

REMEDIAL ACTION PLAN

SHEBOYGAN RIVER AND HARBOR SUPERFUND SITE TECUMSEH DEWATERING SITE, SHEBOYGAN FALLS, WI AND MARYLAND AVENUE DEWATERING SITE, SHEBOYGAN, WI

SME Project Number: 069638.00.025.001

August 10, 2017

SME



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1. INTRODUCTION

We prepared this Remedial Action Plan (RAP) to address previously undiscovered, historical polychlorinated biphenyl (PCB) impact in soils at the Tecumseh Falls dewatering facility of the Sheboygan River and Harbor Superfund Site (Site). The PCB impact was discovered during the post remedial sampling of the facility to evaluate the potential that release of sediment during dewatering may have affected the soil. The RAP is also intended to address the Maryland Avenue dewatering facility where lead and polynuclear aromatic hydrocarbons (PAHs) were encountered in shallow soils at concentrations exceeding commercial/industrial preliminary remedial goals (PRGs).

The objective of this RAP is to evaluate the need for remediation at the two dewatering sites and the remedial options to protect human health and the environment. Descriptions of the Site history and known current environmental conditions; data evaluation, proposed remedial methods, reporting; and the estimated project schedule are presented in the following sections.

2. SITE HISTORY AND CURRENT CONDITIONS

The following subsections summarizes the Site history, current Site conditions, and environmental conditions identified during previous investigations of the Property.

2.1 SITE HISTORY

Tecumseh, a manufacturer of refrigeration and air conditioning compressors and gasoline engines, was located adjacent to the Sheboygan River in Sheboygan Falls, Wisconsin. Polychlorinated biphenyls (PCBs) were found in sewer lines that lead to the River from Tecumseh and in hydraulic fluids used in Tecumseh Products Company's Diecast Division manufacturing processes. Prior to remediation, the contamination level was high in the sediments immediately surrounding the Tecumseh Falls Site, but decreased in concentration downstream.

The Record of Decision (ROD) listed the risks at the Sheboygan River and Harbor Superfund site to be from the chemicals of concern, metals and PCBs. Metals, PCBs, and polynuclear aromatic hydrocarbons (PAHs) were the as potential chemicals of concern (PCOC). The metals listed as the target of concern for the Remedial Investigations were cadmium, chromium, copper, lead, mercury, nickel, and zinc. Pesticides, dioxins, and dibenzofurans were not present in the sediment and as such, were no longer PCOC.

Between 2005 and 2013, Pollution Risk Services (PRS) and others remediated the river sediments. PRS dewatered the dredged sediment at the Tecumseh Falls and Maryland Avenue sites (Figure 1).

2.2 CURRENT CONDITIONS

Following the sediment remediation activities, the two dewatering sites have remained vacant. In accordance with the approved Sampling and Analysis Plans, SME sampled the areas where one of the geo-tubes broke releasing water outside of the dewatering pads, the wastewater treatment facilities, and the Confined Treatment Facility (CTF) or Sediment Management Facility (SMF) in 2016.

The results of this Phase II ESA demonstrated that soil at the Tecumseh Falls facility is impacted with concentrations of PCBs and PAHs; however, the impact was not the result of dewatering releases or activities by PRS. The impacted soil represents an undiscovered historical release from historical operations that occurred prior the remediation performed by PRS.

The concentrations of PAHs and PCBs at several locations at the Tecumseh Falls facility exceed the 2016 cleanup criteria or screening levels for commercial/industrial receptors. As such, impacted soil in these areas must be addressed through remediation or an engineering control before the Tecumseh facility meets the risk goals. The total cumulative direct contact risk is acceptable for commercial/industrial receptors as long as the soil impacted with PAH and PCB at concentrations above the PCSLs are addressed via remediation or engineering controls. There is no residual impact from at the former CTF and SMF from sediment management activities completed by Tecumseh prior the remediation performed by PRS. Figure 2 shows the location of the impacted soils.

The results of this Phase II ESA demonstrated that soil at Maryland Avenue facility was impacted with concentrations of PAHs and lead; however, the impact is not the result of dewatering releases or activities by PRS. The impacted soil represents an undiscovered historical release from historical operations that occurred prior the remediation performed by PRS.

The concentrations of PAHs and/or lead at several locations exceeded the 2016 cleanup criteria or screening levels for commercial/industrial receptors (Figure 3). As such, SME evaluated if the impacted soil in these areas need to be addressed to protect human health and the environment.

3. REMEDIAL EVALUATION

3.1 TECUMSEH FALLS

The two remedial options are either removal of impacted soil and off-site disposal or capping of the impacted soil to prevent direct contact with soils. The former building slab already acts as an engineering control for the soil located beneath it. The draft *Institutional Control, Implementation, and Assurance Plan* addresses this engineering control in Sections 2.3, 2.8, 3.1, 3.3, and 6.3. To be consistent, SME and PRS propose to expand the engineering control to cover the adjoining impacted soils. This option is the most economical by approximately an order of magnitude.

SME will install temporary surface water run-off controls to prevent migration of the impacted soils until we perform remedial activities. Please reference SME Serial Letter #39 (August 10, 2017) for a discussion of the proposed controls.

3.2 MARYLAND AVENUE

The impacted soil is limited to four locations and exposure to only those soils would not be a representative site exposure to future receptors. The USEPA guidance *Calculating Upper Confidence Limit for Exposure Point Concentration at Hazardous Waste Sites* (OSWER 9285 6-10), is an update to the *Risk Assessment Guidance Document for Superfund* (RAGs). This guidance states: "Unless there is site-specific evidence to the contrary, an individual receptor is assumed to be equally exposed to media within all portions of the exposure unit over time frame of the risk assessment." RAGs stated the USEPA recommends using the average concentrations to represent "a reasonable estimate of the concentration over time." However, the OSWER update recommended using a 95% UCL as a reasonable exposure point concentration.

The concentrations of the chemicals of concern (COCs) that exceeded the 2016 screening levels at the Maryland Avenue facility are summarized below. The average COC concentrations in the soil intervals within the POC are provided demonstrating that within the POC, only the concentrations of benzo[a]pyrene are close to the screening level. However, all of the COCs will be evaluated by comparing the 95% UCL to the screening levels.

		SAMPL	E DEPTH II	NTERVAL		2017 RSL				
	0-0.5	0.5-1.5	1.5-3.5	AVERAGE	OR CLEANUP CRITERIA ¹					
	B1	Penze [e]nyrene	6.92	0.414	0.0406	2.5	24			
	B1-1W	Benzolalbhiene	4.28	0.102	< 0.0032	1.46	21			
		Benzo[a]pyrene	27.7	2.02	1.97	10.6	21			
Commission	H4	Benzo[b]fluoranthene	32.5	2.61	2.31	12.5	210			
Samples		Lead	1,530	219	174	641	800			
	H4-2NW	Benzo[a]anthracene	29.2	4.00	0.387	11.2	210			
		Benzo[a]pyrene	23.2	3.73	0.455	9.1	21			
		Benzo[b]fluoranthene	38.2	5.68	0.569	14.8	210			
Results in m	Results in mg/kg.									

SME calculated the 95% UCL using the UEPA program, ProUCL. The results are summarized below and are provided in Appendix A.

