi Square Value (.05)	360.9	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 11.7
Adjusted Chi Square Value	354.7	95% Jackknife UCL 11.8
		95% Standard Bootstrap UCL 11.66
Anderson-Darling Test Statistic	0.913	95% Bootstrap-t UCL 12.5
Anderson-Darling 5% Critical Value	0.733	95% Hall's Bootstrap UCL 17.6
Kolmogorov-Smirnov Test Statistic	0.29	95% Percentile Bootstrap UCL 11.8
Kolmogorov-Smirnov 5% Critical Value	0.236	95% BCA Bootstrap UCL 12.11
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 13.72
		97.5% Chebyshev(Mean, Sd) UCL 15.12
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 17.88
95% Approximate Gamma UCL (Use when n >= 40)	11.8	
95% Adjusted Gamma UCL (Use when n < 40)	12	

Potential UCL to Use	Use 95% Student's-t UCL 11.8
	or 95% Modified-t UCL 11.88

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Ni_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	79.5	Minimum of Log Data	4.376
Maximum	123	Maximum of Log Data	4.812
Mean	97.95	Mean of log Data	4.575
Geometric Mean	97.02	SD of log Data	0.144
Median	102		
SD	14.15		
Std. Error of Mean	3.925		
Coefficient of Variation	0.144		
Skewness	0.242		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.91	Shapiro Wilk Test Statistic	0.909
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	104.9	95% H-UCL	105.6
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	115.1
95% Adjusted-CLT UCL (Chen-1995)	104.7	97.5% Chebyshev (MVUE) UCL	122.5
95% Modified-t UCL (Johnson-1978)	105	99% Chebyshev (MVUE) UCL	137

Gamma Distribution Test		Data Distribution
k star (bias corrected)	40.26	Data appear Normal at 5% Significance Level
Theta Star	2.433	
MLE of Mean	97.95	
MLE of Standard Deviation	15.44	
nu star	1047	
Approximate Chi Square Value (.05)	972.7	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 104.4
Adjusted Chi Square Value	962.6	95% Jackknife UCL 104.9
		95% Standard Bootstrap UCL 104.3
Anderson-Darling Test Statistic	0.629	95% Bootstrap-t UCL 104.7
Anderson-Darling 5% Critical Value	0.733	95% Hall's Bootstrap UCL 104
Kolmogorov-Smirnov Test Statistic	0.239	95% Percentile Bootstrap UCL 104.3
Kolmogorov-Smirnov 5% Critical Value	0.236	95% BCA Bootstrap UCL 104.5
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 115.1
		97.5% Chebyshev(Mean, Sd) UCL 122.5
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 137
95% Approximate Gamma UCL (Use when n >= 40)	105.4	
95% Adjusted Gamma UCL (Use when n < 40)	106.5	

Potential UCL to Use	Use 95% Student's-t UCL 104.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Pb_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	11

Raw Statistics		**Log-transformed Statistics**	
Minimum	21.4	Minimum of Log Data	3.063
Maximum	50.4	Maximum of Log Data	3.92
Mean	39.07	Mean of log Data	3.645
Geometric Mean	38.3	SD of log Data	0.218
Median	41.8		
SD	7.42		
Std. Error of Mean	2.058		
Coefficient of Variation	0.19		
Skewness	-1.003		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.894	Shapiro Wilk Test Statistic	0.827
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	42.74	95% H-UCL	44.05
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	49.52
95% Adjusted-CLT UCL (Chen-1995)	41.84	97.5% Chebyshev (MVUE) UCL	54.01
95% Modified-t UCL (Johnson-1978)	42.64	99% Chebyshev (MVUE) UCL	62.82

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	19.53	Data appear Normal at 5% Significance Level
Theta Star	2	
MLE of Mean	39.07	
MLE of Standard Deviation	8.84	
nu star	507.9	
Approximate Chi Square Value (.05)	456.6	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 42.45
Adjusted Chi Square Value	449.7	95% Jackknife UCL 42.74
		95% Standard Bootstrap UCL 42.36
Anderson-Darling Test Statistic	0.825	95% Bootstrap-t UCL 42.16
Anderson-Darling 5% Critical Value	0.733	95% Hall's Bootstrap UCL 41.98
Kolmogorov-Smirnov Test Statistic	0.274	95% Percentile Bootstrap UCL 42.02
Kolmogorov-Smirnov 5% Critical Value	0.236	95% BCA Bootstrap UCL 41.96
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 48.04
		97.5% Chebyshev(Mean, Sd) UCL 51.92
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 59.55
95% Approximate Gamma UCL (Use when n >= 40)	43.46	
95% Adjusted Gamma UCL (Use when n < 40)	44.12	

Potential UCL to Use		Use 95% Student's-t UCL	42.74

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Sb_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	0.982	Minimum of Log Data	-0.0182
Maximum	5.3	Maximum of Log Data	1.668
Mean	2.051	Mean of log Data	0.639
Geometric Mean	1.894	SD of log Data	0.383
Median	1.95		
SD	1.039		
Std. Error of Mean	0.288		
Coefficient of Variation	0.507		
Skewness	2.847		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.646	Shapiro Wilk Test Statistic	0.853
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	2.565	95% H-UCL	2.54
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2.981
95% Adjusted-CLT UCL (Chen-1995)	2.768	97.5% Chebyshev (MVUE) UCL	3.393
95% Modified-t UCL (Johnson-1978)	2.603	99% Chebyshev (MVUE) UCL	4.204

Gamma Distribution Test		Data Distribution
k star (bias corrected)	5.023	Data do not follow a Discernable Distribution (0.05)
Theta Star	0.408	
MLE of Mean	2.051	
MLE of Standard Deviation	0.915	
nu star	130.6	
Approximate Chi Square Value (.05)	105.2	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 2.525
Adjusted Chi Square Value	102	95% Jackknife UCL 2.565
		95% Standard Bootstrap UCL 2.5
Anderson-Darling Test Statistic	1.048	95% Bootstrap-t UCL 3.135
Anderson-Darling 5% Critical Value	0.735	95% Hall's Bootstrap UCL 4.587
Kolmogorov-Smirnov Test Statistic	0.305	95% Percentile Bootstrap UCL 2.542
Kolmogorov-Smirnov 5% Critical Value	0.237	95% BCA Bootstrap UCL 2.732
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 3.307
		97.5% Chebyshev(Mean, Sd) UCL 3.851
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 4.918
95% Approximate Gamma UCL (Use when n >= 40)	2.546	
95% Adjusted Gamma UCL (Use when n < 40)	2.627	

Potential UCL to Use	
Use 95% Student's-t UCL	2.565
or 95% Modified-t UCL	2.603

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Se_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	3.49	Minimum of Log Data	1.25
Maximum	5.47	Maximum of Log Data	1.699
Mean	4.125	Mean of log Data	1.41
Geometric Mean	4.096	SD of log Data	0.123
Median	4.11		
SD	0.539		
Std. Error of Mean	0.149		
Coefficient of Variation	0.131		
Skewness	1.445		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.867	Shapiro Wilk Test Statistic	0.905
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	4.392	95% H-UCL	4.395
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	4.738
95% Adjusted-CLT UCL (Chen-1995)	4.435	97.5% Chebyshev (MVUE) UCL	5.003
95% Modified-t UCL (Johnson-1978)	4.402	99% Chebyshev (MVUE) UCL	5.525

Gamma Distribution Test		Data Distribution
k star (bias corrected)	53.25	Data appear Normal at 5% Significance Level
Theta Star	0.0775	
MLE of Mean	4.125	
MLE of Standard Deviation	0.565	
nu star	1385	
Approximate Chi Square Value (.05)	1299	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 4.371
Adjusted Chi Square Value	1287	95% Jackknife UCL 4.392
		95% Standard Bootstrap UCL 4.364
Anderson-Darling Test Statistic	0.565	95% Bootstrap-t UCL 4.508
Anderson-Darling 5% Critical Value	0.732	95% Hall's Bootstrap UCL 5.813
Kolmogorov-Smirnov Test Statistic	0.225	95% Percentile Bootstrap UCL 4.375
Kolmogorov-Smirnov 5% Critical Value	0.236	95% BCA Bootstrap UCL 4.429
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 4.777
		97.5% Chebyshev(Mean, Sd) UCL 5.059
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 5.612
95% Approximate Gamma UCL (Use when n >= 40)	4.397	
95% Adjusted Gamma UCL (Use when n < 40)	4.437	

Potential UCL to Use		Use 95% Student's-t UCL	4.392

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sr_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	587	Minimum of Log Data	6.375
Maximum	763	Maximum of Log Data	6.637
Mean	666.6	Mean of log Data	6.5
Geometric Mean	664.9	SD of log Data	0.0737
Median	648		
SD	49.54		
Std. Error of Mean	13.74		
Coefficient of Variation	0.0743		
Skewness	0.41		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.958	Shapiro Wilk Test Statistic	0.963
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	691.1	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	726
95% Adjusted-CLT UCL (Chen-1995)	690.9	97.5% Chebyshev (MVUE) UCL	751.7
95% Modified-t UCL (Johnson-1978)	691.4	99% Chebyshev (MVUE) UCL	802.3

Gamma Distribution Test		Data Distribution
k star (bias corrected)	152.8	Data appear Normal at 5% Significance Level
Theta Star	4.362	
MLE of Mean	666.6	
MLE of Standard Deviation	53.92	
nu star	3974	
Approximate Chi Square Value (.05)	3828	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 689.2
Adjusted Chi Square Value	3808	95% Jackknife UCL 691.1
		95% Standard Bootstrap UCL 688.4
Anderson-Darling Test Statistic	0.345	95% Bootstrap-t UCL 694.6
Anderson-Darling 5% Critical Value	0.732	95% Hall's Bootstrap UCL 691.7
Kolmogorov-Smirnov Test Statistic	0.184	95% Percentile Bootstrap UCL 689.5
Kolmogorov-Smirnov 5% Critical Value	0.236	95% BCA Bootstrap UCL 687.8
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 726.5
		97.5% Chebyshev(Mean, Sd) UCL 752.4
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 803.3
95% Approximate Gamma UCL (Use when n >= 40)	691.9	
95% Adjusted Gamma UCL (Use when n < 40)	695.7	

Potential UCL to Use	Use 95% Student's-t UCL 691.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Tl_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	1.06	Minimum of Log Data	0.0583
Maximum	6.13	Maximum of Log Data	1.813
Mean	3.434	Mean of log Data	1.172
Geometric Mean	3.227	SD of log Data	0.399
Median	3.37		
SD	1.134		
Std. Error of Mean	0.315		
Coefficient of Variation	0.33		
Skewness	0.374		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.902	Shapiro Wilk Test Statistic	0.815
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	3.995	95% H-UCL	4.402
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	5.177
95% Adjusted-CLT UCL (Chen-1995)	3.986	97.5% Chebyshev (MVUE) UCL	5.915
95% Modified-t UCL (Johnson-1978)	4	99% Chebyshev (MVUE) UCL	7.364

Gamma Distribution Test		Data Distribution
k star (bias corrected)	6.377	Data appear Normal at 5% Significance Level
Theta Star	0.538	
MLE of Mean	3.434	
MLE of Standard Deviation	1.36	
nu star	165.8	
Approximate Chi Square Value (.05)	137	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 3.951
Adjusted Chi Square Value	133.3	95% Jackknife UCL 3.995
		95% Standard Bootstrap UCL 3.941
Anderson-Darling Test Statistic	0.798	95% Bootstrap-t UCL 4.022
Anderson-Darling 5% Critical Value	0.735	95% Hall's Bootstrap UCL 4.233
Kolmogorov-Smirnov Test Statistic	0.247	95% Percentile Bootstrap UCL 3.941
Kolmogorov-Smirnov 5% Critical Value	0.237	95% BCA Bootstrap UCL 3.951
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 4.805
		97.5% Chebyshev(Mean, Sd) UCL 5.399
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 6.564
95% Approximate Gamma UCL (Use when n >= 40)	4.155	
95% Adjusted Gamma UCL (Use when n < 40)	4.271	

Potential UCL to Use		Use 95% Student's-t UCL	3.995

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	5.2	Minimum of Log Data	1.649
Maximum	9.58	Maximum of Log Data	2.26
Mean	7.663	Mean of log Data	2.018
Geometric Mean	7.522	SD of log Data	0.203
Median	7.3		
SD	1.507		
Std. Error of Mean	0.418		
Coefficient of Variation	0.197		
Skewness	-0.114		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.897	Shapiro Wilk Test Statistic	0.901
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	8.408	95% H-UCL	8.549
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	9.557
95% Adjusted-CLT UCL (Chen-1995)	8.336	97.5% Chebyshev (MVUE) UCL	10.38
95% Modified-t UCL (Johnson-1978)	8.406	99% Chebyshev (MVUE) UCL	11.98

Gamma Distribution Test		Data Distribution
k star (bias corrected)	20.83	Data appear Normal at 5% Significance Level
Theta Star	0.368	
MLE of Mean	7.663	
MLE of Standard Deviation	1.679	
nu star	541.5	
Approximate Chi Square Value (.05)	488.5	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 8.351
Adjusted Chi Square Value	481.4	95% Jackknife UCL 8.408
		95% Standard Bootstrap UCL 8.327
Anderson-Darling Test Statistic	0.629	95% Bootstrap-t UCL 8.349
Anderson-Darling 5% Critical Value	0.733	95% Hall's Bootstrap UCL 8.304
Kolmogorov-Smirnov Test Statistic	0.208	95% Percentile Bootstrap UCL 8.305
Kolmogorov-Smirnov 5% Critical Value	0.236	95% BCA Bootstrap UCL 8.322
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 9.485
		97.5% Chebyshev(Mean, Sd) UCL 10.27
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 11.82
95% Approximate Gamma UCL (Use when n >= 40)	8.494	
95% Adjusted Gamma UCL (Use when n < 40)	8.62	

Potential UCL to Use		Use 95% Student's-t UCL	8.408

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

V_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	179	Minimum of Log Data	5.187
Maximum	317	Maximum of Log Data	5.759
Mean	248	Mean of log Data	5.496
Geometric Mean	243.8	SD of log Data	0.194
Median	229		
SD	47.43		
Std. Error of Mean	13.16		
Coefficient of Variation	0.191		
Skewness	0.081		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.913	Shapiro Wilk Test Statistic	0.918
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	271.4	95% H-UCL	275.1
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	306.4
95% Adjusted-CLT UCL (Chen-1995)	270	97.5% Chebyshev (MVUE) UCL	331.7
95% Modified-t UCL (Johnson-1978)	271.5	99% Chebyshev (MVUE) UCL	381.3

Gamma Distribution Test		Data Distribution
k star (bias corrected)	22.56	Data appear Normal at 5% Significance Level
Theta Star	10.99	
MLE of Mean	248	
MLE of Standard Deviation	52.22	
nu star	586.5	
Approximate Chi Square Value (.05)	531.3	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 269.6
Adjusted Chi Square Value	523.8	95% Jackknife UCL 271.4
		95% Standard Bootstrap UCL 268.7
Anderson-Darling Test Statistic	0.536	95% Bootstrap-t UCL 271.9
Anderson-Darling 5% Critical Value	0.733	95% Hall's Bootstrap UCL 267.5
Kolmogorov-Smirnov Test Statistic	0.18	95% Percentile Bootstrap UCL 269.5
Kolmogorov-Smirnov 5% Critical Value	0.236	95% BCA Bootstrap UCL 269.5
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 305.3
		97.5% Chebyshev(Mean, Sd) UCL 330.2
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 378.9
95% Approximate Gamma UCL (Use when n >= 40)	273.8	
95% Adjusted Gamma UCL (Use when n < 40)	277.7	

Potential UCL to Use		Use 95% Student's-t UCL	271.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Zn_ppm

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	62.7	Minimum of Log Data	4.138
Maximum	141	Maximum of Log Data	4.949
Mean	111	Mean of log Data	4.689
Geometric Mean	108.8	SD of log Data	0.219
Median	111		
SD	21.89		
Std. Error of Mean	6.072		
Coefficient of Variation	0.197		
Skewness	-0.636		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.928	Shapiro Wilk Test Statistic	0.878
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	121.9	95% H-UCL	125.2
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	140.8
95% Adjusted-CLT UCL (Chen-1995)	119.9	97.5% Chebyshev (MVUE) UCL	153.6
95% Modified-t UCL (Johnson-1978)	121.7	99% Chebyshev (MVUE) UCL	178.7

Gamma Distribution Test		Data Distribution
k star (bias corrected)	18.98	Data appear Normal at 5% Significance Level
Theta Star	5.852	
MLE of Mean	111	
MLE of Standard Deviation	25.49	
nu star	493.4	
Approximate Chi Square Value (.05)	442.9	**Nonparametric Statistics**
Adjusted Level of Significance	0.0301	95% CLT UCL 121
Adjusted Chi Square Value	436	95% Jackknife UCL 121.9
		95% Standard Bootstrap UCL 120.3
Anderson-Darling Test Statistic	0.506	95% Bootstrap-t UCL 120.6
Anderson-Darling 5% Critical Value	0.733	95% Hall's Bootstrap UCL 120
Kolmogorov-Smirnov Test Statistic	0.172	95% Percentile Bootstrap UCL 120.2
Kolmogorov-Smirnov 5% Critical Value	0.236	95% BCA Bootstrap UCL 119.9
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 137.5
		97.5% Chebyshev(Mean, Sd) UCL 149
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 171.5
95% Approximate Gamma UCL (Use when n >= 40)	123.7	
95% Adjusted Gamma UCL (Use when n < 40)	125.6	

Potential UCL to Use	Use 95% Student's-t UCL 121.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

General UCL Statistics for Full Data Sets

User Selected Options

From File	ProUCLinputWyoming.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

As_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	11

Raw Statistics		Log-transformed Statistics	
Minimum	14.6	Minimum of Log Data	2.681
Maximum	22	Maximum of Log Data	3.091
Mean	19.41	Mean of log Data	2.961
Geometric Mean	19.32	SD of log Data	0.103
Median	20		
SD	1.853		
Std. Error of Mean	0.479		
Coefficient of Variation	0.0955		
Skewness	-1.481		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.861	Shapiro Wilk Test Statistic	0.821
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	20.25	95% H-UCL	20.38
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	21.66
95% Adjusted-CLT UCL (Chen-1995)	20	97.5% Chebyshev (MVUE) UCL	22.64
95% Modified-t UCL (Johnson-1978)	20.22	99% Chebyshev (MVUE) UCL	24.55

