# What's New in Rev. 3.0.

1. Charts have been converted to always use Event coordinates
2. Zooming as an option for the scrollbar (UI option)
3. Collapsible Items (UI option)
4. Enhanced Annotations (Programming option)
5. Enhanced Out of Limit Symbol   (Programming option)
6. Variable Spec and Control Limits   (Programming option)
7. Marking a sample internal as bad   (Programming option)
8. Reset N of M counters for control moves   (Programming option)
9. Remove Negative LCL control limits for Variable Control Secondary charts, or Attribute Control Primary charts (Programming option)
10. N of M testing when the most recent point entering the test is within limits (Programming option)
11. Sample Interval Updates with an invalid number of samples (Programming option)
12. Alarm Forcing (Programming Option)
13. A Levey-Jennings Variable Control Chart was added (Programming Option)
14. Batch update with auto-calculated control limits (Programming Option)

Charts have been converted to always use Event coordinates – Originally, the time-based SPC charts used a Time/Date x-scale in the coordinate system, and the batch-based SPC charts used a linear x-scale in the coordinate system. Both of these have been replaced with a coordinate system which uses an Event-based x-scale. In order to maintain backward compatibility, we also keep the old SPCTime... and SPCBatch... control chart classes, but derive them from the new Event-based SPC chart classes. You may see a few differences between the old and new time-based axis implementations. In the new version, no matter what the time stamp is on a SPCTime... SPC chart, adjacent points will always be equally spaced. So if your sample interval is irregular, or you even skip days or weeks in your sampling, the resulting chart will still display equally spaced adjacent sample records. Also, in the new version tick marks are placed on sample intervals. In the old version, the time axis tick marks were independent of the sample interval time stamps. In the new version, this can cause time axis labels to display the irregular time stamps of the sample interval sample times In the old version the tick mark time axis labels would be even values, because they did not use the sample interval time stamp values. You can read more about Event coordinates in the QCChart2D manual which is found in the same folder as QCSPCChart manual.

	Title: Variable Control Chart (X-Bar & R)									Part No.: 283501						Chart No.: 17		
Part Name: Transmission Casing Bolt									Operation:Threading						Spec. Limits:		Units: 0.0001 inch
Operator:J. Fenamore									Machine: #11						Gage: #8645		Zero Equals: zero
Date: 8/14/2017 3:29:09 PM																	
TIME	16:28	16:44	16:58	17:14	17:22	17:40	17:59	18:18	18:34	18:46	19:05	19:19	19:25	19:39	19:52	20:02	20:13
MEAN	34.8	30.7	33.0	29.0	30.3	32.0	29.3	30.4	26.8	24.7	28.6	28.3	30.5	28.9	32.4	30.9	29.1
RANGE	4.8	11.0	9.1	12.4	9.8	11.1	3.9	2.6	10.7	2.5	11.5	13.4	13.6	12.0	5.3	9.8	8.0
SUM	173.8	153.3	165.1	145.0	151.7	159.9	146.5	151.8	133.8	123.7	143.0	141.3	152.7	144.3	162.2	154.5	145.6
ALARM	-	-	-	-	-	-	-	-	-	L	-	-	-	-	-	-	-
NOTES	N	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N
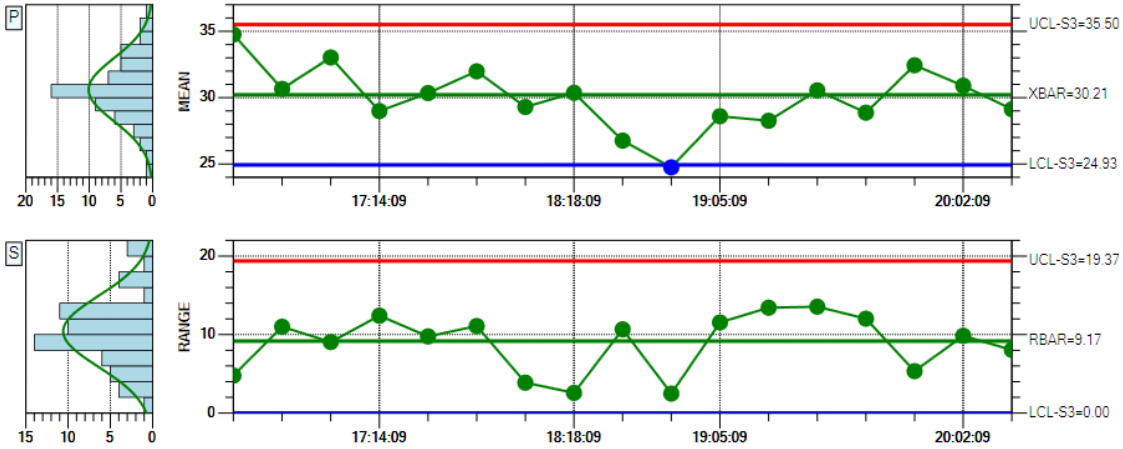
Event-based SPC charts will work with uneven sample intervals. The tick marks will always reflect the timestamp of the associated sample interval

Zooming as an option for the scrollbar (UI option) –The horizontal scrollbar can be replaced (toggled on/off actually) using the UI, with a zoom window, by clicking on the z-button in the lower right corner. The user will be able to scroll the charts by dragging the transparent blue zoom window left or right, or expand the x-axis scale by dragging the left or right edge of the zoom window.

Title: Variable Control Chart (X-Bar & R)							Part No.: 283501					Chart No.: 17						
Part Name: Transmission Casing Bolt							Operation:Threading					Spec. Limits:			Units: 0.0001 inch			
Operator:J. Fenamore							Machine: #11					Gage: #8645			Zero Equals: zero			