CHEMICAL OF CONCERN	EXPOSURE POINT CONCENTRATION	RSL OR CLEANUP CRITERIA
Benzo[a]pyrene	5.21	21
Benzo[a]anthracene	3.48	210
Benzo[b]fluoranthene	8.04	210
Lead	175	800
Results in mg/kg.		

The exposure point concentrations are less than the screening level and exposure to site soils does not pose and unacceptable risk at a carcinogenic risk of 10⁻⁵ and THQ of 1.0. As such, SME and PRS recommended that no further action is required at the Maryland Avenue facility.

4. CONCLUSIONS

The soil at the Tecumseh Falls facility should be capped to protect the public and groundwater. The soil at the Maryland Avenue facility does not pose a risk to the public.

FIGURES

FIGURE 1 - SITE LOCATION MAP AND DEWATERING SITES FIGURE 2 - TECUMSEH PCB IMPACT AREA FIGURE 3 - MARYLAND AVENUE IMPACT AREA



NOTE: DRAWING INFORMATION TAKEN FROM GOOGLE MAPS AND USGS 7.5-MINUTE TOPOGRAPHIC MAPS OF THE SHEBOYGAN SOUTH AND SHEBOYGAN FALLS QUADRANGLES, WISCONSIN, 1994.



Project

SHEBOYGAN RIVER AND HARBOR SUPERFUND SITES

ProjectLocation

SHEBOYGAN AND SHEBOYGAN FALLS, WISCONSIN

Sheet Name

DEWATERING SITES LOCATION MAP

No. Revision Date

Date

CADD

9-12-2016

JWH

Designer JWH

Scale NOT TO SCALE

Project 069638.00.024.001

Figure No.

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DRAWING NOTE: SCALE DEPICTED IS MEANT FOR 11 X 17 AND WILL SCALE INCORRECTLY IF PRINTED OTHER SIZES

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GRAF

РНІС	80' 160' SCALE: 1" = 80'	Project SHEBOYGAN RIVER SUPERFUND SITE
		Project Location
		SHEBOYGAN FALLS, WISCONSIN
D		
	EXISTING TREE AND/OR BRUSH	
_	EXISTING ROAD	Sheet Name
-0-		PHASE II SAMPLE
		EVENT OF
<u> </u>		IMPACTED SOIL-
	LOCATION	TECUMSEH SITE
	REMEDIATED BY EXCAVATION	No. Revision Date
	IMPACTED SOIL	
		Date 7-13-17
		GBK/JAB
		Designer KE
		Scale 1" = 80'
		Project 069638.00.025.001
INFOF TION	RMATION TAKEN FROM PRS 2006 DOCUMENTATION REPORT AND	Figure No. 2
ARTH	PRO WITH IMAGE DATE 6-1-2015.	DRAWING NOTE: SCALE DEPICTED IS MEANT FOR 11" X 17" AND WILL SCALE INCORRECTLY IF PRINTED ON ANY OTHER SIZE MEDIA
		NO REPRODUCTION SHALL BE MADE WITHOUT THE PRIOR CONSENT OF SME





