



Expected QI Macros® Results & Comparison to Minitab 17 or other Resources

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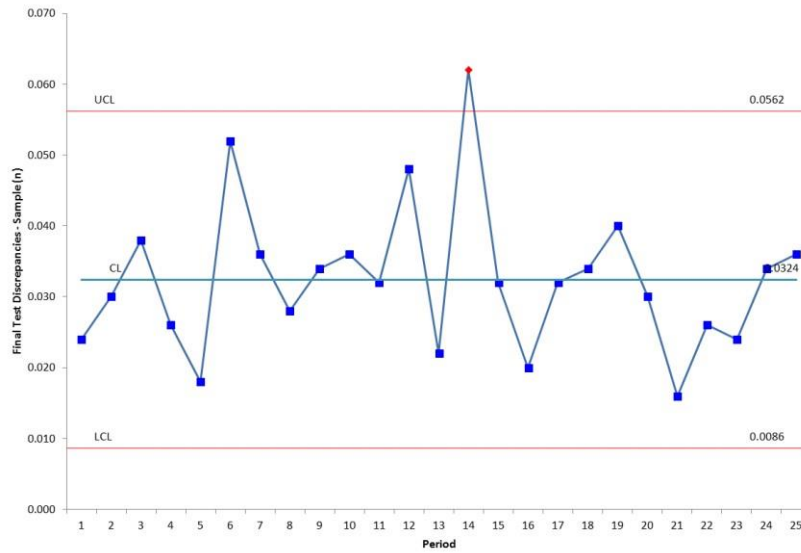
Chart/data

P Chart

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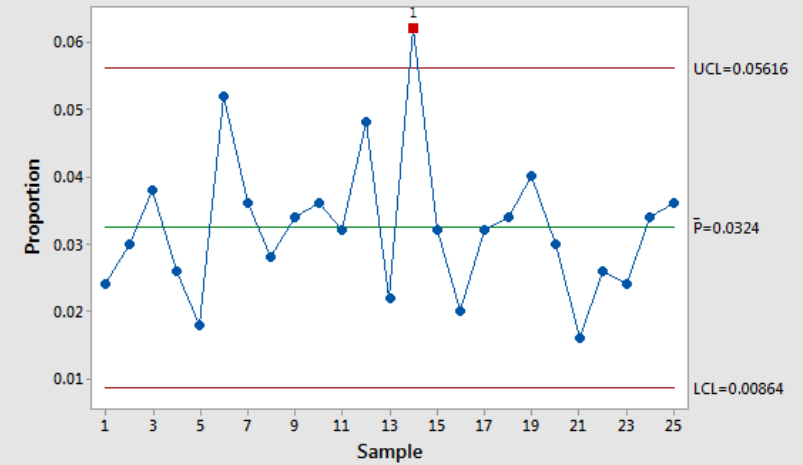
QI Macros for Excel

Final Test Discrepancies / Sample (n) p Chart



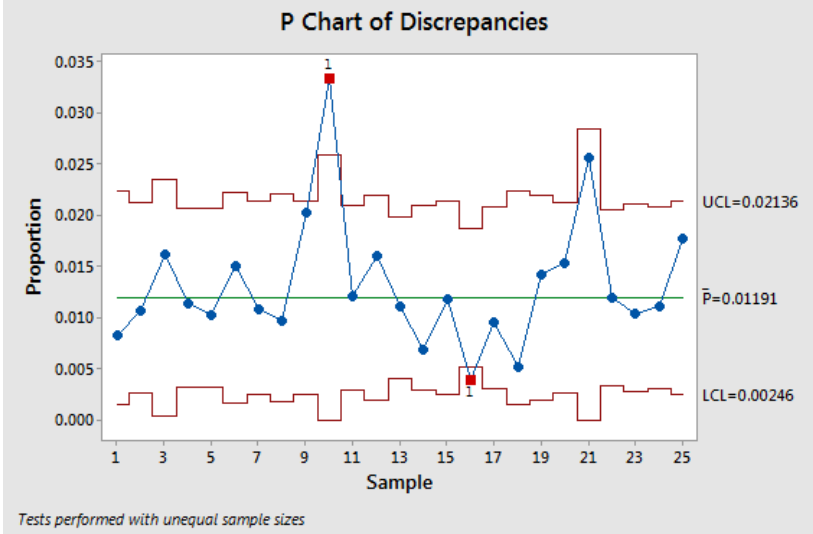
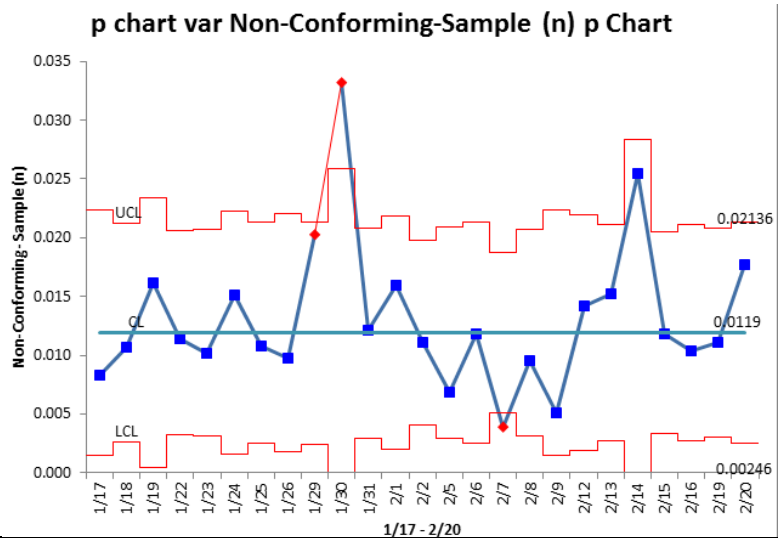
Minitab

P Chart of Final Test Discrepancies

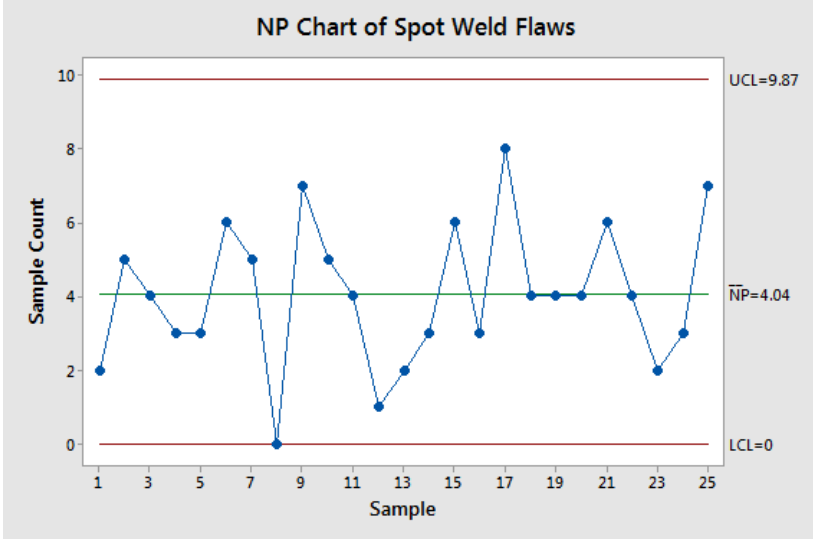
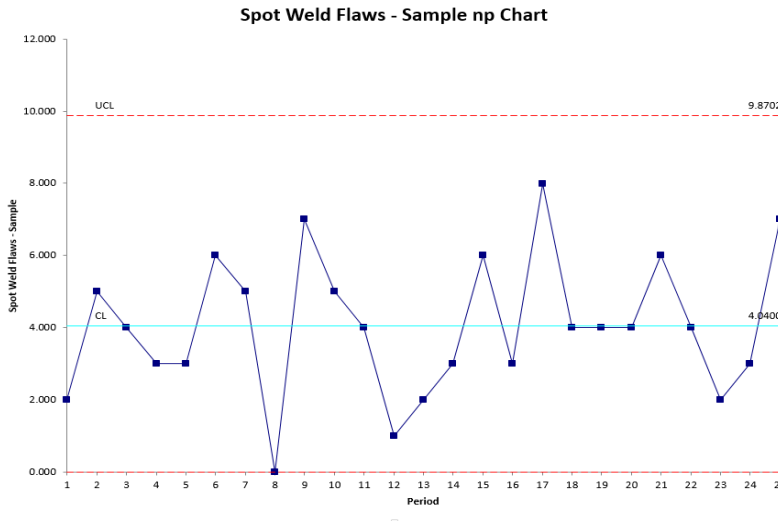