Gamma Distribution Test		Data Distribution
k star (bias corrected)	85.26	Data do not follow a Discernable Distribution (0.05)
Theta Star	0.228	
MLE of Mean	19.41	
MLE of Standard Deviation	2.102	
nu star	2558	
Approximate Chi Square Value (.05)	2441	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 20.19
Adjusted Chi Square Value	2427	95% Jackknife UCL 20.25
		95% Standard Bootstrap UCL 20.15
Anderson-Darling Test Statistic	1.009	95% Bootstrap-t UCL 20.08
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 20.03
Kolmogorov-Smirnov Test Statistic	0.226	95% Percentile Bootstrap UCL 20.11
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 20.01
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 21.49
		97.5% Chebyshev(Mean, Sd) UCL 22.4
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 24.17
95% Approximate Gamma UCL (Use when n >= 40)	20.33	
95% Adjusted Gamma UCL (Use when n < 40)	20.45	

Potential UCL to Use	
Use 95% Student's-t UCL	20.25
or 95% Modified-t UCL	20.22

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Ba_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	9

Raw Statistics		Log-transformed Statistics	
Minimum	2980	Minimum of Log Data	8
Maximum	3370	Maximum of Log Data	8.123
Mean	3174	Mean of log Data	8.062
Geometric Mean	3173	SD of log Data	0.0265
Median	3170		
SD	84.07		
Std. Error of Mean	21.71		
Coefficient of Variation	0.0265		
Skewness	0.102		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.891	Shapiro Wilk Test Statistic	0.891
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	3212	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	3269
95% Adjusted-CLT UCL (Chen-1995)	3210	97.5% Chebyshev (MVUE) UCL	3310
95% Modified-t UCL (Johnson-1978)	3212	99% Chebyshev (MVUE) UCL	3390

Gamma Distribution Test		Data Distribution
k star (bias corrected)	1222	Data appear Normal at 5% Significance Level
Theta Star	2.598	
MLE of Mean	3174	
MLE of Standard Deviation	90.8	
nu star	36656	
Approximate Chi Square Value (.05)	36212	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 3210
Adjusted Chi Square Value	36157	95% Jackknife UCL 3212
		95% Standard Bootstrap UCL 3209
Anderson-Darling Test Statistic	0.856	95% Bootstrap-t UCL 3214
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 3227
Kolmogorov-Smirnov Test Statistic	0.267	95% Percentile Bootstrap UCL 3208
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 3206
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 3269
		97.5% Chebyshev(Mean, Sd) UCL 3310
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 3390
95% Approximate Gamma UCL (Use when n >= 40)	3213	
95% Adjusted Gamma UCL (Use when n < 40)	3218	

Potential UCL to Use	Use 95% Student's-t UCL 3212

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Be_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	11

Raw Statistics		Log-transformed Statistics	
Minimum	2.07	Minimum of Log Data	0.728
Maximum	3.1	Maximum of Log Data	1.131
Mean	2.706	Mean of log Data	0.992
Geometric Mean	2.695	SD of log Data	0.0941
Median	2.74		
SD	0.239		
Std. Error of Mean	0.0618		
Coefficient of Variation	0.0884		
Skewness	-1.274		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.881	Shapiro Wilk Test Statistic	0.845
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	2.815	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2.994
95% Adjusted-CLT UCL (Chen-1995)	2.786	97.5% Chebyshev (MVUE) UCL	3.118
95% Modified-t UCL (Johnson-1978)	2.811	99% Chebyshev (MVUE) UCL	3.362

Gamma Distribution Test		Data Distribution
k star (bias corrected)	101.2	Data appear Normal at 5% Significance Level
Theta Star	0.0268	
MLE of Mean	2.706	
MLE of Standard Deviation	0.269	
nu star	3035	
Approximate Chi Square Value (.05)	2908	
Adjusted Level of Significance	0.0324	
Adjusted Chi Square Value	2892	
Anderson-Darling Test Statistic	0.908	
Anderson-Darling 5% Critical Value	0.734	
Kolmogorov-Smirnov Test Statistic	0.285	
Kolmogorov-Smirnov 5% Critical Value	0.221	
Data not Gamma Distributed at 5% Significance Level		

Nonparametric Statistics	
95% CLT UCL	2.808
95% Jackknife UCL	2.815
95% Standard Bootstrap UCL	2.805
95% Bootstrap-t UCL	2.802
95% Hall's Bootstrap UCL	2.797
95% Percentile Bootstrap UCL	2.797
95% BCA Bootstrap UCL	2.787
95% Chebyshev(Mean, Sd) UCL	2.975
97.5% Chebyshev(Mean, Sd) UCL	3.092
99% Chebyshev(Mean, Sd) UCL	3.321

Assuming Gamma Distribution	
95% Approximate Gamma UCL (Use when n >= 40)	2.824
95% Adjusted Gamma UCL (Use when n < 40)	2.839

Potential UCL to Use	Use 95% Student's-t UCL 2.815

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Cd_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	0.699	Minimum of Log Data	-0.358
Maximum	0.895	Maximum of Log Data	-0.111
Mean	0.804	Mean of log Data	-0.221
Geometric Mean	0.802	SD of log Data	0.0765
Median	0.814		
SD	0.0613		
Std. Error of Mean	0.0158		
Coefficient of Variation	0.0763		
Skewness	0.0412		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.952	Shapiro Wilk Test Statistic	0.954
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	0.832	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.873
95% Adjusted-CLT UCL (Chen-1995)	0.83	97.5% Chebyshev (MVUE) UCL	0.903
95% Modified-t UCL (Johnson-1978)	0.832	99% Chebyshev (MVUE) UCL	0.962

Gamma Distribution Test		Data Distribution
k star (bias corrected)	147	Data appear Normal at 5% Significance Level
Theta Star	0.00547	
MLE of Mean	0.804	
MLE of Standard Deviation	0.0663	
nu star	4409	
Approximate Chi Square Value (.05)	4256	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 0.83
Adjusted Chi Square Value	4237	95% Jackknife UCL 0.832
		95% Standard Bootstrap UCL 0.829
Anderson-Darling Test Statistic	0.293	95% Bootstrap-t UCL 0.832
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 0.831
Kolmogorov-Smirnov Test Statistic	0.138	95% Percentile Bootstrap UCL 0.83
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 0.827
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 0.873
		97.5% Chebyshev(Mean, Sd) UCL 0.903
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 0.962
95% Approximate Gamma UCL (Use when n >= 40)	0.833	
95% Adjusted Gamma UCL (Use when n < 40)	0.837	

Potential UCL to Use	Use 95% Student's-t UCL 0.832

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Co_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	13

Raw Statistics		**Log-transformed Statistics**	
Minimum	31.4	Minimum of Log Data	3.447
Maximum	43.5	Maximum of Log Data	3.773
Mean	38.72	Mean of log Data	3.653
Geometric Mean	38.59	SD of log Data	0.0845
Median	39.4		
SD	3.18		
Std. Error of Mean	0.821		
Coefficient of Variation	0.0821		
Skewness	-0.59		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.952	Shapiro Wilk Test Statistic	0.935
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	40.17	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	42.41
95% Adjusted-CLT UCL (Chen-1995)	39.94	97.5% Chebyshev (MVUE) UCL	44.01
95% Modified-t UCL (Johnson-1978)	40.15	99% Chebyshev (MVUE) UCL	47.14

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	122.6	Data appear Normal at 5% Significance Level
Theta Star	0.316	
MLE of Mean	38.72	
MLE of Standard Deviation	3.497	
nu star	3677	
Approximate Chi Square Value (.05)	3537	
Adjusted Level of Significance	0.0324	
Adjusted Chi Square Value	3520	
Anderson-Darling Test Statistic	0.346	
Anderson-Darling 5% Critical Value	0.734	
Kolmogorov-Smirnov Test Statistic	0.152	
Kolmogorov-Smirnov 5% Critical Value	0.221	
Data appear Gamma Distributed at 5% Significance Level		

Nonparametric Statistics	
95% CLT UCL	40.07
95% Jackknife UCL	40.17
95% Standard Bootstrap UCL	40.01
95% Bootstrap-t UCL	40.09
95% Hall's Bootstrap UCL	39.97
95% Percentile Bootstrap UCL	40.04
95% BCA Bootstrap UCL	39.95
95% Chebyshev(Mean, Sd) UCL	42.3
97.5% Chebyshev(Mean, Sd) UCL	43.85
99% Chebyshev(Mean, Sd) UCL	46.89

Assuming Gamma Distribution	
95% Approximate Gamma UCL (Use when n >= 40)	40.25
95% Adjusted Gamma UCL (Use when n < 40)	40.44

Potential UCL to Use	Use 95% Student's-t UCL 40.17

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Cr_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	54.1	Minimum of Log Data	3.991
Maximum	102	Maximum of Log Data	4.625
Mean	83.64	Mean of log Data	4.418
Geometric Mean	82.93	SD of log Data	0.141
Median	82.4		
SD	10.6		
Std. Error of Mean	2.737		
Coefficient of Variation	0.127		
Skewness	-1.231		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.881	Shapiro Wilk Test Statistic	0.81
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	88.46	95% H-UCL	89.53
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	96.99
95% Adjusted-CLT UCL (Chen-1995)	87.21	97.5% Chebyshev (MVUE) UCL	102.7
95% Modified-t UCL (Johnson-1978)	88.32	99% Chebyshev (MVUE) UCL	114

Gamma Distribution Test		Data Distribution
k star (bias corrected)	46.81	Data do not follow a Discernable Distribution (0.05)
Theta Star	1.787	
MLE of Mean	83.64	
MLE of Standard Deviation	12.22	
nu star	1404	
Approximate Chi Square Value (.05)	1318	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 88.14
Adjusted Chi Square Value	1308	95% Jackknife UCL 88.46
		95% Standard Bootstrap UCL 88.07
Anderson-Darling Test Statistic	0.849	95% Bootstrap-t UCL 87.52
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 87.77
Kolmogorov-Smirnov Test Statistic	0.23	95% Percentile Bootstrap UCL 87.61
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 87.15
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 95.57
		97.5% Chebyshev(Mean, Sd) UCL 100.7
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 110.9
95% Approximate Gamma UCL (Use when n >= 40)	89.1	
95% Adjusted Gamma UCL (Use when n < 40)	89.8	

Potential UCL to Use	Use 95% Student's-t UCL 88.46
	or 95% Modified-t UCL 88.32

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Cu_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	14

Raw Statistics		**Log-transformed Statistics**	
Minimum	118	Minimum of Log Data	4.771
Maximum	171	Maximum of Log Data	5.142
Mean	148.9	Mean of log Data	4.999
Geometric Mean	148.2	SD of log Data	0.0969
Median	144		
SD	14.11		
Std. Error of Mean	3.642		
Coefficient of Variation	0.0948		
Skewness	-0.309		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.941	Shapiro Wilk Test Statistic	0.928
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	155.3	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	165.1
95% Adjusted-CLT UCL (Chen-1995)	154.5	97.5% Chebyshev (MVUE) UCL	172.2
95% Modified-t UCL (Johnson-1978)	155.2	99% Chebyshev (MVUE) UCL	186

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	92.92	Data appear Normal at 5% Significance Level
Theta Star	1.602	
MLE of Mean	148.9	
MLE of Standard Deviation	15.44	
nu star	2788	
Approximate Chi Square Value (.05)	2666	
Adjusted Level of Significance	0.0324	
Adjusted Chi Square Value	2651	
Anderson-Darling Test Statistic	0.459	
Anderson-Darling 5% Critical Value	0.734	
Kolmogorov-Smirnov Test Statistic	0.161	
Kolmogorov-Smirnov 5% Critical Value	0.221	
Data appear Gamma Distributed at 5% Significance Level		

Nonparametric Statistics	
95% CLT UCL	154.9
95% Jackknife UCL	155.3
95% Standard Bootstrap UCL	154.8
95% Bootstrap-t UCL	155.3
95% Hall's Bootstrap UCL	154.8
95% Percentile Bootstrap UCL	154.6
95% BCA Bootstrap UCL	154.4
95% Chebyshev(Mean, Sd) UCL	164.7
97.5% Chebyshev(Mean, Sd) UCL	171.6
99% Chebyshev(Mean, Sd) UCL	185.1

Assuming Gamma Distribution	
95% Approximate Gamma UCL (Use when n >= 40)	155.7
95% Adjusted Gamma UCL (Use when n < 40)	156.5

Potential UCL to Use	Use 95% Student's-t UCL 155.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Hg_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	14

Raw Statistics		Log-transformed Statistics	
Minimum	0.0212	Minimum of Log Data	-3.854
Maximum	0.971	Maximum of Log Data	-0.0294
Mean	0.604	Mean of log Data	-0.931
Geometric Mean	0.394	SD of log Data	1.259
Median	0.695		
SD	0.35		
Std. Error of Mean	0.0903		
Coefficient of Variation	0.579		
Skewness	-0.808		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.828	Shapiro Wilk Test Statistic	0.716
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	0.763	95% H-UCL	2.541
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2.076
95% Adjusted-CLT UCL (Chen-1995)	0.732	97.5% Chebyshev (MVUE) UCL	2.627
95% Modified-t UCL (Johnson-1978)	0.76	99% Chebyshev (MVUE) UCL	3.71

Gamma Distribution Test		Data Distribution
k star (bias corrected)	1.096	Data do not follow a Discernable Distribution (0.05)
Theta Star	0.551	
MLE of Mean	0.604	
MLE of Standard Deviation	0.577	
nu star	32.89	
Approximate Chi Square Value (.05)	20.78	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 0.753
Adjusted Chi Square Value	19.6	95% Jackknife UCL 0.763
		95% Standard Bootstrap UCL 0.748
Anderson-Darling Test Statistic	1.757	95% Bootstrap-t UCL 0.753
Anderson-Darling 5% Critical Value	0.757	95% Hall's Bootstrap UCL 0.728
Kolmogorov-Smirnov Test Statistic	0.337	95% Percentile Bootstrap UCL 0.74
Kolmogorov-Smirnov 5% Critical Value	0.226	95% BCA Bootstrap UCL 0.729
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 0.998
		97.5% Chebyshev(Mean, Sd) UCL 1.168
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 1.503
95% Approximate Gamma UCL (Use when n >= 40)	0.956	
95% Adjusted Gamma UCL (Use when n < 40)	1.014	

Potential UCL to Use	Use 95% Chebyshev (Mean, Sd) UCL 0.998

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Li_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	21.8	Minimum of Log Data	3.082
Maximum	32.9	Maximum of Log Data	3.493
Mean	29.17	Mean of log Data	3.369
Geometric Mean	29.05	SD of log Data	0.0983
Median	29		
SD	2.679		
Std. Error of Mean	0.692		
Coefficient of Variation	0.0918		
Skewness	-1.291		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.895	Shapiro Wilk Test Statistic	0.85
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	30.39	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	32.41
95% Adjusted-CLT UCL (Chen-1995)	30.06	97.5% Chebyshev (MVUE) UCL	33.81
95% Modified-t UCL (Johnson-1978)	30.35	99% Chebyshev (MVUE) UCL	36.56

Gamma Distribution Test		Data Distribution
k star (bias corrected)	93.2	Data appear Normal at 5% Significance Level
Theta Star	0.313	
MLE of Mean	29.17	
MLE of Standard Deviation	3.022	
nu star	2796	
Approximate Chi Square Value (.05)	2674	
Adjusted Level of Significance	0.0324	
Adjusted Chi Square Value	2659	
Anderson-Darling Test Statistic	0.595	
Anderson-Darling 5% Critical Value	0.734	
Kolmogorov-Smirnov Test Statistic	0.17	
Kolmogorov-Smirnov 5% Critical Value	0.221	
Data appear Gamma Distributed at 5% Significance Level		

Nonparametric Statistics	
95% CLT UCL	30.31
95% Jackknife UCL	30.39
95% Standard Bootstrap UCL	30.3
95% Bootstrap-t UCL	30.18
95% Hall's Bootstrap UCL	30.22
95% Percentile Bootstrap UCL	30.25
95% BCA Bootstrap UCL	30.03
95% Chebyshev(Mean, Sd) UCL	32.19
97.5% Chebyshev(Mean, Sd) UCL	33.49
99% Chebyshev(Mean, Sd) UCL	36.06

Assuming Gamma Distribution	
95% Approximate Gamma UCL (Use when n >= 40)	30.5
95% Adjusted Gamma UCL (Use when n < 40)	30.67

Potential UCL to Use	Use 95% Student's-t UCL 30.39

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Mn_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15

Raw Statistics		**Log-transformed Statistics**	
Minimum	145	Minimum of Log Data	4.977
Maximum	283	Maximum of Log Data	5.645
Mean	214.9	Mean of log Data	5.35
Geometric Mean	210.5	SD of log Data	0.213
Median	229		
SD	43.17		
Std. Error of Mean	11.15		
Coefficient of Variation	0.201		
Skewness	-0.357		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.923	Shapiro Wilk Test Statistic	0.901
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	234.5	95% H-UCL	238.9
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	266.9
95% Adjusted-CLT UCL (Chen-1995)	232.1	97.5% Chebyshev (MVUE) UCL	289.3
95% Modified-t UCL (Johnson-1978)	234.3	99% Chebyshev (MVUE) UCL	333.4

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	19.83	Data appear Normal at 5% Significance Level
Theta Star	10.84	
MLE of Mean	214.9	
MLE of Standard Deviation	48.25	
nu star	594.9	
Approximate Chi Square Value (.05)	539.3	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 233.2
Adjusted Chi Square Value	532.8	95% Jackknife UCL 234.5
		95% Standard Bootstrap UCL 232.8
Anderson-Darling Test Statistic	0.658	95% Bootstrap-t UCL 232.6
Anderson-Darling 5% Critical Value	0.735	95% Hall's Bootstrap UCL 232
Kolmogorov-Smirnov Test Statistic	0.187	95% Percentile Bootstrap UCL 232.3
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 231.6
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 263.5
		97.5% Chebyshev(Mean, Sd) UCL 284.5
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 325.8
95% Approximate Gamma UCL (Use when n >= 40)	237	
95% Adjusted Gamma UCL (Use when n < 40)	239.9	

Potential UCL to Use		Use 95% Student's-t UCL	234.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Mo_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	14