Date: 8/14/2017 3:31:21 PM

TIME	20:22	20:31	20:37	20:44	21:03	21:22	21:36	21:48	22:00	22:14	22:27	22:39	22:47	22:53	23:12	23:17	
MEAN	30.95	27.98	28.78	30.73	32.26	30.24	27.22	32.07	28.77	28.59	28.16	32.95	30.26	34.17	29.46	30.98	
RANGE	9.58	9.36	12.18	12.04	9.67	14.53	3.47	13.25	12.35	13.76	11.11	6.57	10.92	7.97	11.47	8.19	
SUM	154.77	139.89	143.89	153.65	161.28	151.21	136.11	160.37	143.84	142.97	140.80	164.74	151.32	170.83	147.31	154.89	
ALARM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NOTES	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	
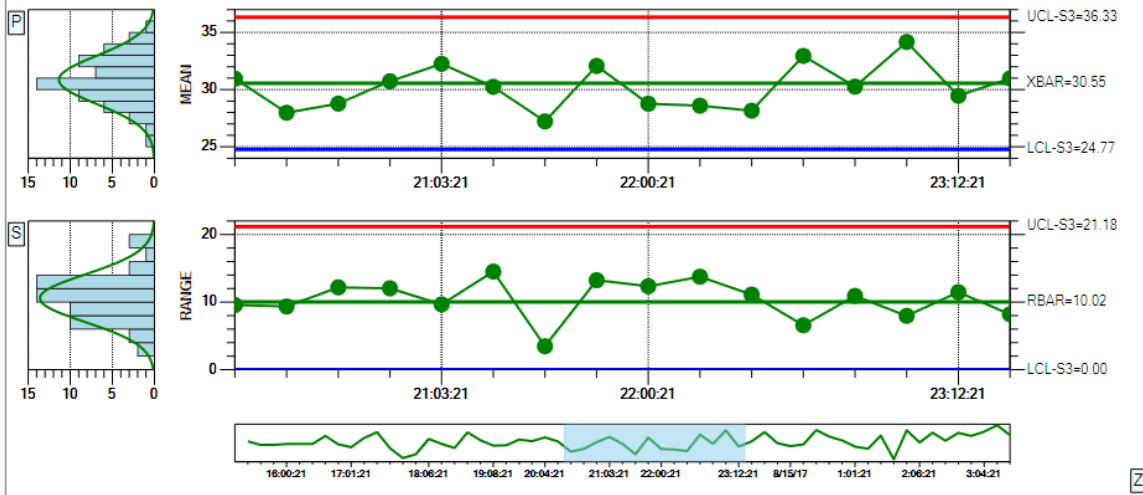
Click on the Z button in the lower right corner and a zoom window will replace the scrollbar. Use the mouse to scroll the charts by dragging the transparent blue zoom window left or right, or expand the x-axis scale by dragging the left or right edge of the zoom window.

If the number of points in the display exceeds the initial setup value for the number of data points, the table is temporarily removed to prevent overlap of the table columns. If the number of data points is reduced to <= the initial number of points, the table will reappear.
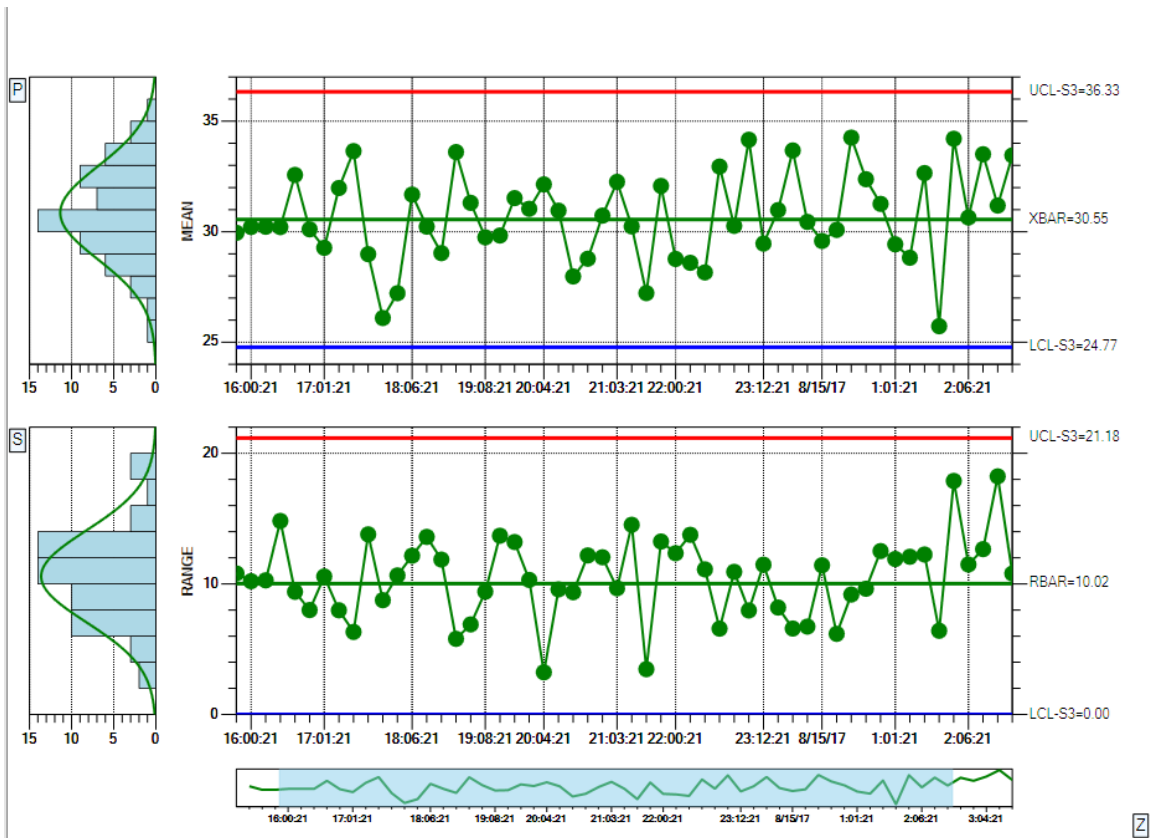
If you use the zoom window to display a lot of points, the table at the top will disappear to prevent the table columns from overlapping.

Collapsible Items (UI option) – Buttons on the top and right of the table permit the user to selectively collapse/restore rows of the table, freeing up more space for the charts. Buttons to the left and bottom of the Primary and Secondary charts also permit the user to collapse/restore either of those charts, allowing the remaining chart to display in all of the remaining space.