APPENDIX 1 PROUCL DOCUMENTATION

	A B C				П			J				
1		General UCL Statistics	ior ruli Data	Seis								
2	User Selected Options											
3	From File	Sheet1.wst										
4	Full Precision											
5	Confidence Coefficient	95%										
6	Number of Bootstrap Operations											
7												
8												
9	Benzo(a)pyrene											
10												
11			General	Statistics								
12	Numb	per of Valid Observations	5 75			Num	ber of D	Distinct	Observ	ations	70	
13												
14	Raw St	tatistics				Log-transf	formed	Statisti	ics			
15		Minimun	n 0.0013				Ν	Minimur	m of Lo	g Data	-6.64	5
16		Maximun	n 27.7				Ν	laximur	m of Lo	g Data	3.32	1
17		Mear	n 1.183					Mea	an of lo	g Data	-2.49)1
18		Geometric Mear	n 0.0828					S	SD of lo	g Data	2.449	Э
19		Mediar	n 0.0611									
20		SE	4.204									
21		Std. Error of Mear	n 0.485									
21		Coefficient of Variation	1 3.552									
22		Skewness	5.508									
23												
24			Relevant U	CL Statistics								
25	Normal Dist	ribution Test			L	ognormal	Distrib	oution T	est			
20		Lilliefors Test Statistic	0.389			- J	L	illiefors	Test S	tatistic	0.073	39
27									<u> </u>			`
20		Lilliefors Critical Value	e 0.102				Li	illiefors	Critical	l Value	0.102	2
28	Data not Normal at 5	Lilliefors Critical Value	90.102		Data appea	r Loanorm	Li nal at 5	illiefors	Critical ificanc	l Value e Leve	0.102	2
28 29	Data not Normal at 5	Lilliefors Critical Value % Significance Level	9.102		Data appea	r Lognorm	Li nal at 5	illiefors % Sign	Critical iificanc	l Value e Leve	0.102 I	2
28 29 30	Data not Normal at 5	Lilliefors Critical Value % Significance Level	0.102		Data appea	r Lognorm	Li nal at 5	illiefors % Sign	Critical	l Value e Leve	0.102	2
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28 29 30 31 32	Data not Normal at 5 Assuming Norm	Lilliefors Critical Value % Significance Level mal Distribution 95% Student's-t UCI sted for Skewness)	0.102 1.992		Data appea Ass	ur Lognorm	Li nal at 5 gnorma % Chel	illiefors % Sign al Distri	bution 95% I	H-UCL	0.102 5.207	7
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28 29 30 31 32 33 34	Data not Normal at 5 Assuming Norm 95% UCLs (Adjus 95% Adjusted 95% Modifie	Lilliefors Critical Value % Significance Level mal Distribution 95% Student's-t UCI sted for Skewness) d-CLT UCL (Chen-1995 ad-t UCL (Johnson-1978)	 0.102 1.992 2.312 2.044 		Data appea Ass	er Lognorm Suming Log 95 97.5	Li nal at 5 gnorma % Chel % Chel	illiefors % Sign al Distri byshev byshev	bution 95% I (MVUE (MVUE	H-UCL H-UCL H-UCL H-UCL	0.102 5.207 4.372 5.642 8.137	7 2 2 7 2 7 7 2 7 7 7 7 7 7 7 7 7 7 7 7
28 29 30 31 32 33 34 35	Data not Normal at 5 Assuming Norm 95% UCLs (Adjust 95% Adjuster 95% Modifie	Lilliefors Critical Value % Significance Level mal Distribution 95% Student's-t UCI sted for Skewness) d-CLT UCL (Chen-1995 ed-t UCL (Johnson-1978	 0.102 1.992 2.312 2.044 		Data appea Ass	ur Lognorm suming Log 95 97.5 99	Li nal at 5 gnorma % Chel % Chel % Chel	illiefors % Sign al Distri byshev byshev byshev	bution 95% I (MVUE (MVUE	H-UCL E) UCL E) UCL E) UCL E) UCL	0.102 5.207 4.372 5.642 8.137	7 2 2 7
28 29 30 31 32 33 34 35 36	Data not Normal at 5 Assuming Norm 95% UCLs (Adjusted 95% Adjusted 95% Modifie	Lilliefors Critical Value % Significance Level mal Distribution 95% Student's-t UCI sted for Skewness) d-CLT UCL (Chen-1995 ed-t UCL (Johnson-1978 ribution Test	 0.102 1.992 2.312 2.044 		Data appea	uming Log 95 97.5 99	Li nal at 5 gnorma % Chel % Chel % Chel	illiefors % Sign al Distri byshev byshev byshev	bution 95% I (MVUE (MVUE	H-UCL E) UCL E) UCL E) UCL E) UCL	0.102 5.207 4.372 5.642 8.137	7 2 2 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7
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28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46	Data not Normal at 5 Assuming Norm 95% UCLs (Adjus 95% Adjusted 95% Modifie Gamma Dist ML Approximate Adjus Ad	Lilliefors Critical Value % Significance Level mal Distribution 95% Student's-t UCI sted for Skewness) d-CLT UCL (Chen-1995 ed-t UCL (Johnson-1978 tribution Test k star (bias corrected Theta Sta MLE of Mear LE of Standard Deviatior nu sta e Chi Square Value (.05 ted Level of Significance ljusted Chi Square Value	 0.102 1.992 2.312 2.044 2.044 0.263 4.501 1.183 2.308 39.44 26.05 0.0468 25.84 4.505 		Data appea	r Lognorm suming Log 95 97.5 99 Data r Lognorm Nonparar 95	Li nal at 5 gnorma % Chel % Chel % Chel Distrib nal at 5 metric \$	illiefors % Sign al Distril byshev byshev byshev ution % Sign % Sign 9 55% J ndard B	Critical ificance bution 95% I (MVUE (MVUE (MVUE ificance ificance cs 95% CL ackknif Bootstra	T UCL E Leve T UCL T UCL fe UCL fe UCL p UCL	0.102 5.207 4.372 5.642 8.137 8.137 1.982 1.982 1.992	2 7 2 7 7 2 7 2 2 7 7 2 2 2 2 2 2 2 2 2
28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47	Data not Normal at 5 Assuming Norm 95% UCLs (Adjus 95% Adjusted 95% Modifie Gamma Dist ML Approximate Adjus Adjus Adjus	Lilliefors Critical Value % Significance Level mal Distribution 95% Student's-t UCI sted for Skewness) d-CLT UCL (Chen-1995 ed-t UCL (Johnson-1978 ribution Test k star (bias corrected Theta Sta MLE of Mear LE of Standard Deviatior nu sta e Chi Square Value (.05 ted Level of Significance ijusted Chi Square Value	 0.102 1.992 2.312 2.044 2.044 0.263 4.501 1.183 2.308 39.44 26.05 0.0468 25.84 24.292 2.4292 		Data appea	Ir Lognorm Suming Log 95 97.5 99 Data Ir Lognorm Nonparar 95	Li nal at 5 gnorma % Chel % Chel % Chel Distrib nal at 5 metric \$	illiefors % Sign al Distril byshev byshev byshev ution % Sign % Sign Statistic 9 95% J ndard B	Critical ificance bution 95% I (MVUE (MVUE ificance ificance cs 25% CL ackknif Bootstrap	H-UCL H-UCL UCL UCL UCL UCL E) UCL C E Leve T UCL fe UCL p UCL -t UCL	0.102 5.207 4.372 5.642 8.137 8.137 9 1.982 1.982 1.992 1.962 4.372	2 7 2 2 7 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48	Data not Normal at 5 Assuming Norm 95% UCLs (Adjust 95% Adjusted 95% Modifie Gamma Dist Gamma Dist ML Approximate Adjus Adjus	Lilliefors Critical Value % Significance Level mal Distribution 95% Student's-t UCI sted for Skewness) d-CLT UCL (Chen-1995 ed-t UCL (Johnson-1978 ribution Test k star (bias corrected Theta Sta MLE of Mear LE of Standard Deviatior nu sta e Chi Square Value (.05 ited Level of Significance ljusted Chi Square Value son-Darling Test Statistic Darling 5% Critical Value	 0.102 1.992 2.312 2.044 2.044 0.263 4.501 1.183 2.308 39.44 26.05 0.0468 25.84 25.84 24.292 0.881 		Data appea	r Lognorm 95 97.5 99 Data r Lognorm Nonparar 95	Li nal at 5 gnorma % Chel % Chel Distrib nal at 5 metric \$	illiefors % Sign al Distril byshev byshev ution % Sign % Sign Statistic 9 95% J ndard B 95% Bo Hall's B	Critical ificance bution 95% I (MVUE (MVUE ificance ificance cs 95% CL ackknif Bootstrap Bootstra	H-UCL H-UCL) UCL) UCL) UCL) UCL) UCL) UCL) H-UCL IP UCL IP UCL	0.102 5.207 4.372 5.642 8.137 8.137 1.982 1.992 1.992 1.992 4.372 5.299	2 7 2 2 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7
28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49	Data not Normal at 5 Assuming Norm 95% UCLs (Adjus 95% Adjusted 95% Modifie 95% Modifie Gamma Dist ML Approximate Adjus	Lilliefors Critical Value % Significance Level mal Distribution 95% Student's-t UCI sted for Skewness) d-CLT UCL (Chen-1995 ed-t UCL (Johnson-1978 tribution Test k star (bias corrected Theta Sta MLE of Mear LE of Standard Deviation nu sta e Chi Square Value (.05 ted Level of Significance ljusted Chi Square Value son-Darling Test Statistic Darling 5% Critical Value ov-Smirnov Test Statistic	 0.102 1.992 2.312 2.044 2.044 0.263 4.501 1.183 2.308 39.44 26.05 0.0468 25.84 25.84 20.881 0.196 		Data appea	r Lognorm suming Log 95 97.5 99 Data r Lognorm Nonparar 95	Li nal at 5 gnorma % Chel % Chel % Chel Distrib nal at 5 metric \$	illiefors % Sign al Distril byshev byshev byshev ution % Sign % Sign % Sign 95% J ndard B 95% J ndard B 95% Bo Hall's B entile B	Critical ificance bution 95% I (MVUE (MVUE (MVUE ificance ificance ificance cs 95% CL ackknif Bootstra Bootstra Bootstra	T Value e Leve H-UCL D) UCL D) UCL D) UCL D) UCL E) UCL fe UCL ap UCL ap UCL	0.102 5.207 4.372 5.642 8.137 8.137 9 1.982 1.982 1.992 1.962 4.372 5.299 2.144	2 7 2 2 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7
28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50	Data not Normal at 5 Assuming Norm 95% UCLs (Adjus 95% Adjusted 95% Modifie Gamma Dist Gamma Dist Adjus Adju	Lilliefors Critical Value % Significance Level mal Distribution 95% Student's-t UCI sted for Skewness) d-CLT UCL (Chen-1995 ed-t UCL (Johnson-1978 ribution Test k star (bias corrected Theta Sta MLE of Mear LE of Standard Deviatior nu sta e Chi Square Value (.05 ted Level of Significance lijusted Chi Square Value son-Darling Test Statistic Darling 5% Critical Value ov-Smirnov Test Statistic	 0.102 1.992 2.312 2.044 2.044 0.263 4.501 1.183 2.308 39.44 26.05 0.0468 25.84 25.84 2.5.84 0.881 0.196 0.113 		Data appea	Ir Lognorm Suming Log 95 97.5 99 Data Ir Lognorm Nonparar 95	Li nal at 5 gnorma % Chel % Chel % Chel Distrib nal at 5 % Star § % Star § 95% [% Perc 95%	illiefors % Sign al Distril byshev byshev byshev ution % Sign % Sign % Sign % Sign 95% J ndard B 95% J ndard B 95% Bo Hall's B entile B entile B	Critical ificance bution 95% I (MVUE (MVUE ificance ificance cs 25% CL ackknif Bootstrap Bootstrap Bootstrap Bootstrap	H-UCL H-UCL UCL UCL UCL UCL UCL E UCL C C UCL C C UCL C C C C C C C C C C C C C	0.102 5.207 4.372 5.642 8.137 8.137 9 1.982 1.982 1.992 4.372 5.299 2.144 2.447	2 7 2 2 2 7 7 7 7 2 2 2 2 2 2 2 2 2 2 2
28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51	Data not Normal at 5 Assuming Norm 95% UCLs (Adjust 95% Adjusted 95% Modifie Gamma Dist Gamma Dist ML Approximate Adjus Adjus Adjus Adjus Adjus	Lilliefors Critical Value % Significance Level mal Distribution 95% Student's-t UCI sted for Skewness) d-CLT UCL (Chen-1995 ed-t UCL (Johnson-1978 ribution Test k star (bias corrected Theta Sta MLE of Mear LE of Standard Deviatior nu sta e Chi Square Value (.05 ited Level of Significance ljusted Chi Square Value con-Darling Test Statistic Darling 5% Critical Value cov-Smirnov Test Statistic mirnov 5% Critical Value ed at 5% Significance Level	 0.102 1.992 2.312 2.044 <		Data appea	r Lognorm ourming Log 95 97.5 99 Data r Lognorm Nonparar 95 95%	Li nal at 5 gnorma % Chel % Chel Distrib nal at 5 S% Star 95% Star 95% Star 95% Star 95% Star 95% Star	illiefors % Sign al Distril byshev byshev byshev ution % Sign % S	Critical ificanc bution 95% I (MVUE (MVUE (MVUE ificanc ificanc cs 95% CL ackknif Bootstra bootstra Bootstra Bootstra Bootstra Bootstra Bootstra Bootstra	H-UCL H-UCL H-UCL H-UCL H-UCL H H-UCL H H-UCL H H H-UCL H H H-UCL H H H H H H H H H H H H H H H H H H H	0.102 5.207 4.372 5.642 8.137 5.642 8.137 1.982 1.982 1.992 1.992 2.144 2.447 3.299	2 7 2 2 7 7 7 7 2 2 7 2 2 2 2 2 2 2 2 2
28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52	Data not Normal at 5 Assuming Norm 95% UCLs (Adjus 95% Adjusted 95% Modifie 95% Modifie Gamma Dist	Lilliefors Critical Value % Significance Level mal Distribution 95% Student's-t UCI sted for Skewness) d-CLT UCL (Chen-1995 ed-t UCL (Johnson-1978 tribution Test k star (bias corrected Theta Sta MLE of Mear LE of Standard Deviation nu sta e Chi Square Value (.05 ted Level of Significance ljusted Chi Square Value con-Darling Test Statistic Darling 5% Critical Value cov-Smirnov Test Statistic mirnov 5% Critical Value ed at 5% Significance Le	 0.102 1.992 2.312 2.044 2.044 0.263 4.501 1.183 2.308 39.44 26.05 0.0468 25.84 25.84 0.196 0.113 avel 		Data appea	r Lognorm suming Log 95 97.5 99 Data r Lognorm Nonparar 95 95 95% 97.5%	Li nal at 5 gnorma % Chel % Chel % Chel Distrib nal at 5 Distrib nal at 5 S% Star S 95% % Perc 95% % Perc 95% % Chebys	illiefors % Sign al Distril byshev byshev byshev ution % Sign % Sign % Sign % Sign 95% J ndard B 95% J ndard B 95% Bo Hall's B entile B shev(M shev(M	Critical ificance bution 95% I (MVUE (MVUE ificance ificance ificance ificance cs 25% CL ackknif bootstrap Bootstrap Bootstra Bootstra Bootstra Bootstra Bootstra Bootstra Bootstra Bootstra Bootstra Bootstra Bootstra	H-UCL H-UCL UCL UCL UCL UCL UCL UCL E UCL F UCL F UCL F UCL F UCL D D UCL D D D UCL D D D D D D D D D D D D D	0.102 5.207 4.372 5.642 8.137 5.642 8.137 5.642 8.137 5.207 1.982 1.982 1.982 1.992 1.962 4.372 5.299 2.144 2.447 3.299 4.215	2 7 2 2 7 7 7 7 2 7 7 2 2 2 2 2 2 2 2 2
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	Data not Normal at 5 Assuming Norm 95% UCLs (Adjus 95% Adjusted 95% Modifie 95% Modifie Gamma Dist Gamma Dist ML Approximate Adjus A	Lilliefors Critical Value % Significance Level mal Distribution 95% Student's-t UCI sted for Skewness) d-CLT UCL (Chen-1995 ed-t UCL (Johnson-1978 tribution Test k star (bias corrected Theta Sta MLE of Mear LE of Standard Deviatior nu sta e Chi Square Value (.05 ted Level of Significance ljusted Chi Square Value con-Darling Test Statistic Darling 5% Critical Value cov-Smirnov Test Statistic mirnov 5% Critical Value ad at 5% Significance Level mma Distribution	 0.102 1.992 2.312 2.044 2.0468 <		Data appea	r Lognorm Juming Log 95 97.5 99 Data r Lognorm Nonparar 95 95 95 95% 95% 95%	Li nal at 5 gnorma % Chel % Chel % Chel Distrib nal at 5 % Star 95% % Star 95% % Perc 95% % Perc 95% % Chebys Chebys	illiefors % Sign al Distril byshev byshev byshev ution % Sign % S	Critical ificance bution 95% I (MVUE (MVUE ificance ificance cs 25% CL ackknif Bootstrap Bootstrap Bootstrap Bootstrap Bootstrap Bootstrap Bootstrap Bootstrap Bootstrap Bootstrap Bootstrap Bootstrap	H-UCL H-UCL UCL UCL UCL UCL UCL E UCL C C C C C C C C C C C C C	0.102 5.207 4.372 5.642 8.137 5.642 8.137 5.642 8.137 1.982 1.982 1.992 4.372 5.299 2.144 2.447 3.299 4.215 6.014	2 7 2 2 2 7 7 7 7 2 2 2 2 2 2 2 2 2 2 2

