Quality Digest Webinar

PQ Systems
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Five Costly Mistakes Applying SPC
(and how to avoid them)

Presenters

Steve Daum
Director of Development
PQ Systems

Matt Savage
SPC Product Manager
PQ Systems

Guest Moderator

Dirk Dusharme
Editor in Chief
Quality Digest

#1 Capability before stability

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- Check before you test
- Think SBC instead of SPC
  - Stability Before Capability
- Compare Cpk to Ppk

Capability before stability

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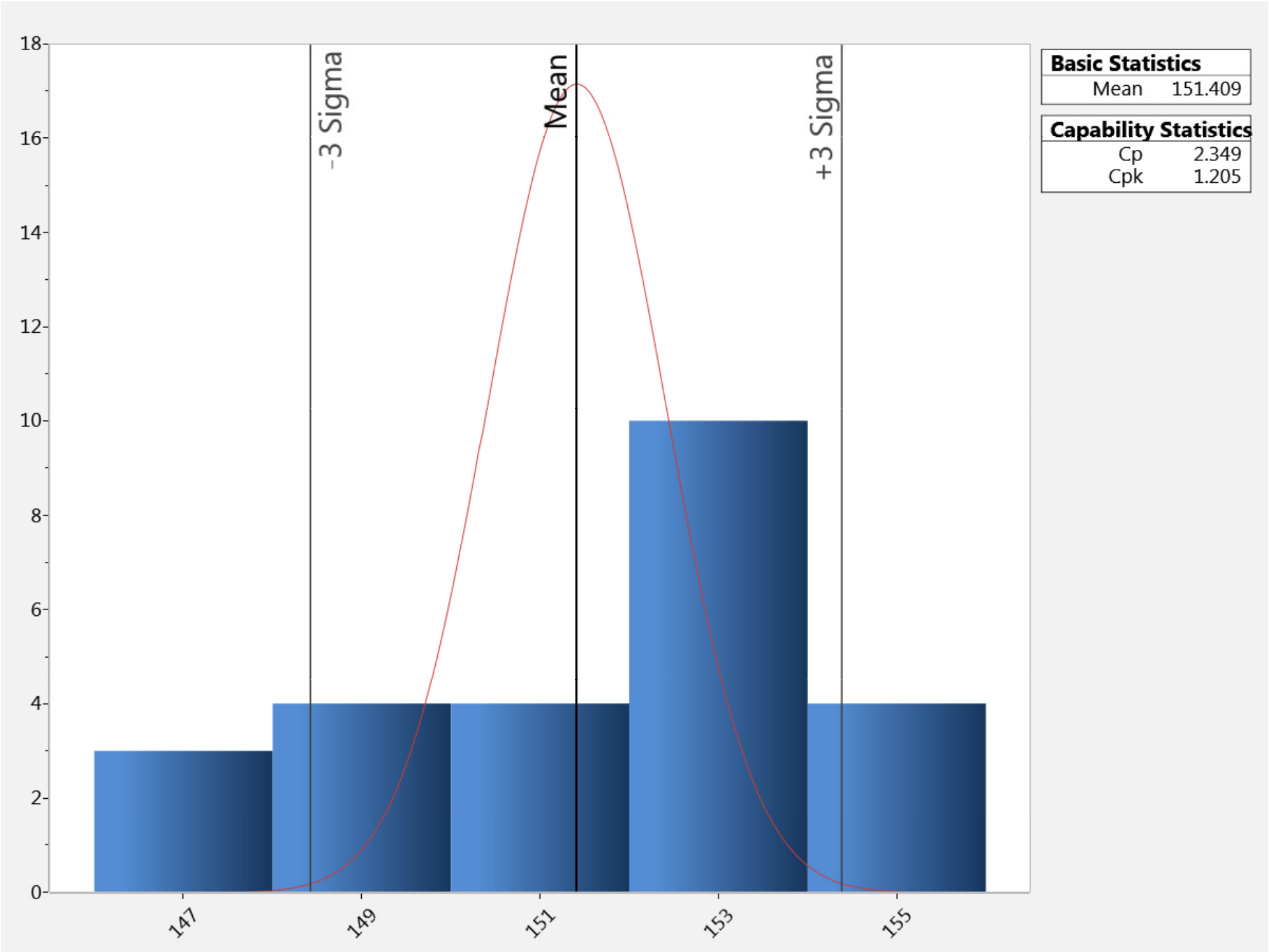
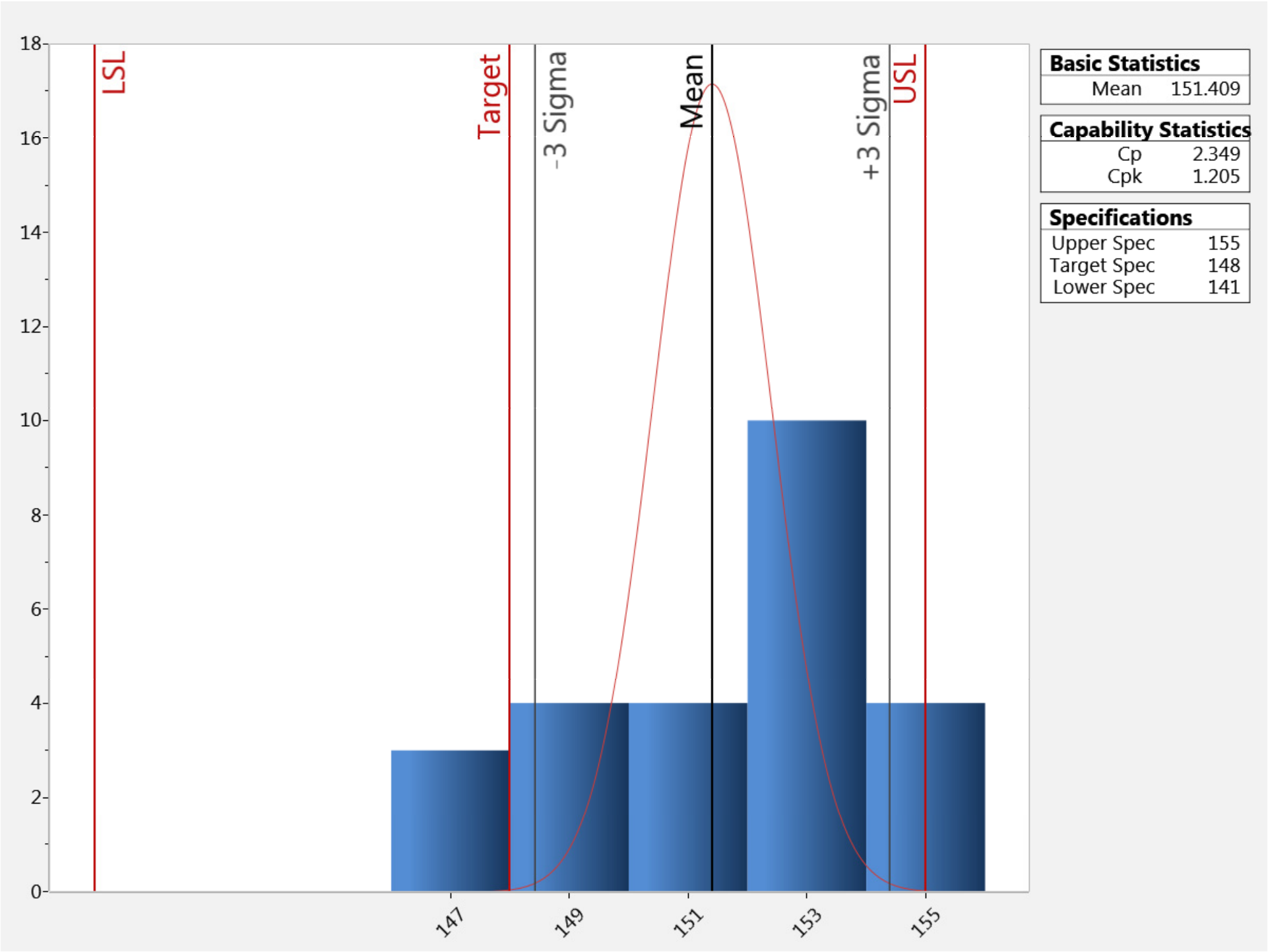
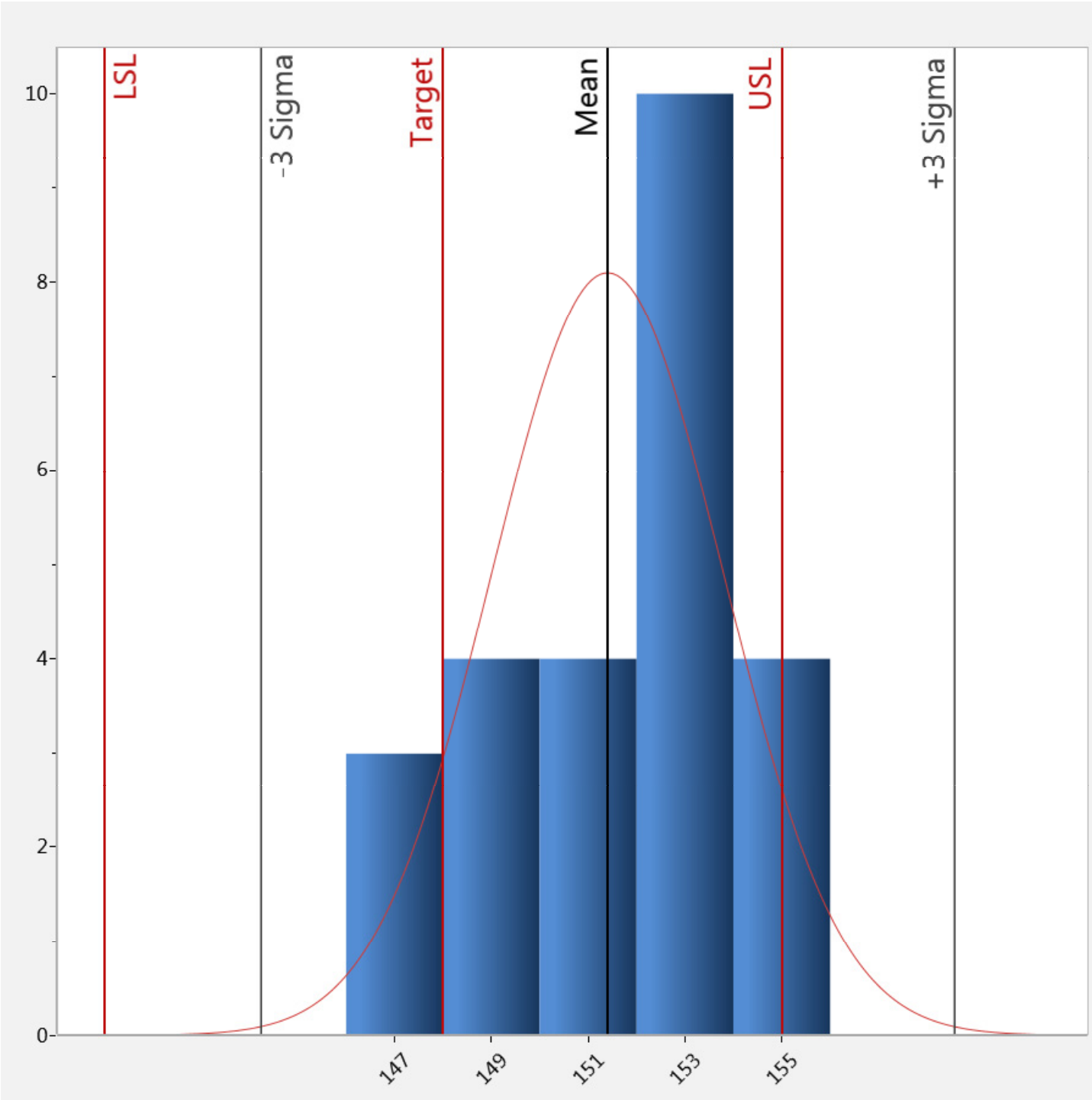
Cp 2.3