Title: Variable Control Chart (X-Bar & Sigma)   Part No.: 283501   Chart No.: 17

Part Name: Transmission Casing Bolt   Operation:Threading

Operator:J. Fenamore   Machine: #11

Date: 8/14/2017 4:19:28 PM

| TIME	16:19	16:34	16:49	17:04	17:19	17:34	17:49	18:04	18:19	18:34	18:49	19:04	19:19	19:34	19:49	20:04	20:19
MEAN	62.3	61.0	67.4	61.8	61.5	63.2	61.4	58.5	65.5	64.6	59.7	61.9	63.7	60.7	65.5	61.6	60.5
SIGMA	6.6	4.9	4.7	6.4	8.3	7.0	4.2	3.5	6.9	6.3	5.9	7.0	5.9	7.5	6.6	6.4	5.3
SUM	374.0	365.8	404.2	370.7	369.0	379.4	368.6	350.9	393.0	387.9	358.3	371.2	382.4	364.3	393.0	369.7	363.1
Cpk	-1.55	-1.58	-1.77	-1.62	-1.49	-1.46	-1.54	-1.59	-1.56	-1.57	-1.55	-1.51	-1.52	-1.51	-1.50	-1.48	-1.48
Cpm	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Ppk	-1.38	-1.59	-1.62	-1.58	-1.46	-1.46	-1.52	-1.52	-1.51	-1.52	-1.50	-1.49	-1.51	-1.49	-1.49	-1.49	-1.49
NO. INSP.	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
NOTES	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Buttons on the top, right and left of the display permit the user to selectively collapse portions of the chart.
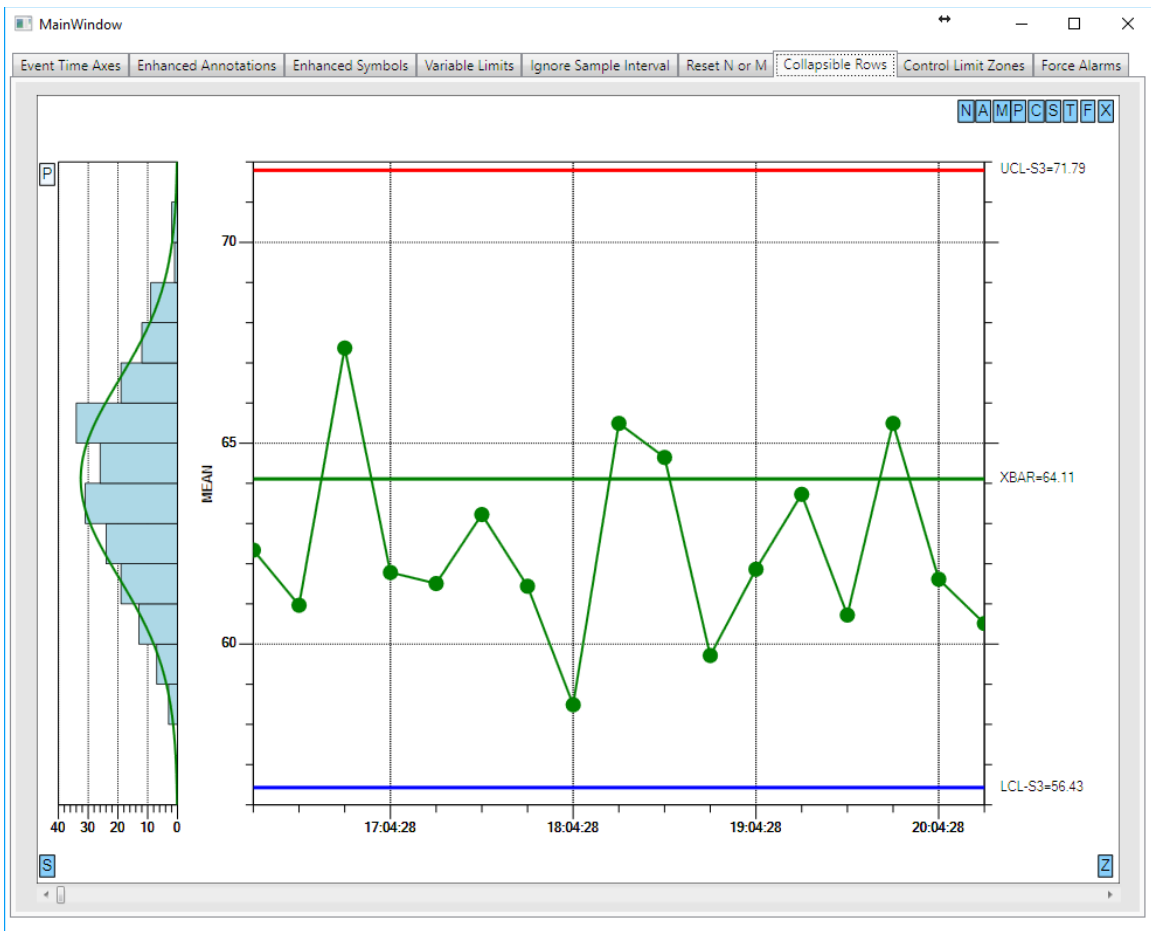
In the example above, all of the chart options except for the Primary chart, have been toggled off using the buttons.

Enhanced Annotations (Programming option) – The chart annotations have been enhanced with a vertical line with accompanying text using programmer specified justification.
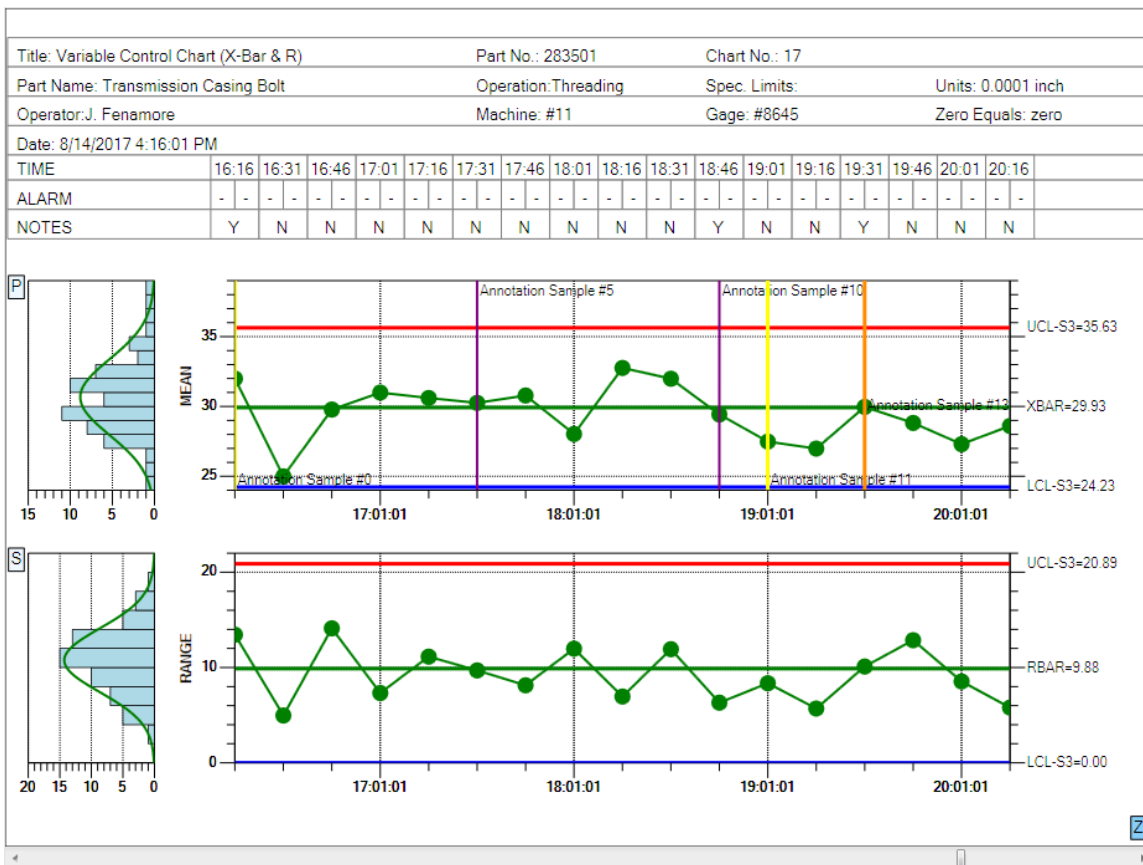
The enhanced chart annotations include a vertical line to mark the data point, and many justification options (top, middle, bottom, left, right and center).