	A B C D E	F	G	H		J	K	L				
55	95% Adjusted Gamma UCL (Use when n < 40)	1.806										
56	Dotential LICI to Lloo							5 207				
57						Use	30 /0 ⊓-UUL	5.207				
58	ProUCL computes and output	uts H-statisti	c based UCL	s for histori	cal reasons	only.						
59 60	H-statistic often results in unstable (both high a	and low) valu	ues of UCL95	i as shown i	n examples	in the Techr	nical Guide.					
61	It is therefore recommended to avoid the use of H-statistic based 95% UCLs.											
62	Use of nonparametric methods are preferred to con	npute UCL9	5 for skewed	data sets w	hich do not f	ollow a gam	ma distributi	on.				
63												
64	Note: Suggestions regarding the selection of a 95%	UCL are pr	ovided to he	p the user t	o select the	most approp	oriate 95% U	CL.				
65	These recommendations are based upon the res	ults of the si	mulation stu	dies summa	rized in Sing	jh, Singh, ar	nd laci (2002))				
66	and Singh and Singh (2003). For	additional in	sight, the use	er may want	to consult a	statistician.						
67												
68												
69	Benzo(a)anthracene											
70		General	Statistics									
71	Number of Valid Observations	75	Statistics		Number	r of Distinct (Observations	71				
72	Number of Missing Values	6			Number	of Distinct (55561 4410113	71				
73		•										
74	Raw Statistics			L	_og-transfori	med Statistic	s					
76	Minimum	0.00165				Minimum	of Log Data	-6.407				
77	Maximum	29.2				Maximum	of Log Data	3.374				
78	Mean	1.232				Mea	n of log Data	-2.58				
79	Geometric Mean	0.0758				SI	D of log Data	2.445				
80	Median	0.0398										
81	SD	4.464										
82	Std. Error of Mean	0.515										
83	Coefficient of Variation	3.624										
84	Skewness	5.553										
85		Relevant I I	CL Statistics									
86	Normal Distribution Test			L	ognormal Di	stribution Te	est					
8/	Lilliefors Test Statistic	0.391			ognorna Di	Lilliefors	Test Statistic	0.11				
80 80	Lilliefors Critical Value	0.102	Lilliefors Critical Value 0.102									
09 90	Data not Normal at 5% Significance Level			Data not L	.ognormal at	5% Signific	ance Level					
91												
92	Assuming Normal Distribution			Ass	uming Logno	ormal Distrib	oution					
93	95% Student's-t UCL	2.09	95% H-UCL 4.701									
94	95% UCLs (Adjusted for Skewness)				95%	Chebyshev (MVUE) UCL	3.95 <mark>8</mark>				
95	95% Adjusted-CLT UCL (Chen-1995)	2.433	97.5% Chebyshev (MVUE) UCL									
96	95% Modified-t UCL (Johnson-1978)	2.145			99%	Chebyshev (MVUE) UCL	/.363				
97	Commo Distribution Toot				Data Di							
98		0 253	Data Distribution									
99	k star (blas colfected) Theta Star	4 872		ala uu 110(1				<i>יו</i>				
100	MI F of Mean	1.232										
101	MLE of Standard Deviation	2.45										
102	nu star	37.92										
103	Approximate Chi Square Value (.05)	24.82			Nonparame	tric Statistic	S					
105	Adjusted Level of Significance	0.0468			-	95	5% CLT UCL	2.079				
106	Adjusted Chi Square Value	24.61				95% Ja	ckknife UCL	2.09				
107					95%	Standard Bo	ootstrap UCL	2.097				
108	Anderson-Darling Test Statistic	5.13				95% Boo	otstrap-t UCL	4.89				