Cpk 1.2


-3 Sigma
Mean
+3 Sigma
18
16
14
12
10
8
6
4
2
0
147
149
151
153
155
Basic Statistics
Mean 151.409
Capability Statistics
Cp 2.349
Cpk 1.205


LSL
Target
-3 Sigma
Mean
+3 Sigma
USL
18
16
14
12
10
8
6
4
2
0
147
149
151
153
155
Basic Statistics
Mean 151.409
Capability Statistics
Cp 2.349
Cpk 1.205
Specifications
Upper Spec 155
Target Spec 148
Lower Spec 141



Basic Statistics	
Mean	151.409
Sigma of the individuals	2.391
Dpm (i)	66,595

Subgroup Statistics	
	mR = 2
Estimated Sigma	0.993

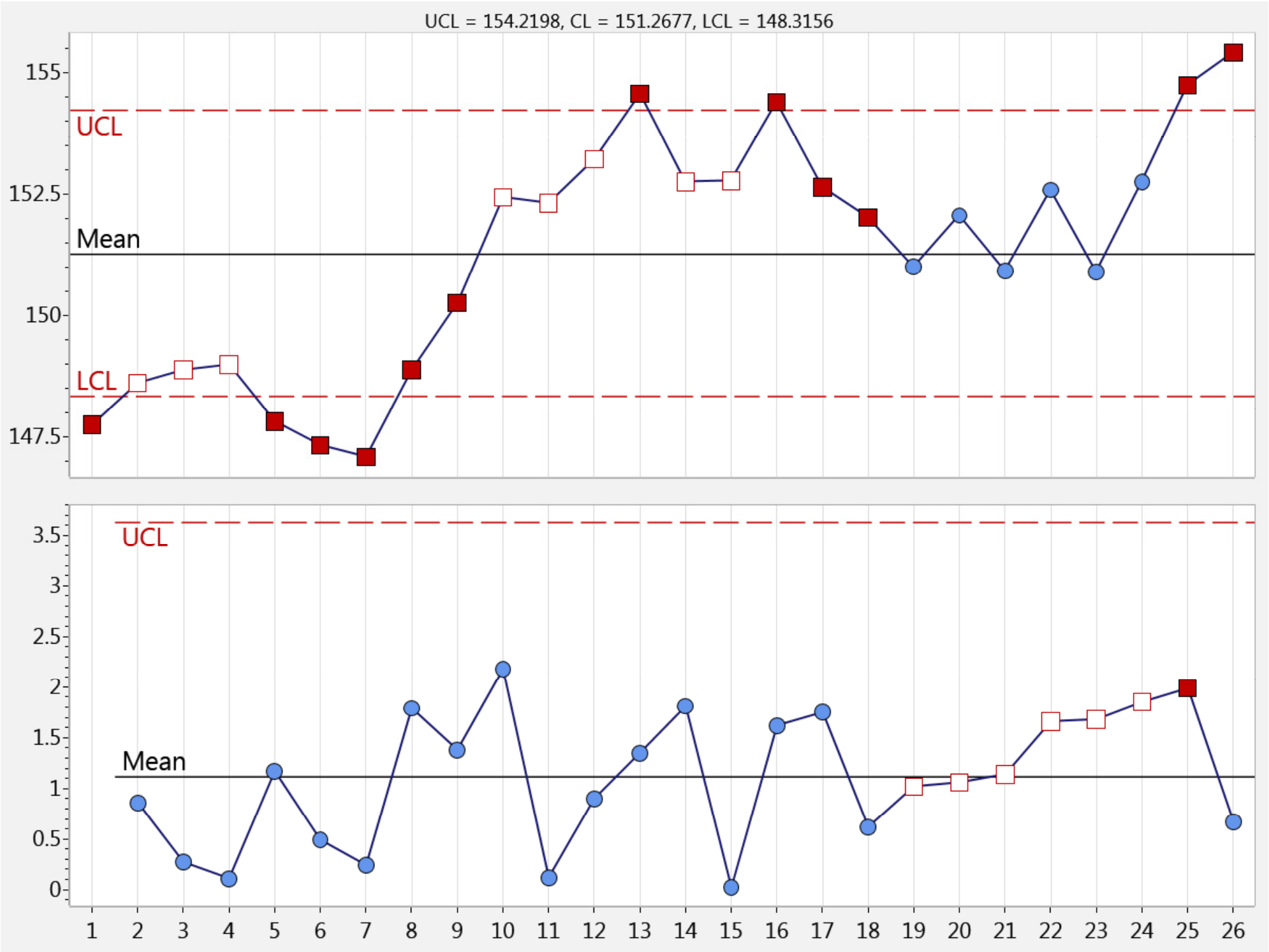
Performance Statistics	
Pp	0.976
Ppk	0.501

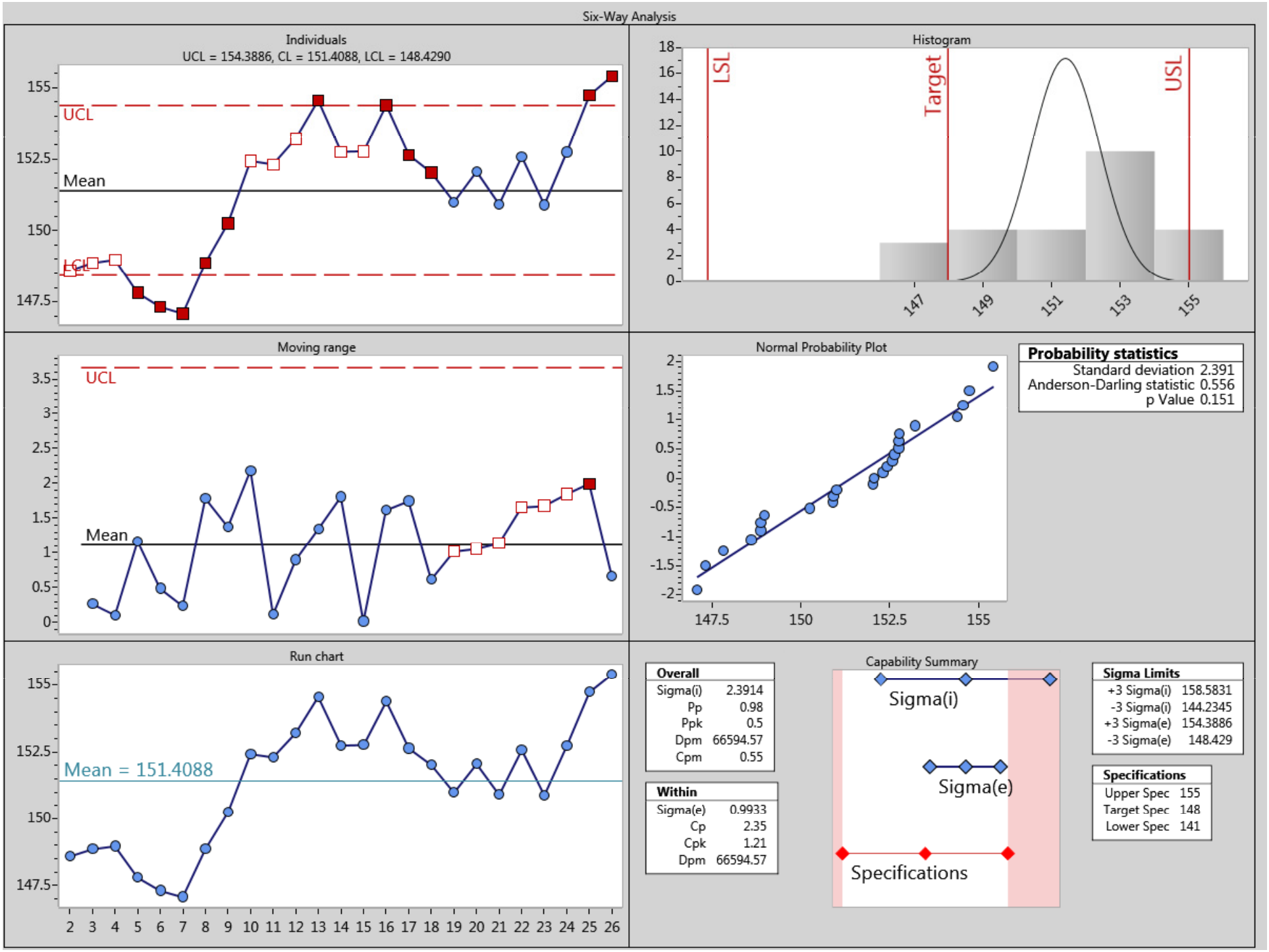
Capability Statistics	
Cp	2.349
Cpk	1.205