Pchart

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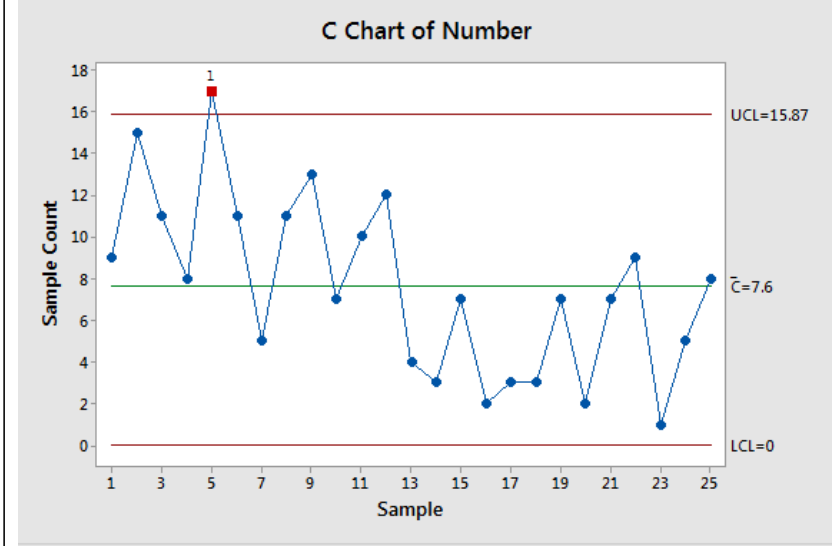
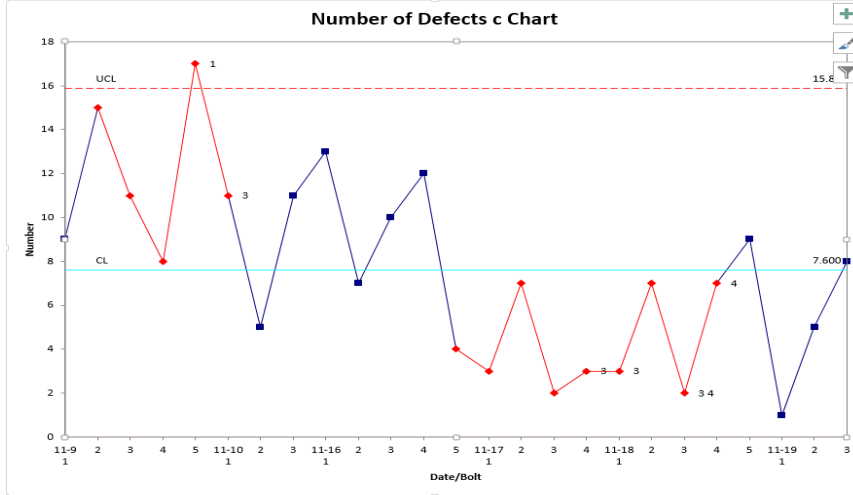
np Chart



C Chart

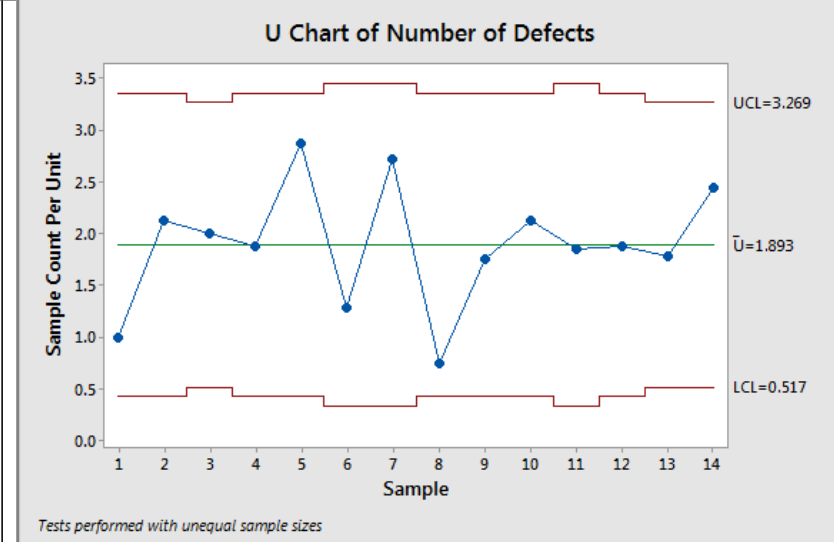
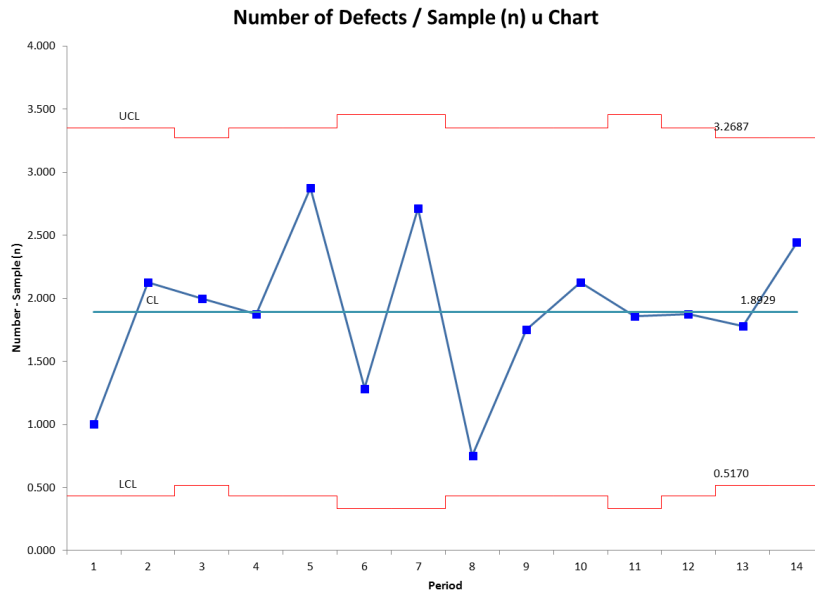
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(This example displays the “show rule numbers” option.)

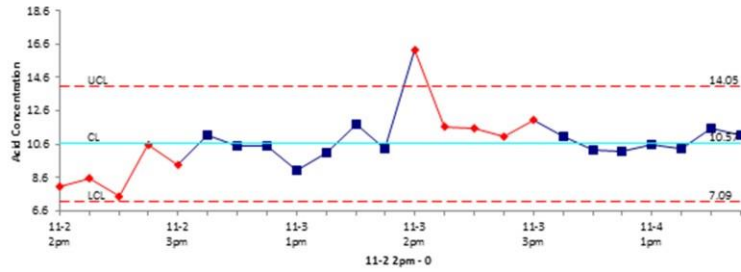


u

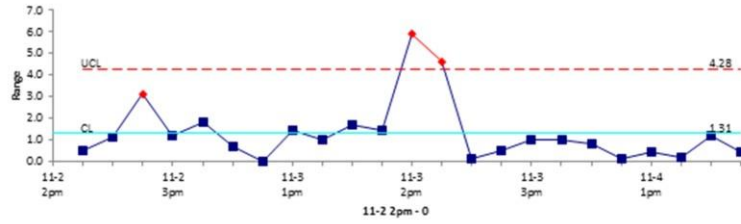
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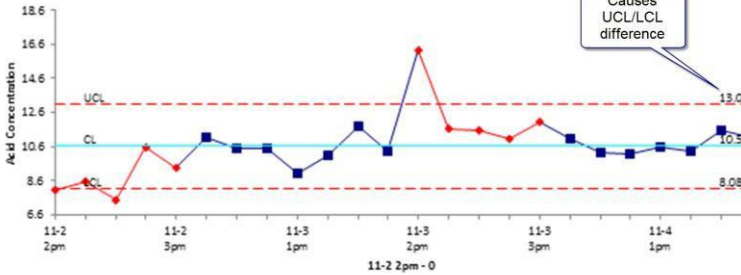
X Acid Concentration