		•	u u					
109	Anderson-Darling 5% Critical Value	0.886			95% Hall's Bootstrap UCL 5.827			
110	Kolmogorov-Smirnov Test Statistic	0.215		95% Percentile Bootstrap UCL 2.147				
111	Kolmogorov-Smirnov 5% Critical Value	0.113		95% BCA Bootstrap UCL 2.56				
110	Data not Gamma Distributed at 5% Significance Leve	vel	95% Chebyshev(Mean, Sd) UCL					
112					97.5% Chebyshev(Mean. Sd) UCL 4 45			
113	Assuming Gamma Distribution				99% Chebyshev(Mean_Sd) UCL 6.36			
114	95% Approximate Gamma UCL (Use when $n \ge 40$) 1 882							
115	05% Adjusted Commo LICL (Use when n < 40)	(1 + (1 + 2 + 2 + 2 + 2 + 2 + 2 + 2 + 2 + 2 +						
116	95% Aujusted Gamma UCL (Use when h < 40)	1.090						
117								
118	Potential UCL to Use				Use 95% Chebyshev (Mean, Sd) UCL 3.478			
119								
120	Note: Suggestions regarding the selection of a 95%	UCL are p	provided to hel	p the user	to select the most appropriate 95% UCL.			
121	These recommendations are based upon the result	ilts of the s	simulation stud	lies summ	arized in Singh, Singh, and laci (2002)			
122	and Singh and Singh (2003). For a	dditional in	nsight, the use	r may wan	t to consult a statistician.			
123								
124								
125	Benzo(b)fluoranthene							
126								
127		General	I Statistics					
122	Number of Valid Observations	75			Number of Distinct Observations 73			
120			1					
129	Raw Statistics				Log-transformed Statistics			
130	Minimum (0.00145			Minimum of Log Data -6 536	;		
131	Maximum 3	38.2			Maximum of Log Data 3 643	, 		
132	Moon 1	1 6/5			Moon of log Data 2,157	,		
133		0.110						
134					SD of log Data 2.479			
135	Median (0.0887						
	SD 5	5.812	1					
136		o o= :						
136 137	Std. Error of Mean	0.671						
136 137 138	Std. Error of Mean Coefficient of Variation	0.671 3.532						
136 137 138 139	Std. Error of Mean C Coefficient of Variation 3 Skewness 5	0.671 3.532 5.545						
136 137 138 139 140	Std. Error of Mean 0 Coefficient of Variation 3 Skewness 5	0.671 3.532 5.545						
136 137 138 139 140 141	Std. Error of Mean C Coefficient of Variation 3 Skewness 5	0.671 3.532 5.545 Relevant U	JCL Statistics					
136 137 138 139 140 141 142	Std. Error of Mean C Coefficient of Variation 3 Skewness 5 Normal Distribution Test	0.671 3.532 5.545 Relevant U	JCL Statistics		Lognormal Distribution Test			
136 137 138 139 140 141 142 143	Std. Error of Mean 0 Coefficient of Variation 3 Skewness 5 Normal Distribution Test Lilliefors Test Statistic 0	0.671 3.532 5.545 Relevant U	JCL Statistics		Lognormal Distribution Test Lilliefors Test Statistic 0.0772	2		
136 137 138 139 140 141 142 143 144	Std. Error of Mean (Coefficient of Variation 3 Skewness 5 Normal Distribution Test Lilliefors Test Statistic (Lilliefors Critical Value (0.671 3.532 5.545 Relevant U 0.389 0.102	JCL Statistics		Lognormal Distribution Test Lilliefors Test Statistic 0.0772 Lilliefors Critical Value 0.102	2		
136 137 138 139 140 141 142 143 144 145	Std. Error of Mean Coefficient of Variation Coefficient of Variation Skewness Skewness E Normal Distribution Test Lilliefors Test Statistic Lilliefors Critical Value C Data not Normal at 5% Significance Level	0.671 3.532 5.545 Relevant U 0.389 0.102	JCL Statistics	Data appea	Lognormal Distribution Test Lilliefors Test Statistic 0.0772 Lilliefors Critical Value 0.102 ar Lognormal at 5% Significance Level	2		
136 137 138 139 140 141 142 143 144 145 146	Std. Error of Mean (Coefficient of Variation 3 Skewness 5 Normal Distribution Test Lilliefors Test Statistic (Lilliefors Critical Value (Data not Normal at 5% Significance Level	0.671 3.532 5.545 Relevant U 0.389 0.102	JCL Statistics	Data appea	Lognormal Distribution Test Lilliefors Test Statistic 0.0772 Lilliefors Critical Value 0.102 ar Lognormal at 5% Significance Level	2		
136 137 138 139 140 141 142 143 144 145 146 147	Std. Error of Mean (Coefficient of Variation 3 Skewness 5 Normal Distribution Test Lilliefors Test Statistic (Lilliefors Critical Value (Data not Normal at 5% Significance Level Assuming Normal Distribution	0.671 3.532 5.545 Relevant U 0.389 0.102	JCL Statistics	Data appea	Lognormal Distribution Test Lilliefors Test Statistic 0.0772 Lilliefors Critical Value 0.102 ar Lognormal at 5% Significance Level suming Lognormal Distribution	2		
136 137 138 139 140 141 142 143 144 145 146 147 148	Std. Error of Mean (Coefficient of Variation 3 Skewness 5 Normal Distribution Test Lilliefors Test Statistic (Lilliefors Critical Value (Data not Normal at 5% Significance Level Assuming Normal Distribution 95% Student's-t UCL 2	0.671 3.532 5.545 Relevant U 0.389 0.102 2.763	JCL Statistics	Data appea	Lognormal Distribution Test Lilliefors Test Statistic 0.0772 Lilliefors Critical Value 0.102 ar Lognormal at 5% Significance Level suming Lognormal Distribution 95% H-UCL 8.039	2		
136 137 138 139 140 141 142 143 144 145 146 147 148	Std. Error of Mean (Coefficient of Variation 3 Skewness 5 Normal Distribution Test Lilliefors Test Statistic (Lilliefors Critical Value (Data not Normal at 5% Significance Level Assuming Normal Distribution 95% Student's-t UCL 2 95% UCLs (Adjusted for Skewness)	0.671 3.532 5.545 Relevant U 0.389 0.102 2.763	JCL Statistics	Data appea	Lognormal Distribution Test Lilliefors Test Statistic 0.0772 Lilliefors Critical Value 0.102 ar Lognormal at 5% Significance Level suming Lognormal Distribution 95% H-UCL 8.039 95% Chebyshev (MVUE) UCL 6.611	2		
136 137 138 139 140 141 142 143 144 145 146 147 148 149 150	Std. Error of Mean Coefficient of Variation Coefficient of Variation Skewness Skewness F Normal Distribution Test Lilliefors Test Statistic Lilliefors Critical Value C Data not Normal at 5% Significance Level Student's-t UCL Assuming Normal Distribution 95% Student's-t UCL 95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995)	0.671 3.532 5.545 Relevant U 0.389 0.102 2.763 3.208	JCL Statistics	Data appea	Lognormal Distribution Test Lilliefors Test Statistic 0.0772 Lilliefors Critical Value 0.102 ar Lognormal at 5% Significance Level suming Lognormal Distribution 95% H-UCL 8.039 95% Chebyshev (MVUE) UCL 6.611 97.5% Chebyshev (MVUE) UCL 8.542	2		
136 137 138 139 140 141 142 143 144 145 146 147 148 149 150	Std. Error of Mean Coefficient of Variation Skewness Skewness Normal Distribution Test Lilliefors Test Statistic Lilliefors Critical Value Data not Normal at 5% Significance Level Assuming Normal Distribution 95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978)	0.671 3.532 5.545 Relevant U 0.389 0.102 2.763 3.208 2.835	JCL Statistics	Data appea	Lognormal Distribution Test Lilliefors Test Statistic 0.0772 Lilliefors Critical Value 0.102 ar Lognormal at 5% Significance Level suming Lognormal Distribution 95% H-UCL 8.039 95% Chebyshev (MVUE) UCL 8.611 97.5% Chebyshev (MVUE) UCL 8.542 99% Chebyshev (MVUE) UCL 12 33	2		
136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151	Std. Error of Mean Coefficient of Variation Coefficient of Variation Skewness Skewness Skewness Normal Distribution Test Illiefors Test Statistic Lilliefors Critical Value Coefficient of Variation Data not Normal at 5% Significance Level Assuming Normal Distribution 95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) 2	0.671 3.532 5.545 Relevant U 0.389 0.102 2.763 3.208 2.835	JCL Statistics	Data appea	Lognormal Distribution Test Lilliefors Test Statistic 0.0772 Lilliefors Critical Value 0.102 ar Lognormal at 5% Significance Level suming Lognormal Distribution 95% H-UCL 8.039 95% Chebyshev (MVUE) UCL 6.611 97.5% Chebyshev (MVUE) UCL 8.542 99% Chebyshev (MVUE) UCL 12.33	2		
136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152	Std. Error of Mean Coefficient of Variation Coefficient of Variation Skewness Skewness F Normal Distribution Test Lilliefors Test Statistic Lilliefors Critical Value C Data not Normal at 5% Significance Level Assuming Normal Distribution 95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) 2	0.671 3.532 5.545 Relevant U 0.389 0.102 2.763 3.208 2.835	JCL Statistics	Data appea	Lognormal Distribution Test Lilliefors Test Statistic 0.0772 Lilliefors Critical Value 0.102 ar Lognormal at 5% Significance Level suming Lognormal Distribution 95% H-UCL 8.039 95% Chebyshev (MVUE) UCL 6.611 97.5% Chebyshev (MVUE) UCL 8.542 99% Chebyshev (MVUE) UCL 12.33 Data Distribution	2		