Raw Statistics		Log-transformed Statistics	
Minimum	4.95	Minimum of Log Data	1.599
Maximum	6.09	Maximum of Log Data	1.807
Mean	5.689	Mean of log Data	1.737
Geometric Mean	5.682	SD of log Data	0.053
Median	5.78		
SD	0.293		
Std. Error of Mean	0.0755		
Coefficient of Variation	0.0514		
Skewness	-1.227		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.91	Shapiro Wilk Test Statistic	0.892
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	5.822	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	6.029
95% Adjusted-CLT UCL (Chen-1995)	5.788	97.5% Chebyshev (MVUE) UCL	6.176
95% Modified-t UCL (Johnson-1978)	5.818	99% Chebyshev (MVUE) UCL	6.465

Gamma Distribution Test		Data Distribution
k star (bias corrected)	311.3	Data appear Normal at 5% Significance Level
Theta Star	0.0183	
MLE of Mean	5.689	
MLE of Standard Deviation	0.322	
nu star	9340	
Approximate Chi Square Value (.05)	9116	
Adjusted Level of Significance	0.0324	
Adjusted Chi Square Value	9089	
Anderson-Darling Test Statistic	0.586	
Anderson-Darling 5% Critical Value	0.734	
Kolmogorov-Smirnov Test Statistic	0.163	
Kolmogorov-Smirnov 5% Critical Value	0.221	
Data appear Gamma Distributed at 5% Significance Level		

Nonparametric Statistics	
95% CLT UCL	5.814
95% Jackknife UCL	5.822
95% Standard Bootstrap UCL	5.809
95% Bootstrap-t UCL	5.8
95% Hall's Bootstrap UCL	5.793
95% Percentile Bootstrap UCL	5.801
95% BCA Bootstrap UCL	5.795
95% Chebyshev(Mean, Sd) UCL	6.019
97.5% Chebyshev(Mean, Sd) UCL	6.161
99% Chebyshev(Mean, Sd) UCL	6.441

Assuming Gamma Distribution	
95% Approximate Gamma UCL (Use when n >= 40)	5.829
95% Adjusted Gamma UCL (Use when n < 40)	5.846

Potential UCL to Use	Use 95% Student's-t UCL 5.822

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Ni_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	14

Raw Statistics		Log-transformed Statistics	
Minimum	106	Minimum of Log Data	4.663
Maximum	180	Maximum of Log Data	5.193
Mean	157.6	Mean of log Data	5.054
Geometric Mean	156.6	SD of log Data	0.122
Median	158		
SD	17.04		
Std. Error of Mean	4.399		
Coefficient of Variation	0.108		
Skewness	-2.014		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.811	Shapiro Wilk Test Statistic	0.74
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	165.3	95% H-UCL	167.1
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	179.4
95% Adjusted-CLT UCL (Chen-1995)	162.4	97.5% Chebyshev (MVUE) UCL	188.8
95% Modified-t UCL (Johnson-1978)	165	99% Chebyshev (MVUE) UCL	207.3

Gamma Distribution Test		Data Distribution
k star (bias corrected)	62.59	Data do not follow a Discernable Distribution (0.05)
Theta Star	2.518	
MLE of Mean	157.6	
MLE of Standard Deviation	19.92	
nu star	1878	
Approximate Chi Square Value (.05)	1778	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 164.8
Adjusted Chi Square Value	1766	95% Jackknife UCL 165.3
		95% Standard Bootstrap UCL 164.6
Anderson-Darling Test Statistic	1.102	95% Bootstrap-t UCL 163.5
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 163.3
Kolmogorov-Smirnov Test Statistic	0.238	95% Percentile Bootstrap UCL 164.1
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 162.9
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 176.8
		97.5% Chebyshev(Mean, Sd) UCL 185.1
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 201.4
95% Approximate Gamma UCL (Use when n >= 40)	166.4	
95% Adjusted Gamma UCL (Use when n < 40)	167.6	

Potential UCL to Use	
Use 95% Student's-t UCL	165.3
or 95% Modified-t UCL	165

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Pb_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	25	Minimum of Log Data	3.219
Maximum	33.1	Maximum of Log Data	3.5
Mean	28.37	Mean of log Data	3.343
Geometric Mean	28.31	SD of log Data	0.0704
Median	28.2		
SD	2.025		
Std. Error of Mean	0.523		
Coefficient of Variation	0.0714		
Skewness	0.639		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.971	Shapiro Wilk Test Statistic	0.982
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	29.29	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	30.62
95% Adjusted-CLT UCL (Chen-1995)	29.33	97.5% Chebyshev (MVUE) UCL	31.6
95% Modified-t UCL (Johnson-1978)	29.31	99% Chebyshev (MVUE) UCL	33.51

Gamma Distribution Test		Data Distribution
k star (bias corrected)	171.7	Data appear Normal at 5% Significance Level
Theta Star	0.165	
MLE of Mean	28.37	
MLE of Standard Deviation	2.165	
nu star	5151	
Approximate Chi Square Value (.05)	4986	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 29.23
Adjusted Chi Square Value	4965	95% Jackknife UCL 29.29
		95% Standard Bootstrap UCL 29.18
Anderson-Darling Test Statistic	0.173	95% Bootstrap-t UCL 29.44
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 29.52
Kolmogorov-Smirnov Test Statistic	0.0941	95% Percentile Bootstrap UCL 29.22
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 29.31
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 30.65
		97.5% Chebyshev(Mean, Sd) UCL 31.64
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 33.58
95% Approximate Gamma UCL (Use when n >= 40)	29.32	
95% Adjusted Gamma UCL (Use when n < 40)	29.44	

Potential UCL to Use	Use 95% Student's-t UCL 29.29

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sb_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	1.65	Minimum of Log Data	0.501
Maximum	2.11	Maximum of Log Data	0.747
Mean	1.917	Mean of log Data	0.648
Geometric Mean	1.911	SD of log Data	0.0819
Median	1.91		
SD	0.153		
Std. Error of Mean	0.0394		
Coefficient of Variation	0.0797		
Skewness	-0.661		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.898	Shapiro Wilk Test Statistic	0.884
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	1.986	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2.094
95% Adjusted-CLT UCL (Chen-1995)	1.974	97.5% Chebyshev (MVUE) UCL	2.17
95% Modified-t UCL (Johnson-1978)	1.985	99% Chebyshev (MVUE) UCL	2.321

Gamma Distribution Test		Data Distribution
k star (bias corrected)	130.3	Data appear Normal at 5% Significance Level
Theta Star	0.0147	
MLE of Mean	1.917	
MLE of Standard Deviation	0.168	
nu star	3909	
Approximate Chi Square Value (.05)	3764	
Adjusted Level of Significance	0.0324	
Adjusted Chi Square Value	3747	
Anderson-Darling Test Statistic	0.657	
Anderson-Darling 5% Critical Value	0.734	
Kolmogorov-Smirnov Test Statistic	0.173	
Kolmogorov-Smirnov 5% Critical Value	0.221	
Data appear Gamma Distributed at 5% Significance Level		

Nonparametric Statistics	
95% CLT UCL	1.982
95% Jackknife UCL	1.986
95% Standard Bootstrap UCL	1.98
95% Bootstrap-t UCL	1.979
95% Hall's Bootstrap UCL	1.976
95% Percentile Bootstrap UCL	1.977
95% BCA Bootstrap UCL	1.977
95% Chebyshev(Mean, Sd) UCL	2.089
97.5% Chebyshev(Mean, Sd) UCL	2.163
99% Chebyshev(Mean, Sd) UCL	2.309

Assuming Gamma Distribution	
95% Approximate Gamma UCL (Use when n >= 40)	1.99
95% Adjusted Gamma UCL (Use when n < 40)	1.999

Potential UCL to Use	Use 95% Student's-t UCL 1.986

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Se_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	14

Raw Statistics		**Log-transformed Statistics**	
Minimum	11.2	Minimum of Log Data	2.416
Maximum	13.5	Maximum of Log Data	2.603
Mean	12.35	Mean of log Data	2.513
Geometric Mean	12.34	SD of log Data	0.0553
Median	12.3		
SD	0.68		
Std. Error of Mean	0.176		
Coefficient of Variation	0.0551		
Skewness	-0.0735		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.975	Shapiro Wilk Test Statistic	0.973
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	12.66	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	13.12
95% Adjusted-CLT UCL (Chen-1995)	12.64	97.5% Chebyshev (MVUE) UCL	13.46
95% Modified-t UCL (Johnson-1978)	12.66	99% Chebyshev (MVUE) UCL	14.11

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	281.4	Data appear Normal at 5% Significance Level
Theta Star	0.0439	
MLE of Mean	12.35	
MLE of Standard Deviation	0.736	
nu star	8442	
Approximate Chi Square Value (.05)	8229	
Adjusted Level of Significance	0.0324	
Adjusted Chi Square Value	8203	
Anderson-Darling Test Statistic	0.176	
Anderson-Darling 5% Critical Value	0.734	
Kolmogorov-Smirnov Test Statistic	0.105	
Kolmogorov-Smirnov 5% Critical Value	0.221	
Data appear Gamma Distributed at 5% Significance Level		

Nonparametric Statistics	
95% CLT UCL	12.64
95% Jackknife UCL	12.66
95% Standard Bootstrap UCL	12.64
95% Bootstrap-t UCL	12.67
95% Hall's Bootstrap UCL	12.65
95% Percentile Bootstrap UCL	12.63
95% BCA Bootstrap UCL	12.63
95% Chebyshev(Mean, Sd) UCL	13.12
97.5% Chebyshev(Mean, Sd) UCL	13.45
99% Chebyshev(Mean, Sd) UCL	14.1

Assuming Gamma Distribution	
95% Approximate Gamma UCL (Use when n >= 40)	12.67
95% Adjusted Gamma UCL (Use when n < 40)	12.71

Potential UCL to Use	Use 95% Student's-t UCL 12.66

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Sr_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	11

Raw Statistics		Log-transformed Statistics	
Minimum	2180	Minimum of Log Data	7.687
Maximum	2400	Maximum of Log Data	7.783
Mean	2293	Mean of log Data	7.737
Geometric Mean	2292	SD of log Data	0.0254
Median	2290		
SD	58.12		
Std. Error of Mean	15.01		
Coefficient of Variation	0.0254		
Skewness	-0.00362		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.976	Shapiro Wilk Test Statistic	0.976
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	2319	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2358
95% Adjusted-CLT UCL (Chen-1995)	2317	97.5% Chebyshev (MVUE) UCL	2386
95% Modified-t UCL (Johnson-1978)	2319	99% Chebyshev (MVUE) UCL	2442

Gamma Distribution Test		Data Distribution
k star (bias corrected)	1333	Data appear Normal at 5% Significance Level
Theta Star	1.72	
MLE of Mean	2293	
MLE of Standard Deviation	62.8	
nu star	39983	
Approximate Chi Square Value (.05)	39519	
Adjusted Level of Significance	0.0324	
Adjusted Chi Square Value	39462	
Anderson-Darling Test Statistic	0.23	
Anderson-Darling 5% Critical Value	0.734	
Kolmogorov-Smirnov Test Statistic	0.145	
Kolmogorov-Smirnov 5% Critical Value	0.221	
Data appear Gamma Distributed at 5% Significance Level		

Nonparametric Statistics	
95% CLT UCL	2317
95% Jackknife UCL	2319
95% Standard Bootstrap UCL	2316
95% Bootstrap-t UCL	2319
95% Hall's Bootstrap UCL	2319
95% Percentile Bootstrap UCL	2317
95% BCA Bootstrap UCL	2316
95% Chebyshev(Mean, Sd) UCL	2358
97.5% Chebyshev(Mean, Sd) UCL	2386
99% Chebyshev(Mean, Sd) UCL	2442

Assuming Gamma Distribution	
95% Approximate Gamma UCL (Use when n >= 40)	2320
95% Adjusted Gamma UCL (Use when n < 40)	2323

Potential UCL to Use	Use 95% Student's-t UCL 2319

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Tl_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	14

Raw Statistics		Log-transformed Statistics	
Minimum	0.472	Minimum of Log Data	-0.751
Maximum	0.747	Maximum of Log Data	-0.292
Mean	0.594	Mean of log Data	-0.527
Geometric Mean	0.59	SD of log Data	0.113
Median	0.593		
SD	0.0678		
Std. Error of Mean	0.0175		
Coefficient of Variation	0.114		
Skewness	0.5		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.951	Shapiro Wilk Test Statistic	0.962
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	0.624	95% H-UCL	0.626
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.669
95% Adjusted-CLT UCL (Chen-1995)	0.625	97.5% Chebyshev (MVUE) UCL	0.702
95% Modified-t UCL (Johnson-1978)	0.625	99% Chebyshev (MVUE) UCL	0.767

Gamma Distribution Test		Data Distribution
k star (bias corrected)	66.79	Data appear Normal at 5% Significance Level
Theta Star	0.00889	
MLE of Mean	0.594	
MLE of Standard Deviation	0.0726	
nu star	2004	
Approximate Chi Square Value (.05)	1901	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 0.622
Adjusted Chi Square Value	1888	95% Jackknife UCL 0.624
		95% Standard Bootstrap UCL 0.621
Anderson-Darling Test Statistic	0.371	95% Bootstrap-t UCL 0.628
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 0.637
Kolmogorov-Smirnov Test Statistic	0.151	95% Percentile Bootstrap UCL 0.622
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 0.625
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 0.67
		97.5% Chebyshev(Mean, Sd) UCL 0.703
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 0.768
95% Approximate Gamma UCL (Use when n >= 40)	0.626	
95% Adjusted Gamma UCL (Use when n < 40)	0.63	

Potential UCL to Use	Use 95% Student's-t UCL 0.624

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	7.29	Minimum of Log Data	1.987
Maximum	11.2	Maximum of Log Data	2.416
Mean	8.748	Mean of log Data	2.162
Geometric Mean	8.686	SD of log Data	0.122
Median	8.45		
SD	1.118		
Std. Error of Mean	0.289		
Coefficient of Variation	0.128		
Skewness	1.197		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.875	Shapiro Wilk Test Statistic	0.91
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	9.257	95% H-UCL	9.266
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	9.945
95% Adjusted-CLT UCL (Chen-1995)	9.318	97.5% Chebyshev (MVUE) UCL	10.46
95% Modified-t UCL (Johnson-1978)	9.271	99% Chebyshev (MVUE) UCL	11.48

Gamma Distribution Test		Data Distribution
k star (bias corrected)	56.33	Data appear Gamma Distributed at 5% Significance Level
Theta Star	0.155	
MLE of Mean	8.748	
MLE of Standard Deviation	1.166	
nu star	1690	
Approximate Chi Square Value (.05)	1595	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 9.223
Adjusted Chi Square Value	1584	95% Jackknife UCL 9.257
		95% Standard Bootstrap UCL 9.201
Anderson-Darling Test Statistic	0.643	95% Bootstrap-t UCL 9.451
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 9.923
Kolmogorov-Smirnov Test Statistic	0.177	95% Percentile Bootstrap UCL 9.233
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 9.287
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 10.01
		97.5% Chebyshev(Mean, Sd) UCL 10.55
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 11.62
95% Approximate Gamma UCL (Use when n >= 40)	9.266	
95% Adjusted Gamma UCL (Use when n < 40)	9.332	

Potential UCL to Use	Use 95% Approximate Gamma UCL 9.266

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

V_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	218	Minimum of Log Data	5.384
Maximum	376	Maximum of Log Data	5.93
Mean	312.3	Mean of log Data	5.733
Geometric Mean	308.9	SD of log Data	0.157
Median	317		
SD	45.98		
Std. Error of Mean	11.87		
Coefficient of Variation	0.147		
Skewness	-0.65		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.945	Shapiro Wilk Test Statistic	0.916
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	333.2	95% H-UCL	337
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	367.8
95% Adjusted-CLT UCL (Chen-1995)	329.7	97.5% Chebyshev (MVUE) UCL	391.8
95% Modified-t UCL (Johnson-1978)	332.9	99% Chebyshev (MVUE) UCL	438.8

Gamma Distribution Test		Data Distribution
k star (bias corrected)	36.58	Data appear Normal at 5% Significance Level
Theta Star	8.538	
MLE of Mean	312.3	
MLE of Standard Deviation	51.64	
nu star	1097	
Approximate Chi Square Value (.05)	1022	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 331.9
Adjusted Chi Square Value	1013	95% Jackknife UCL 333.2
		95% Standard Bootstrap UCL 331.2
Anderson-Darling Test Statistic	0.451	95% Bootstrap-t UCL 331
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 330.4
Kolmogorov-Smirnov Test Statistic	0.157	95% Percentile Bootstrap UCL 331.3
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 330.1
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 364.1
		97.5% Chebyshev(Mean, Sd) UCL 386.5
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 430.5
95% Approximate Gamma UCL (Use when n >= 40)	335.5	
95% Adjusted Gamma UCL (Use when n < 40)	338.5	

Potential UCL to Use		Use 95% Student's-t UCL	333.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Zn_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	14

Raw Statistics		Log-transformed Statistics	
Minimum	87.9	Minimum of Log Data	4.476
Maximum	186	Maximum of Log Data	5.226
Mean	135.2	Mean of log Data	4.888
Geometric Mean	132.7	SD of log Data	0.202
Median	136		
SD	26.95		
Std. Error of Mean	6.959		
Coefficient of Variation	0.199		
Skewness	0.227		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.96	Shapiro Wilk Test Statistic	0.96
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	147.5	95% H-UCL	149.3
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	166.1
95% Adjusted-CLT UCL (Chen-1995)	147.1	97.5% Chebyshev (MVUE) UCL	179.5
95% Modified-t UCL (Johnson-1978)	147.5	99% Chebyshev (MVUE) UCL	205.8

Gamma Distribution Test		Data Distribution
k star (bias corrected)	21.42	Data appear Normal at 5% Significance Level
Theta Star	6.311	
MLE of Mean	135.2	
MLE of Standard Deviation	29.21	
nu star	642.6	
Approximate Chi Square Value (.05)	584.8	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 146.6
Adjusted Chi Square Value	578	95% Jackknife UCL 147.5
		95% Standard Bootstrap UCL 146.3
Anderson-Darling Test Statistic	0.34	95% Bootstrap-t UCL 148.5
Anderson-Darling 5% Critical Value	0.735	95% Hall's Bootstrap UCL 147
Kolmogorov-Smirnov Test Statistic	0.172	95% Percentile Bootstrap UCL 146.9
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 146.3
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 165.5
		97.5% Chebyshev(Mean, Sd) UCL 178.7
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 204.4
95% Approximate Gamma UCL (Use when n >= 40)	148.6	
95% Adjusted Gamma UCL (Use when n < 40)	150.3	