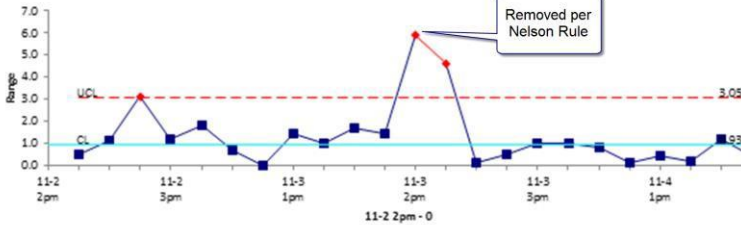
mR Acid Concentration



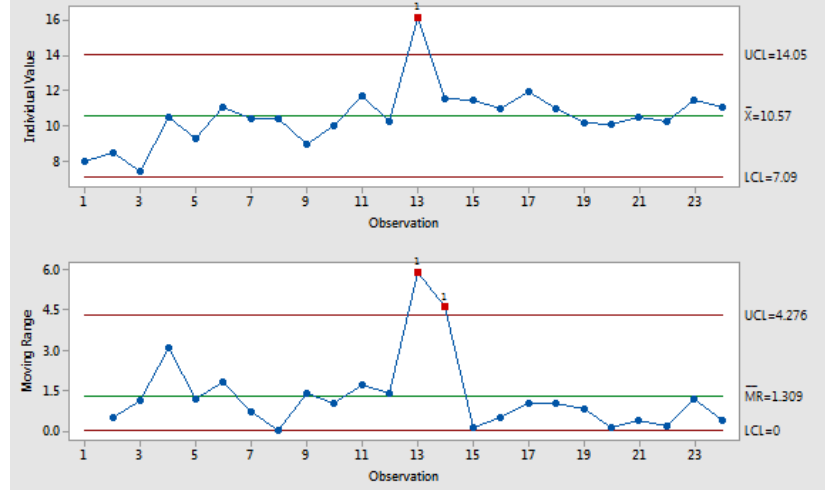
X Acid Concentration



mR Acid Concentration

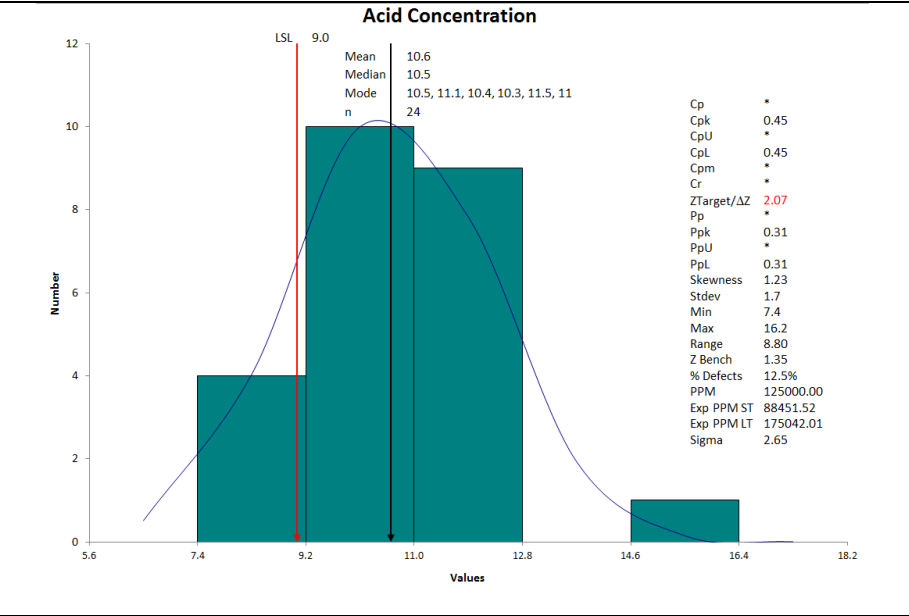


I-MR Chart of Acid Concentration

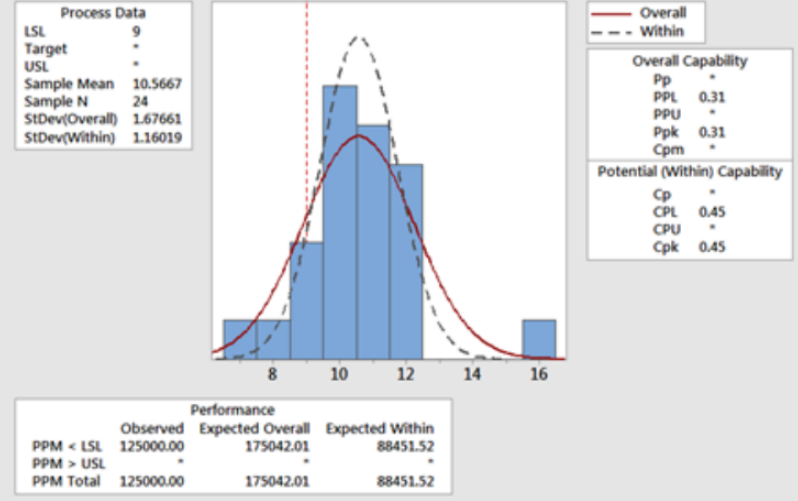


Histogram

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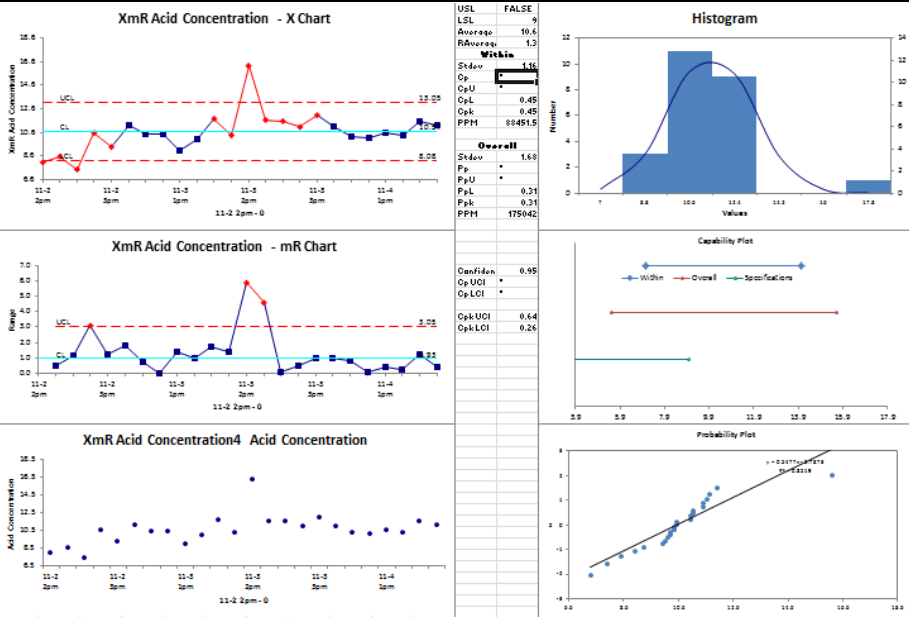


Process Capability Report for Acid Concentration

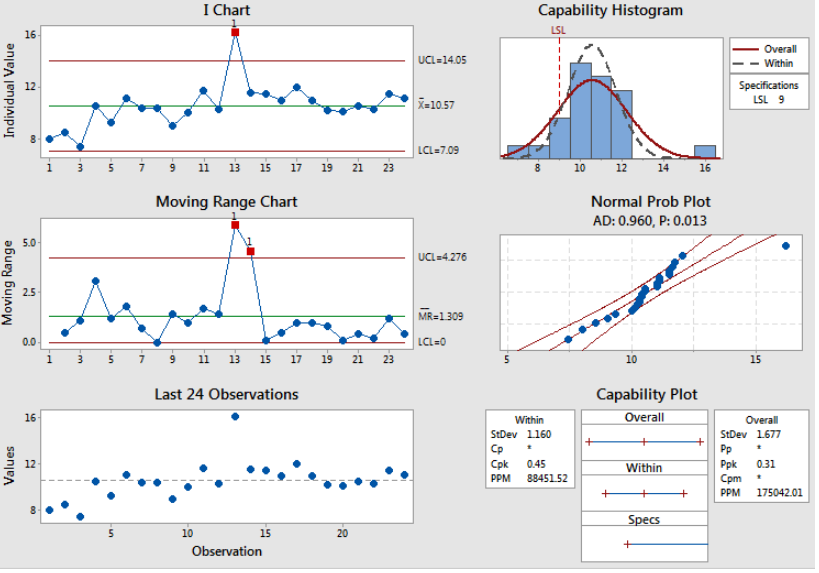


Capability Suite

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Process Capability Sixpack Report for Acid Concentration