Enhanced Out of Limit Symbol   (Programming option) – One of the SPC chart options is to mark a data point which is outside of control limits by changing the color of the symbol. It is now possible to also also change the size and symbol type for out of limit symbols.
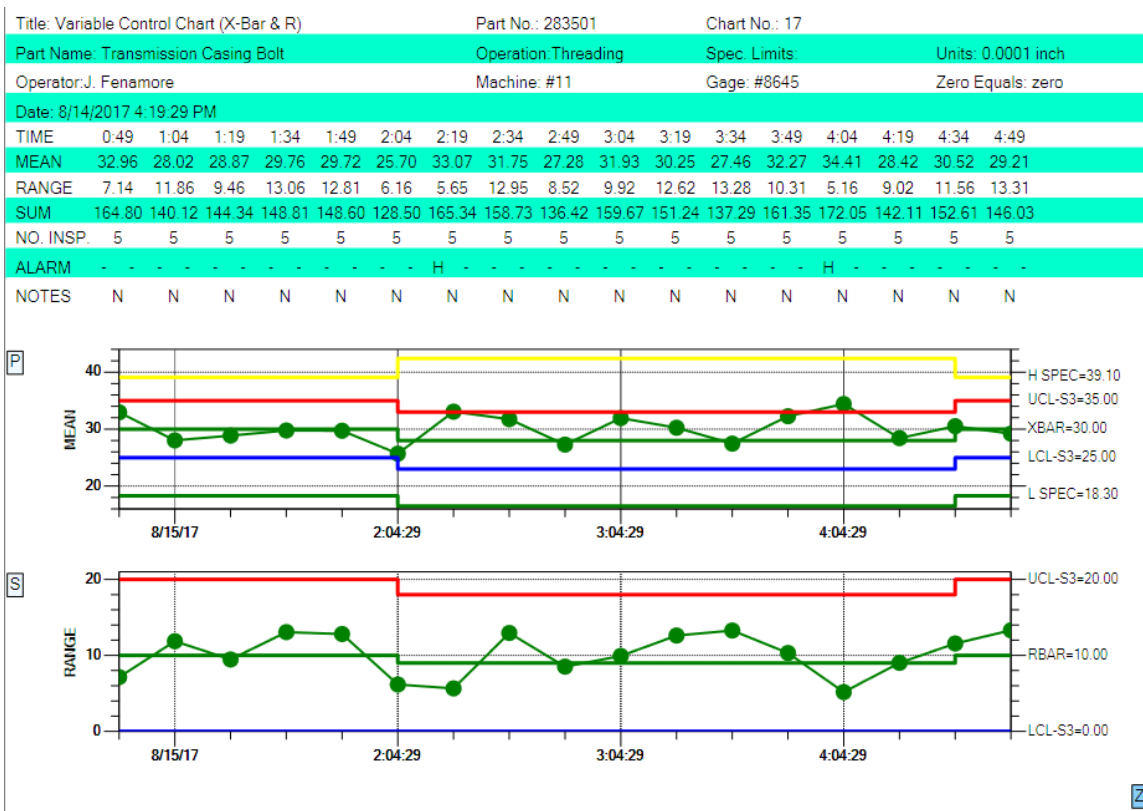
Title: Variable Control Chart (X-Bar & R)					Part No.: 283501				Chart No.: 17							
Part Name: Transmission Casing Bolt					Operation:Threading				Spec. Limits:				Units: 0.0001 inch			
Operator:J. Fenamore					Machine: #11				Gage: #8645				Zero Equals: zero			

Date: 8/14/2017 4:16:02 PM

TIME	7:01	7:16	7:31	7:46	8:01	8:16	8:31	8:46	9:01	9:16	9:31	9:46	10:01	10:16	10:31	10:46	11:01
MEAN	34.6	25.4	31.5	33.0	31.3	29.8	29.8	30.8	35.5	32.7	25.5	30.4	31.9	32.2	33.5	25.4	31.9
RANGE	18.9	14.7	21.5	21.4	18.8	15.9	23.0	7.6	12.8	13.8	2.3	21.5	12.3	13.4	15.6	8.2	15.4
SUM	138.6	76.2	157.4	132.2	156.5	149.0	148.8	123.4	142.2	163.3	76.4	91.1	127.4	128.8	167.5	76.1	127.6
ALARM	H	-	-	-	-	H	-	H	-	-	-	-	-	H	-	-	H
NOTES	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	Y	N	N
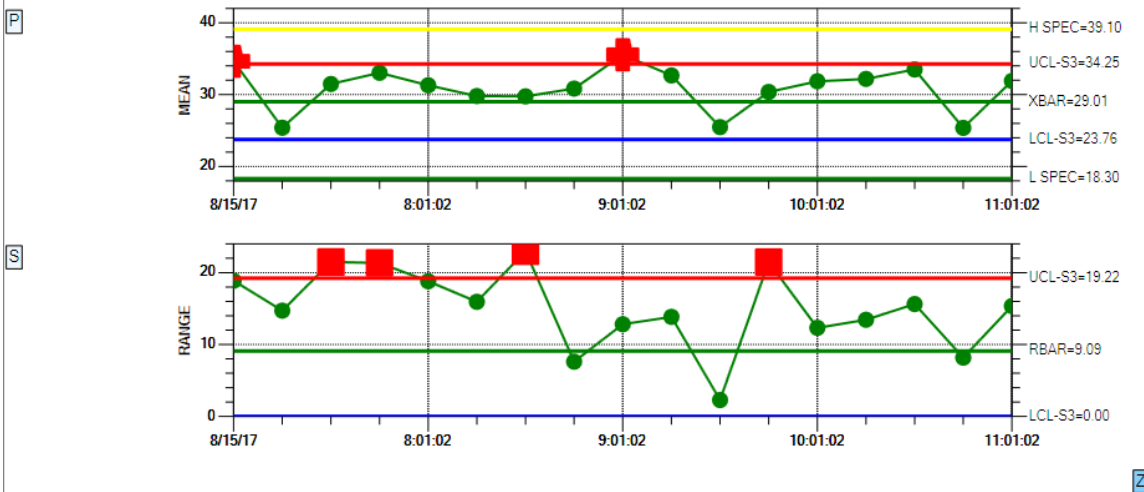
A data point which is outside of control limits can be automatically marked using color, symbol type, and size.