Potential UCL to Use	Use 95% Student's-t UCL 147.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Full Data Sets

User Selected Options

From File	ProUCLinputNewMexicoBottomAsh.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

As_ppm

General Statistics

Number of Valid Observations	18	Number of Distinct Observations	18

Raw Statistics		**Log-transformed Statistics**	
Minimum	1.24	Minimum of Log Data	0.215
Maximum	18.1	Maximum of Log Data	2.896
Mean	3.046	Mean of log Data	0.851
Geometric Mean	2.343	SD of log Data	0.583
Median	2.175		
SD	3.805		
Std. Error of Mean	0.897		
Coefficient of Variation	1.249		
Skewness	4.066		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.396	Shapiro Wilk Test Statistic	0.728
Shapiro Wilk Critical Value	0.897	Shapiro Wilk Critical Value	0.897
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	4.606	95% H-UCL	3.741
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	4.468
95% Adjusted-CLT UCL (Chen-1995)	5.44	97.5% Chebyshev (MVUE) UCL	5.213
95% Modified-t UCL (Johnson-1978)	4.749	99% Chebyshev (MVUE) UCL	6.676

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	1.75	Data do not follow a Discernable Distribution (0.05)
Theta Star	1.741	
MLE of Mean	3.046	
MLE of Standard Deviation	2.303	
nu star	62.98	
Approximate Chi Square Value (.05)	45.73	**Nonparametric Statistics**
Adjusted Level of Significance	0.0357	95% CLT UCL 4.521
Adjusted Chi Square Value	44.32	95% Jackknife UCL 4.606
		95% Standard Bootstrap UCL 4.469
Anderson-Darling Test Statistic	2.464	95% Bootstrap-t UCL 10.18
Anderson-Darling 5% Critical Value	0.752	95% Hall's Bootstrap UCL 10.82
Kolmogorov-Smirnov Test Statistic	0.314	95% Percentile Bootstrap UCL 4.776
Kolmogorov-Smirnov 5% Critical Value	0.206	95% BCA Bootstrap UCL 5.737
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 6.955
		97.5% Chebyshev(Mean, Sd) UCL 8.647
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 11.97
95% Approximate Gamma UCL (Use when n >= 40)	4.196	
95% Adjusted Gamma UCL (Use when n < 40)	4.329	

Potential UCL to Use	Use 95% Chebyshev (Mean, Sd) UCL 6.955

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Ba_ppm

General Statistics

Number of Valid Observations	18	Number of Distinct Observations	16

Raw Statistics		**Log-transformed Statistics**	
Minimum	983	Minimum of Log Data	6.891
Maximum	2000	Maximum of Log Data	7.601
Mean	1415	Mean of log Data	7.237
Geometric Mean	1390	SD of log Data	0.196
Median	1435		
SD	277.3		
Std. Error of Mean	65.35		
Coefficient of Variation	0.196		
Skewness	0.406		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.959	Shapiro Wilk Test Statistic	0.966
Shapiro Wilk Critical Value	0.897	Shapiro Wilk Critical Value	0.897
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	1529	95% H-UCL	1542
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1701
95% Adjusted-CLT UCL (Chen-1995)	1529	97.5% Chebyshev (MVUE) UCL	1825
95% Modified-t UCL (Johnson-1978)	1530	99% Chebyshev (MVUE) UCL	2068

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	23.28	Data appear Normal at 5% Significance Level
Theta Star	60.78	
MLE of Mean	1415	
MLE of Standard Deviation	293.3	
nu star	838.2	
Approximate Chi Square Value (.05)	772	**Nonparametric Statistics**
Adjusted Level of Significance	0.0357	95% CLT UCL 1523
Adjusted Chi Square Value	766	95% Jackknife UCL 1529
		95% Standard Bootstrap UCL 1519
Anderson-Darling Test Statistic	0.313	95% Bootstrap-t UCL 1534
Anderson-Darling 5% Critical Value	0.739	95% Hall's Bootstrap UCL 1544
Kolmogorov-Smirnov Test Statistic	0.141	95% Percentile Bootstrap UCL 1519
Kolmogorov-Smirnov 5% Critical Value	0.203	95% BCA Bootstrap UCL 1521
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 1700
		97.5% Chebyshev(Mean, Sd) UCL 1823
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 2065
95% Approximate Gamma UCL (Use when n >= 40)	1536	
95% Adjusted Gamma UCL (Use when n < 40)	1549	

Potential UCL to Use		Use 95% Student's-t UCL	1529

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Be_ppm

General Statistics

Number of Valid Observations	18	Number of Distinct Observations	17

Raw Statistics		**Log-transformed Statistics**	
Minimum	3.41	Minimum of Log Data	1.227
Maximum	5.33	Maximum of Log Data	1.673
Mean	4.157	Mean of log Data	1.416
Geometric Mean	4.122	SD of log Data	0.133
Median	4.085		
SD	0.566		
Std. Error of Mean	0.133		
Coefficient of Variation	0.136		
Skewness	0.601		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.927	Shapiro Wilk Test Statistic	0.941
Shapiro Wilk Critical Value	0.897	Shapiro Wilk Critical Value	0.897
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	4.389	95% H-UCL	4.401
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	4.727
95% Adjusted-CLT UCL (Chen-1995)	4.397	97.5% Chebyshev (MVUE) UCL	4.974
95% Modified-t UCL (Johnson-1978)	4.393	99% Chebyshev (MVUE) UCL	5.459

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	49.18	Data appear Normal at 5% Significance Level
Theta Star	0.0845	
MLE of Mean	4.157	
MLE of Standard Deviation	0.593	
nu star	1771	
Approximate Chi Square Value (.05)	1674	**Nonparametric Statistics**
Adjusted Level of Significance	0.0357	95% CLT UCL 4.377
Adjusted Chi Square Value	1665	95% Jackknife UCL 4.389
		95% Standard Bootstrap UCL 4.376
Anderson-Darling Test Statistic	0.479	95% Bootstrap-t UCL 4.427
Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL 4.396
Kolmogorov-Smirnov Test Statistic	0.203	95% Percentile Bootstrap UCL 4.379
Kolmogorov-Smirnov 5% Critical Value	0.203	95% BCA Bootstrap UCL 4.388
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 4.739
		97.5% Chebyshev(Mean, Sd) UCL 4.991
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 5.485
95% Approximate Gamma UCL (Use when n >= 40)	4.397	
95% Adjusted Gamma UCL (Use when n < 40)	4.421	

Potential UCL to Use		Use 95% Student's-t UCL	4.389

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Co_ppm

General Statistics

Number of Valid Observations	18	Number of Distinct Observations	18

Raw Statistics		Log-transformed Statistics	
Minimum	7.29	Minimum of Log Data	1.987
Maximum	10.6	Maximum of Log Data	2.361
Mean	8.582	Mean of log Data	2.143
Geometric Mean	8.527	SD of log Data	0.117
Median	8.41		
SD	1.016		
Std. Error of Mean	0.239		
Coefficient of Variation	0.118		
Skewness	0.476		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.943	Shapiro Wilk Test Statistic	0.95
Shapiro Wilk Critical Value	0.897	Shapiro Wilk Critical Value	0.897
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	8.999	95% H-UCL	9.018
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	9.612
95% Adjusted-CLT UCL (Chen-1995)	9.005	97.5% Chebyshev (MVUE) UCL	10.06
95% Modified-t UCL (Johnson-1978)	9.003	99% Chebyshev (MVUE) UCL	10.93

Gamma Distribution Test		Data Distribution
k star (bias corrected)	64.49	Data appear Normal at 5% Significance Level
Theta Star	0.133	
MLE of Mean	8.582	
MLE of Standard Deviation	1.069	
nu star	2322	
Approximate Chi Square Value (.05)	2211	**Nonparametric Statistics**
Adjusted Level of Significance	0.0357	95% CLT UCL 8.976
Adjusted Chi Square Value	2200	95% Jackknife UCL 8.999
		95% Standard Bootstrap UCL 8.961
Anderson-Darling Test Statistic	0.322	95% Bootstrap-t UCL 9.04
Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL 9.004
Kolmogorov-Smirnov Test Statistic	0.13	95% Percentile Bootstrap UCL 8.963
Kolmogorov-Smirnov 5% Critical Value	0.203	95% BCA Bootstrap UCL 8.986
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 9.626
		97.5% Chebyshev(Mean, Sd) UCL 10.08
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 10.96
95% Approximate Gamma UCL (Use when n >= 40)	9.013	
95% Adjusted Gamma UCL (Use when n < 40)	9.055	

Potential UCL to Use	Use 95% Student's-t UCL 8.999

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Cr_ppm

General Statistics

Number of Valid Observations	18	Number of Distinct Observations	15

Raw Statistics		**Log-transformed Statistics**	
Minimum	17.5	Minimum of Log Data	2.862
Maximum	30.1	Maximum of Log Data	3.405
Mean	22.31	Mean of log Data	3.092
Geometric Mean	22.02	SD of log Data	0.165
Median	20.7		
SD	3.829		
Std. Error of Mean	0.903		
Coefficient of Variation	0.172		
Skewness	0.759		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.896	Shapiro Wilk Test Statistic	0.917
Shapiro Wilk Critical Value	0.897	Shapiro Wilk Critical Value	0.897
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	23.88	95% H-UCL	23.96
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	26.1
95% Adjusted-CLT UCL (Chen-1995)	23.97	97.5% Chebyshev (MVUE) UCL	27.75
95% Modified-t UCL (Johnson-1978)	23.91	99% Chebyshev (MVUE) UCL	30.97

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	31.73	Data Follow Appr. Gamma Distribution at 5% Significance Level
Theta Star	0.703	
MLE of Mean	22.31	
MLE of Standard Deviation	3.961	
nu star	1142	
Approximate Chi Square Value (.05)	1065	**Nonparametric Statistics**
Adjusted Level of Significance	0.0357	95% CLT UCL 23.8
Adjusted Chi Square Value	1058	95% Jackknife UCL 23.88
		95% Standard Bootstrap UCL 23.76
Anderson-Darling Test Statistic	0.737	95% Bootstrap-t UCL 24.07
Anderson-Darling 5% Critical Value	0.739	95% Hall's Bootstrap UCL 23.86
Kolmogorov-Smirnov Test Statistic	0.212	95% Percentile Bootstrap UCL 23.82
Kolmogorov-Smirnov 5% Critical Value	0.203	95% BCA Bootstrap UCL 24.03
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 26.25
		97.5% Chebyshev(Mean, Sd) UCL 27.95
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 31.29
95% Approximate Gamma UCL (Use when n >= 40)	23.93	
95% Adjusted Gamma UCL (Use when n < 40)	24.1	

Potential UCL to Use		Use 95% Approximate Gamma UCL	23.93

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Cu_ppm

General Statistics

Number of Valid Observations	18	Number of Distinct Observations	13

Raw Statistics		**Log-transformed Statistics**	
Minimum	40.4	Minimum of Log Data	3.699
Maximum	47.5	Maximum of Log Data	3.861
Mean	42.87	Mean of log Data	3.758
Geometric Mean	42.84	SD of log Data	0.0387
Median	42.5		
SD	1.695		
Std. Error of Mean	0.399		
Coefficient of Variation	0.0395		
Skewness	1.282		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.901	Shapiro Wilk Test Statistic	0.913
Shapiro Wilk Critical Value	0.897	Shapiro Wilk Critical Value	0.897
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	43.57	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	44.58
95% Adjusted-CLT UCL (Chen-1995)	43.66	97.5% Chebyshev (MVUE) UCL	45.32
95% Modified-t UCL (Johnson-1978)	43.59	99% Chebyshev (MVUE) UCL	46.77

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	580.7	Data appear Normal at 5% Significance Level
Theta Star	0.0738	
MLE of Mean	42.87	
MLE of Standard Deviation	1.779	
nu star	20905	
Approximate Chi Square Value (.05)	20570	**Nonparametric Statistics**
Adjusted Level of Significance	0.0357	95% CLT UCL 43.53
Adjusted Chi Square Value	20538	95% Jackknife UCL 43.57
		95% Standard Bootstrap UCL 43.51
Anderson-Darling Test Statistic	0.607	95% Bootstrap-t UCL 43.76
Anderson-Darling 5% Critical Value	0.737	95% Hall's Bootstrap UCL 43.96
Kolmogorov-Smirnov Test Statistic	0.157	95% Percentile Bootstrap UCL 43.57
Kolmogorov-Smirnov 5% Critical Value	0.203	95% BCA Bootstrap UCL 43.63
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 44.61
		97.5% Chebyshev(Mean, Sd) UCL 45.37
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 46.85
95% Approximate Gamma UCL (Use when n >= 40)	43.57	
95% Adjusted Gamma UCL (Use when n < 40)	43.64	

Potential UCL to Use	Use 95% Student's-t UCL 43.57

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Li_ppm

General Statistics

Number of Valid Observations	18	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	82.6	Minimum of Log Data	4.414
Maximum	120	Maximum of Log Data	4.787
Mean	98.37	Mean of log Data	4.584
Geometric Mean	97.9	SD of log Data	0.101
Median	97.75		
SD	10		
Std. Error of Mean	2.357		
Coefficient of Variation	0.102		
Skewness	0.353		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.952	Shapiro Wilk Test Statistic	0.957
Shapiro Wilk Critical Value	0.897	Shapiro Wilk Critical Value	0.897
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	102.5	95% H-UCL	102.7
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	108.6
95% Adjusted-CLT UCL (Chen-1995)	102.5	97.5% Chebyshev (MVUE) UCL	113
95% Modified-t UCL (Johnson-1978)	102.5	99% Chebyshev (MVUE) UCL	121.7

Gamma Distribution Test		Data Distribution
k star (bias corrected)	86.48	Data appear Normal at 5% Significance Level
Theta Star	1.137	
MLE of Mean	98.37	
MLE of Standard Deviation	10.58	
nu star	3113	
Approximate Chi Square Value (.05)	2985	**Nonparametric Statistics**
Adjusted Level of Significance	0.0357	95% CLT UCL 102.2
Adjusted Chi Square Value	2973	95% Jackknife UCL 102.5
		95% Standard Bootstrap UCL 102.2
Anderson-Darling Test Statistic	0.4	95% Bootstrap-t UCL 102.6
Anderson-Darling 5% Critical Value	0.737	95% Hall's Bootstrap UCL 102.6
Kolmogorov-Smirnov Test Statistic	0.162	95% Percentile Bootstrap UCL 102.2
Kolmogorov-Smirnov 5% Critical Value	0.203	95% BCA Bootstrap UCL 102.1
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 108.6
		97.5% Chebyshev(Mean, Sd) UCL 113.1
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 121.8
95% Approximate Gamma UCL (Use when n >= 40)	102.6	
95% Adjusted Gamma UCL (Use when n < 40)	103	

Potential UCL to Use	Use 95% Student's-t UCL 102.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Mn_ppm

General Statistics

Number of Valid Observations	18	Number of Distinct Observations	18

Raw Statistics		**Log-transformed Statistics**	
Minimum	159	Minimum of Log Data	5.069
Maximum	308	Maximum of Log Data	5.73
Mean	238.1	Mean of log Data	5.461
Geometric Mean	235.4	SD of log Data	0.158
Median	239.5		
SD	35.63		
Std. Error of Mean	8.398		
Coefficient of Variation	0.15		
Skewness	-0.316		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.96	Shapiro Wilk Test Statistic	0.929
Shapiro Wilk Critical Value	0.897	Shapiro Wilk Critical Value	0.897
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	252.7	95% H-UCL	255
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	277
95% Adjusted-CLT UCL (Chen-1995)	251.2	97.5% Chebyshev (MVUE) UCL	293.7
95% Modified-t UCL (Johnson-1978)	252.6	99% Chebyshev (MVUE) UCL	326.7

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	37.01	Data appear Normal at 5% Significance Level
Theta Star	6.432	
MLE of Mean	238.1	
MLE of Standard Deviation	39.13	
nu star	1332	
Approximate Chi Square Value (.05)	1249	**Nonparametric Statistics**
Adjusted Level of Significance	0.0357	95% CLT UCL 251.9
Adjusted Chi Square Value	1241	95% Jackknife UCL 252.7
		95% Standard Bootstrap UCL 251.4
Anderson-Darling Test Statistic	0.476	95% Bootstrap-t UCL 251.9
Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL 252.8
Kolmogorov-Smirnov Test Statistic	0.152	95% Percentile Bootstrap UCL 251.1
Kolmogorov-Smirnov 5% Critical Value	0.203	95% BCA Bootstrap UCL 250.7
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 274.7
		97.5% Chebyshev(Mean, Sd) UCL 290.5
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 321.6
95% Approximate Gamma UCL (Use when n >= 40)	254	
95% Adjusted Gamma UCL (Use when n < 40)	255.6	

Potential UCL to Use		Use 95% Student's-t UCL	252.7

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Mo_ppm

General Statistics

Number of Valid Observations	18	Number of Distinct Observations	17

Raw Statistics		**Log-transformed Statistics**	
Minimum	2.15	Minimum of Log Data	0.765
Maximum	3.64	Maximum of Log Data	1.292
Mean	2.709	Mean of log Data	0.987
Geometric Mean	2.684	SD of log Data	0.14
Median	2.705		
SD	0.395		
Std. Error of Mean	0.0931		
Coefficient of Variation	0.146		
Skewness	0.967		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.909	Shapiro Wilk Test Statistic	0.94
Shapiro Wilk Critical Value	0.897	Shapiro Wilk Critical Value	0.897
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	2.871	95% H-UCL	2.877
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	3.1
95% Adjusted-CLT UCL (Chen-1995)	2.885	97.5% Chebyshev (MVUE) UCL	3.27
95% Modified-t UCL (Johnson-1978)	2.875	99% Chebyshev (MVUE) UCL	3.603