136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153	Std. Error of Mean Coefficient of Variation Coefficient of Variation Skewness Skewness E Normal Distribution Test E Lilliefors Test Statistic C Lilliefors Critical Value C Data not Normal at 5% Significance Level Student's-t UCL Assuming Normal Distribution 95% Student's-t UCL 95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) 2 Gamma Distribution Test Exter (bias corrected)	0.671 3.532 5.545 Relevant U 0.389 0.102 2.763 3.208 2.835	JCL Statistics	Data appea	Lognormal Distribution Test Lilliefors Test Statistic 0.0772 Lilliefors Critical Value 0.102 ar Lognormal at 5% Significance Level suming Lognormal Distribution 95% H-UCL 8.039 95% Chebyshev (MVUE) UCL 8.039 95% Chebyshev (MVUE) UCL 6.611 97.5% Chebyshev (MVUE) UCL 8.542 99% Chebyshev (MVUE) UCL 12.33 Data Distribution ar Lognormal at 5% Significance Level	2		
136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 151 152 153 154	Std. Error of Mean Coefficient of Variation Skewness Skewness F Normal Distribution Test Lilliefors Test Statistic Lilliefors Critical Value Data not Normal at 5% Significance Level Assuming Normal Distribution 95% Student's-t UCL 95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) Gamma Distribution Test k star (bias corrected)	0.671 3.532 5.545 Relevant U 0.389 0.102 2.763 3.208 2.835 0.263 6.249	JCL Statistics	Data appea	Lognormal Distribution Test Lilliefors Test Statistic 0.0772 Lilliefors Critical Value 0.102 ar Lognormal at 5% Significance Level suming Lognormal Distribution 95% H-UCL 8.039 95% Chebyshev (MVUE) UCL 6.611 97.5% Chebyshev (MVUE) UCL 8.542 99% Chebyshev (MVUE) UCL 12.33 Data Distribution ar Lognormal at 5% Significance Level	2		
136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154	Std. Error of Mean Coefficient of Variation Coefficient of Variation Skewness Skewness F Normal Distribution Test Lilliefors Test Statistic Lilliefors Critical Value C Data not Normal at 5% Significance Level Assuming Normal Distribution 95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) 2 Gamma Distribution Test k star (bias corrected)	0.671 3.532 5.545 Relevant U 0.389 0.102 2.763 3.208 2.835 0.263 6.249	JCL Statistics	Data appea	Lognormal Distribution Test Lilliefors Test Statistic 0.0772 Lilliefors Critical Value 0.102 ar Lognormal at 5% Significance Level suming Lognormal Distribution 95% H-UCL 8.039 95% Chebyshev (MVUE) UCL 6.611 97.5% Chebyshev (MVUE) UCL 8.542 99% Chebyshev (MVUE) UCL 12.33 Data Distribution ar Lognormal at 5% Significance Level	2		
136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155	Std. Error of Mean Coefficient of Variation Coefficient of Variation Skewness Skewness E Normal Distribution Test Lilliefors Test Statistic Lilliefors Critical Value Coefficient's Test Statistic Data not Normal at 5% Significance Level Assuming Normal Distribution 95% Student's-t UCL 95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) Gamma Distribution Test k star (bias corrected) MLE of Mean	0.671 3.532 5.545 Relevant U 0.389 0.102 2.763 2.763 3.208 2.835 0.263 6.249 1.645	JCL Statistics	Data appea	Lognormal Distribution Test Lilliefors Test Statistic 0.0772 Lilliefors Critical Value 0.102 ar Lognormal at 5% Significance Level suming Lognormal Distribution 95% H-UCL 8.039 95% Chebyshev (MVUE) UCL 6.611 97.5% Chebyshev (MVUE) UCL 8.542 99% Chebyshev (MVUE) UCL 12.33 Data Distribution ar Lognormal at 5% Significance Level	2		
136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157	Std. Error of Mean Coefficient of Variation Coefficient of Variation Skewness Skewness Skewness Normal Distribution Test Lilliefors Test Statistic Lilliefors Critical Value Coefficient of Variation Data not Normal at 5% Significance Level Coefficient's-t UCL Assuming Normal Distribution 95% Student's-t UCL 95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) 2 Gamma Distribution Test k star (bias corrected) MLE of Mean 1 MLE of Standard Deviation 3	0.671 3.532 5.545 Relevant U 0.389 0.102 2.763 3.208 2.835 0.263 6.249 1.645 3.207	JCL Statistics	Data appea	Lognormal Distribution Test Lilliefors Test Statistic 0.0772 Lilliefors Critical Value 0.102 ar Lognormal at 5% Significance Level suming Lognormal Distribution 95% H-UCL 8.039 95% Chebyshev (MVUE) UCL 6.611 97.5% Chebyshev (MVUE) UCL 8.542 99% Chebyshev (MVUE) UCL 12.33 Data Distribution ar Lognormal at 5% Significance Level	2		
136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158	Std. Error of Mean Coefficient of Variation Coefficient of Variation Skewness Skewness F Normal Distribution Test Lilliefors Test Statistic Lilliefors Critical Value C Data not Normal at 5% Significance Level Assuming Normal Distribution 95% UCLs (Adjusted for Skewness) 95% Student's-t UCL 2 95% Adjusted-CLT UCL (Chen-1995) 3 95% Modified-t UCL (Johnson-1978) 2 Gamma Distribution Test k star (bias corrected) K star (bias corrected) MLE of Mean MLE of Mean 1 MLE of Standard Deviation 3 nu star 3	0.671 3.532 5.545 Relevant U 0.389 0.102 2.763 3.208 2.835 0.263 6.249 1.645 3.207 39.5	JCL Statistics	Data appea	Lognormal Distribution Test Lilliefors Test Statistic 0.0772 Lilliefors Critical Value 0.102 ar Lognormal at 5% Significance Level suming Lognormal Distribution 95% H-UCL 8.039 95% Chebyshev (MVUE) UCL 8.039 95% Chebyshev (MVUE) UCL 6.611 97.5% Chebyshev (MVUE) UCL 8.542 99% Chebyshev (MVUE) UCL 12.33 Data Distribution ar Lognormal at 5% Significance Level	2		
136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 155 156 157 158 159	Std. Error of Mean Coefficient of Variation Coefficient of Variation Skewness Skewness Skewness Normal Distribution Test Illiefors Test Statistic Lilliefors Critical Value Coefficient of Variation Data not Normal at 5% Significance Level Data not Normal at 5% Significance Level Assuming Normal Distribution 95% Student's-t UCL 95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) 3 95% Modified-t UCL (Johnson-1978) 2 Gamma Distribution Test K star (bias corrected) 0 Theta Star 0 MLE of Mean 1 MLE of Standard Deviation 3 nu star 3 Approximate Chi Square Value (.05) 2	0.671 3.532 5.545 Relevant U 0.389 0.102 2.763 3.208 2.835 0.263 6.249 1.645 3.207 39.5 26.1	JCL Statistics	Data appea	Lognormal Distribution Test Lilliefors Test Statistic 0.0772 Lilliefors Critical Value 0.102 ar Lognormal at 5% Significance Level suming Lognormal Distribution 95% H-UCL 8.039 95% Chebyshev (MVUE) UCL 6.611 97.5% Chebyshev (MVUE) UCL 8.542 99% Chebyshev (MVUE) UCL 12.33 Data Distribution ar Lognormal at 5% Significance Level Nonparametric Statistics	2		
136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160	Std. Error of Mean Coefficient of Variation Coefficient of Variation Skewness Skewness F Normal Distribution Test Lilliefors Test Statistic Lilliefors Critical Value Coefficient of Variation Data not Normal at 5% Significance Level Data not Normal at 5% Significance Level Assuming Normal Distribution 95% Student's-t UCL 95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) 2 Gamma Distribution Test K star (bias corrected) K star (bias corrected) MLE of Mean MLE of Mean 1 MLE of Standard Deviation 3 Approximate Chi Square Value (.05) 2 Adjusted Level of Significance 0	0.671 3.532 5.545 Relevant U 0.389 0.102 2.763 2.763 3.208 2.835 0.263 6.249 1.645 3.207 39.5 26.1 0.0468	JCL Statistics	Data appea	Lognormal Distribution Test Lilliefors Test Statistic 0.0772 Lilliefors Critical Value 0.102 ar Lognormal at 5% Significance Level 0.102 suming Lognormal Distribution 95% H-UCL 8.039 95% Chebyshev (MVUE) UCL 6.611 97.5% Chebyshev (MVUE) UCL 8.542 99% Chebyshev (MVUE) UCL 12.33 Data Distribution ar Lognormal at 5% Significance Level Nonparametric Statistics 95% CLT UCL 2.749	2		
136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161	Std. Error of Mean Coefficient of Variation Coefficient of Variation Skewness Skewness F Normal Distribution Test Lilliefors Test Statistic Lilliefors Critical Value Coefficient of Variation Data not Normal at 5% Significance Level Std. Error of Mean Assuming Normal Distribution 95% Student's-t UCL 95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) 2 Gamma Distribution Test K star (bias corrected) K star (bias corrected) C Theta Star MLE of Mean MLE of Standard Deviation nu star Approximate Chi Square Value (.05) 2 Adjusted Level of Significance C Adjusted Chi Square Value 2 2	0.671 3.532 5.545 Relevant U 0.389 0.102 2.763 2.763 3.208 2.835 0.263 6.249 1.645 3.207 39.5 26.1 0.0468 25.89	JCL Statistics	Data appea	Lognormal Distribution Test Lilliefors Test Statistic 0.0772 Lilliefors Critical Value 0.102 ar Lognormal at 5% Significance Level suming Lognormal Distribution 95% H-UCL 8.039 95% Chebyshev (MVUE) UCL 6.611 97.5% Chebyshev (MVUE) UCL 8.542 99% Chebyshev (MVUE) UCL 12.33 Data Distribution ar Lognormal at 5% Significance Level Nonparametric Statistics 95% CLT UCL 2.749 95% Jackknife UCL 2.763	2		