In the example above, the out of control symbol for the Primary chart is an extra large plus sign, while for the the Secondary chart it is an extra large square, both contrasting with the default circle symbol.

Variable Spec and Control Limits (Programming option) – In addition to variable control limits, charts can now have variable specification limits.

Title: Variable Control Chart (X-Bar & R)								Part No.: 283501				Chart No.: 17				
Part Name: Transmission Casing Bolt								Operation:Threading				Spec. Limits:		Units: 0.0001 inch			
Operator:J. Fenamore								Machine: #11				Gage: #8645		Zero Equals: zero			
Date: 8/14/2017 4:19:29 PM																	
TIME	0:49	1:04	1:19	1:34	1:49	2:04	2:19	2:34	2:49	3:04	3:19	3:34	3:49	4:04	4:19	4:34	4:49
MEAN	32.96	28.02	28.87	29.76	29.72	25.70	33.07	31.75	27.28	31.93	30.25	27.46	32.27	34.41	28.42	30.52	29.21
RANGE	7.14	11.86	9.46	13.06	12.81	6.16	5.65	12.95	8.52	9.92	12.62	13.28	10.31	5.16	9.02	11.56	13.31
SUM	164.80	140.12	144.34	148.81	148.60	128.50	165.34	158.73	136.42	159.67	151.24	137.29	161.35	172.05	142.11	152.61	146.03
NO. INSP.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
ALARM	-	-	-	-	-	-	-	-	H	-	-	-	-	-	-	-	H	-	-	-	-	-	-
NOTES	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Control limits and specification limits can be adjusted on a sample interval by sample interval basis.
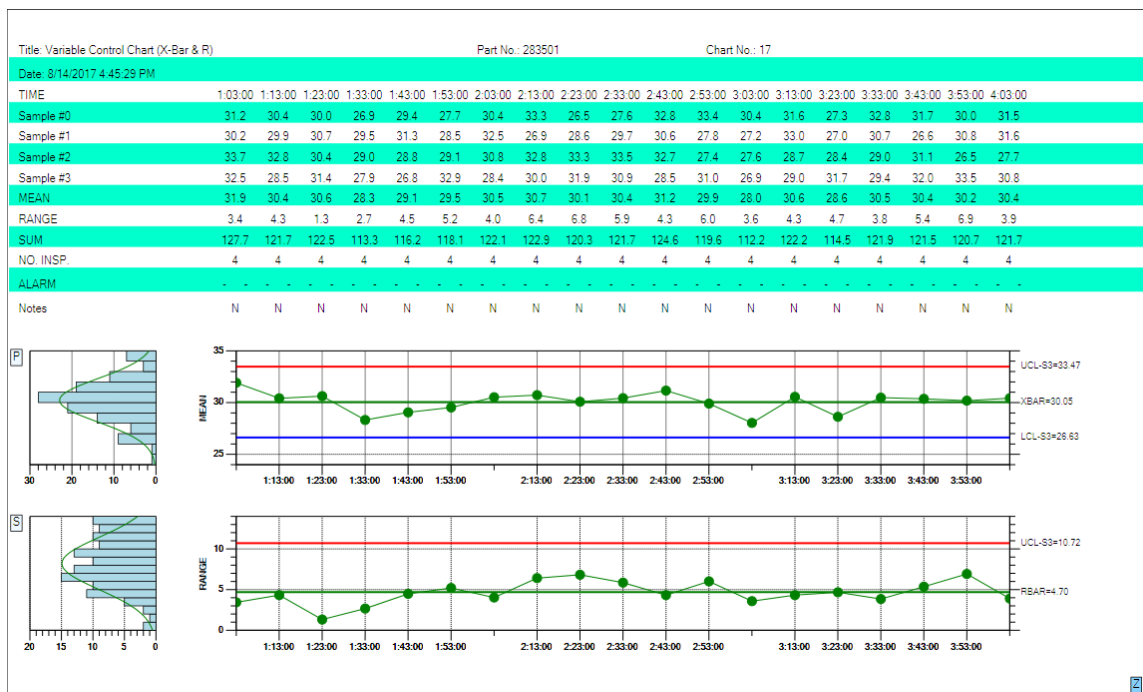
Marking a sample internal as bad (Programming option) – A sample interval can be marked as bad. This will disable plotting of the sample interval in the Primary and Secondary charts. It will also prevent the sample interval values from being evaluated in control limit testing, and in auto-calculations for control limits and y-axis range.
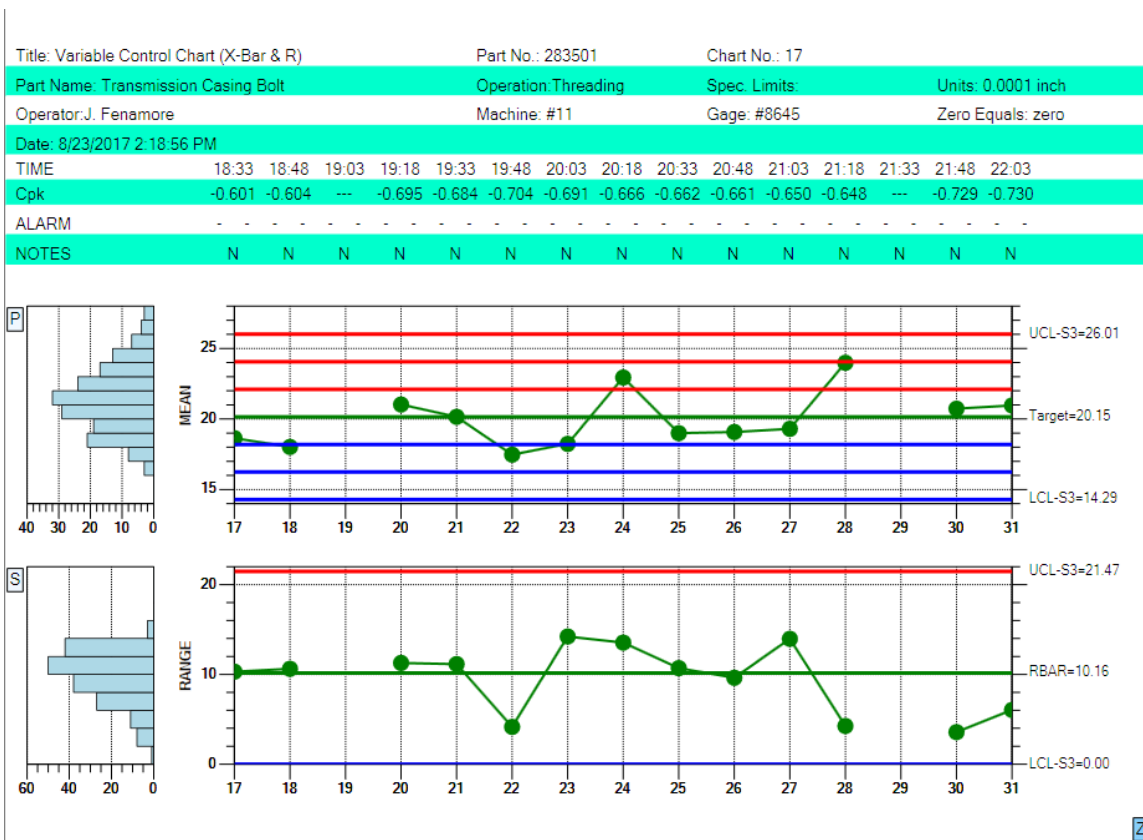
A hole (sample intervals 19 and 29 in the picture above) will appear in the main plot of the Primary and Secondary charts when a sample interval is marked bad.