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	43.97	Data appear Normal at 5% Significance Level
Theta Star	0.0616	
MLE of Mean	2.709	
MLE of Standard Deviation	0.409	
nu star	1583	
Approximate Chi Square Value (.05)	1491	**Nonparametric Statistics**
Adjusted Level of Significance	0.0357	95% CLT UCL 2.863
Adjusted Chi Square Value	1483	95% Jackknife UCL 2.871
		95% Standard Bootstrap UCL 2.856
Anderson-Darling Test Statistic	0.496	95% Bootstrap-t UCL 2.913
Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL 2.96
Kolmogorov-Smirnov Test Statistic	0.172	95% Percentile Bootstrap UCL 2.859
Kolmogorov-Smirnov 5% Critical Value	0.203	95% BCA Bootstrap UCL 2.888
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 3.115
		97.5% Chebyshev(Mean, Sd) UCL 3.291
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 3.636
95% Approximate Gamma UCL (Use when n >= 40)	2.875	
95% Adjusted Gamma UCL (Use when n < 40)	2.892	

Potential UCL to Use	Use 95% Student's-t UCL 2.871

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Ni_ppm

General Statistics

Number of Valid Observations	18	Number of Distinct Observations	18

Raw Statistics		**Log-transformed Statistics**	
Minimum	28.8	Minimum of Log Data	3.36
Maximum	49.5	Maximum of Log Data	3.902
Mean	35.75	Mean of log Data	3.565
Geometric Mean	35.32	SD of log Data	0.158
Median	34.9		
SD	5.833		
Std. Error of Mean	1.375		
Coefficient of Variation	0.163		
Skewness	0.779		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.928	Shapiro Wilk Test Statistic	0.947
Shapiro Wilk Critical Value	0.897	Shapiro Wilk Critical Value	0.897
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	38.14	95% H-UCL	38.26
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	41.55
95% Adjusted-CLT UCL (Chen-1995)	38.28	97.5% Chebyshev (MVUE) UCL	44.06
95% Modified-t UCL (Johnson-1978)	38.18	99% Chebyshev (MVUE) UCL	49

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	34.94	Data appear Normal at 5% Significance Level
Theta Star	1.023	
MLE of Mean	35.75	
MLE of Standard Deviation	6.048	
nu star	1258	
Approximate Chi Square Value (.05)	1176	**Nonparametric Statistics**
Adjusted Level of Significance	0.0357	95% CLT UCL 38.01
Adjusted Chi Square Value	1169	95% Jackknife UCL 38.14
		95% Standard Bootstrap UCL 37.95
Anderson-Darling Test Statistic	0.372	95% Bootstrap-t UCL 38.5
Anderson-Darling 5% Critical Value	0.739	95% Hall's Bootstrap UCL 38.42
Kolmogorov-Smirnov Test Statistic	0.142	95% Percentile Bootstrap UCL 37.87
Kolmogorov-Smirnov 5% Critical Value	0.203	95% BCA Bootstrap UCL 38.31
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 41.74
		97.5% Chebyshev(Mean, Sd) UCL 44.34
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 49.43
95% Approximate Gamma UCL (Use when n >= 40)	38.22	
95% Adjusted Gamma UCL (Use when n < 40)	38.47	

Potential UCL to Use	Use 95% Student's-t UCL 38.14

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Pb_ppm

General Statistics

Number of Valid Observations	18	Number of Distinct Observations	15

Raw Statistics		**Log-transformed Statistics**	
Minimum	16.5	Minimum of Log Data	2.803
Maximum	23	Maximum of Log Data	3.135
Mean	19.22	Mean of log Data	2.953
Geometric Mean	19.16	SD of log Data	0.0848
Median	19.2		
SD	1.674		
Std. Error of Mean	0.395		
Coefficient of Variation	0.0871		
Skewness	0.916		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.915	Shapiro Wilk Test Statistic	0.937
Shapiro Wilk Critical Value	0.897	Shapiro Wilk Critical Value	0.897
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	19.91	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	20.9
95% Adjusted-CLT UCL (Chen-1995)	19.96	97.5% Chebyshev (MVUE) UCL	21.62
95% Modified-t UCL (Johnson-1978)	19.92	99% Chebyshev (MVUE) UCL	23.05

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	120.8	Data appear Normal at 5% Significance Level
Theta Star	0.159	
MLE of Mean	19.22	
MLE of Standard Deviation	1.749	
nu star	4349	
Approximate Chi Square Value (.05)	4197	**Nonparametric Statistics**
Adjusted Level of Significance	0.0357	95% CLT UCL 19.87
Adjusted Chi Square Value	4183	95% Jackknife UCL 19.91
		95% Standard Bootstrap UCL 19.86
Anderson-Darling Test Statistic	0.515	95% Bootstrap-t UCL 20.09
Anderson-Darling 5% Critical Value	0.737	95% Hall's Bootstrap UCL 20.28
Kolmogorov-Smirnov Test Statistic	0.183	95% Percentile Bootstrap UCL 19.87
Kolmogorov-Smirnov 5% Critical Value	0.203	95% BCA Bootstrap UCL 19.94
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 20.94
		97.5% Chebyshev(Mean, Sd) UCL 21.69
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 23.15
95% Approximate Gamma UCL (Use when n >= 40)	19.92	
95% Adjusted Gamma UCL (Use when n < 40)	19.99	

Potential UCL to Use	Use 95% Student's-t UCL 19.91

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sb_ppm

General Statistics

Number of Valid Observations	18	Number of Distinct Observations	18

Raw Statistics		Log-transformed Statistics	
Minimum	0.401	Minimum of Log Data	-0.914
Maximum	0.911	Maximum of Log Data	-0.0932
Mean	0.623	Mean of log Data	-0.509
Geometric Mean	0.601	SD of log Data	0.274
Median	0.61		
SD	0.169		
Std. Error of Mean	0.0397		
Coefficient of Variation	0.271		
Skewness	0.271		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.933	Shapiro Wilk Test Statistic	0.938
Shapiro Wilk Critical Value	0.897	Shapiro Wilk Critical Value	0.897
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	0.692	95% H-UCL	0.705
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.8
95% Adjusted-CLT UCL (Chen-1995)	0.691	97.5% Chebyshev (MVUE) UCL	0.877
95% Modified-t UCL (Johnson-1978)	0.692	99% Chebyshev (MVUE) UCL	1.027

Gamma Distribution Test		Data Distribution
k star (bias corrected)	12.03	Data appear Normal at 5% Significance Level
Theta Star	0.0517	
MLE of Mean	0.623	
MLE of Standard Deviation	0.179	
nu star	433.2	
Approximate Chi Square Value (.05)	386	**Nonparametric Statistics**
Adjusted Level of Significance	0.0357	95% CLT UCL 0.688
Adjusted Chi Square Value	381.7	95% Jackknife UCL 0.692
		95% Standard Bootstrap UCL 0.686
Anderson-Darling Test Statistic	0.393	95% Bootstrap-t UCL 0.696
Anderson-Darling 5% Critical Value	0.739	95% Hall's Bootstrap UCL 0.689
Kolmogorov-Smirnov Test Statistic	0.135	95% Percentile Bootstrap UCL 0.688
Kolmogorov-Smirnov 5% Critical Value	0.203	95% BCA Bootstrap UCL 0.682
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 0.796
		97.5% Chebyshev(Mean, Sd) UCL 0.871
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 1.018
95% Approximate Gamma UCL (Use when n >= 40)	0.699	
95% Adjusted Gamma UCL (Use when n < 40)	0.707	

Potential UCL to Use		Use 95% Student's-t UCL	0.692

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sr_ppm

General Statistics

Number of Valid Observations	18	Number of Distinct Observations	17

Raw Statistics		Log-transformed Statistics	
Minimum	270	Minimum of Log Data	5.598
Maximum	408	Maximum of Log Data	6.011
Mean	328.9	Mean of log Data	5.789
Geometric Mean	326.7	SD of log Data	0.12
Median	339		
SD	39.07		
Std. Error of Mean	9.21		
Coefficient of Variation	0.119		
Skewness	0.0621		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.946	Shapiro Wilk Test Statistic	0.942
Shapiro Wilk Critical Value	0.897	Shapiro Wilk Critical Value	0.897
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	344.9	95% H-UCL	346.1
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	369.4
95% Adjusted-CLT UCL (Chen-1995)	344.2	97.5% Chebyshev (MVUE) UCL	387
95% Modified-t UCL (Johnson-1978)	344.9	99% Chebyshev (MVUE) UCL	421.4

Gamma Distribution Test		Data Distribution
k star (bias corrected)	62.11	Data appear Normal at 5% Significance Level
Theta Star	5.295	
MLE of Mean	328.9	
MLE of Standard Deviation	41.73	
nu star	2236	
Approximate Chi Square Value (.05)	2127	**Nonparametric Statistics**
Adjusted Level of Significance	0.0357	95% CLT UCL 344
Adjusted Chi Square Value	2117	95% Jackknife UCL 344.9
		95% Standard Bootstrap UCL 343.8
Anderson-Darling Test Statistic	0.493	95% Bootstrap-t UCL 344.9
Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL 344.7
Kolmogorov-Smirnov Test Statistic	0.167	95% Percentile Bootstrap UCL 343.9
Kolmogorov-Smirnov 5% Critical Value	0.203	95% BCA Bootstrap UCL 344.9
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 369
		97.5% Chebyshev(Mean, Sd) UCL 386.4
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 420.5
95% Approximate Gamma UCL (Use when n >= 40)	345.7	
95% Adjusted Gamma UCL (Use when n < 40)	347.4	

Potential UCL to Use		Use 95% Student's-t UCL	344.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U_ppm

General Statistics

Number of Valid Observations	18	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	9.03	Minimum of Log Data	2.201
Maximum	11	Maximum of Log Data	2.398
Mean	9.663	Mean of log Data	2.267
Geometric Mean	9.648	SD of log Data	0.0577
Median	9.365		
SD	0.573		
Std. Error of Mean	0.135		
Coefficient of Variation	0.0593		
Skewness	1.119		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.861	Shapiro Wilk Test Statistic	0.871
Shapiro Wilk Critical Value	0.897	Shapiro Wilk Critical Value	0.897
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	9.898	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	10.24
95% Adjusted-CLT UCL (Chen-1995)	9.924	97.5% Chebyshev (MVUE) UCL	10.48
95% Modified-t UCL (Johnson-1978)	9.904	99% Chebyshev (MVUE) UCL	10.97

Gamma Distribution Test		Data Distribution
k star (bias corrected)	260.2	Data do not follow a Discernable Distribution (0.05)
Theta Star	0.0371	
MLE of Mean	9.663	
MLE of Standard Deviation	0.599	
nu star	9366	
Approximate Chi Square Value (.05)	9142	**Nonparametric Statistics**
Adjusted Level of Significance	0.0357	95% CLT UCL 9.885
Adjusted Chi Square Value	9120	95% Jackknife UCL 9.898
		95% Standard Bootstrap UCL 9.881
Anderson-Darling Test Statistic	1.036	95% Bootstrap-t UCL 9.942
Anderson-Darling 5% Critical Value	0.737	95% Hall's Bootstrap UCL 9.919
Kolmogorov-Smirnov Test Statistic	0.255	95% Percentile Bootstrap UCL 9.881
Kolmogorov-Smirnov 5% Critical Value	0.203	95% BCA Bootstrap UCL 9.913
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 10.25
		97.5% Chebyshev(Mean, Sd) UCL 10.51
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 11.01
95% Approximate Gamma UCL (Use when n >= 40)	9.9	
95% Adjusted Gamma UCL (Use when n < 40)	9.923	

Potential UCL to Use	
Use 95% Student's-t UCL	9.898
or 95% Modified-t UCL	9.904

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

V_ppm

General Statistics

Number of Valid Observations	18	Number of Distinct Observations	17

Raw Statistics		Log-transformed Statistics	
Minimum	69.4	Minimum of Log Data	4.24
Maximum	95.5	Maximum of Log Data	4.559
Mean	77.53	Mean of log Data	4.346
Geometric Mean	77.18	SD of log Data	0.0964
Median	74.1		
SD	7.79		
Std. Error of Mean	1.836		
Coefficient of Variation	0.1		
Skewness	1.104		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.855	Shapiro Wilk Test Statistic	0.872
Shapiro Wilk Critical Value	0.897	Shapiro Wilk Critical Value	0.897
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	80.73	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	85.21
95% Adjusted-CLT UCL (Chen-1995)	81.06	97.5% Chebyshev (MVUE) UCL	88.54
95% Modified-t UCL (Johnson-1978)	80.81	99% Chebyshev (MVUE) UCL	95.07

Gamma Distribution Test		Data Distribution
k star (bias corrected)	92.57	Data do not follow a Discernable Distribution (0.05)
Theta Star	0.838	
MLE of Mean	77.53	
MLE of Standard Deviation	8.058	
nu star	3333	
Approximate Chi Square Value (.05)	3199	**Nonparametric Statistics**
Adjusted Level of Significance	0.0357	95% CLT UCL 80.55
Adjusted Chi Square Value	3187	95% Jackknife UCL 80.73
		95% Standard Bootstrap UCL 80.48
Anderson-Darling Test Statistic	1.027	95% Bootstrap-t UCL 81.68
Anderson-Darling 5% Critical Value	0.737	95% Hall's Bootstrap UCL 80.97
Kolmogorov-Smirnov Test Statistic	0.211	95% Percentile Bootstrap UCL 80.63
Kolmogorov-Smirnov 5% Critical Value	0.203	95% BCA Bootstrap UCL 81.06
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 85.54
		97.5% Chebyshev(Mean, Sd) UCL 89
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 95.8
95% Approximate Gamma UCL (Use when n >= 40)	80.76	
95% Adjusted Gamma UCL (Use when n < 40)	81.08	

Potential UCL to Use		
	Use 95% Student's-t UCL	80.73
	or 95% Modified-t UCL	80.81

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Zn_ppm

General Statistics

Number of Valid Observations	18	Number of Distinct Observations	18

Raw Statistics		**Log-transformed Statistics**	
Minimum	26.5	Minimum of Log Data	3.277
Maximum	53.2	Maximum of Log Data	3.974
Mean	32.38	Mean of log Data	3.463
Geometric Mean	31.92	SD of log Data	0.167
Median	31.1		
SD	6.184		
Std. Error of Mean	1.457		
Coefficient of Variation	0.191		
Skewness	2.351		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.755	Shapiro Wilk Test Statistic	0.842
Shapiro Wilk Critical Value	0.897	Shapiro Wilk Critical Value	0.897
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	34.92	95% H-UCL	34.77
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	37.9
95% Adjusted-CLT UCL (Chen-1995)	35.64	97.5% Chebyshev (MVUE) UCL	40.31
95% Modified-t UCL (Johnson-1978)	35.05	99% Chebyshev (MVUE) UCL	45.04

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	29.36	Data Follow Appr. Gamma Distribution at 5% Significance Level
Theta Star	1.103	
MLE of Mean	32.38	
MLE of Standard Deviation	5.976	
nu star	1057	
Approximate Chi Square Value (.05)	982.6	**Nonparametric Statistics**
Adjusted Level of Significance	0.0357	95% CLT UCL 34.78
Adjusted Chi Square Value	975.7	95% Jackknife UCL 34.92
		95% Standard Bootstrap UCL 34.73
Anderson-Darling Test Statistic	0.85	95% Bootstrap-t UCL 36.53
Anderson-Darling 5% Critical Value	0.739	95% Hall's Bootstrap UCL 45.84
Kolmogorov-Smirnov Test Statistic	0.177	95% Percentile Bootstrap UCL 34.82
Kolmogorov-Smirnov 5% Critical Value	0.203	95% BCA Bootstrap UCL 36.02
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 38.74
		97.5% Chebyshev(Mean, Sd) UCL 41.49
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 46.89
95% Approximate Gamma UCL (Use when n >= 40)	34.84	
95% Adjusted Gamma UCL (Use when n < 40)	35.08	

Potential UCL to Use		Use 95% Approximate Gamma UCL	34.84

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Full Data Sets

User Selected Options

From File	ProUCLinputOhioBottomAsh.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

As_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15

Raw Statistics		**Log-transformed Statistics**	
Minimum	3.6	Minimum of Log Data	1.281
Maximum	12.9	Maximum of Log Data	2.557
Mean	5.981	Mean of log Data	1.71
Geometric Mean	5.526	SD of log Data	0.392
Median	5.27		
SD	2.751		
Std. Error of Mean	0.71		
Coefficient of Variation	0.46		
Skewness	1.634		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.798	Shapiro Wilk Test Statistic	0.897
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	7.232	95% H-UCL	7.326
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	8.6
95% Adjusted-CLT UCL (Chen-1995)	7.47	97.5% Chebyshev (MVUE) UCL	9.754
95% Modified-t UCL (Johnson-1978)	7.282	99% Chebyshev (MVUE) UCL	12.02

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	5.228	Data appear Gamma Distributed at 5% Significance Level
Theta Star	1.144	
MLE of Mean	5.981	
MLE of Standard Deviation	2.616	
nu star	156.9	
Approximate Chi Square Value (.05)	128.9	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 7.15
Adjusted Chi Square Value	125.8	95% Jackknife UCL 7.232
		95% Standard Bootstrap UCL 7.12
Anderson-Darling Test Statistic	0.716	95% Bootstrap-t UCL 8.218
Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL 12.8
Kolmogorov-Smirnov Test Statistic	0.171	95% Percentile Bootstrap UCL 7.139
Kolmogorov-Smirnov 5% Critical Value	0.222	95% BCA Bootstrap UCL 7.375
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 9.077
		97.5% Chebyshev(Mean, Sd) UCL 10.42
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 13.05
95% Approximate Gamma UCL (Use when n >= 40)	7.278	
95% Adjusted Gamma UCL (Use when n < 40)	7.459	

Potential UCL to Use		Use 95% Approximate Gamma UCL	7.278

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Ba_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	12

Raw Statistics		**Log-transformed Statistics**	
Minimum	474	Minimum of Log Data	6.161
Maximum	518	Maximum of Log Data	6.25
Mean	491.9	Mean of log Data	6.198
Geometric Mean	491.8	SD of log Data	0.0228
Median	491		
SD	11.27		
Std. Error of Mean	2.911		
Coefficient of Variation	0.0229		
Skewness	0.531		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.958	Shapiro Wilk Test Statistic	0.961
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	497.1	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	504.6
95% Adjusted-CLT UCL (Chen-1995)	497.1	97.5% Chebyshev (MVUE) UCL	510
95% Modified-t UCL (Johnson-1978)	497.1	99% Chebyshev (MVUE) UCL	520.8