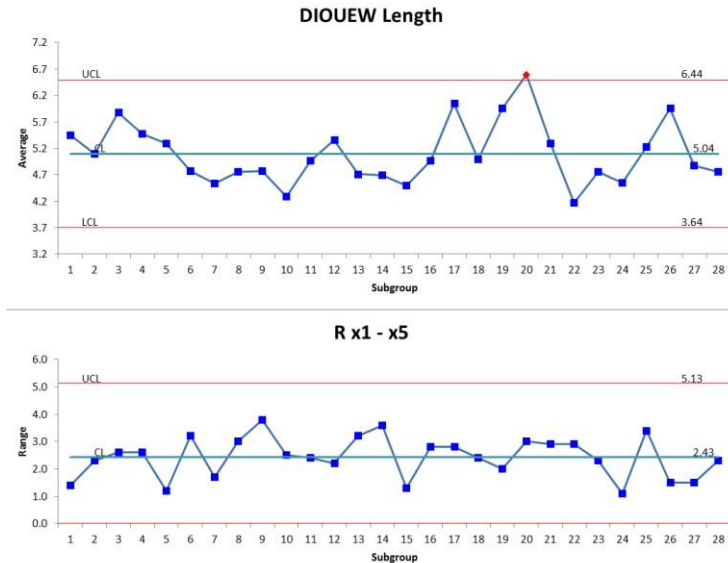
Chart/data	QI Macros for Excel	Minitab																																																				
XMedianR AIAG SPC 2 nd Edition page 84	<div style="text-align: center;"> <h3>QI Macros for Excel</h3> </div>	<div style="text-align: center;"> <h3>Minitab</h3> <p>Doesn't have an XMedianR</p> </div>																																																				
Histogram	<div style="text-align: center;"> <h3>X Median R Histogram</h3> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td>Mean</td><td>14.98</td></tr> <tr><td>Median</td><td>15.00</td></tr> <tr><td>Mode</td><td>13, 14</td></tr> <tr><td>n</td><td>130</td></tr> <tr><td>Cp</td><td>0.66</td></tr> <tr><td>Cpk</td><td>0.66</td></tr> <tr><td>CpU</td><td>0.66</td></tr> <tr><td>CpL</td><td>0.66</td></tr> <tr><td>Cpm</td><td>0.62</td></tr> <tr><td>Cr</td><td>1.51</td></tr> <tr><td>ZTarget/ΔZ</td><td>0.01</td></tr> <tr><td>Pp</td><td>0.62</td></tr> <tr><td>Ppk</td><td>0.61</td></tr> <tr><td>PpU</td><td>0.62</td></tr> <tr><td>PpL</td><td>0.61</td></tr> <tr><td>Skewness</td><td>0.05</td></tr> <tr><td>Stdev</td><td>2.17</td></tr> <tr><td>Min</td><td>9.00</td></tr> <tr><td>Max</td><td>20.00</td></tr> <tr><td>Range</td><td>11.00</td></tr> <tr><td>Z Bench</td><td>1.68</td></tr> <tr><td>% Defects</td><td>3.8%</td></tr> <tr><td>PPM</td><td>38461.54</td></tr> <tr><td>Exp PPM ST</td><td>46936.72</td></tr> <tr><td>Exp PPM LT</td><td>64962.02</td></tr> <tr><td>Sigma</td><td>3.27</td></tr> </table> </div>	Mean	14.98	Median	15.00	Mode	13, 14	n	130	Cp	0.66	Cpk	0.66	CpU	0.66	CpL	0.66	Cpm	0.62	Cr	1.51	ZTarget/ΔZ	0.01	Pp	0.62	Ppk	0.61	PpU	0.62	PpL	0.61	Skewness	0.05	Stdev	2.17	Min	9.00	Max	20.00	Range	11.00	Z Bench	1.68	% Defects	3.8%	PPM	38461.54	Exp PPM ST	46936.72	Exp PPM LT	64962.02	Sigma	3.27	
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Chart/data

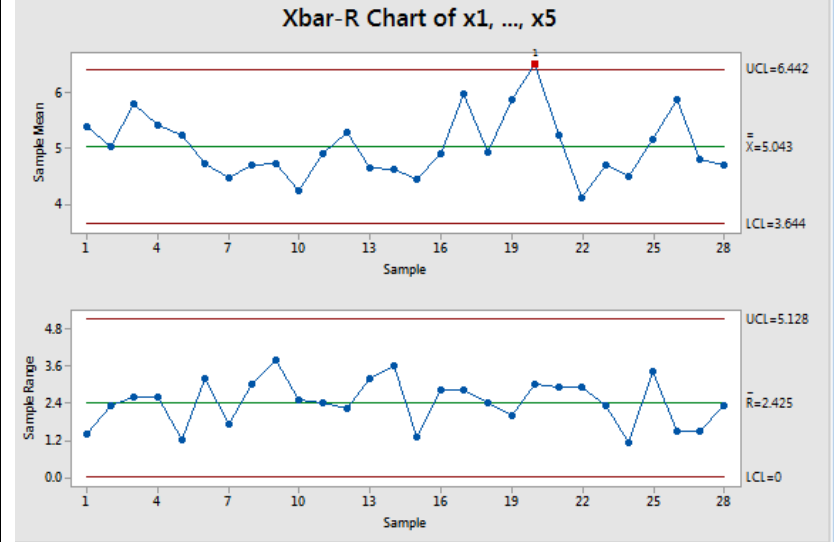
XbarR

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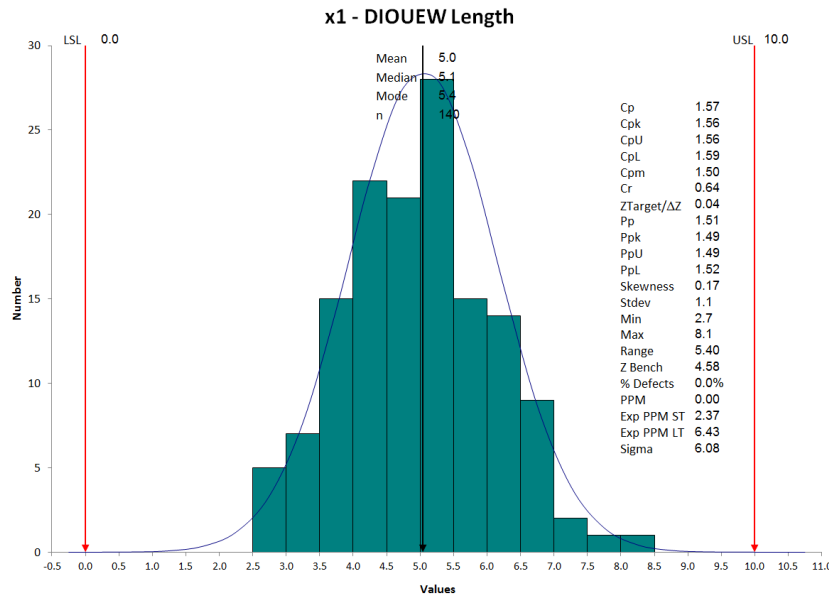
QI Macros for Excel