Specifications	
Upper Spec	155
Target Spec	148
Lower Spec	141

Footnotes

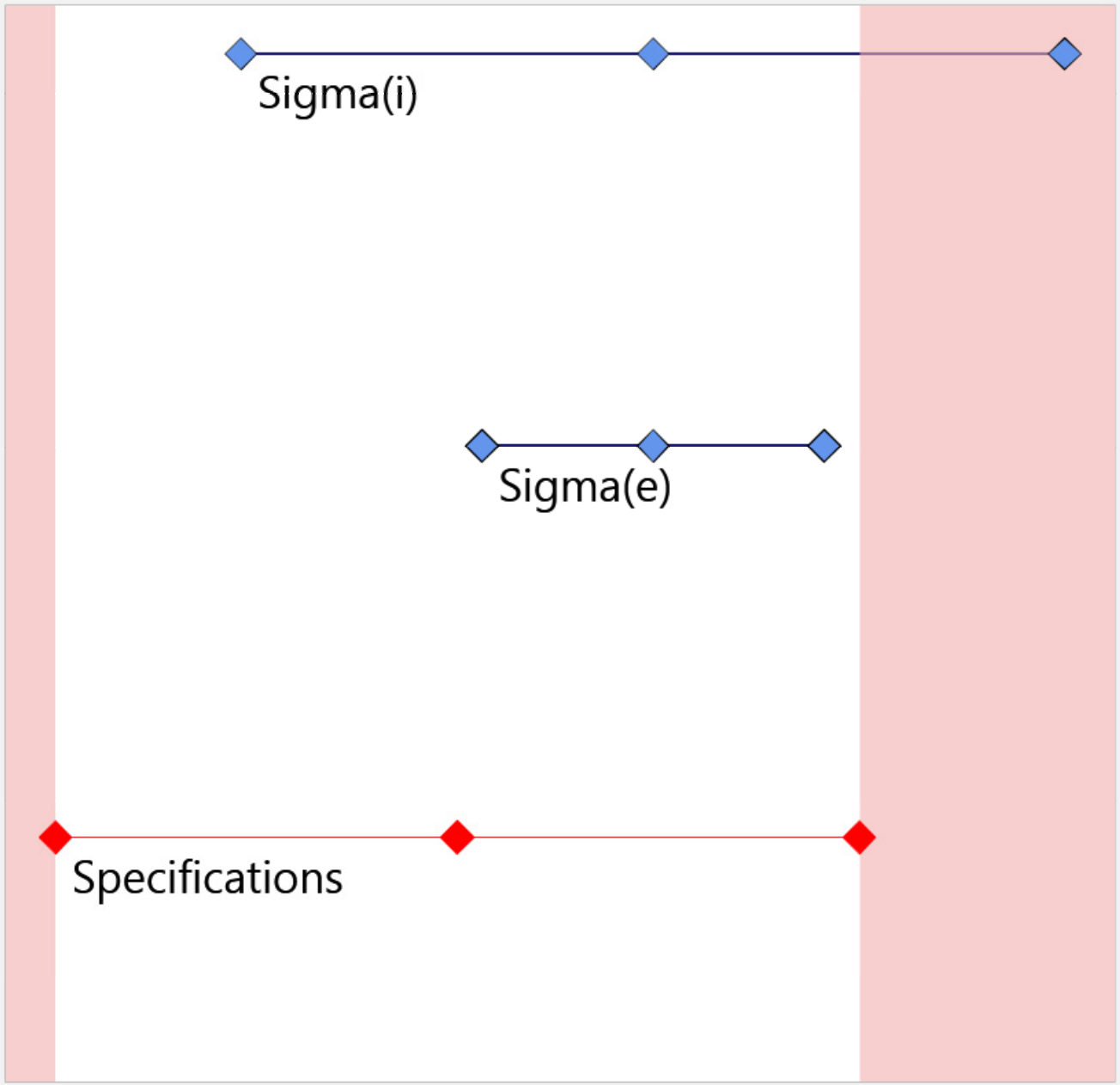
(i) = Uses Sigma of the individuals


UCL = 154.2198, CL = 151.2677, LCL = 148.3156
155
152.5
150
147.5
UCL
Mean
LCL
3.5
3
2.5
2
1.5
1
0.5
0
UCL
Mean
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26


Six-Way Analysis
Individuals
UCL = 154.3886, CL = 151.4088, LCL = 148.4290
UCL
Mean
LCL
155
152.5
150
147.5
Histogram
LSL
Target
USL
18
16
14
12
10
8
6
4
2
0
147
149
151
153
155
Moving range
UCL
Mean
3.5
3
2.5
2
1.5
1
0.5
0
Normal Probability Plot
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
147.5
150
152.5
155
Probability statistics
Standard deviation 2.391
Anderson-Darling statistic 0.556
p Value 0.151
Run chart
Mean = 151.4088
155
152.5
150
147.5
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
Overall
Sigma(i) 2.3914
Pp 0.98
Ppk 0.5
Dpm 66594.57
Cpm 0.55
Within
Sigma(e) 0.9933
Cp 2.35
Cpk 1.21
Dpm 66594.57
Capability Summary
Sigma(i)
Sigma(e)
Specifications
Sigma Limits
+3 Sigma(i) 158.5831
-3 Sigma(i) 144.2345
+3 Sigma(e) 154.3886
-3 Sigma(e) 148.429
Specifications
Upper Spec 155
Target Spec 148
Lower Spec 141

Overall	
Sigma(i)	2.391
Pp	0.98
Ppk	0.5
Dpm	66594.57
Cpm	0.55

Within	
Sigma(e)	0.993
Cp	2.35
Cpk	1.21
Dpm	66594.57



Sigma Limits	
+3 Sigma(i)	158.583
-3 Sigma(i)	144.235
+3 Sigma(e)	154.389
-3 Sigma(e)	148.429

Specifications	
Upper Spec	155
Target Spec	148
Lower Spec	141

Ideal Capability Summary

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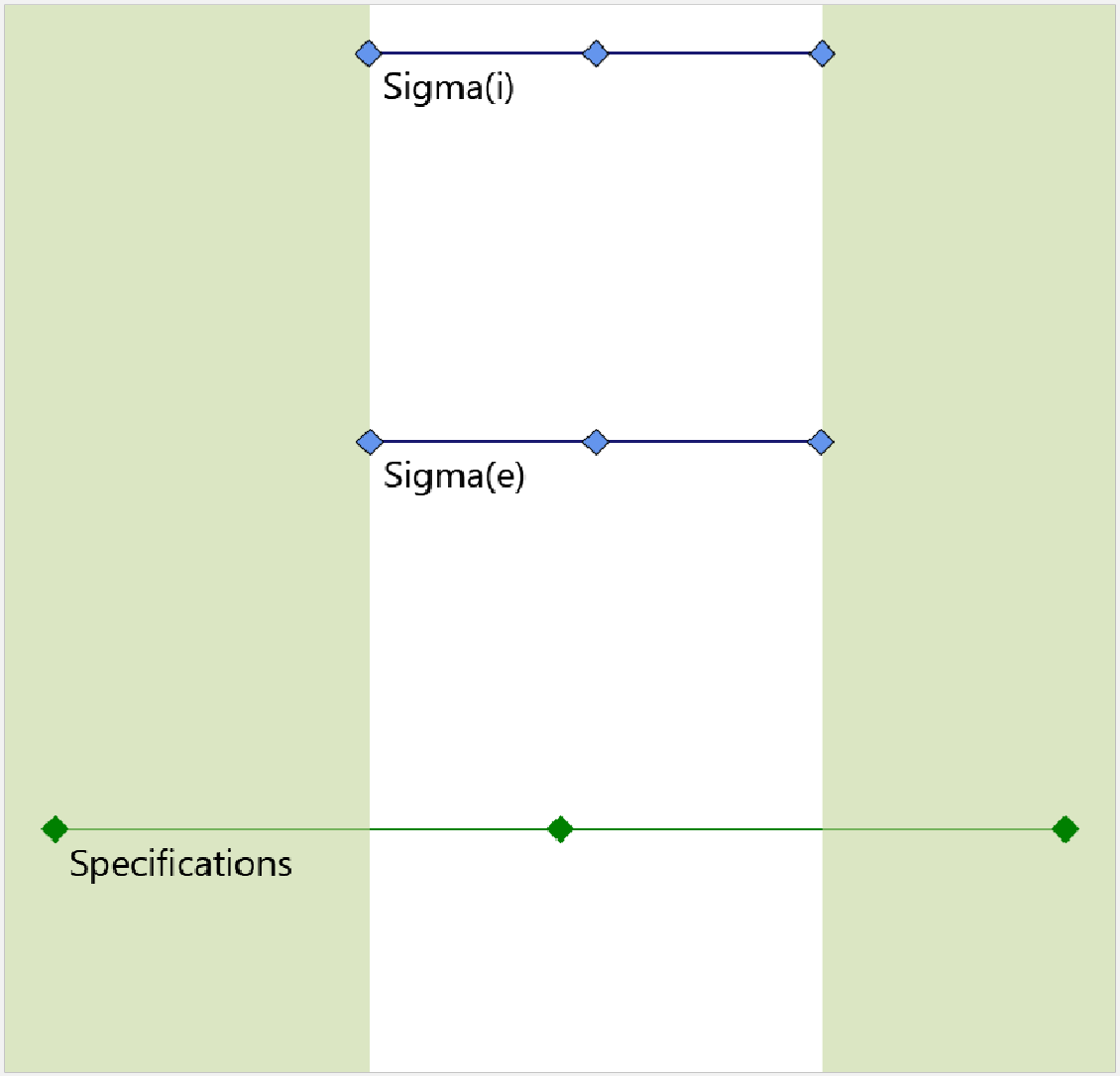
Overall	
Sigma(i)	1.047
Pp	2.23
Ppk	2.07
Dpm	0
Cpm	2.01