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	1643	Data appear Normal at 5% Significance Level
Theta Star	0.299	
MLE of Mean	491.9	
MLE of Standard Deviation	12.14	
nu star	49288	
Approximate Chi Square Value (.05)	48773	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 496.7
Adjusted Chi Square Value	48710	95% Jackknife UCL 497.1
		95% Standard Bootstrap UCL 496.5
Anderson-Darling Test Statistic	0.265	95% Bootstrap-t UCL 497.3
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 497.8
Kolmogorov-Smirnov Test Statistic	0.134	95% Percentile Bootstrap UCL 496.9
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 496.9
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 504.6
		97.5% Chebyshev(Mean, Sd) UCL 510.1
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 520.9
95% Approximate Gamma UCL (Use when n >= 40)	497.1	
95% Adjusted Gamma UCL (Use when n < 40)	497.8	

Potential UCL to Use		Use 95% Student's-t UCL	497.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Be_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	14

Raw Statistics		Log-transformed Statistics	
Minimum	7.72	Minimum of Log Data	2.044
Maximum	10.3	Maximum of Log Data	2.332
Mean	9.019	Mean of log Data	2.195
Geometric Mean	8.984	SD of log Data	0.0911
Median	8.84		
SD	0.825		
Std. Error of Mean	0.213		
Coefficient of Variation	0.0914		
Skewness	0.23		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.954	Shapiro Wilk Test Statistic	0.961
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	9.394	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	9.945
95% Adjusted-CLT UCL (Chen-1995)	9.383	97.5% Chebyshev (MVUE) UCL	10.35
95% Modified-t UCL (Johnson-1978)	9.396	99% Chebyshev (MVUE) UCL	11.13

Gamma Distribution Test		Data Distribution
k star (bias corrected)	103.2	Data appear Normal at 5% Significance Level
Theta Star	0.0874	
MLE of Mean	9.019	
MLE of Standard Deviation	0.888	
nu star	3097	
Approximate Chi Square Value (.05)	2968	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 9.37
Adjusted Chi Square Value	2953	95% Jackknife UCL 9.394
		95% Standard Bootstrap UCL 9.363
Anderson-Darling Test Statistic	0.23	95% Bootstrap-t UCL 9.41
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 9.377
Kolmogorov-Smirnov Test Statistic	0.112	95% Percentile Bootstrap UCL 9.355
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 9.361
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 9.947
		97.5% Chebyshev(Mean, Sd) UCL 10.35
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 11.14
95% Approximate Gamma UCL (Use when n >= 40)	9.409	
95% Adjusted Gamma UCL (Use when n < 40)	9.458	

Potential UCL to Use		Use 95% Student's-t UCL	9.394

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Co_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	11

Raw Statistics		Log-transformed Statistics	
Minimum	34.5	Minimum of Log Data	3.541
Maximum	37.7	Maximum of Log Data	3.63
Mean	36.23	Mean of log Data	3.59
Geometric Mean	36.22	SD of log Data	0.0231
Median	36.2		
SD	0.835		
Std. Error of Mean	0.216		
Coefficient of Variation	0.023		
Skewness	-0.257		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.965	Shapiro Wilk Test Statistic	0.963
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	36.61	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	37.18
95% Adjusted-CLT UCL (Chen-1995)	36.57	97.5% Chebyshev (MVUE) UCL	37.58
95% Modified-t UCL (Johnson-1978)	36.61	99% Chebyshev (MVUE) UCL	38.38

Gamma Distribution Test		Data Distribution
k star (bias corrected)	1609	Data appear Normal at 5% Significance Level
Theta Star	0.0225	
MLE of Mean	36.23	
MLE of Standard Deviation	0.903	
nu star	48266	
Approximate Chi Square Value (.05)	47756	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 36.59
Adjusted Chi Square Value	47693	95% Jackknife UCL 36.61
		95% Standard Bootstrap UCL 36.57
Anderson-Darling Test Statistic	0.325	95% Bootstrap-t UCL 36.59
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 36.59
Kolmogorov-Smirnov Test Statistic	0.131	95% Percentile Bootstrap UCL 36.57
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 36.56
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 37.17
		97.5% Chebyshev(Mean, Sd) UCL 37.58
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 38.38
95% Approximate Gamma UCL (Use when n >= 40)	36.62	
95% Adjusted Gamma UCL (Use when n < 40)	36.67	

Potential UCL to Use	Use 95% Student's-t UCL 36.61

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Cr_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	266	Minimum of Log Data	5.583
Maximum	461	Maximum of Log Data	6.133
Mean	377	Mean of log Data	5.925
Geometric Mean	374.3	SD of log Data	0.126
Median	374		
SD	44.89		
Std. Error of Mean	11.59		
Coefficient of Variation	0.119		
Skewness	-0.641		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.953	Shapiro Wilk Test Statistic	0.914
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	397.4	95% H-UCL	400.4
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	430.8
95% Adjusted-CLT UCL (Chen-1995)	394	97.5% Chebyshev (MVUE) UCL	454
95% Modified-t UCL (Johnson-1978)	397.1	99% Chebyshev (MVUE) UCL	499.6

Gamma Distribution Test		Data Distribution
k star (bias corrected)	56.38	Data appear Normal at 5% Significance Level
Theta Star	6.687	
MLE of Mean	377	
MLE of Standard Deviation	50.21	
nu star	1691	
Approximate Chi Square Value (.05)	1597	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 396.1
Adjusted Chi Square Value	1586	95% Jackknife UCL 397.4
		95% Standard Bootstrap UCL 395.4
Anderson-Darling Test Statistic	0.392	95% Bootstrap-t UCL 394.9
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 395.2
Kolmogorov-Smirnov Test Statistic	0.141	95% Percentile Bootstrap UCL 394.9
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 392.9
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 427.5
		97.5% Chebyshev(Mean, Sd) UCL 449.4
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 492.3
95% Approximate Gamma UCL (Use when n >= 40)	399.3	
95% Adjusted Gamma UCL (Use when n < 40)	402.2	

Potential UCL to Use	Use 95% Student's-t UCL 397.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Cu_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	14

Raw Statistics		**Log-transformed Statistics**	
Minimum	54	Minimum of Log Data	3.989
Maximum	69.1	Maximum of Log Data	4.236
Mean	61.37	Mean of log Data	4.115
Geometric Mean	61.25	SD of log Data	0.0647
Median	60.9		
SD	4.001		
Std. Error of Mean	1.033		
Coefficient of Variation	0.0652		
Skewness	0.423		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.956	Shapiro Wilk Test Statistic	0.962
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	63.19	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	65.84
95% Adjusted-CLT UCL (Chen-1995)	63.19	97.5% Chebyshev (MVUE) UCL	67.77
95% Modified-t UCL (Johnson-1978)	63.21	99% Chebyshev (MVUE) UCL	71.57

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	203.9	Data appear Normal at 5% Significance Level
Theta Star	0.301	
MLE of Mean	61.37	
MLE of Standard Deviation	4.297	
nu star	6118	
Approximate Chi Square Value (.05)	5938	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 63.07
Adjusted Chi Square Value	5916	95% Jackknife UCL 63.19
		95% Standard Bootstrap UCL 63
Anderson-Darling Test Statistic	0.328	95% Bootstrap-t UCL 63.54
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 63.43
Kolmogorov-Smirnov Test Statistic	0.157	95% Percentile Bootstrap UCL 63.02
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 63.23
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 65.87
		97.5% Chebyshev(Mean, Sd) UCL 67.82
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 71.65
95% Approximate Gamma UCL (Use when n >= 40)	63.24	
95% Adjusted Gamma UCL (Use when n < 40)	63.47	

Potential UCL to Use		Use 95% Student's-t UCL	63.19

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Li_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	86.4	Minimum of Log Data	4.459
Maximum	98.6	Maximum of Log Data	4.591
Mean	92.8	Mean of log Data	4.53
Geometric Mean	92.74	SD of log Data	0.0359
Median	92.5		
SD	3.328		
Std. Error of Mean	0.859		
Coefficient of Variation	0.0359		
Skewness	0.0566		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.981	Shapiro Wilk Test Statistic	0.982
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	94.31	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	96.55
95% Adjusted-CLT UCL (Chen-1995)	94.23	97.5% Chebyshev (MVUE) UCL	98.17
95% Modified-t UCL (Johnson-1978)	94.32	99% Chebyshev (MVUE) UCL	101.4

Gamma Distribution Test		Data Distribution
k star (bias corrected)	666.4	Data appear Normal at 5% Significance Level
Theta Star	0.139	
MLE of Mean	92.8	
MLE of Standard Deviation	3.595	
nu star	19993	
Approximate Chi Square Value (.05)	19665	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 94.21
Adjusted Chi Square Value	19625	95% Jackknife UCL 94.31
		95% Standard Bootstrap UCL 94.2
Anderson-Darling Test Statistic	0.166	95% Bootstrap-t UCL 94.35
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 94.31
Kolmogorov-Smirnov Test Statistic	0.0956	95% Percentile Bootstrap UCL 94.2
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 94.12
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 96.55
		97.5% Chebyshev(Mean, Sd) UCL 98.17
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 101.3
95% Approximate Gamma UCL (Use when n >= 40)	94.35	
95% Adjusted Gamma UCL (Use when n < 40)	94.54	

Potential UCL to Use		Use 95% Student's-t UCL	94.31

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Mo_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	6.31	Minimum of Log Data	1.842
Maximum	10.2	Maximum of Log Data	2.322
Mean	8.121	Mean of log Data	2.086
Geometric Mean	8.056	SD of log Data	0.131
Median	8.17		
SD	1.053		
Std. Error of Mean	0.272		
Coefficient of Variation	0.13		
Skewness	0.0659		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.984	Shapiro Wilk Test Statistic	0.979
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	8.599	95% H-UCL	8.645
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	9.323
95% Adjusted-CLT UCL (Chen-1995)	8.573	97.5% Chebyshev (MVUE) UCL	9.843
95% Modified-t UCL (Johnson-1978)	8.6	99% Chebyshev (MVUE) UCL	10.87

Gamma Distribution Test		Data Distribution
k star (bias corrected)	50.44	Data appear Normal at 5% Significance Level
Theta Star	0.161	
MLE of Mean	8.121	
MLE of Standard Deviation	1.143	
nu star	1513	
Approximate Chi Square Value (.05)	1424	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 8.568
Adjusted Chi Square Value	1413	95% Jackknife UCL 8.599
		95% Standard Bootstrap UCL 8.536
Anderson-Darling Test Statistic	0.177	95% Bootstrap-t UCL 8.611
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 8.587
Kolmogorov-Smirnov Test Statistic	0.106	95% Percentile Bootstrap UCL 8.569
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 8.583
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 9.306
		97.5% Chebyshev(Mean, Sd) UCL 9.818
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 10.83
95% Approximate Gamma UCL (Use when n >= 40)	8.63	
95% Adjusted Gamma UCL (Use when n < 40)	8.695	

Potential UCL to Use		Use 95% Student's-t UCL	8.599

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Ni_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	162	Minimum of Log Data	5.088
Maximum	240	Maximum of Log Data	5.481
Mean	202.3	Mean of log Data	5.305
Geometric Mean	201.4	SD of log Data	0.0985
Median	207		
SD	19.47		
Std. Error of Mean	5.026		
Coefficient of Variation	0.0962		
Skewness	-0.301		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.971	Shapiro Wilk Test Statistic	0.96
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	211.2	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	224.8
95% Adjusted-CLT UCL (Chen-1995)	210.2	97.5% Chebyshev (MVUE) UCL	234.5
95% Modified-t UCL (Johnson-1978)	211.1	99% Chebyshev (MVUE) UCL	253.6

Gamma Distribution Test		Data Distribution
k star (bias corrected)	90.09	Data appear Normal at 5% Significance Level
Theta Star	2.246	
MLE of Mean	202.3	
MLE of Standard Deviation	21.32	
nu star	2703	
Approximate Chi Square Value (.05)	2583	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 210.6
Adjusted Chi Square Value	2568	95% Jackknife UCL 211.2
		95% Standard Bootstrap UCL 210.3
Anderson-Darling Test Statistic	0.319	95% Bootstrap-t UCL 210.4
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 210.9
Kolmogorov-Smirnov Test Statistic	0.141	95% Percentile Bootstrap UCL 210
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 209.7
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 224.2
		97.5% Chebyshev(Mean, Sd) UCL 233.7
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 252.3
95% Approximate Gamma UCL (Use when n >= 40)	211.7	
95% Adjusted Gamma UCL (Use when n < 40)	212.9	

Potential UCL to Use	Use 95% Student's-t UCL 211.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Pb_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	14

Raw Statistics		**Log-transformed Statistics**	
Minimum	13.9	Minimum of Log Data	2.632
Maximum	40	Maximum of Log Data	3.689
Mean	17.45	Mean of log Data	2.816
Geometric Mean	16.71	SD of log Data	0.272
Median	15		
SD	6.619		
Std. Error of Mean	1.709		
Coefficient of Variation	0.379		
Skewness	3.228		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.535	Shapiro Wilk Test Statistic	0.644
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	20.46	95% H-UCL	19.86
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	22.65
95% Adjusted-CLT UCL (Chen-1995)	21.78	97.5% Chebyshev (MVUE) UCL	24.97
95% Modified-t UCL (Johnson-1978)	20.69	99% Chebyshev (MVUE) UCL	29.52

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	9.47	Data do not follow a Discernable Distribution (0.05)
Theta Star	1.842	
MLE of Mean	17.45	
MLE of Standard Deviation	5.669	
nu star	284.1	
Approximate Chi Square Value (.05)	246.1	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 20.26
Adjusted Chi Square Value	241.7	95% Jackknife UCL 20.46
		95% Standard Bootstrap UCL 20.13
Anderson-Darling Test Statistic	2.247	95% Bootstrap-t UCL 27.95
Anderson-Darling 5% Critical Value	0.737	95% Hall's Bootstrap UCL 30.08
Kolmogorov-Smirnov Test Statistic	0.345	95% Percentile Bootstrap UCL 20.49
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 22.25
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 24.9
		97.5% Chebyshev(Mean, Sd) UCL 28.12
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 34.45
95% Approximate Gamma UCL (Use when n >= 40)	20.14	
95% Adjusted Gamma UCL (Use when n < 40)	20.51	

Potential UCL to Use	Use 95% Student's-t UCL 20.46
	or 95% Modified-t UCL 20.69

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sb_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	0.867	Minimum of Log Data	-0.143
Maximum	3.2	Maximum of Log Data	1.163
Mean	1.289	Mean of log Data	0.172
Geometric Mean	1.188	SD of log Data	0.384
Median	1.02		
SD	0.645		
Std. Error of Mean	0.167		
Coefficient of Variation	0.5		
Skewness	2.245		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.679	Shapiro Wilk Test Statistic	0.782
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	1.582	95% H-UCL	1.563
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1.833
95% Adjusted-CLT UCL (Chen-1995)	1.666	97.5% Chebyshev (MVUE) UCL	2.075
95% Modified-t UCL (Johnson-1978)	1.599	99% Chebyshev (MVUE) UCL	2.552

Gamma Distribution Test		Data Distribution
k star (bias corrected)	5.061	Data do not follow a Discernable Distribution (0.05)
Theta Star	0.255	
MLE of Mean	1.289	
MLE of Standard Deviation	0.573	
nu star	151.8	
Approximate Chi Square Value (.05)	124.3	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 1.563
Adjusted Chi Square Value	121.3	95% Jackknife UCL 1.582
		95% Standard Bootstrap UCL 1.553
Anderson-Darling Test Statistic	1.543	95% Bootstrap-t UCL 1.888
Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL 1.709
Kolmogorov-Smirnov Test Statistic	0.258	95% Percentile Bootstrap UCL 1.583
Kolmogorov-Smirnov 5% Critical Value	0.222	95% BCA Bootstrap UCL 1.657
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 2.015
		97.5% Chebyshev(Mean, Sd) UCL 2.329
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 2.946
95% Approximate Gamma UCL (Use when n >= 40)	1.574	
95% Adjusted Gamma UCL (Use when n < 40)	1.614	

Potential UCL to Use	Use 95% Student's-t UCL 1.582
	or 95% Modified-t UCL 1.599

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sr_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	554	Minimum of Log Data	6.317
Maximum	636	Maximum of Log Data	6.455
Mean	601.1	Mean of log Data	6.398
Geometric Mean	600.4	SD of log Data	0.049
Median	615		
SD	29.22		
Std. Error of Mean	7.544		
Coefficient of Variation	0.0486		
Skewness	-0.341		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.869	Shapiro Wilk Test Statistic	0.868
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	614.4	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	634.2
95% Adjusted-CLT UCL (Chen-1995)	612.8	97.5% Chebyshev (MVUE) UCL	648.6
95% Modified-t UCL (Johnson-1978)	614.2	99% Chebyshev (MVUE) UCL	676.8

Gamma Distribution Test		Data Distribution
k star (bias corrected)	358.9	Data do not follow a Discernable Distribution (0.05)
Theta Star	1.675	
MLE of Mean	601.1	
MLE of Standard Deviation	31.73	
nu star	10766	
Approximate Chi Square Value (.05)	10525	
Adjusted Level of Significance	0.0324	
Adjusted Chi Square Value	10496	
Anderson-Darling Test Statistic	0.911	
Anderson-Darling 5% Critical Value	0.734	
Kolmogorov-Smirnov Test Statistic	0.228	
Kolmogorov-Smirnov 5% Critical Value	0.221	
Data not Gamma Distributed at 5% Significance Level		

Nonparametric Statistics	
95% CLT UCL	613.5
95% Jackknife UCL	614.4
95% Standard Bootstrap UCL	613
95% Bootstrap-t UCL	612.7
95% Hall's Bootstrap UCL	611.7
95% Percentile Bootstrap UCL	613
95% BCA Bootstrap UCL	612.9
95% Chebyshev(Mean, Sd) UCL	634
97.5% Chebyshev(Mean, Sd) UCL	648.2
99% Chebyshev(Mean, Sd) UCL	676.1

Assuming Gamma Distribution	
95% Approximate Gamma UCL (Use when n >= 40)	614.8
95% Adjusted Gamma UCL (Use when n < 40)	616.5