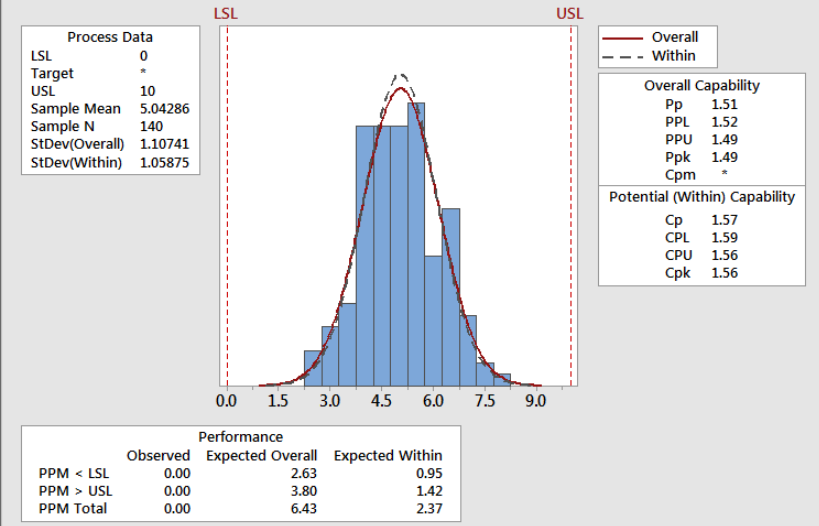
Minitab



Histogram

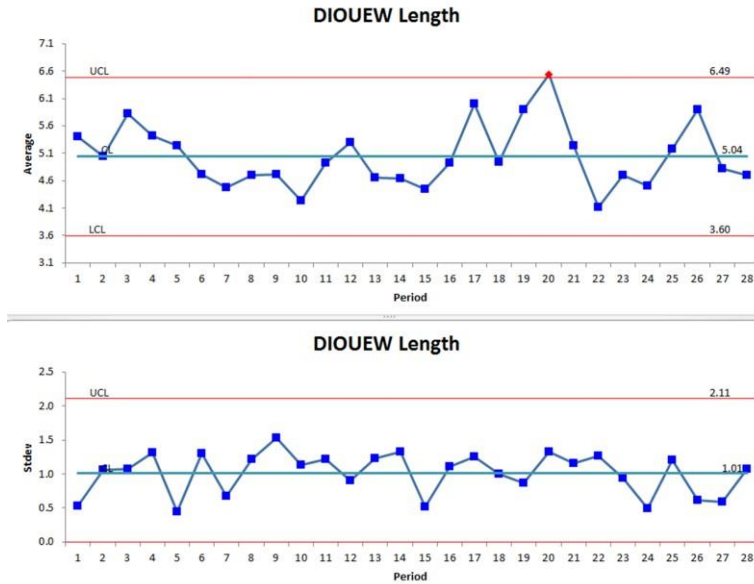


Process Capability Report for x1, ..., x5

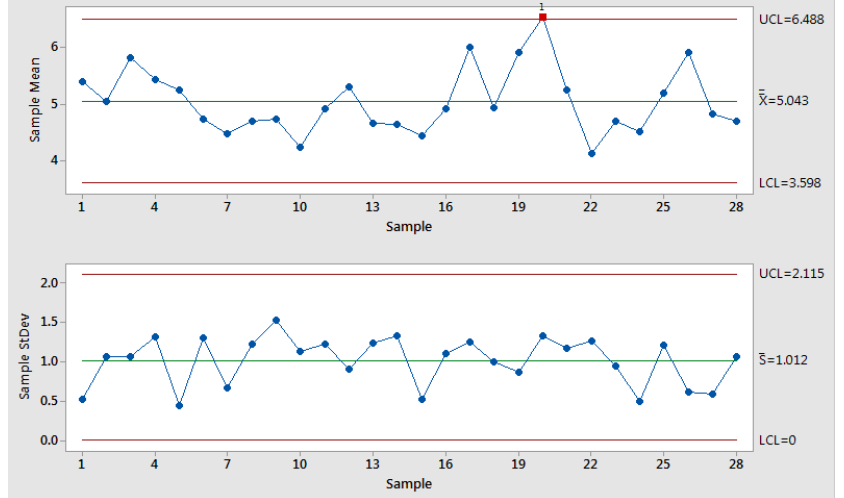


XbarS

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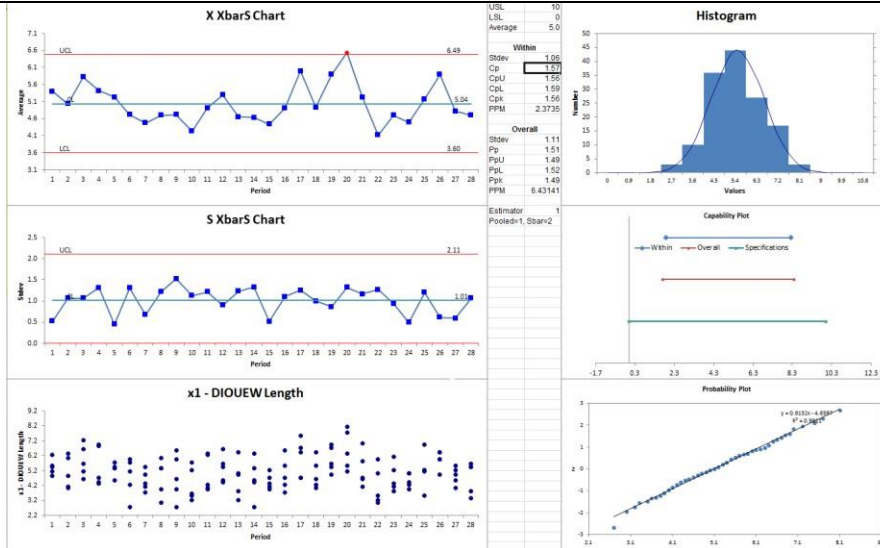


Xbar-S Chart of x1, ..., x5

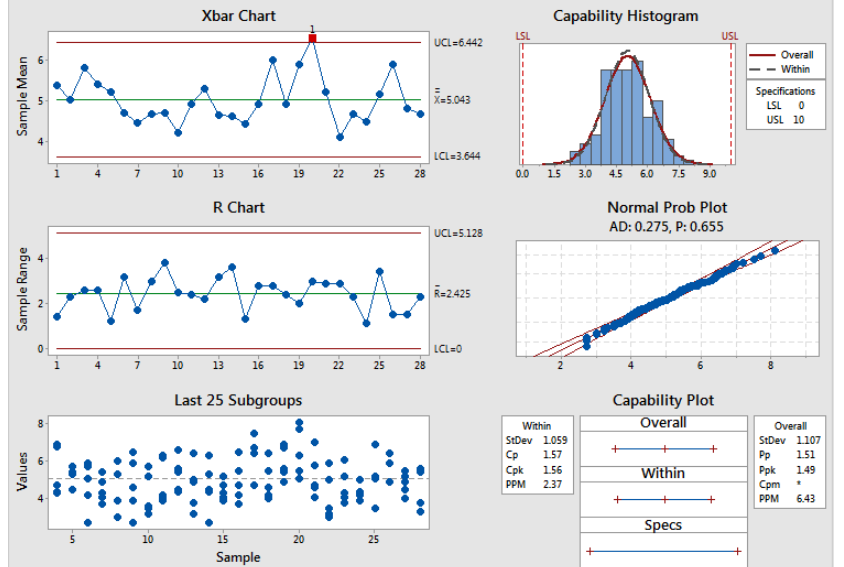


Capability Suite

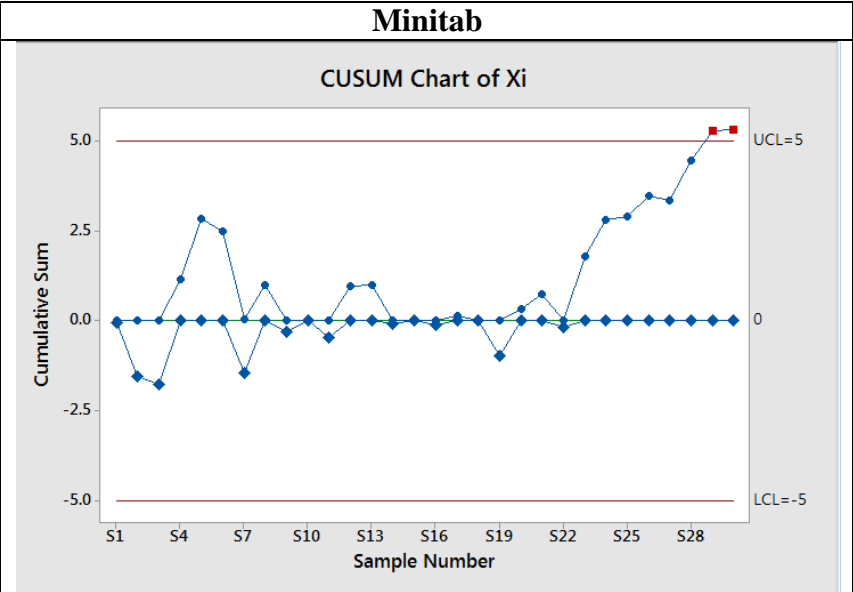
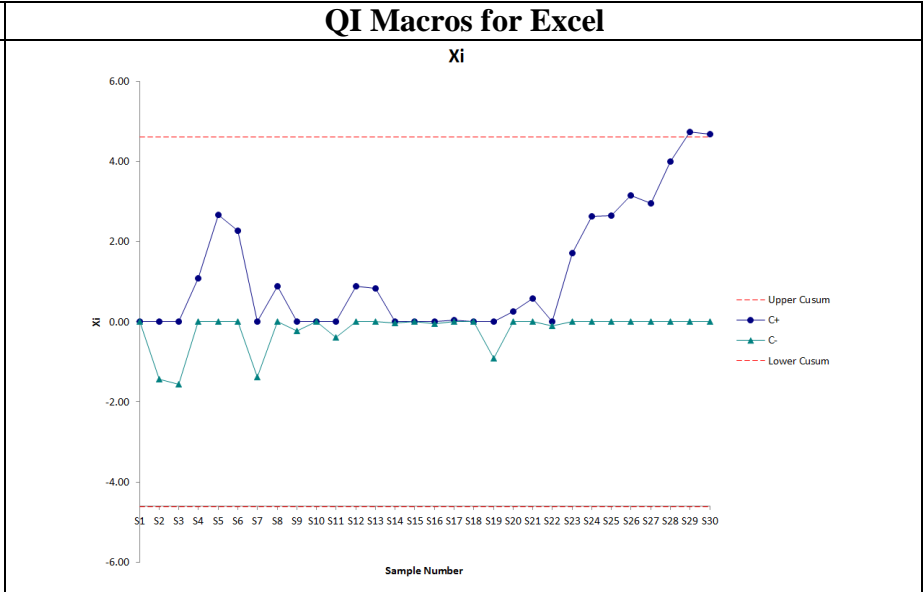
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Process Capability Sixpack Report for x1, ..., x5