Within	
Sigma(e)	1.044
Cp	2.24
Cpk	2.08
Dpm	0



Sigma Limits	
+3 Sigma(i)	151.627
-3 Sigma(i)	145.345
+3 Sigma(e)	151.618
-3 Sigma(e)	145.354

Specifications	
Upper Spec	155
Target Spec	148
Lower Spec	141

#1 Capability before stability

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To avoid Mistake #1:

- Don’t start with Cpk
- Review control charts first
- Compare Cpk to Ppk

#2 Misuse of control limits

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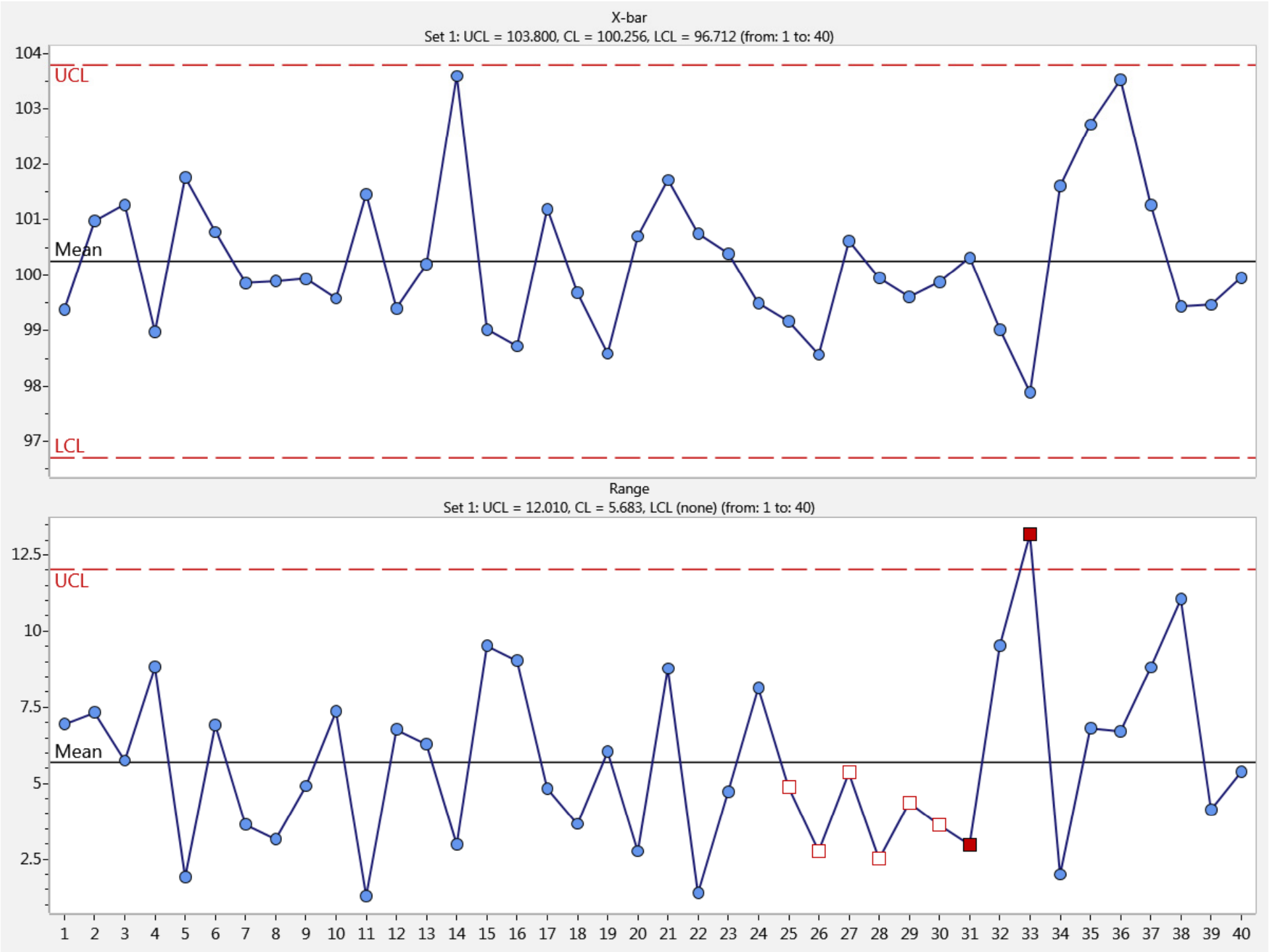
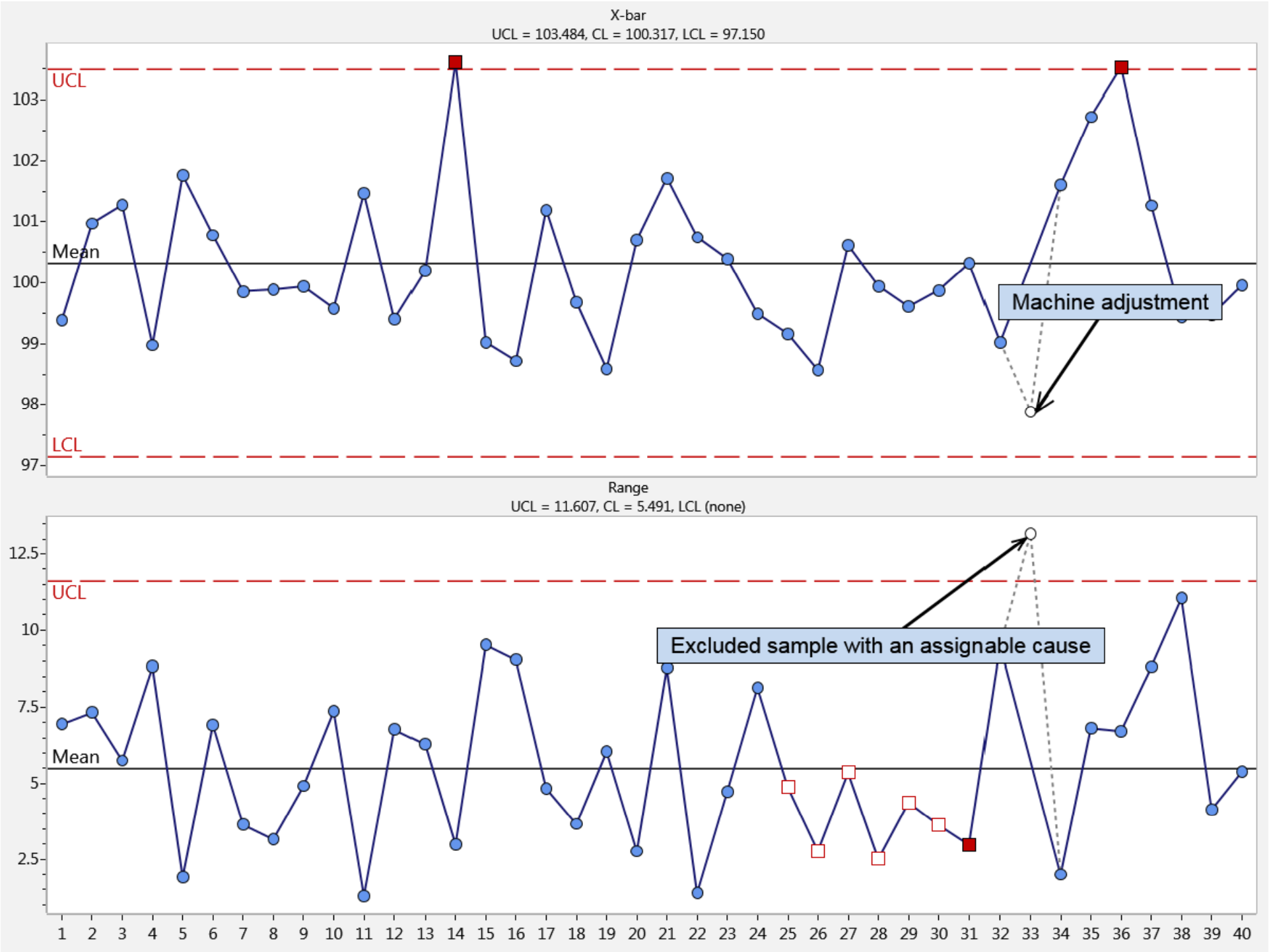
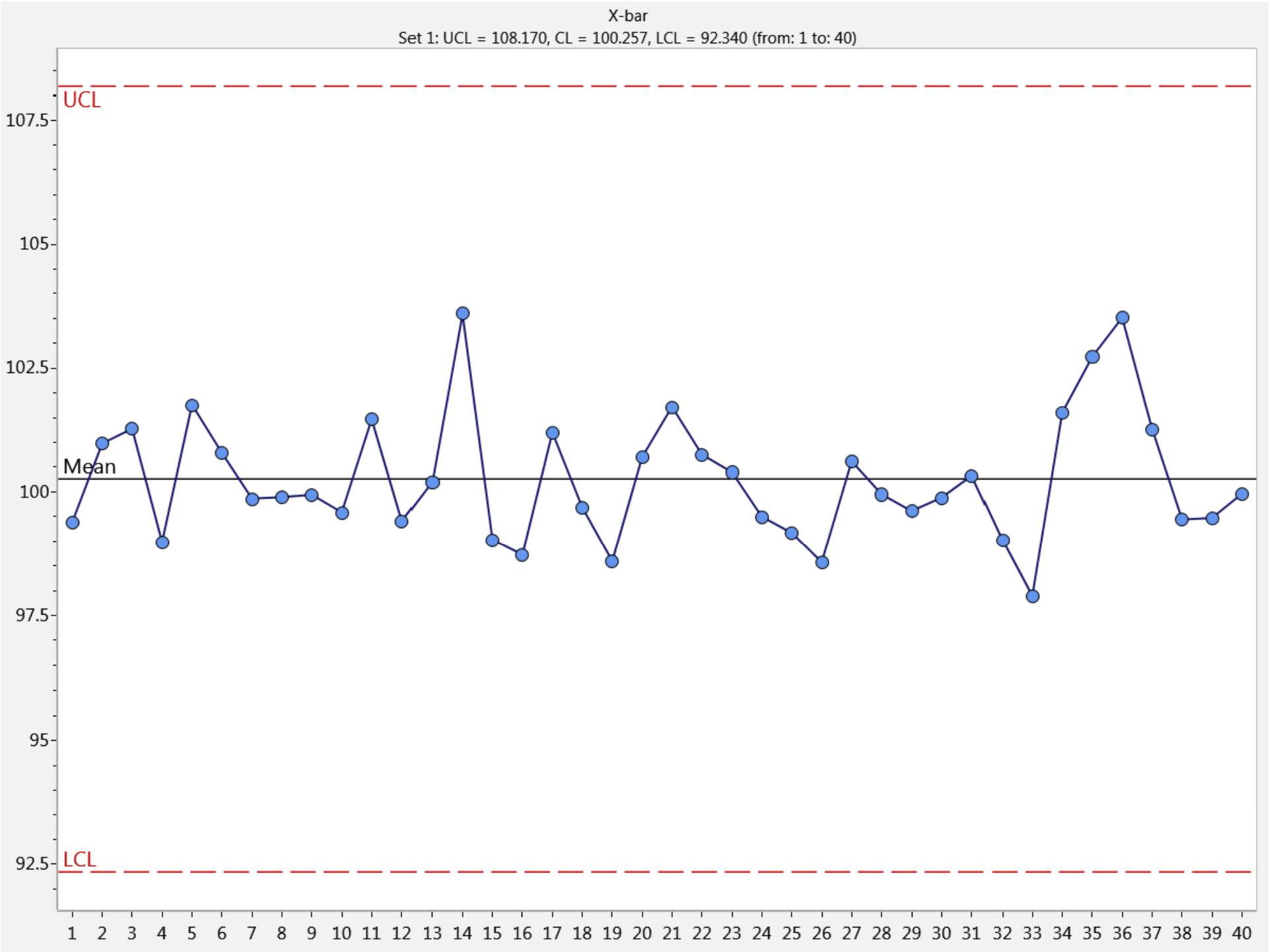
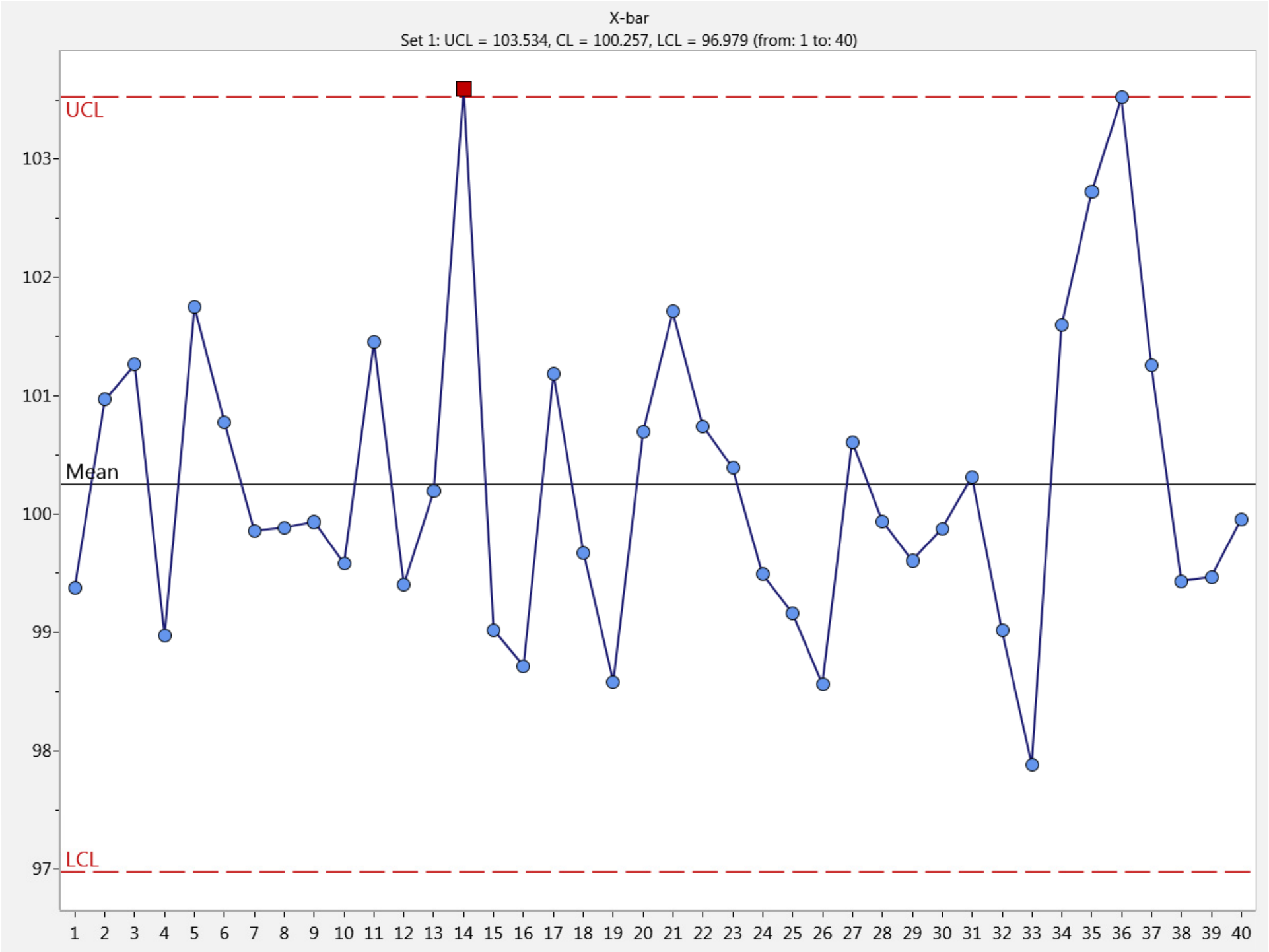
- Relying on Excel
  - Wrong standard deviation (STDEV.P, STDEV, STDEV.S)
  - Wrong formula