Potential UCL to Use	
Use 95% Student's-t UCL	614.4
or 95% Modified-t UCL	614.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Tl_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	0.446	Minimum of Log Data	-0.807
Maximum	0.684	Maximum of Log Data	-0.38
Mean	0.554	Mean of log Data	-0.595
Geometric Mean	0.551	SD of log Data	0.0985
Median	0.55		
SD	0.0547		
Std. Error of Mean	0.0141		
Coefficient of Variation	0.0988		
Skewness	0.425		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.94	Shapiro Wilk Test Statistic	0.946
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	0.579	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.615
95% Adjusted-CLT UCL (Chen-1995)	0.579	97.5% Chebyshev (MVUE) UCL	0.642
95% Modified-t UCL (Johnson-1978)	0.579	99% Chebyshev (MVUE) UCL	0.694

Gamma Distribution Test		Data Distribution
k star (bias corrected)	88.59	Data appear Normal at 5% Significance Level
Theta Star	0.00625	
MLE of Mean	0.554	
MLE of Standard Deviation	0.0589	
nu star	2658	
Approximate Chi Square Value (.05)	2539	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 0.577
Adjusted Chi Square Value	2525	95% Jackknife UCL 0.579
		95% Standard Bootstrap UCL 0.577
Anderson-Darling Test Statistic	0.492	95% Bootstrap-t UCL 0.582
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 0.585
Kolmogorov-Smirnov Test Statistic	0.169	95% Percentile Bootstrap UCL 0.577
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 0.577
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 0.616
		97.5% Chebyshev(Mean, Sd) UCL 0.642
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 0.695
95% Approximate Gamma UCL (Use when n >= 40)	0.58	
95% Adjusted Gamma UCL (Use when n < 40)	0.583	

Potential UCL to Use		Use 95% Student's-t UCL	0.579

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	5.27	Minimum of Log Data	1.662
Maximum	7.08	Maximum of Log Data	1.957
Mean	5.753	Mean of log Data	1.747
Geometric Mean	5.739	SD of log Data	0.0711
Median	5.63		
SD	0.435		
Std. Error of Mean	0.112		
Coefficient of Variation	0.0756		
Skewness	2.183		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.788	Shapiro Wilk Test Statistic	0.825
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	5.95	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	6.213
95% Adjusted-CLT UCL (Chen-1995)	6.005	97.5% Chebyshev (MVUE) UCL	6.412
95% Modified-t UCL (Johnson-1978)	5.961	99% Chebyshev (MVUE) UCL	6.803

Gamma Distribution Test		Data Distribution
k star (bias corrected)	163.1	Data Follow Appr. Gamma Distribution at 5% Significance Level
Theta Star	0.0353	
MLE of Mean	5.753	
MLE of Standard Deviation	0.45	
nu star	4893	
Approximate Chi Square Value (.05)	4731	
Adjusted Level of Significance	0.0324	
Adjusted Chi Square Value	4712	
Anderson-Darling Test Statistic	0.933	
Anderson-Darling 5% Critical Value	0.734	
Kolmogorov-Smirnov Test Statistic	0.206	
Kolmogorov-Smirnov 5% Critical Value	0.221	
Data follow Appr. Gamma Distribution at 5% Significance Level		

Nonparametric Statistics	
95% CLT UCL	5.937
95% Jackknife UCL	5.95
95% Standard Bootstrap UCL	5.934
95% Bootstrap-t UCL	6.094
95% Hall's Bootstrap UCL	6.807
95% Percentile Bootstrap UCL	5.949
95% BCA Bootstrap UCL	5.997
95% Chebyshev(Mean, Sd) UCL	6.242
97.5% Chebyshev(Mean, Sd) UCL	6.454
99% Chebyshev(Mean, Sd) UCL	6.87

Assuming Gamma Distribution	
95% Approximate Gamma UCL (Use when n >= 40)	5.949
95% Adjusted Gamma UCL (Use when n < 40)	5.974

Potential UCL to Use	Use 95% Approximate Gamma UCL 5.949

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

V_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	192	Minimum of Log Data	5.257
Maximum	221	Maximum of Log Data	5.398
Mean	209.2	Mean of log Data	5.342
Geometric Mean	209	SD of log Data	0.0443
Median	211		
SD	9.19		
Std. Error of Mean	2.373		
Coefficient of Variation	0.0439		
Skewness	-0.367		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.945	Shapiro Wilk Test Statistic	0.942
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	213.4	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	219.6
95% Adjusted-CLT UCL (Chen-1995)	212.9	97.5% Chebyshev (MVUE) UCL	224.1
95% Modified-t UCL (Johnson-1978)	213.3	99% Chebyshev (MVUE) UCL	233

Gamma Distribution Test		Data Distribution
k star (bias corrected)	439.4	Data appear Normal at 5% Significance Level
Theta Star	0.476	
MLE of Mean	209.2	
MLE of Standard Deviation	9.98	
nu star	13183	
Approximate Chi Square Value (.05)	12917	
Adjusted Level of Significance	0.0324	
Adjusted Chi Square Value	12885	
Anderson-Darling Test Statistic	0.333	
Anderson-Darling 5% Critical Value	0.734	
Kolmogorov-Smirnov Test Statistic	0.136	
Kolmogorov-Smirnov 5% Critical Value	0.221	
Data appear Gamma Distributed at 5% Significance Level		

Nonparametric Statistics	
95% CLT UCL	213.1
95% Jackknife UCL	213.4
95% Standard Bootstrap UCL	213
95% Bootstrap-t UCL	212.9
95% Hall's Bootstrap UCL	212.6
95% Percentile Bootstrap UCL	212.9
95% BCA Bootstrap UCL	212.8
95% Chebyshev(Mean, Sd) UCL	219.5
97.5% Chebyshev(Mean, Sd) UCL	224
99% Chebyshev(Mean, Sd) UCL	232.8

Assuming Gamma Distribution	
95% Approximate Gamma UCL (Use when n >= 40)	213.5
95% Adjusted Gamma UCL (Use when n < 40)	214

Potential UCL to Use	Use 95% Student's-t UCL 213.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Zn_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	14

Raw Statistics		**Log-transformed Statistics**	
Minimum	55.9	Minimum of Log Data	4.024
Maximum	72.9	Maximum of Log Data	4.289
Mean	61.17	Mean of log Data	4.112
Geometric Mean	61.06	SD of log Data	0.0606
Median	61.2		
SD	3.876		
Std. Error of Mean	1.001		
Coefficient of Variation	0.0634		
Skewness	1.908		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.798	Shapiro Wilk Test Statistic	0.829
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	62.93	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	65.34
95% Adjusted-CLT UCL (Chen-1995)	63.34	97.5% Chebyshev (MVUE) UCL	67.14
95% Modified-t UCL (Johnson-1978)	63.01	99% Chebyshev (MVUE) UCL	70.69

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	227	Data do not follow a Discernable Distribution (0.05)
Theta Star	0.269	
MLE of Mean	61.17	
MLE of Standard Deviation	4.06	
nu star	6809	
Approximate Chi Square Value (.05)	6618	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 62.81
Adjusted Chi Square Value	6595	95% Jackknife UCL 62.93
		95% Standard Bootstrap UCL 62.74
Anderson-Darling Test Statistic	0.965	95% Bootstrap-t UCL 63.59
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 71.67
Kolmogorov-Smirnov Test Statistic	0.226	95% Percentile Bootstrap UCL 62.85
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 63.5
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 65.53
		97.5% Chebyshev(Mean, Sd) UCL 67.42
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 71.12
95% Approximate Gamma UCL (Use when n >= 40)	62.93	
95% Adjusted Gamma UCL (Use when n < 40)	63.15	

Potential UCL to Use	Use 95% Student's-t UCL 62.93
	or 95% Modified-t UCL 63.01

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Full Data Sets

User Selected Options

From File	ProUCLinputWyomingBottomAsh.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

As_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	4.99	Minimum of Log Data	1.607
Maximum	7.73	Maximum of Log Data	2.045
Mean	6.479	Mean of log Data	1.861
Geometric Mean	6.429	SD of log Data	0.132
Median	6.65		
SD	0.815		
Std. Error of Mean	0.21		
Coefficient of Variation	0.126		
Skewness	-0.597		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.935	Shapiro Wilk Test Statistic	0.912
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	6.85	95% H-UCL	6.901
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	7.444
95% Adjusted-CLT UCL (Chen-1995)	6.791	97.5% Chebyshev (MVUE) UCL	7.861
95% Modified-t UCL (Johnson-1978)	6.845	99% Chebyshev (MVUE) UCL	8.679

Gamma Distribution Test		Data Distribution
k star (bias corrected)	51.15	Data appear Normal at 5% Significance Level
Theta Star	0.127	
MLE of Mean	6.479	
MLE of Standard Deviation	0.906	
nu star	1534	
Approximate Chi Square Value (.05)	1445	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 6.826
Adjusted Chi Square Value	1434	95% Jackknife UCL 6.85
		95% Standard Bootstrap UCL 6.822
Anderson-Darling Test Statistic	0.545	95% Bootstrap-t UCL 6.807
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 6.781
Kolmogorov-Smirnov Test Statistic	0.189	95% Percentile Bootstrap UCL 6.809
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 6.77
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 7.397
		97.5% Chebyshev(Mean, Sd) UCL 7.794
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 8.574
95% Approximate Gamma UCL (Use when n >= 40)	6.883	
95% Adjusted Gamma UCL (Use when n < 40)	6.934	

Potential UCL to Use	Use 95% Student's-t UCL 6.85

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Ba_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	2440	Minimum of Log Data	7.8
Maximum	2990	Maximum of Log Data	8.003
Mean	2753	Mean of log Data	7.919
Geometric Mean	2749	SD of log Data	0.061
Median	2790		
SD	164.9		
Std. Error of Mean	42.58		
Coefficient of Variation	0.0599		
Skewness	-0.593		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.936	Shapiro Wilk Test Statistic	0.925
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	2828	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2943
95% Adjusted-CLT UCL (Chen-1995)	2816	97.5% Chebyshev (MVUE) UCL	3024
95% Modified-t UCL (Johnson-1978)	2827	99% Chebyshev (MVUE) UCL	3185

Gamma Distribution Test		Data Distribution
k star (bias corrected)	233.3	Data appear Normal at 5% Significance Level
Theta Star	11.8	
MLE of Mean	2753	
MLE of Standard Deviation	180.3	
nu star	6998	
Approximate Chi Square Value (.05)	6805	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 2823
Adjusted Chi Square Value	6781	95% Jackknife UCL 2828
		95% Standard Bootstrap UCL 2820
Anderson-Darling Test Statistic	0.421	95% Bootstrap-t UCL 2822
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 2816
Kolmogorov-Smirnov Test Statistic	0.173	95% Percentile Bootstrap UCL 2821
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 2815
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 2939
		97.5% Chebyshev(Mean, Sd) UCL 3019
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 3177
95% Approximate Gamma UCL (Use when n >= 40)	2832	
95% Adjusted Gamma UCL (Use when n < 40)	2841	

Potential UCL to Use		Use 95% Student's-t UCL	2828

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Be_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	2.99	Minimum of Log Data	1.095
Maximum	3.78	Maximum of Log Data	1.33
Mean	3.365	Mean of log Data	1.21
Geometric Mean	3.354	SD of log Data	0.0812
Median	3.37		
SD	0.272		
Std. Error of Mean	0.0702		
Coefficient of Variation	0.0808		
Skewness	-0.0312		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.936	Shapiro Wilk Test Statistic	0.932
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	3.488	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	3.672
95% Adjusted-CLT UCL (Chen-1995)	3.479	97.5% Chebyshev (MVUE) UCL	3.805
95% Modified-t UCL (Johnson-1978)	3.488	99% Chebyshev (MVUE) UCL	4.067

Gamma Distribution Test		Data Distribution
k star (bias corrected)	130.7	Data appear Normal at 5% Significance Level
Theta Star	0.0257	
MLE of Mean	3.365	
MLE of Standard Deviation	0.294	
nu star	3922	
Approximate Chi Square Value (.05)	3778	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 3.48
Adjusted Chi Square Value	3760	95% Jackknife UCL 3.488
		95% Standard Bootstrap UCL 3.476
Anderson-Darling Test Statistic	0.358	95% Bootstrap-t UCL 3.48
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 3.472
Kolmogorov-Smirnov Test Statistic	0.124	95% Percentile Bootstrap UCL 3.476
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 3.481
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 3.67
		97.5% Chebyshev(Mean, Sd) UCL 3.803
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 4.063
95% Approximate Gamma UCL (Use when n >= 40)	3.493	
95% Adjusted Gamma UCL (Use when n < 40)	3.51	

Potential UCL to Use		Use 95% Student's-t UCL	3.488

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Co_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	36.6	Minimum of Log Data	3.6
Maximum	55	Maximum of Log Data	4.007
Mean	46.03	Mean of log Data	3.824
Geometric Mean	45.77	SD of log Data	0.111
Median	46.1		
SD	5		
Std. Error of Mean	1.291		
Coefficient of Variation	0.109		
Skewness	-0.165		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.976	Shapiro Wilk Test Statistic	0.969
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	48.3	95% H-UCL	48.5
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	51.77
95% Adjusted-CLT UCL (Chen-1995)	48.09	97.5% Chebyshev (MVUE) UCL	54.25
95% Modified-t UCL (Johnson-1978)	48.29	99% Chebyshev (MVUE) UCL	59.13

Gamma Distribution Test		Data Distribution
k star (bias corrected)	71.14	Data appear Normal at 5% Significance Level
Theta Star	0.647	
MLE of Mean	46.03	
MLE of Standard Deviation	5.457	
nu star	2134	
Approximate Chi Square Value (.05)	2028	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 48.15
Adjusted Chi Square Value	2015	95% Jackknife UCL 48.3
		95% Standard Bootstrap UCL 48.15
Anderson-Darling Test Statistic	0.264	95% Bootstrap-t UCL 48.21
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 48.16
Kolmogorov-Smirnov Test Statistic	0.161	95% Percentile Bootstrap UCL 48.1
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 47.95
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 51.65
		97.5% Chebyshev(Mean, Sd) UCL 54.09
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 58.87
95% Approximate Gamma UCL (Use when n >= 40)	48.44	
95% Adjusted Gamma UCL (Use when n < 40)	48.75	

Potential UCL to Use		Use 95% Student's-t UCL	48.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Cr_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	62.8	Minimum of Log Data	4.14
Maximum	89.9	Maximum of Log Data	4.499
Mean	76.23	Mean of log Data	4.327
Geometric Mean	75.68	SD of log Data	0.124
Median	74.6		
SD	9.402		
Std. Error of Mean	2.427		
Coefficient of Variation	0.123		
Skewness	0.0319		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.921	Shapiro Wilk Test Statistic	0.92
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	80.5	95% H-UCL	80.86
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	86.9
95% Adjusted-CLT UCL (Chen-1995)	80.24	97.5% Chebyshev (MVUE) UCL	91.52
95% Modified-t UCL (Johnson-1978)	80.51	99% Chebyshev (MVUE) UCL	100.6

Gamma Distribution Test		Data Distribution
k star (bias corrected)	56.03	Data appear Normal at 5% Significance Level
Theta Star	1.361	
MLE of Mean	76.23	
MLE of Standard Deviation	10.18	
nu star	1681	
Approximate Chi Square Value (.05)	1587	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 80.22
Adjusted Chi Square Value	1575	95% Jackknife UCL 80.5
		95% Standard Bootstrap UCL 80.08
Anderson-Darling Test Statistic	0.478	95% Bootstrap-t UCL 80.56
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 80.01
Kolmogorov-Smirnov Test Statistic	0.151	95% Percentile Bootstrap UCL 80.01
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 80.1
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 86.81
		97.5% Chebyshev(Mean, Sd) UCL 91.39
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 100.4
95% Approximate Gamma UCL (Use when n >= 40)	80.75	
95% Adjusted Gamma UCL (Use when n < 40)	81.33	

Potential UCL to Use	Use 95% Student's-t UCL 80.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Cu_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	110	Minimum of Log Data	4.7
Maximum	148	Maximum of Log Data	4.997
Mean	130.5	Mean of log Data	4.868
Geometric Mean	130	SD of log Data	0.0838
Median	133		
SD	10.82		
Std. Error of Mean	2.793		
Coefficient of Variation	0.0829		
Skewness	-0.12		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.974	Shapiro Wilk Test Statistic	0.971
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	135.4	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	142.8
95% Adjusted-CLT UCL (Chen-1995)	135	97.5% Chebyshev (MVUE) UCL	148.1
95% Modified-t UCL (Johnson-1978)	135.4	99% Chebyshev (MVUE) UCL	158.6

Gamma Distribution Test		Data Distribution
k star (bias corrected)	123.3	Data appear Normal at 5% Significance Level
Theta Star	1.058	
MLE of Mean	130.5	
MLE of Standard Deviation	11.75	
nu star	3698	
Approximate Chi Square Value (.05)	3557	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 135.1
Adjusted Chi Square Value	3541	95% Jackknife UCL 135.4
		95% Standard Bootstrap UCL 134.9
Anderson-Darling Test Statistic	0.21	95% Bootstrap-t UCL 135.3
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 134.9
Kolmogorov-Smirnov Test Statistic	0.138	95% Percentile Bootstrap UCL 134.9
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 134.9
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 142.6
		97.5% Chebyshev(Mean, Sd) UCL 147.9
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 158.3
95% Approximate Gamma UCL (Use when n >= 40)	135.6	
95% Adjusted Gamma UCL (Use when n < 40)	136.3	

Potential UCL to Use		Use 95% Student's-t UCL	135.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Li_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	29.5	Minimum of Log Data	3.384
Maximum	39.3	Maximum of Log Data	3.671
Mean	34.85	Mean of log Data	3.548
Geometric Mean	34.73	SD of log Data	0.0883
Median	35.4		
SD	3.031		
Std. Error of Mean	0.783		
Coefficient of Variation	0.087		
Skewness	-0.244		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.962	Shapiro Wilk Test Statistic	0.956
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	36.23	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	38.32
95% Adjusted-CLT UCL (Chen-1995)	36.09	97.5% Chebyshev (MVUE) UCL	39.82
95% Modified-t UCL (Johnson-1978)	36.22	99% Chebyshev (MVUE) UCL	42.77