	A B C D E	F	G H I J K L								
163	Anderson-Darling Test Statistic	4.059	95% Bootstrap-t UCL 5.841								
164	Anderson-Darling 5% Critical Value	0.881	95% Hall's Bootstrap UCL 7.705								
165	Kolmogorov-Smirnov Test Statistic	0.199	95% Percentile Bootstrap UCL 2.912								
166	Kolmogorov-Smirnov 5% Critical Value	0.113	95% BCA Bootstrap UCL 3.297								
167	Data not Gamma Distributed at 5% Significance Le	evel	95% Chebyshev(Mean, Sd) UCL 4.571								
107	v		97.5% Chebyshev(Mean, Sd) UCL 5.836								
108	Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 8.323								
169	95% Approximate Gamma LICL (Use when $n \ge 40$)	95% Approximate Gamma LICL (Lise when $n \ge 40$) 2.49									
1/0	95% Adjusted Gamma UCL (Use when $n < 40$)	2.10									
171		2.011									
172											
173	Potential OCL to Use		USE 95% H-UCL 8.039								
174											
175	75 ProUCL computes and outputs H-statistic based UCLs for historical reasons only.										
176	H-statistic often results in unstable (both high a	and low) valu	lues of UCL95 as shown in examples in the Technical Guide.								
177	It is therefore recommend	led to avoid t	I the use of H-statistic based 95% UCLs.								
178	Use of nonparametric methods are preferred to cor	npute UCL9	95 for skewed data sets which do not follow a gamma distribution.								
179											
180	Note: Suggestions regarding the selection of a 95%	6 UCL are pr	provided to help the user to select the most appropriate 95% UCL.								
181	These recommendations are based upon the res	sults of the si	simulation studies summarized in Singh, Singh, and laci (2002)								
182	and Singh and Singh (2003). For	additional in	nsight, the user may want to consult a statistician.								
183											
184											
185	Lead										
186											
187		General	al Statistics								
107	Number of Valid Observations	65	Number of Distinct Observations 54								
190	Number of Missing Values	10									
100											
101	Raw Statistics		Log-transformed Statistics								
102	Minimum	1.3	Minimum of Log Data 0.262								
192	Maximum	1530	Maximum of Log Data 7.333								
193	Mean	69.59	Mean of log Data 2.795								
194	Geometric Mean	16.37	SD of log Data 1 729								
195	Median	13.8									
196		194.9									
197	Std. Error of Moon	24 17									
198		2 201									
199											
200	Skewness	0.001									
201		D -1									
202		Relevant U									
203	Normal Distribution Test	0.055	Lognormal Distribution Test								
204	Lilliefors Test Statistic	0.363	Lilliefors Test Statistic 0.13								
205	Lilliefors Critical Value	0.11	Lilliefors Critical Value 0.11								
206	Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level								
207											
208	Assuming Normal Distribution		Assuming Lognormal Distribution								
209	95% Student's-t UCL	. 109.9	95% H-UCL 130.9								
210	95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL 161.6								
211	95% Adjusted-CLT UCL (Chen-1995)	131.1	97.5% Chebyshev (MVUE) UCL 201.6								
212	95% Modified-t UCL (Johnson-1978)	113.3	99% Chebyshev (MVUE) UCL 280.1								
213		1									
214	Gamma Distribution Test		Data Distribution								
215	k star (bias corrected)	0.436	Data do not follow a Discernable Distribution (0.05)								
210	Theta Star	159.5									
< 1 D		1									