X-bar
Set 1: UCL = 103.800, CL = 100.256, LCL = 96.712 (from: 1 to: 40)
UCL
Mean
LCL
Range
Set 1: UCL = 12.010, CL = 5.683, LCL (none) (from: 1 to: 40)
UCL
Mean


X-bar
UCL = 103.484, CL = 100.317, LCL = 97.150
UCL
Mean
LCL
103
102
101
100
99
98
97
Machine adjustment
Range
UCL = 11.607, CL = 5.491, LCL (none)
UCL
Mean
12.5
10
7.5
5
2.5
Excluded sample with an assignable cause
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40


X-bar
Set 1: UCL = 108.170, CL = 100.257, LCL = 92.340 (from: 1 to: 40)
UCL
Mean
LCL
107.5
105
102.5
100
97.5
95
92.5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40


X-bar
Set 1: UCL = 103.534, CL = 100.257, LCL = 96.979 (from: 1 to: 40)
UCL
Mean
LCL
103
102
101
100
99
98
97
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

#2 Misuse of control limits

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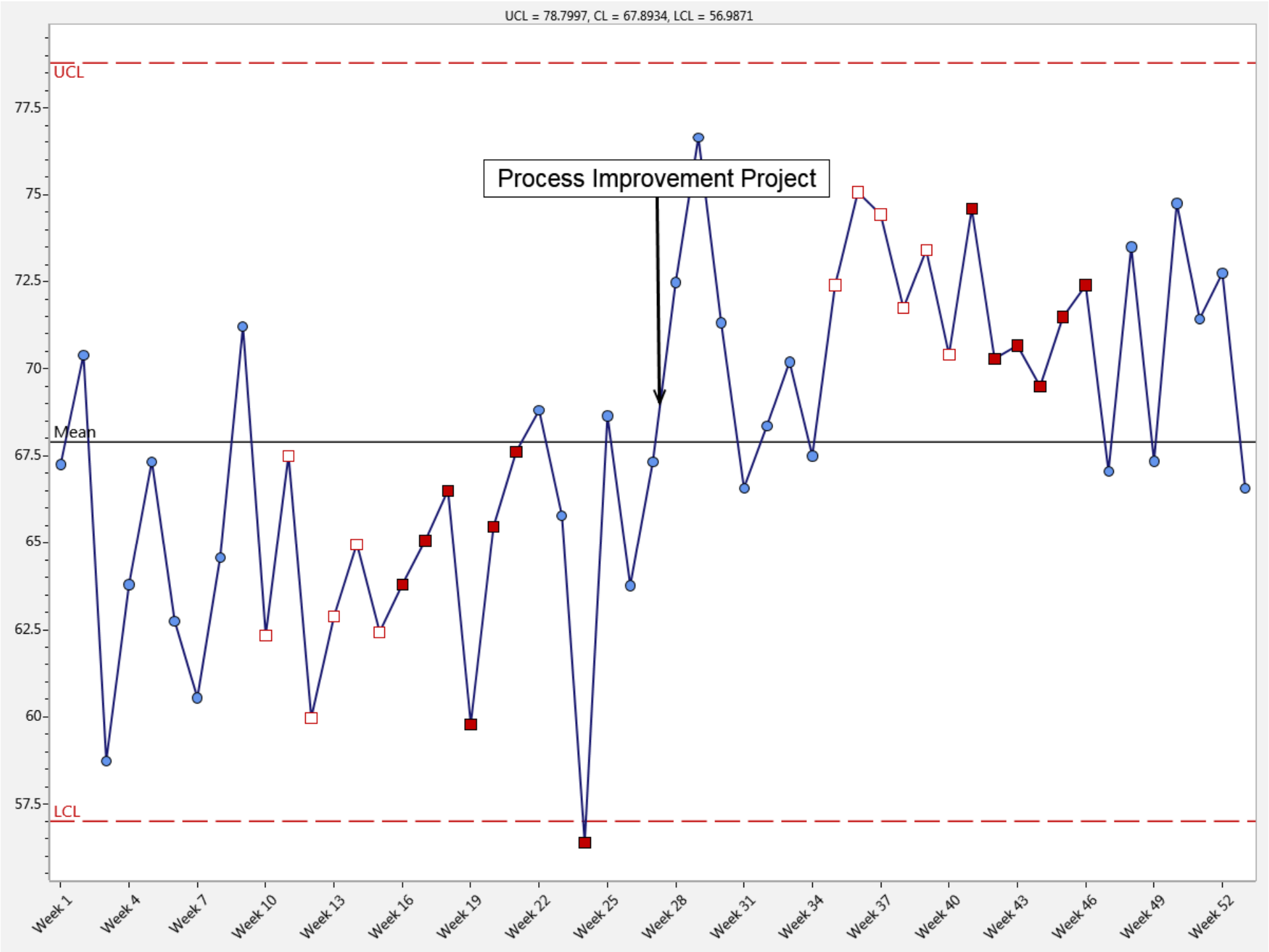
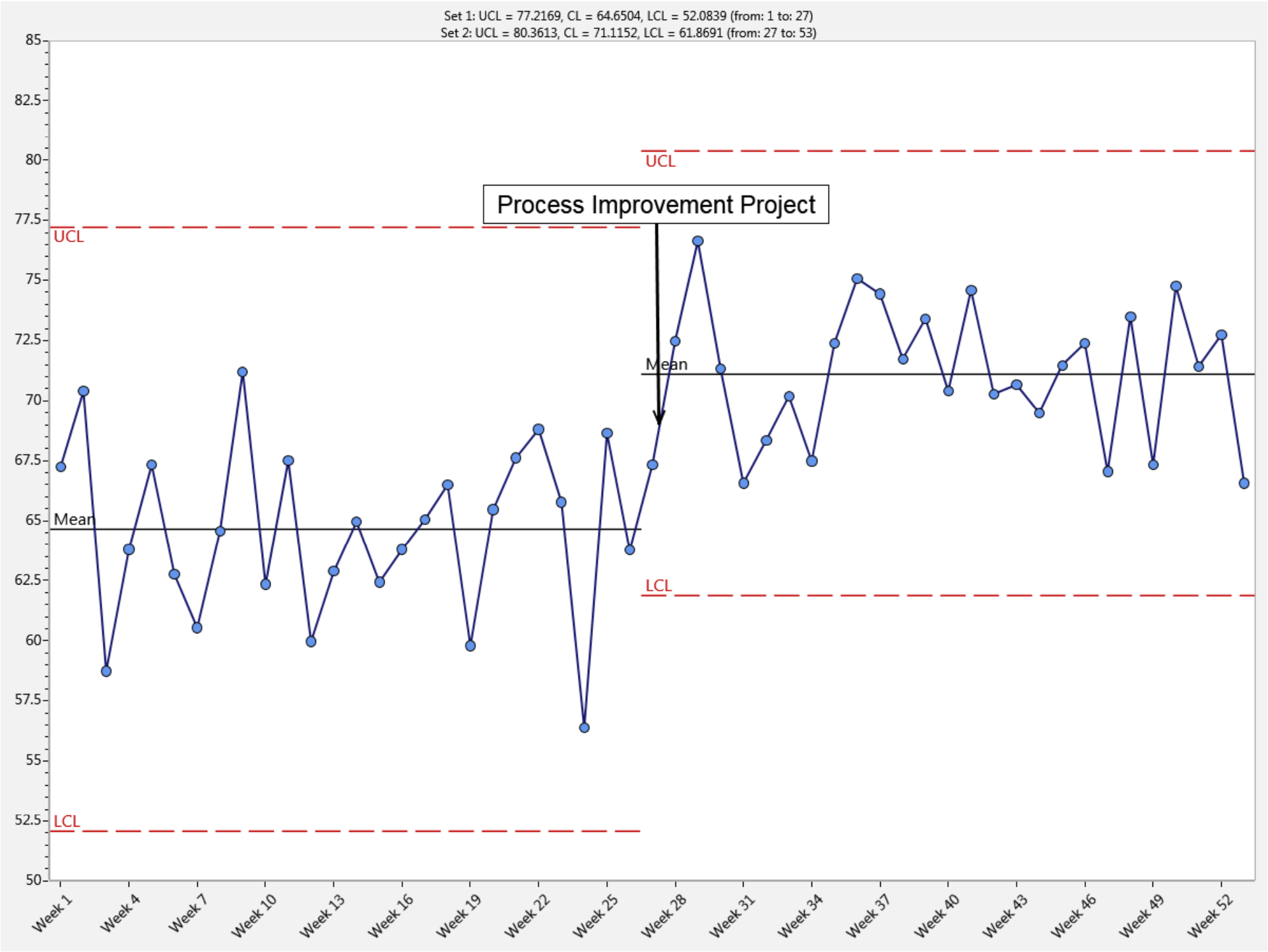
- Relying on Excel
  - Wrong standard deviation (STDEV.P, STDEV, STDEV.S)
  - Wrong formula
- Never computing limits