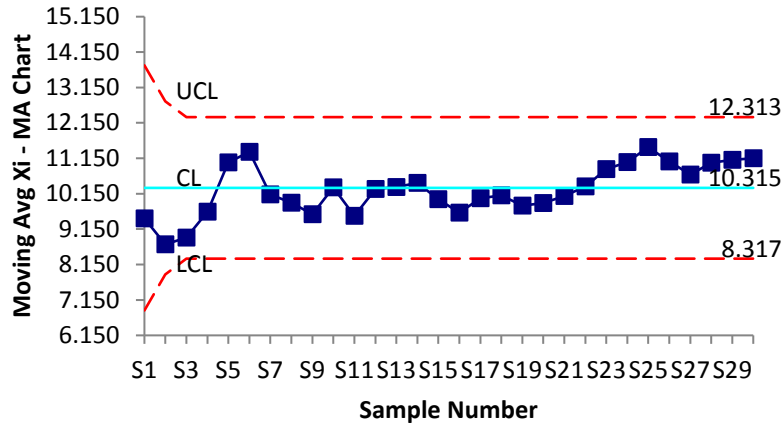
Chart/data
 Cusum
 Montgomery
 Intro to SPC
 5th Edition,
 page 393



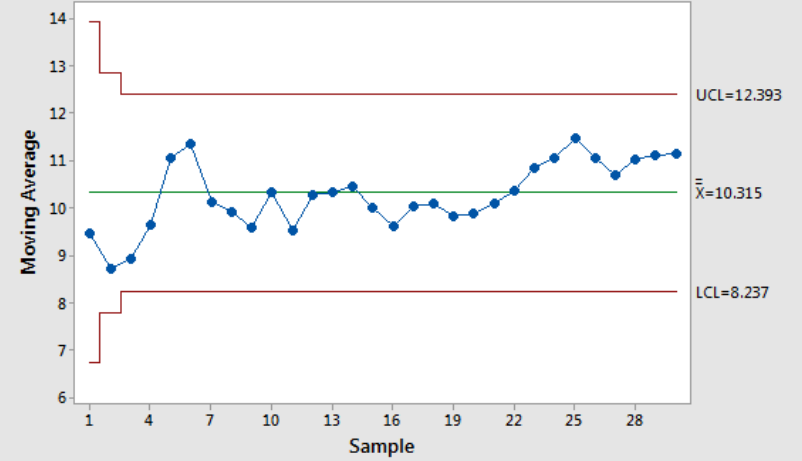
Moving Average

Montgomery
Intro to SPC
4th Edition,
page 438-439

Moving Avg Xi - MA Chart



Moving Average Chart of Xi



Moving Average Chart of Xi

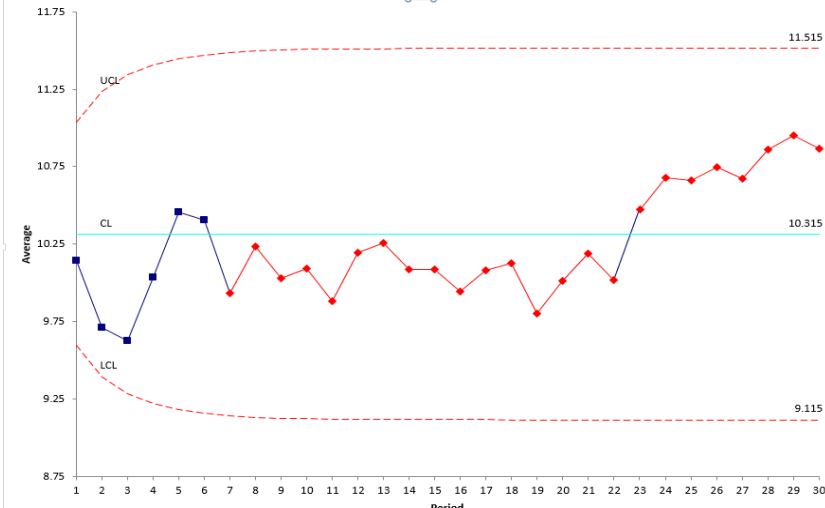
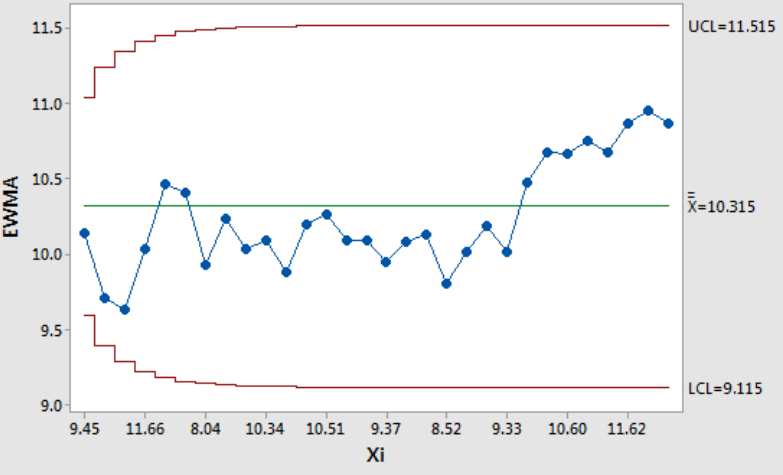
Moving Average Chart of Xi

Standard Deviation of Xi

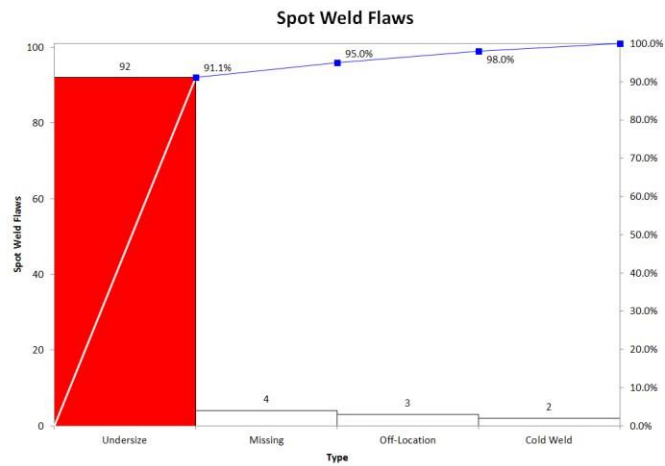
Standard deviation of Xi = 1.15354

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
	Xi	MEAN1	STDE1	PPOI1	CENL1	CONL1	CONL2	STAG1	SSIZ1	TRES1	MEAN2	STDE2
1	9.45										10.315	1.19987

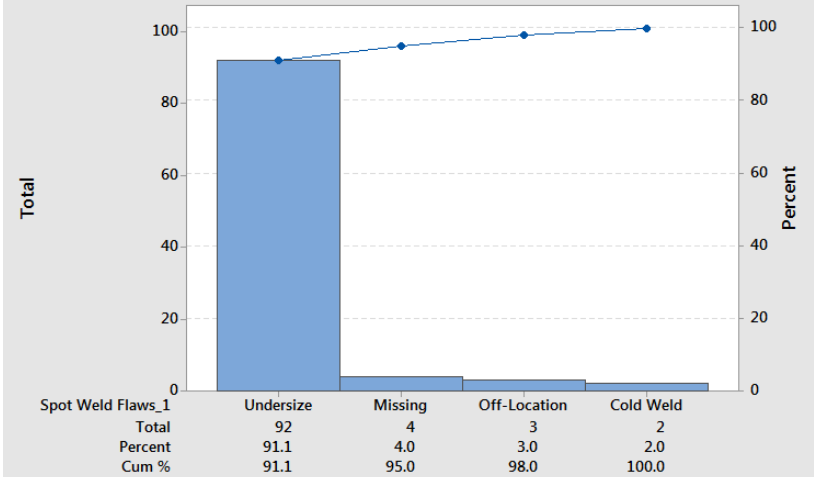
Minitab seems to calculate Stdev differently for MA Chart which results in different control limits.