Reset N of M counters for control moves   (Programming option) – There are cases when a user wants to keeps the same chart going, adding new sample intervals with new data, after the issue which caused the process to go out of control has been remedied. But many of the control limit tests found in the named control rules (WECO, Nelson, etc.) use N of M tests, where N out of M sample intervals must violate a specific rule. For example, a WECO rule says that if 4 out of 5 samples are outside of 1-sigma, it is an alarm condition. But if the process is now in control, the user may want to reset all N or M counts back to 0, exactly as if the plotting of the chart had started at the first sample interval. So we have added a reset mechanism for the N or M rules to a zero count for all rules.

Remove Negative LCL control limits for Variable Control Secondary charts, or Attribute Control Primary charts (Programming option) - We added a routine which when called will disable (both from display and alarm checking) any chart LCL control limit if the limit value is <= a specified value, 0.0 in most cases.

| Title: Variable Control Chart (X-Bar & R)								Part No.: 283501				Chart No.: 17						
Date: 8/14/2017 4:45:29 PM																		
TIME	1:03:00	1:13:00	1:23:00	1:33:00	1:43:00	1:53:00	2:03:00	2:13:00	2:23:00	2:33:00	2:43:00	2:53:00	3:03:00	3:13:00	3:23:00	3:33:00	3:43:00	3:53:00 4:03:00
Sample #0	31.2	30.4	30.0	26.9	29.4	27.7	30.4	33.3	26.5	27.6	32.8	33.4	30.4	31.6	27.3	32.8	31.7	30.0 31.5
Sample #1	30.2	29.9	30.7	29.5	31.3	28.5	32.5	26.9	28.6	29.7	30.6	27.8	27.2	33.0	27.0	30.7	26.6	30.8 31.6
Sample #2	33.7	32.8	30.4	29.0	28.8	29.1	30.8	32.8	33.3	33.5	32.7	27.4	27.6	28.7	28.4	29.0	31.1	26.5 27.7
Sample #3	32.5	28.5	31.4	27.9	26.8	32.9	28.4	30.0	31.9	30.9	28.5	31.0	26.9	29.0	31.7	29.4	32.0	33.5 30.8
MEAN	31.9	30.4	30.6	28.3	29.1	29.5	30.5	30.7	30.1	30.4	31.2	29.9	28.0	30.6	28.6	30.5	30.4	30.2 30.4
RANGE	3.4	4.3	1.3	2.7	4.5	5.2	4.0	6.4	6.8	5.9	4.3	6.0	3.6	4.3	4.7	3.8	5.4	6.9 3.9
SUM	127.7	121.7	122.5	113.3	116.2	118.1	122.1	122.9	120.3	121.7	124.6	119.6	112.2	122.2	114.5	121.9	121.5	120.7 121.7
NO. INSP.	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4 4
ALARM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -
Notes	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Note that the lower control limit for the Secondary (Range) chart is not present. It was calculated be 0.0, and was removed by the software.

N of M testing when the most recent point entering the test is within limits (Programming option) - Our default mode takes a strict approach to N of M testing. Regardless of the value of the most recent point to enter the calculation (even if it is within the test limits), if N of M values are outside of limits we consider the sample interval to be in alarm. But some customers challenged this interpretation and presented us with published examples which show that if the most recent point is within limits and the previous N points out of limits, the sample interval should NOT be considered in alarm. We researched the issue and found no agreement. It is implemented in the published literature both ways. So a simple global flag has been added you can use to choose one evaluation method or the other, with the default being our original method.

Sample Interval Update with an invalid number of samples (Programming option) - When you have specified one of the fixed sample size charts, a more lenient evaluation method for sample interval updates has been implemented. You can now enter less than or greater than the specified number of samples for an interval update without the software complaining. It will process the samples as if the proper number of values was entered, without introducing zero values into the sample interval. So if the specified number of samples per sample interval is 5, and 3 are entered, it will still work. It will calculate the mean and range of the sample interval using only 3 values. However, it will not adjust the control limits to take into account the incorrect number of samples, unlike what is done in the dedicated variable sample size (_VSS) charts. Also, you can not enter in a single value for any of the control charts which require more than one value. Because then you cannot calculate the range, or sigma value of the sample interval, something the software uses internally.