- Never re-computing limits


UCL = 78.7997, CL = 67.8934, LCL = 56.9871
UCL
77.5
75
72.5
70
Mean
67.5
65
62.5
60
57.5
LCL
Process Improvement Project
Week 1
Week 4
Week 7
Week 10
Week 13
Week 16
Week 19
Week 22
Week 25
Week 28
Week 31
Week 34
Week 37
Week 40
Week 43
Week 46
Week 49
Week 52


Set 1: UCL = 77.2169, CL = 64.6504, LCL = 52.0839 (from: 1 to: 27)
Set 2: UCL = 80.3613, CL = 71.1152, LCL = 61.8691 (from: 27 to: 53)
Process Improvement Project
UCL
UCL
LCL
LCL
Mean
Mean
85
82.5
80
77.5
75
72.5
70
67.5
65
62.5
60
57.5
55
52.5
50
Week 1
Week 4
Week 7
Week 10
Week 13
Week 16
Week 19
Week 22
Week 25
Week 28
Week 31
Week 34
Week 37
Week 40
Week 43
Week 46
Week 49
Week 52

#2 Misuse of control limits

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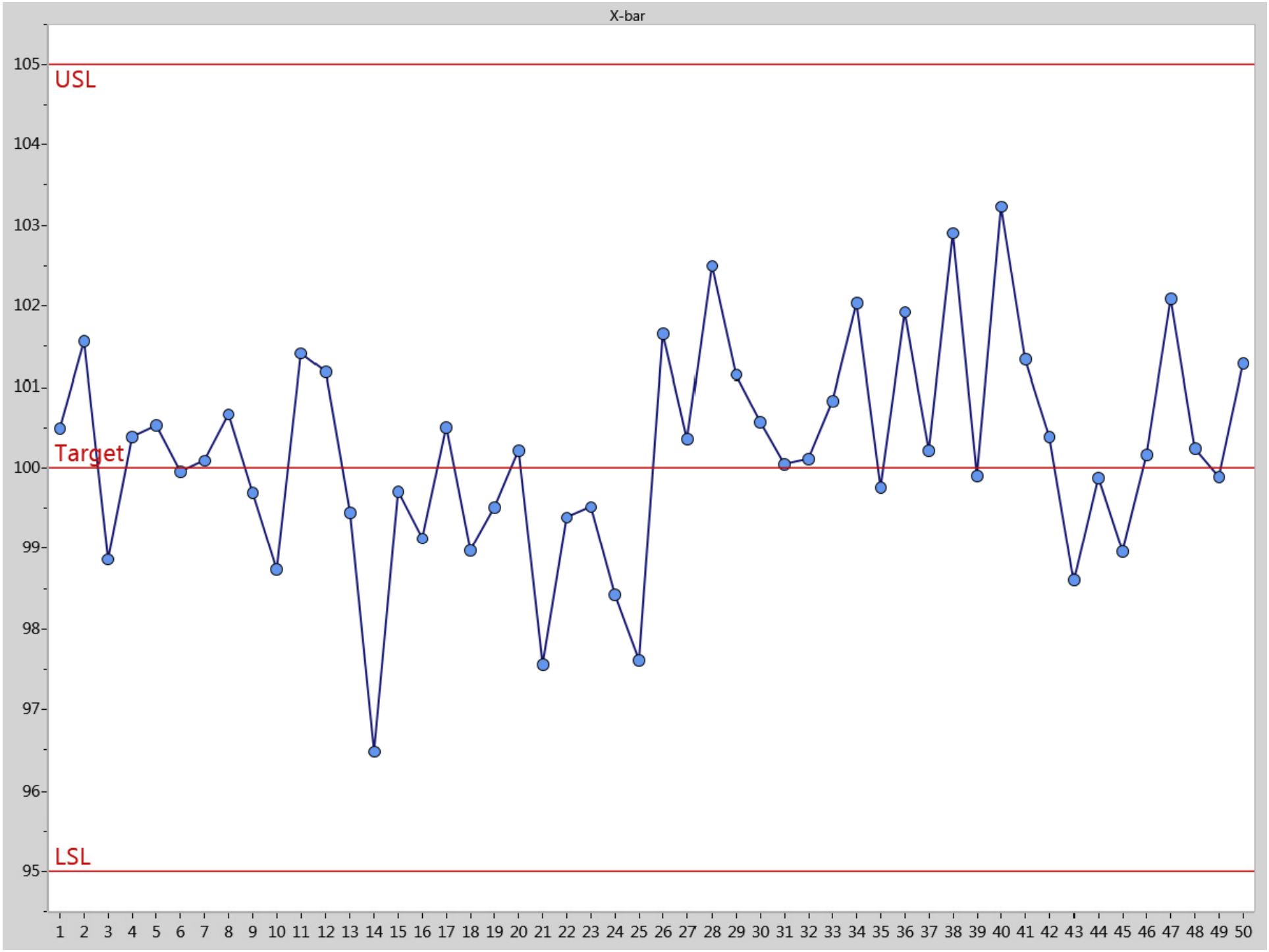
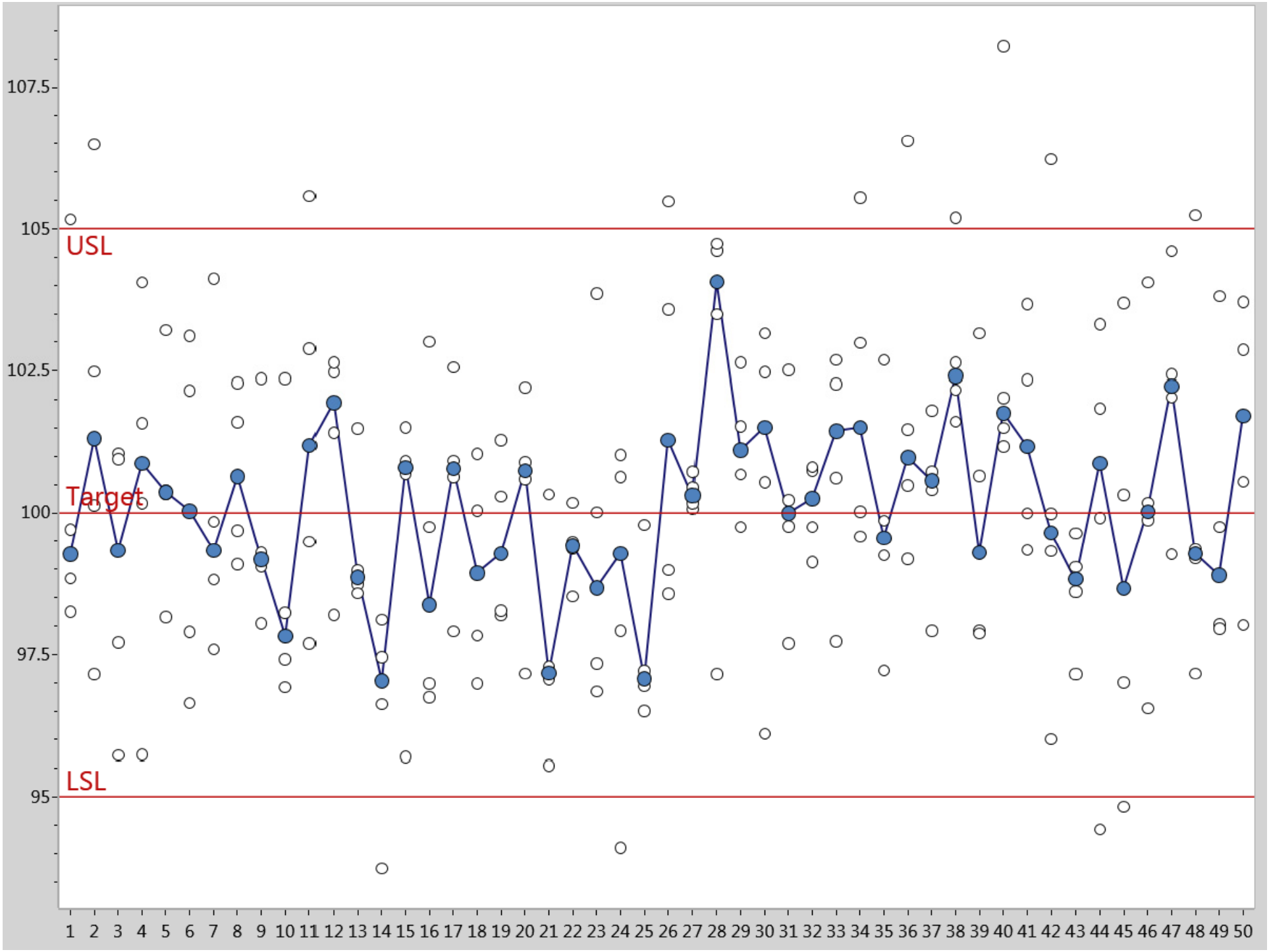
- Relying on Excel
  - Wrong standard deviation (STDEV.P, STDEV, STDEV.S)
  - Wrong formula
- Never computing limits
- Never re-computing limits
- Waiting for enough data
- Confusing specification limits with control limits