Chart/data	QI Macros for Excel	Minitab
EWMA	<p style="text-align: center;">QI Macros for Excel</p> <p style="text-align: center;">xi</p>  <p>The chart displays the EWMA of data points over 30 periods. The central line (CL) is at 10.315. The upper control limit (UCL) is at 11.515 and the lower control limit (LCL) is at 9.115. The data points, shown as red diamonds connected by a red line, fluctuate around the CL, with a notable upward trend starting around period 22.</p>	<p style="text-align: center;">Minitab</p> <p style="text-align: center;">EWMA Chart of Xi</p>  <p>The Minitab chart shows the EWMA of data points for variable Xi. The central line represents the mean $\bar{X} = 10.315$. The upper control limit (UCL) is at 11.515 and the lower control limit (LCL) is at 9.115. The data points, shown as blue circles connected by a blue line, fluctuate around the mean, with a notable upward trend starting around Xi = 10.51.</p>

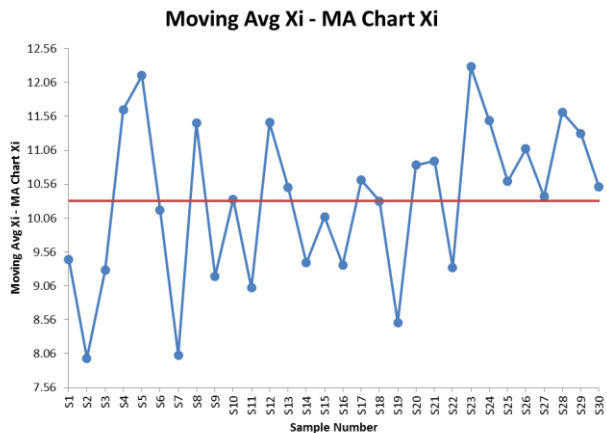
Pareto
AIAG Spot
Weld Flaws



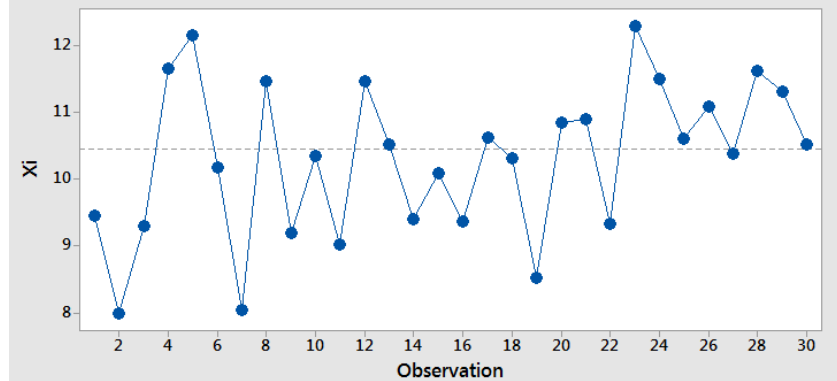
Pareto Chart of Spot Weld Flaws_1



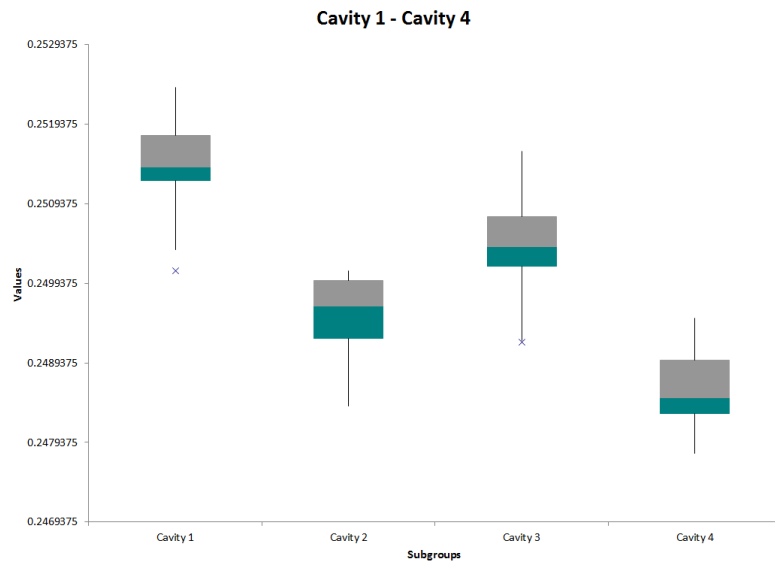
Run Chart



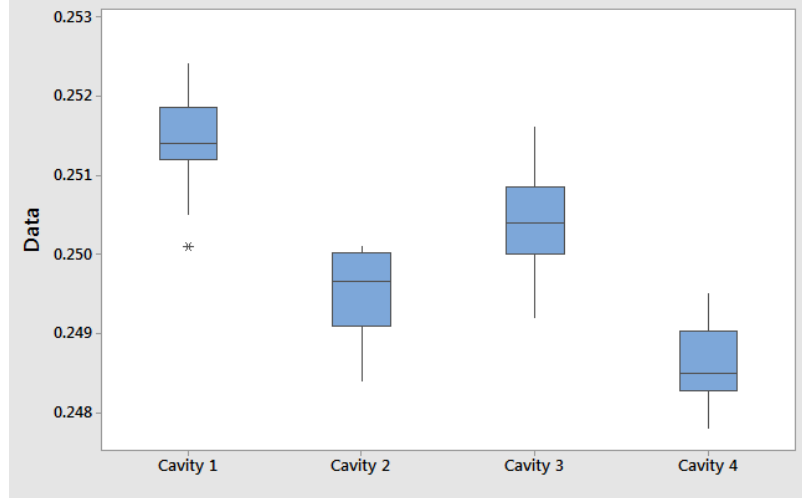
Run Chart of Xi



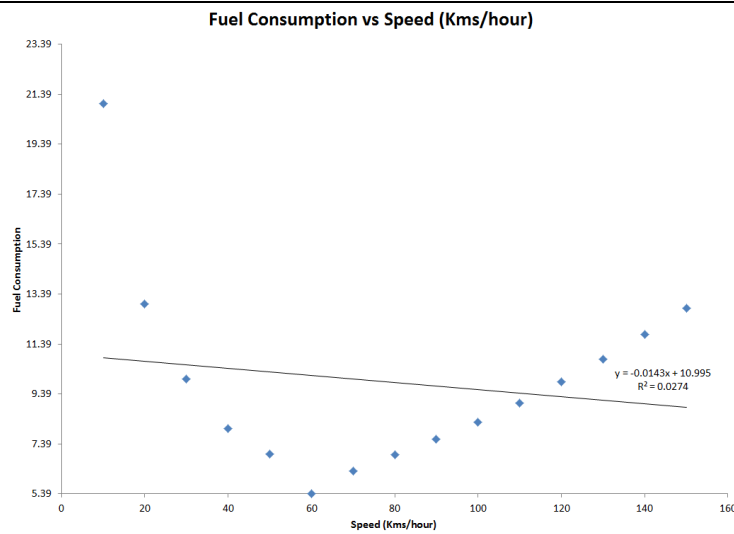
Box and Whisker



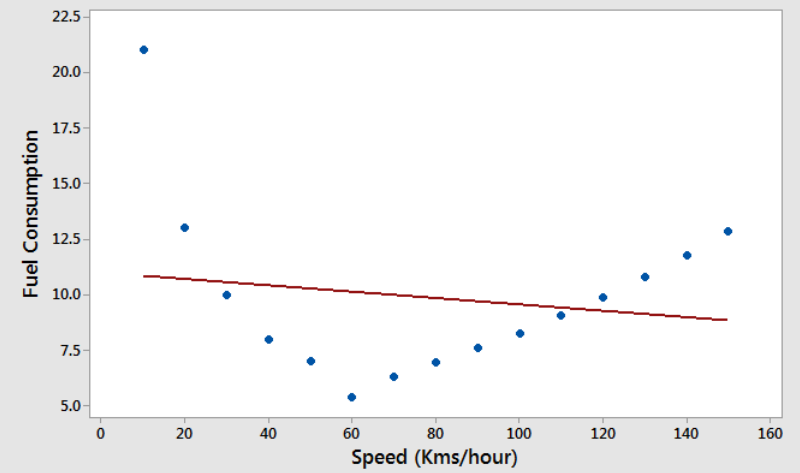
Boxplot of Cavity 1, Cavity 2, Cavity 3, Cavity 4



Scatter

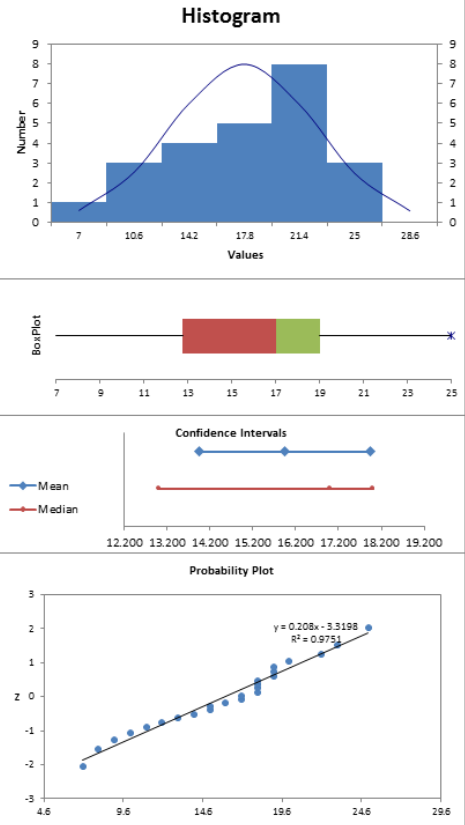


Scatterplot of Fuel Consumption vs Speed (Kms/hour)