	А	В	С	D	E	F	G	Н	I		J	K	L
217	7 MLE of Mean												
218			М	rd Deviation	105.4								
219	nu star					56.72							
220			Approximat	e Chi Square	Value (.05)	40.41			Nonpara	ame	tric Statistics	5	
221		Adjusted Level of Significance									95	5% CLT UCL	109.4
222			Ac	ljusted Chi S	quare Value	40.1					95% Ja	ckknife UCL	109.9
223									ç	95%	Standard Bo	otstrap UCL	108.6
224			Anders	son-Darling T	est Statistic	2.458					95% Boo	tstrap-t UCL	178.1
225			Anderson-	Darling 5% C	ritical Value	0.829				9	5% Hall's Bo	otstrap UCL	257.4
226			Kolmogor	ov-Smirnov T	est Statistic	0.155			9	5% F	Percentile Bo	otstrap UCL	112.7
227		K	olmogorov-S	mirnov 5% C	ritical Value	0.118				ę	95% BCA Bo	otstrap UCL	144.8
228	Da	ita not Gami	ma Distribute	ed at 5% Sig	nificance Le	vel			95%	% Ch	ebyshev(Me	an, Sd) UCL	175
229									97.5%	% Ch	ebyshev(Me	an, Sd) UCL	220.6
230		As	suming Gam	nma Distribut	ion				99%	% Ch	ebyshev(Me	an, Sd) UCL	310.1
231	95	95% Approximate Gamma UCL (Use when n >= 40)			97.68								
232		95% Adju	isted Gamma	a UCL (Use w	/hen n < 40)	98.44							
233													
234			Potential l	JCL to Use				ι	Jse 95%	6 Che	ebyshev (Me	an, Sd) UCL	175
235													
236	No	te: Suggesti	ions regardir	ng the select	ion of a 95%	UCL are pr	ovided to hel	lp the user to	o select	the I	most approp	riate 95% U	CL.
237		These recon	nmendations	s are based ι	pon the res	ults of the si	mulation stud	dies summa	rized in	Sing	ıh, Singh, ar	d laci (2002)
238			and Singh	and Singh (2	2003). For a	additional in:	sight, the use	er may want	to cons	ult a	statistician.		
239													



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