Gamma Distribution Test		Data Distribution
k star (bias corrected)	111.3	Data appear Normal at 5% Significance Level
Theta Star	0.313	
MLE of Mean	34.85	
MLE of Standard Deviation	3.304	
nu star	3339	
Approximate Chi Square Value (.05)	3206	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 36.14
Adjusted Chi Square Value	3190	95% Jackknife UCL 36.23
		95% Standard Bootstrap UCL 36.08
Anderson-Darling Test Statistic	0.232	95% Bootstrap-t UCL 36.18
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 36.07
Kolmogorov-Smirnov Test Statistic	0.117	95% Percentile Bootstrap UCL 36.08
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 36.05
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 38.26
		97.5% Chebyshev(Mean, Sd) UCL 39.74
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 42.64
95% Approximate Gamma UCL (Use when n >= 40)	36.3	
95% Adjusted Gamma UCL (Use when n < 40)	36.49	

Potential UCL to Use	Use 95% Student's-t UCL 36.23

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Mn_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	145	Minimum of Log Data	4.977
Maximum	282	Maximum of Log Data	5.642
Mean	249.6	Mean of log Data	5.501
Geometric Mean	245	SD of log Data	0.213
Median	265		
SD	43.34		
Std. Error of Mean	11.19		
Coefficient of Variation	0.174		
Skewness	-2.096		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.646	Shapiro Wilk Test Statistic	0.595
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	269.3	95% H-UCL	278
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	310.7
95% Adjusted-CLT UCL (Chen-1995)	261.5	97.5% Chebyshev (MVUE) UCL	336.8
95% Modified-t UCL (Johnson-1978)	268.3	99% Chebyshev (MVUE) UCL	388.2

Gamma Distribution Test		Data Distribution
k star (bias corrected)	21.79	Data do not follow a Discernable Distribution (0.05)
Theta Star	11.46	
MLE of Mean	249.6	
MLE of Standard Deviation	53.47	
nu star	653.7	
Approximate Chi Square Value (.05)	595.4	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 268
Adjusted Chi Square Value	588.5	95% Jackknife UCL 269.3
		95% Standard Bootstrap UCL 267.6
Anderson-Darling Test Statistic	2.619	95% Bootstrap-t UCL 264.5
Anderson-Darling 5% Critical Value	0.735	95% Hall's Bootstrap UCL 263.1
Kolmogorov-Smirnov Test Statistic	0.319	95% Percentile Bootstrap UCL 266.4
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 262.4
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 298.4
		97.5% Chebyshev(Mean, Sd) UCL 319.5
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 360.9
95% Approximate Gamma UCL (Use when n >= 40)	274	
95% Adjusted Gamma UCL (Use when n < 40)	277.2	

Potential UCL to Use		Use 95% Student's-t UCL	269.3
		or 95% Modified-t UCL	268.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Mo_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	3	Minimum of Log Data	1.099
Maximum	3.37	Maximum of Log Data	1.215
Mean	3.187	Mean of log Data	1.158
Geometric Mean	3.185	SD of log Data	0.0366
Median	3.21		
SD	0.116		
Std. Error of Mean	0.03		
Coefficient of Variation	0.0365		
Skewness	-0.269		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.95	Shapiro Wilk Test Statistic	0.946
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	3.239	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	3.318
95% Adjusted-CLT UCL (Chen-1995)	3.234	97.5% Chebyshev (MVUE) UCL	3.375
95% Modified-t UCL (Johnson-1978)	3.239	99% Chebyshev (MVUE) UCL	3.487

Gamma Distribution Test		Data Distribution
k star (bias corrected)	640.7	Data appear Normal at 5% Significance Level
Theta Star	0.00497	
MLE of Mean	3.187	
MLE of Standard Deviation	0.126	
nu star	19220	
Approximate Chi Square Value (.05)	18899	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 3.236
Adjusted Chi Square Value	18860	95% Jackknife UCL 3.239
		95% Standard Bootstrap UCL 3.233
Anderson-Darling Test Statistic	0.319	95% Bootstrap-t UCL 3.238
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 3.233
Kolmogorov-Smirnov Test Statistic	0.12	95% Percentile Bootstrap UCL 3.233
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 3.231
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 3.317
		97.5% Chebyshev(Mean, Sd) UCL 3.374
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 3.485
95% Approximate Gamma UCL (Use when n >= 40)	3.241	
95% Adjusted Gamma UCL (Use when n < 40)	3.248	

Potential UCL to Use		Use 95% Student's-t UCL	3.239

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Ni_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	65.3	Minimum of Log Data	4.179
Maximum	255	Maximum of Log Data	5.541
Mean	93.91	Mean of log Data	4.466
Geometric Mean	87.04	SD of log Data	0.357
Median	77.3		
SD	48.59		
Std. Error of Mean	12.55		
Coefficient of Variation	0.517		
Skewness	3.011		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.573	Shapiro Wilk Test Statistic	0.718
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	116	95% H-UCL	111.6
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	130.1
95% Adjusted-CLT UCL (Chen-1995)	125	97.5% Chebyshev (MVUE) UCL	146.5
95% Modified-t UCL (Johnson-1978)	117.6	99% Chebyshev (MVUE) UCL	178.6

Gamma Distribution Test		Data Distribution
k star (bias corrected)	5.445	Data do not follow a Discernable Distribution (0.05)
Theta Star	17.25	
MLE of Mean	93.91	
MLE of Standard Deviation	40.24	
nu star	163.4	
Approximate Chi Square Value (.05)	134.8	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 114.5
Adjusted Chi Square Value	131.6	95% Jackknife UCL 116
		95% Standard Bootstrap UCL 114.3
Anderson-Darling Test Statistic	1.898	95% Bootstrap-t UCL 182.3
Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL 203
Kolmogorov-Smirnov Test Statistic	0.269	95% Percentile Bootstrap UCL 116.6
Kolmogorov-Smirnov 5% Critical Value	0.222	95% BCA Bootstrap UCL 127.4
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 148.6
		97.5% Chebyshev(Mean, Sd) UCL 172.3
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 218.7
95% Approximate Gamma UCL (Use when n >= 40)	113.8	
95% Adjusted Gamma UCL (Use when n < 40)	116.6	

Potential UCL to Use	
Use 95% Student's-t UCL	116
or 95% Modified-t UCL	117.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Pb_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	14

Raw Statistics		Log-transformed Statistics	
Minimum	7.59	Minimum of Log Data	2.027
Maximum	10.5	Maximum of Log Data	2.351
Mean	9.265	Mean of log Data	2.22
Geometric Mean	9.21	SD of log Data	0.114
Median	9.52		
SD	1.022		
Std. Error of Mean	0.264		
Coefficient of Variation	0.11		
Skewness	-0.582		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.887	Shapiro Wilk Test Statistic	0.874
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	9.729	95% H-UCL	9.781
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	10.46
95% Adjusted-CLT UCL (Chen-1995)	9.656	97.5% Chebyshev (MVUE) UCL	10.98
95% Modified-t UCL (Johnson-1978)	9.723	99% Chebyshev (MVUE) UCL	11.99

Gamma Distribution Test		Data Distribution
k star (bias corrected)	67.35	Data appear Normal at 5% Significance Level
Theta Star	0.138	
MLE of Mean	9.265	
MLE of Standard Deviation	1.129	
nu star	2021	
Approximate Chi Square Value (.05)	1917	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 9.699
Adjusted Chi Square Value	1905	95% Jackknife UCL 9.729
		95% Standard Bootstrap UCL 9.678
Anderson-Darling Test Statistic	0.733	95% Bootstrap-t UCL 9.708
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 9.641
Kolmogorov-Smirnov Test Statistic	0.198	95% Percentile Bootstrap UCL 9.669
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 9.659
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 10.41
		97.5% Chebyshev(Mean, Sd) UCL 10.91
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 11.89
95% Approximate Gamma UCL (Use when n >= 40)	9.764	
95% Adjusted Gamma UCL (Use when n < 40)	9.828	

Potential UCL to Use		Use 95% Student's-t UCL	9.729

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Sb_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	0.568	Minimum of Log Data	-0.566
Maximum	1.05	Maximum of Log Data	0.0488
Mean	0.746	Mean of log Data	-0.305
Geometric Mean	0.737	SD of log Data	0.161
Median	0.773		
SD	0.122		
Std. Error of Mean	0.0316		
Coefficient of Variation	0.164		
Skewness	0.727		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.922	Shapiro Wilk Test Statistic	0.943
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	0.801	95% H-UCL	0.806
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.881
95% Adjusted-CLT UCL (Chen-1995)	0.804	97.5% Chebyshev (MVUE) UCL	0.94
95% Modified-t UCL (Johnson-1978)	0.802	99% Chebyshev (MVUE) UCL	1.055

Gamma Distribution Test		Data Distribution
k star (bias corrected)	33.01	Data appear Normal at 5% Significance Level
Theta Star	0.0226	
MLE of Mean	0.746	
MLE of Standard Deviation	0.13	
nu star	990.4	
Approximate Chi Square Value (.05)	918.3	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 0.798
Adjusted Chi Square Value	909.8	95% Jackknife UCL 0.801
		95% Standard Bootstrap UCL 0.796
Anderson-Darling Test Statistic	0.402	95% Bootstrap-t UCL 0.805
Anderson-Darling 5% Critical Value	0.735	95% Hall's Bootstrap UCL 0.821
Kolmogorov-Smirnov Test Statistic	0.145	95% Percentile Bootstrap UCL 0.796
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 0.802
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 0.883
		97.5% Chebyshev(Mean, Sd) UCL 0.943
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 1.06
95% Approximate Gamma UCL (Use when n >= 40)	0.804	
95% Adjusted Gamma UCL (Use when n < 40)	0.812	

Potential UCL to Use		Use 95% Student's-t UCL	0.801

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sr_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	11

Raw Statistics		Log-transformed Statistics	
Minimum	2370	Minimum of Log Data	7.771
Maximum	2680	Maximum of Log Data	7.894
Mean	2539	Mean of log Data	7.839
Geometric Mean	2538	SD of log Data	0.0325
Median	2560		
SD	81.98		
Std. Error of Mean	21.17		
Coefficient of Variation	0.0323		
Skewness	-0.409		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.944	Shapiro Wilk Test Statistic	0.94
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	2577	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2632
95% Adjusted-CLT UCL (Chen-1995)	2572	97.5% Chebyshev (MVUE) UCL	2672
95% Modified-t UCL (Johnson-1978)	2576	99% Chebyshev (MVUE) UCL	2751

Gamma Distribution Test		Data Distribution
k star (bias corrected)	815.1	Data appear Normal at 5% Significance Level
Theta Star	3.115	
MLE of Mean	2539	
MLE of Standard Deviation	88.94	
nu star	24454	
Approximate Chi Square Value (.05)	24091	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 2574
Adjusted Chi Square Value	24047	95% Jackknife UCL 2577
		95% Standard Bootstrap UCL 2573
Anderson-Darling Test Statistic	0.488	95% Bootstrap-t UCL 2575
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 2573
Kolmogorov-Smirnov Test Statistic	0.206	95% Percentile Bootstrap UCL 2573
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 2570
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 2632
		97.5% Chebyshev(Mean, Sd) UCL 2672
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 2750
95% Approximate Gamma UCL (Use when n >= 40)	2578	
95% Adjusted Gamma UCL (Use when n < 40)	2582	

Potential UCL to Use		Use 95% Student's-t UCL	2577

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

Tl_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	0.102	Minimum of Log Data	-2.283
Maximum	0.294	Maximum of Log Data	-1.224
Mean	0.166	Mean of log Data	-1.836
Geometric Mean	0.159	SD of log Data	0.283
Median	0.159		
SD	0.0498		
Std. Error of Mean	0.0129		
Coefficient of Variation	0.301		
Skewness	1.149		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.915	Shapiro Wilk Test Statistic	0.97
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	0.188	95% H-UCL	0.191
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.219
95% Adjusted-CLT UCL (Chen-1995)	0.191	97.5% Chebyshev (MVUE) UCL	0.242
95% Modified-t UCL (Johnson-1978)	0.189	99% Chebyshev (MVUE) UCL	0.287

Gamma Distribution Test		Data Distribution
k star (bias corrected)	10.52	Data appear Normal at 5% Significance Level
Theta Star	0.0157	
MLE of Mean	0.166	
MLE of Standard Deviation	0.0511	
nu star	315.7	
Approximate Chi Square Value (.05)	275.5	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 0.187
Adjusted Chi Square Value	270.9	95% Jackknife UCL 0.188
		95% Standard Bootstrap UCL 0.186
Anderson-Darling Test Statistic	0.264	95% Bootstrap-t UCL 0.194
Anderson-Darling 5% Critical Value	0.737	95% Hall's Bootstrap UCL 0.199
Kolmogorov-Smirnov Test Statistic	0.149	95% Percentile Bootstrap UCL 0.188
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 0.192
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 0.222
		97.5% Chebyshev(Mean, Sd) UCL 0.246
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 0.294
95% Approximate Gamma UCL (Use when n >= 40)	0.19	
95% Adjusted Gamma UCL (Use when n < 40)	0.193	

Potential UCL to Use		Use 95% Student's-t UCL	0.188

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	8.44	Minimum of Log Data	2.133
Maximum	9.55	Maximum of Log Data	2.257
Mean	8.983	Mean of log Data	2.195
Geometric Mean	8.977	SD of log Data	0.0391
Median	8.95		
SD	0.351		
Std. Error of Mean	0.0906		
Coefficient of Variation	0.039		
Skewness	-0.00444		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.951	Shapiro Wilk Test Statistic	0.95
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	9.143	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	9.379
95% Adjusted-CLT UCL (Chen-1995)	9.132	97.5% Chebyshev (MVUE) UCL	9.55
95% Modified-t UCL (Johnson-1978)	9.143	99% Chebyshev (MVUE) UCL	9.886

Gamma Distribution Test		Data Distribution
k star (bias corrected)	561.6	Data appear Normal at 5% Significance Level
Theta Star	0.016	
MLE of Mean	8.983	
MLE of Standard Deviation	0.379	
nu star	16848	
Approximate Chi Square Value (.05)	16547	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 9.132
Adjusted Chi Square Value	16511	95% Jackknife UCL 9.143
		95% Standard Bootstrap UCL 9.127
Anderson-Darling Test Statistic	0.283	95% Bootstrap-t UCL 9.143
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL 9.131
Kolmogorov-Smirnov Test Statistic	0.129	95% Percentile Bootstrap UCL 9.137
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 9.125
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 9.378
		97.5% Chebyshev(Mean, Sd) UCL 9.549
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 9.884
95% Approximate Gamma UCL (Use when n >= 40)	9.147	
95% Adjusted Gamma UCL (Use when n < 40)	9.167	

Potential UCL to Use		Use 95% Student's-t UCL	9.143

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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

V_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15

Raw Statistics		Log-transformed Statistics	
Minimum	279	Minimum of Log Data	5.631
Maximum	591	Maximum of Log Data	6.382
Mean	411.3	Mean of log Data	5.981
Geometric Mean	395.7	SD of log Data	0.286
Median	347		
SD	120.5		
Std. Error of Mean	31.11		
Coefficient of Variation	0.293		
Skewness	0.467		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.81	Shapiro Wilk Test Statistic	0.829
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	466.1	95% H-UCL	475.5
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	544.6
95% Adjusted-CLT UCL (Chen-1995)	466.5	97.5% Chebyshev (MVUE) UCL	602.4
95% Modified-t UCL (Johnson-1978)	466.8	99% Chebyshev (MVUE) UCL	715.9

Gamma Distribution Test		Data Distribution
k star (bias corrected)	10.47	Data do not follow a Discernable Distribution (0.05)
Theta Star	39.28	
MLE of Mean	411.3	
MLE of Standard Deviation	127.1	
nu star	314.2	
Approximate Chi Square Value (.05)	274.1	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 462.5
Adjusted Chi Square Value	269.5	95% Jackknife UCL 466.1
		95% Standard Bootstrap UCL 460.6
Anderson-Darling Test Statistic	1.288	95% Bootstrap-t UCL 470
Anderson-Darling 5% Critical Value	0.737	95% Hall's Bootstrap UCL 457.4
Kolmogorov-Smirnov Test Statistic	0.289	95% Percentile Bootstrap UCL 462.3
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL 465.8
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 546.9
		97.5% Chebyshev(Mean, Sd) UCL 605.6
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 720.9
95% Approximate Gamma UCL (Use when n >= 40)	471.5	
95% Adjusted Gamma UCL (Use when n < 40)	479.5	

Potential UCL to Use		Use 95% Student's-t UCL	466.1
		or 95% Modified-t UCL	466.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Zn_ppm

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	14

Raw Statistics		Log-transformed Statistics	
Minimum	51.7	Minimum of Log Data	3.945
Maximum	152	Maximum of Log Data	5.024
Mean	84.93	Mean of log Data	4.385
Geometric Mean	80.22	SD of log Data	0.345
Median	74		
SD	30.68		
Std. Error of Mean	7.922		
Coefficient of Variation	0.361		
Skewness	0.863		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.905	Shapiro Wilk Test Statistic	0.94
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	98.88	95% H-UCL	101.6
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	118.2
95% Adjusted-CLT UCL (Chen-1995)	99.84	97.5% Chebyshev (MVUE) UCL	132.7
95% Modified-t UCL (Johnson-1978)	99.17	99% Chebyshev (MVUE) UCL	161.1

Gamma Distribution Test		Data Distribution
k star (bias corrected)	7.186	Data appear Normal at 5% Significance Level
Theta Star	11.82	
MLE of Mean	84.93	
MLE of Standard Deviation	31.68	
nu star	215.6	
Approximate Chi Square Value (.05)	182.6	**Nonparametric Statistics**
Adjusted Level of Significance	0.0324	95% CLT UCL 97.96
Adjusted Chi Square Value	178.9	95% Jackknife UCL 98.88
		95% Standard Bootstrap UCL 97.97
Anderson-Darling Test Statistic	0.383	95% Bootstrap-t UCL 102.8
Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL 100.4
Kolmogorov-Smirnov Test Statistic	0.147	95% Percentile Bootstrap UCL 97.41
Kolmogorov-Smirnov 5% Critical Value	0.222	95% BCA Bootstrap UCL 100.5
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 119.5
		97.5% Chebyshev(Mean, Sd) UCL 134.4
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 163.8
95% Approximate Gamma UCL (Use when n >= 40)	100.3	
95% Adjusted Gamma UCL (Use when n < 40)	102.4	

Potential UCL to Use	Use 95% Student's-t UCL 98.88

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.