|																		
Sample #0	38.2	24.0	21.9	38.7	20.2	23.9	37.4	31.5	33.9	20.8	39.1	41.9	27.2	37.9	40.6	40.2	35.9	[S]
Sample #1	34.0	41.0	22.8	24.8	35.1	27.8	38.9	40.0	41.5	40.8	43.8	31.3	39.4	28.2	28.6	36.3	30.2	
Sample #2	26.7	21.4	25.5	36.9	33.2	25.7	23.3	24.8	27.8	30.3	32.6	26.1	30.7	23.5	40.0	38.0	21.7	
Sample #3	32.2	40.5	43.9	34.7	---	31.4	38.2	24.4	39.0	27.3	30.5	35.8	24.3	37.8	31.8	27.6	23.1	
Sample #4	28.1	---	43.2	20.3	---	32.8	---	28.9	---	26.3	21.2	---	22.0	24.6	25.8	22.6	33.2	
MEAN	31.8	31.7	31.5	31.1	29.5	28.3	34.4	29.9	35.5	29.1	33.4	33.8	28.7	30.4	33.4	32.9	28.8	[C]
RANGE	11.4	19.6	22.1	18.4	14.9	8.9	15.6	15.6	13.7	20.0	22.6	15.8	17.4	14.4	14.8	17.6	14.2	
SUM	159.2	126.9	157.4	155.3	88.5	141.5	137.8	149.6	142.2	145.5	167.1	135.3	143.6	152.0	166.9	164.6	144.0	
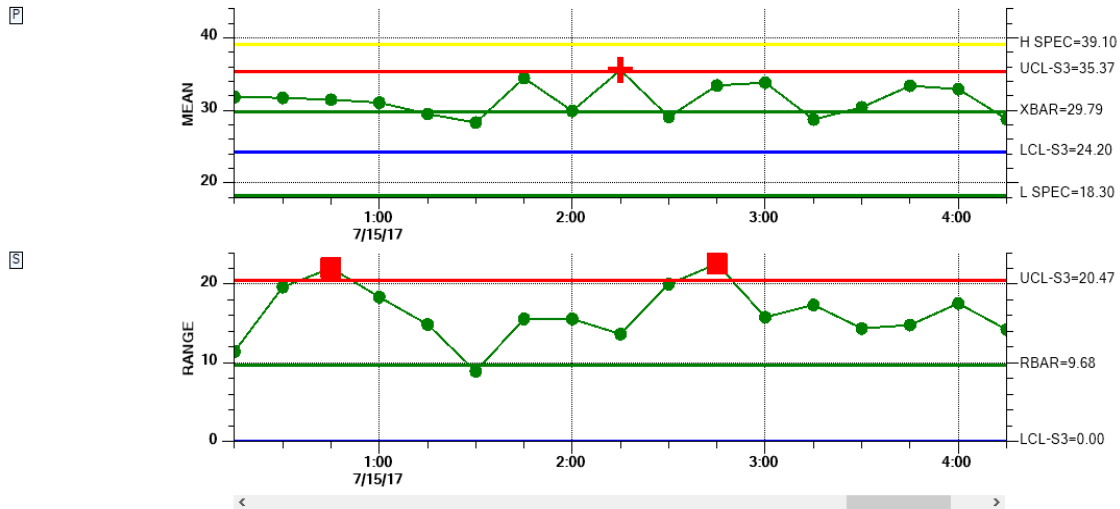
Note that the sample data in the table has many columns where the number of samples is less than the specified 5 samples per sample interval.

Alarm Forcing – High and low control lines can be set to explicit values, or you can have the software auto-calculated the values based on historical data. As new sample intervals are added to the chart, the new values are compared to existing control limits and the alarm conditions noted. But, you can override the alarm limit display, so that a normal condition shows as an alarm, or an alarm condition shows as normal.
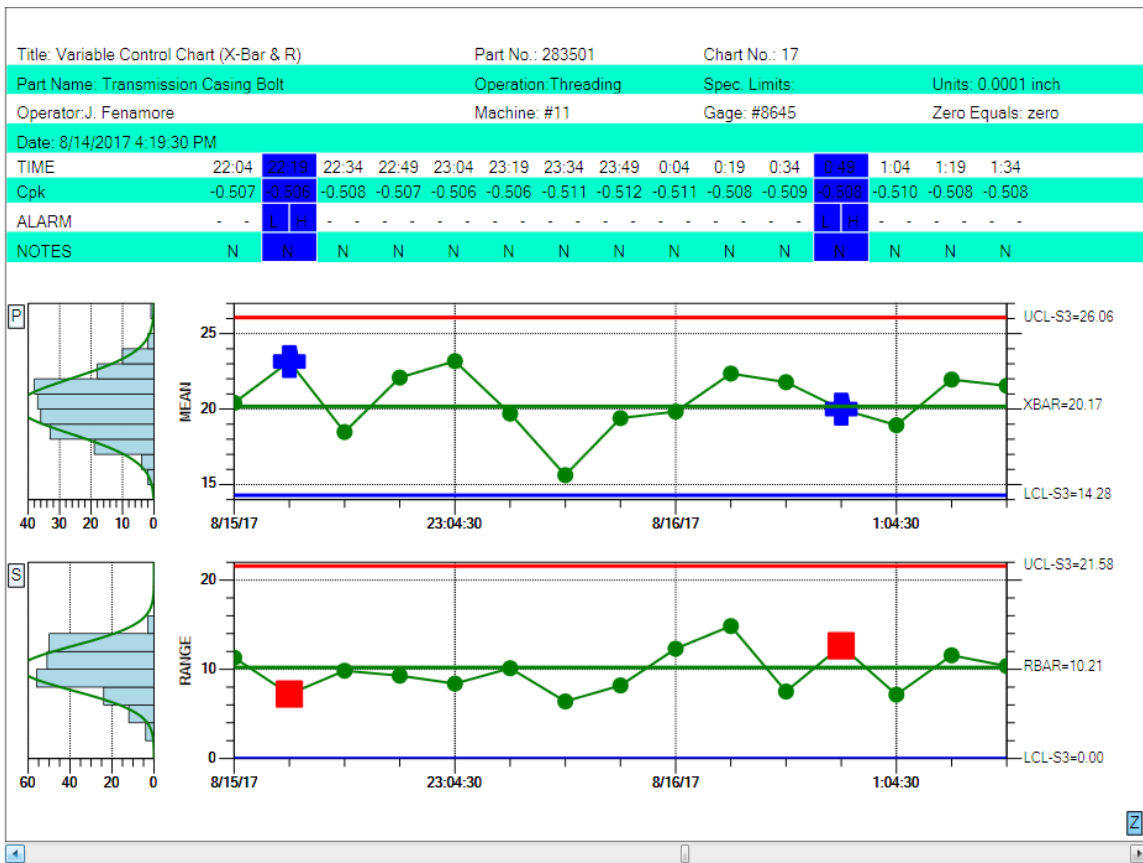
Sample intervals are forced to into an alarm state, regardless of the calculated value.