X-bar
USL
Target
LSL
105
104
103
102
101
100
99
98
97
96
95
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50


107.5
105
102.5
100
97.5
95
USL
Target
LSL
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

#2 Misuse of control limits

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To avoid Mistake #2

- Follow standards
- Revise limits when needed
- More is better, less will work
- Specification limits ≠ Control limits

#3 Not assessing the measurement system

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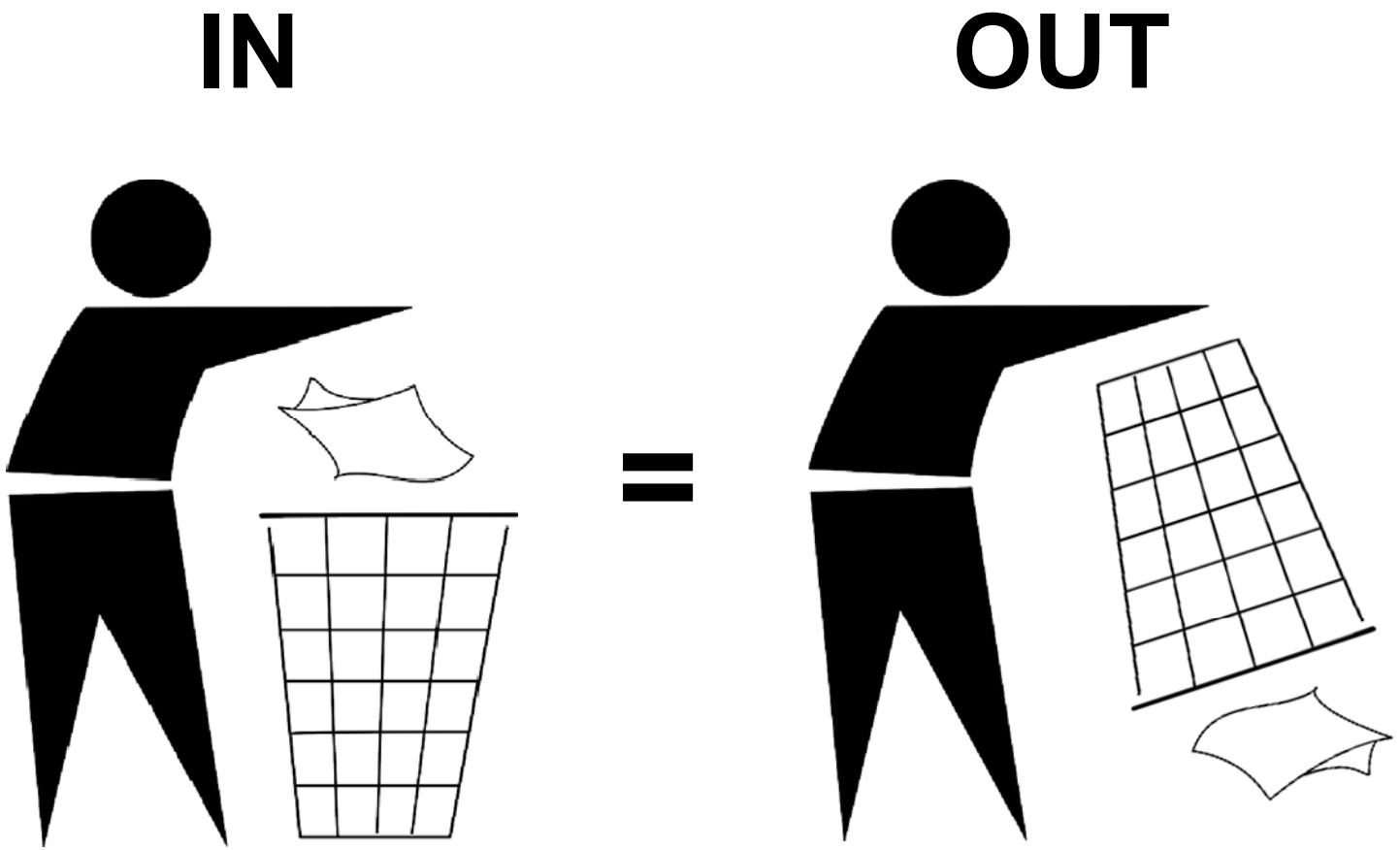