Descriptive Statistics and Normality

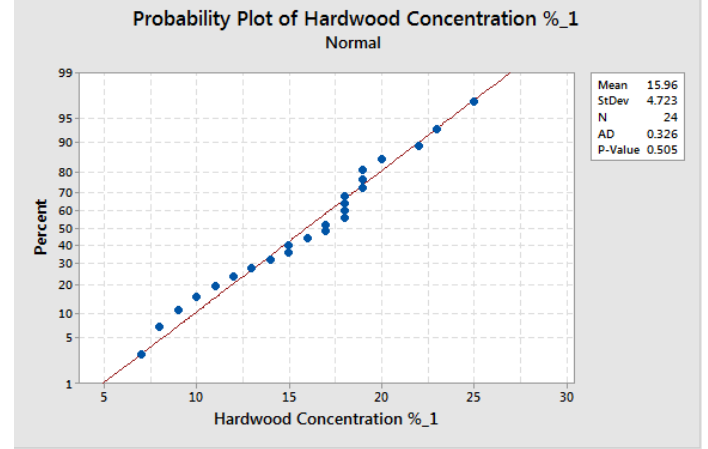
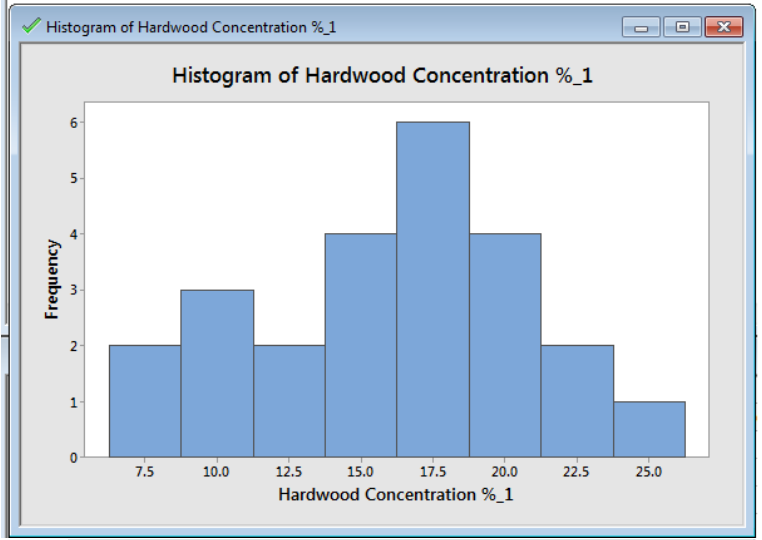
Hardwood Concentration	n	5%	10%	15%	20%	Anderson-Darling	Data is Normal
Obs1	7	12	14	19	A-Squared	0.326	
Obs2	8	17	18	25	p	0.505	
Obs3	15	13	19	22	95% Critical Value	0.787	
Obs4	11	18	17	23	99% Critical Value	1.092	
Obs5	9	19	16	18	Mean	15.958	
Obs6	10	15	18	20	Mode	18.000	
					Standard Deviation	4.723	
					Variance	22.303	
					Skewedness	-0.223	
					Kurtosis	-0.476	
					n	24.000	
					Std Err	0.964	
					Minimum	7.000	
					1st Quartile	12.750	
					Median	17.000	
					3rd Quartile	19.000	
					Maximum	25.000	
					Range	18.000	
					Confidence Interval for Mean (Mu)	13.964	
						17.952	
					For Stdev (sigma)	3.670	
						6.625	
					for Median	13.000	
						18.000	
					k-Factor Two-sided	1.770	
						0.99	30.147
					k-Factor One-sided	3.305	
						28.611	
					k Two-sided	3.004	
					k One-sided	2.679	



Descriptive Statistics: Hardwood Concentration %_1

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3
Hardwood Concentration %	24	0	15.958	0.964	4.723	7.000	12.250	17.000	19.000

Variable	Maximum
Hardwood Concentration %	25.000



ANOVA

Groups	Count	Sum	Average	Variance
5%	6	60	10	8
10%	6	94	15.66667	7.866667
15%	6	102	17	3.2
20%	6	127	21.16667	6.966667

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	382.7917	3	127.5972	19.60521	0.000	3.098391
Within Groups	130.1667	20	6.508333			
Total	512.9583	23				

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Factor	3	382.8	127.597	19.61	0.000
Error	20	130.2	6.508		
Total	23	513.0			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
2.55114	74.62%	70.82%	63.46%

Means

Factor	N	Mean	StDev	95% CI
5%	6	10.00	2.83	(7.83, 12.17)
10%	6	15.67	2.80	(13.49, 17.84)
15%	6	17.000	1.789	(14.827, 19.173)
20%	6	21.17	2.64	(18.99, 23.34)

t Test
2-sample
Equal
Variances

Catalyst 1	Catalyst2	t-Test: Two-Sample Assuming Equal Variances	α	0.05
91.5	89.19	Equal Sample Sizes		
94.18	90.95	Mean	92.255	92.7325
92.18	90.46	Variance	5.688314	8.900993
95.39	93.21	Observations	8	8
91.79	97.19	Pooled Variance	7.294654	
89.07	97.04	Hypothesized Mean Difference	0	
94.72	91.07	df	14	
89.21	92.75	t Stat	-0.354	
		P(T<=t) one-tail	0.364	Cannot Reject Null Hypothesis because p > 0.05 (Means are the same)
		T Critical one-tail	1.761	
		P(T<=t) two-tail	0.729	Cannot Reject Null Hypothesis because p > 0.05 (Means are the same)
		T Critical Two-tail	2.145	

Two-Sample T-Test and CI: Catalyst 1, Catalyst2

Two-sample T for Catalyst 1 vs Catalyst2

	N	Mean	StDev	SE Mean
Catalyst 1	8	92.26	2.39	0.84
Catalyst2	8	92.73	2.98	1.1

Difference = μ (Catalyst 1) - μ (Catalyst2)
 Estimate for difference: -0.48
 95% CI for difference: (-3.39, 2.44)
 T-Test of difference = 0 (vs ≠): T-Value = -0.35 P-Value = 0.729 DF = 13

Appendix

Expected Differences

Stability Analysis

Both QI Macros and Minitab let you define what stability rules you want to use. QI Macros defaults to Montgomery's rules but lets you select from Juran, AIAG, Westgard, Healthcare (IHI) and Western Electric rules. You can also further customize rules in QI Macros. See <https://www.qimacros.com/control-chart/stability-analysis-control-chart-rules/> .

Minitab requires you to define the rules you want to use each time you run a chart. QI Macros offer additional tests that Minitab does not. Minitab also treats trends differently than QI Macros. For example, one common set of rules is 6 points in a row increasing or decreasing. Once you have 6 points in a row that meet these criteria, QI Macros will turn all 6 points red. Minitab will not turn any points red until the 7th point and then will only turn the 7th point.

Upper and Lower control limits on u, p, and XbarS charts – since the sample size on these charts vary, the upper and lower control limits vary (from point to point). Minitab displays the UCL and LCL for the last point. QI Macros displays the UCL and LCL for the 3rd to the last point. Note the control limit lines are the same, only the value displayed is different. Also, the center lines are both the same since these do not vary.

Histogram - Standard Deviation calculation

QI Macros uses the standard deviation calculation of Microsoft Excel. Minitab uses a different calculation which returns slightly different results. The standard deviation difference will cause slight differences in the following calculations: **Pp, Ppk, Z score and Expected PPM.**

Histogram Cp, Cpk calculation when subgroup size is 3

The difference in the two calculations is the constant used in the sigma estimator calculation. This effects Cp and Cpk but not Pp and Ppk. See formulas: <https://www.qimacros.com/process-capability-analysis/cp-cpk-formula/>

Per Juran and Montgomery, QI Macros uses a constant of 1.693 when there are 3 subgroups. It looks like Minitab is using something like 1.093.

Cusum and Moving Average Chart Control Limits

Control limits are slightly different because QI Macros uses standard deviation while Minitab uses sigma estimator.