Levey-Jennings Chart - We added a new SPC chart type, the Levey-Jennings chart, using the Westgard rules.
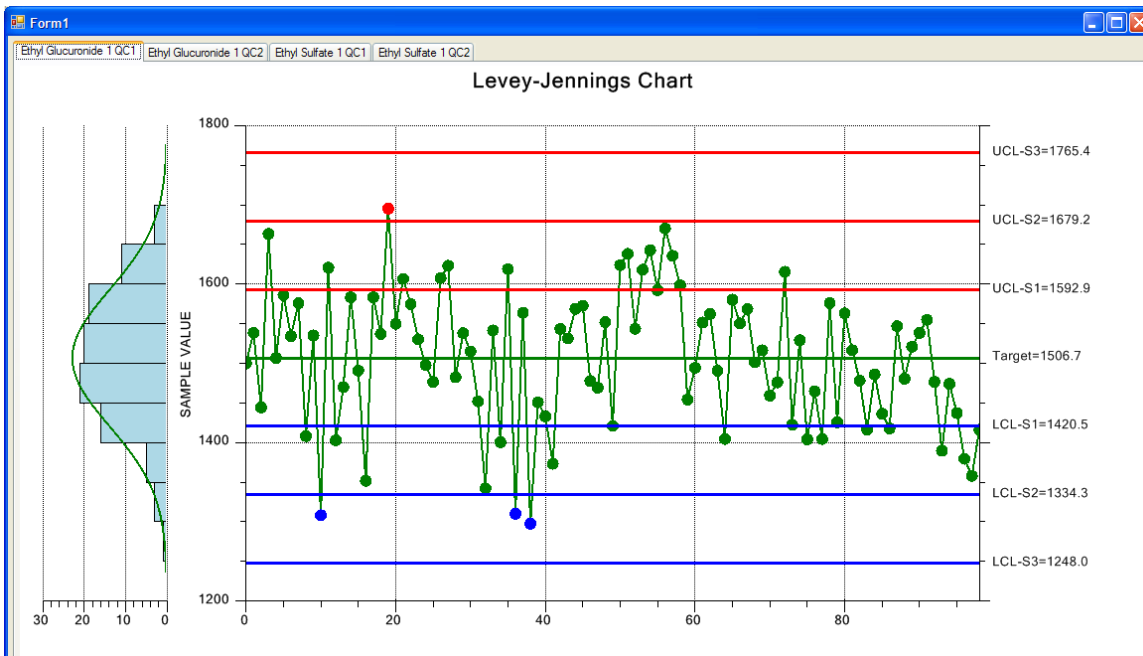

Typical Levey-Jennings Chart using Batch Sampling

The Levey-Jennings chart is used almost exclusively in laboratory settings. It uses a chart very similar to the Individual Range chart above, the major difference being that it only uses the Primary individual data point graph of the chart and does not include the Secondary moving range graph. Also, the Levey-Jennings chart uses the Westgard rules which utilizes tests involving 1-, 2- and 3- sigma control limits.

Batch update with auto-calculated control limits

We added a routine (**CalculateControlLimitsFromBatch**) in the main SPCChartBase class, which will calculate a set of control limits based on a batch of N sample intervals. So if your first batch has 20 sample intervals, you would call that routine and you would get back the control limits specific to that set of data. Then you would set the control limits to those values, then update the chart with your sample interval data. The data would be evaluated against the control limits you just set. Then, you can take another batch of N sample intervals, calculate the limits, set the limits, and update the graph again. The new process data, and control limits will be appended to the line plots of the existing chart. The new limits will only apply to the new data values. Repeat ad infinitum.
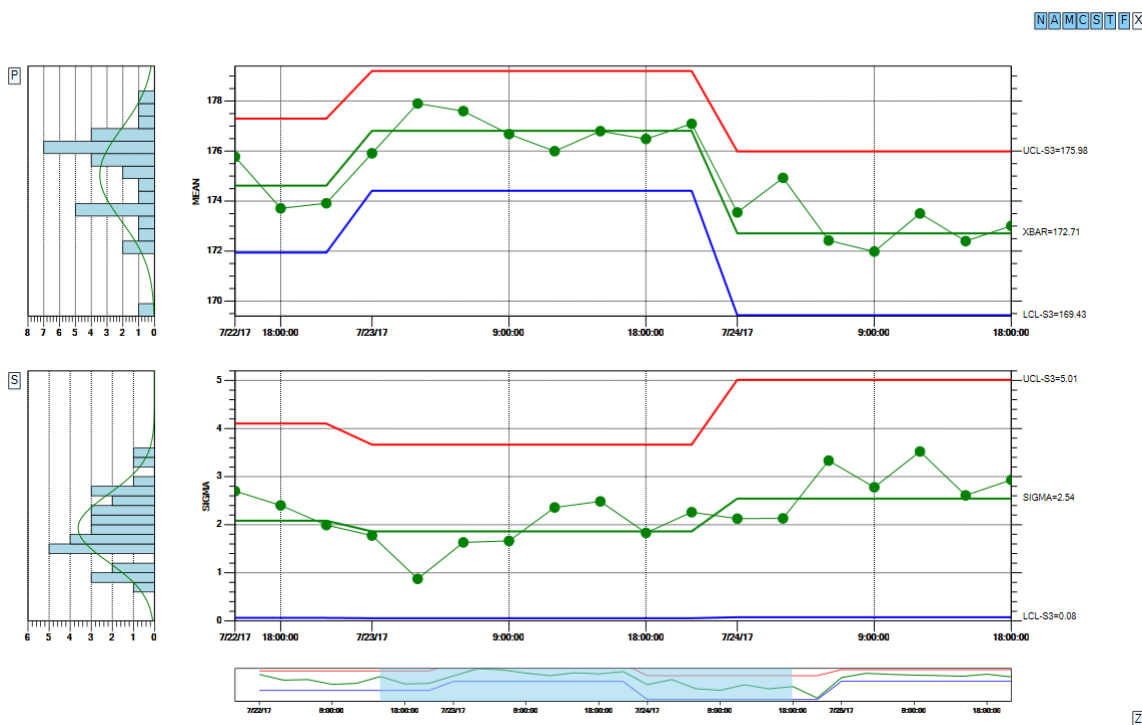
You can auto-calculate control limits for batches of process values, and concatenate the resulting graphs together.

To make it even easier to use, we added flags to the CalculateControlLimitsFromBatch routine which can optionally set the calculated control limits, and update the chart with the supplied data, eliminating the need for the programmer to that externally. So the way this works is that each batch will display all at once, appended to the existing data. There is no incremental update of one sample interval at a time.