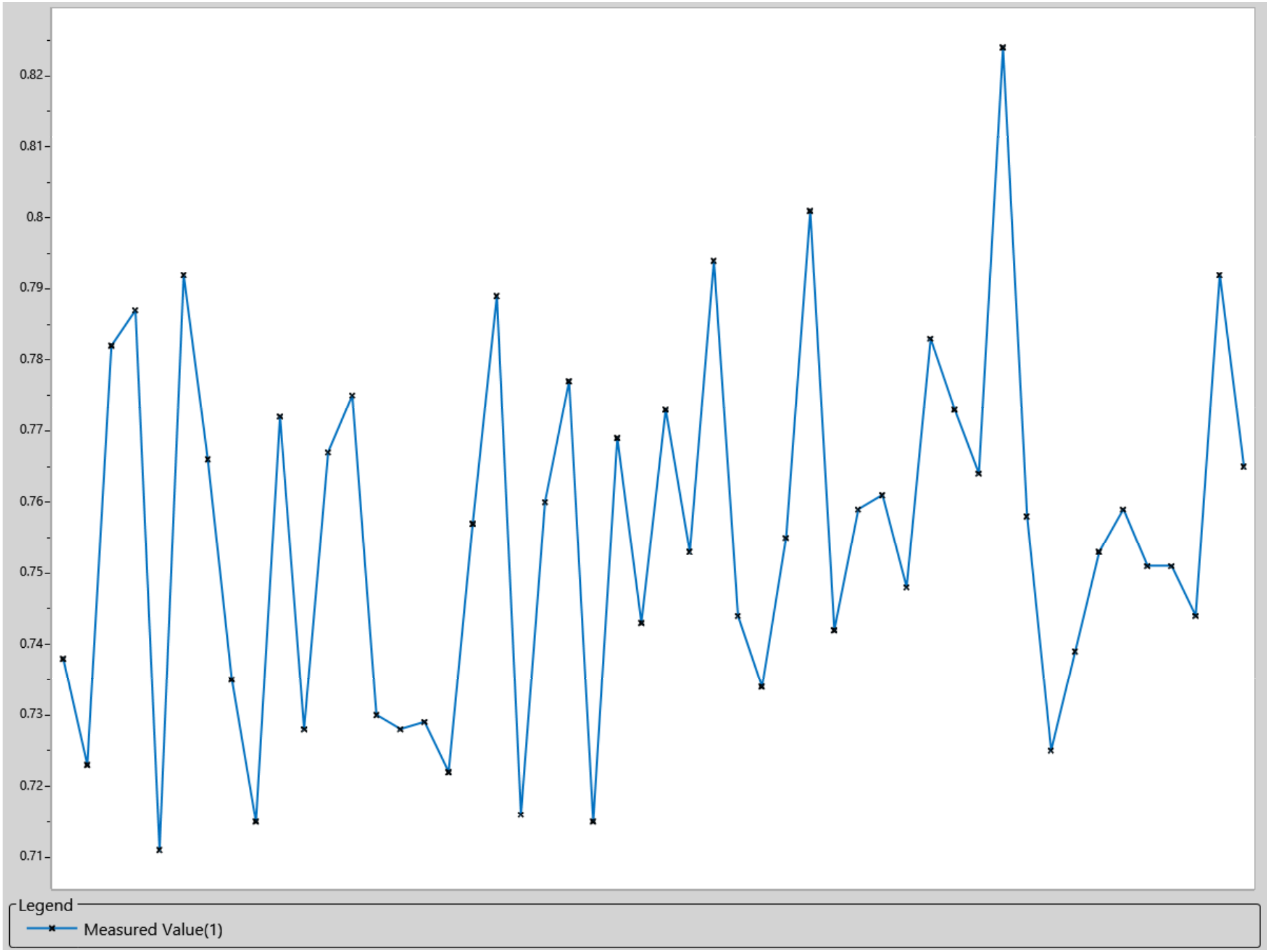
0.82
0.81
0.8
0.79
0.78
0.77
0.76
0.75
0.74
0.73
0.72
0.71
Legend
Measured Value(1)

#3 Not assessing the measurement system

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Measurement Unit Analysis

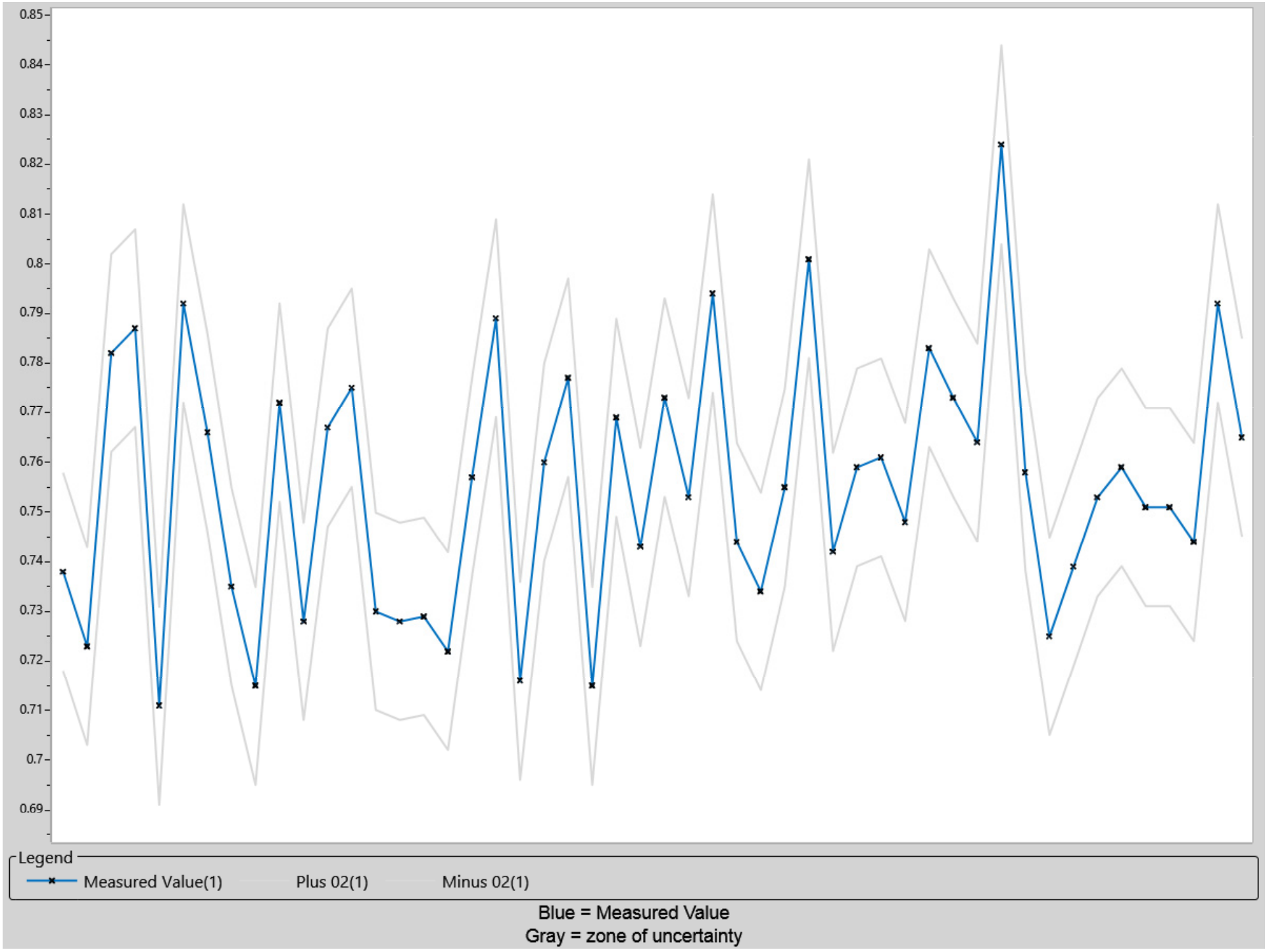
Repeatability - Equipment Variation (EV)
EV = 0.2018 %EV = 17.61

Reproducibility - Appraiser Variation (AV)
AV = 0.2298 %AV = 20.05

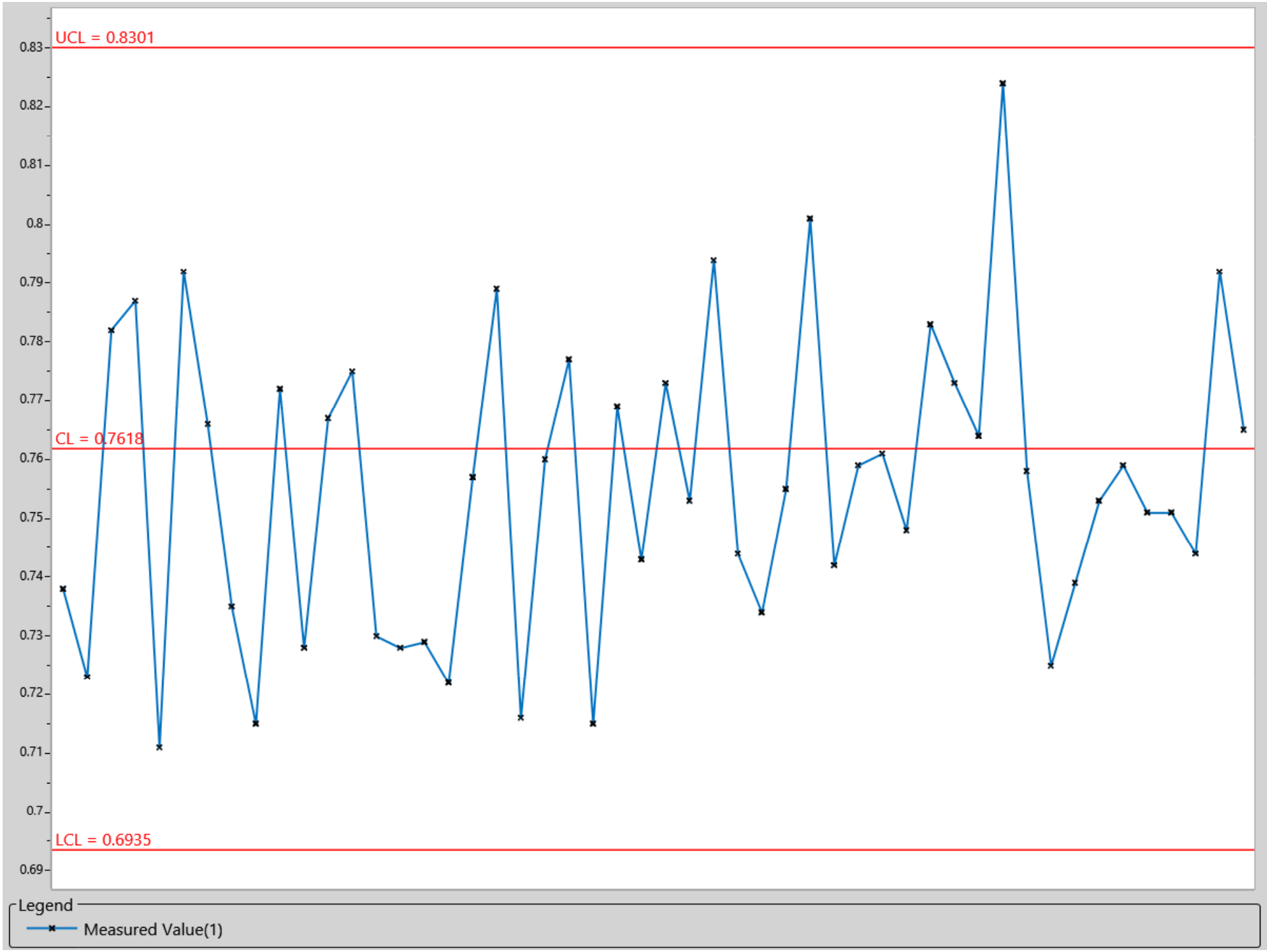
Repeatability & Reproducibility (R&R)
R&R = 0.3058 %R&R = 26.68

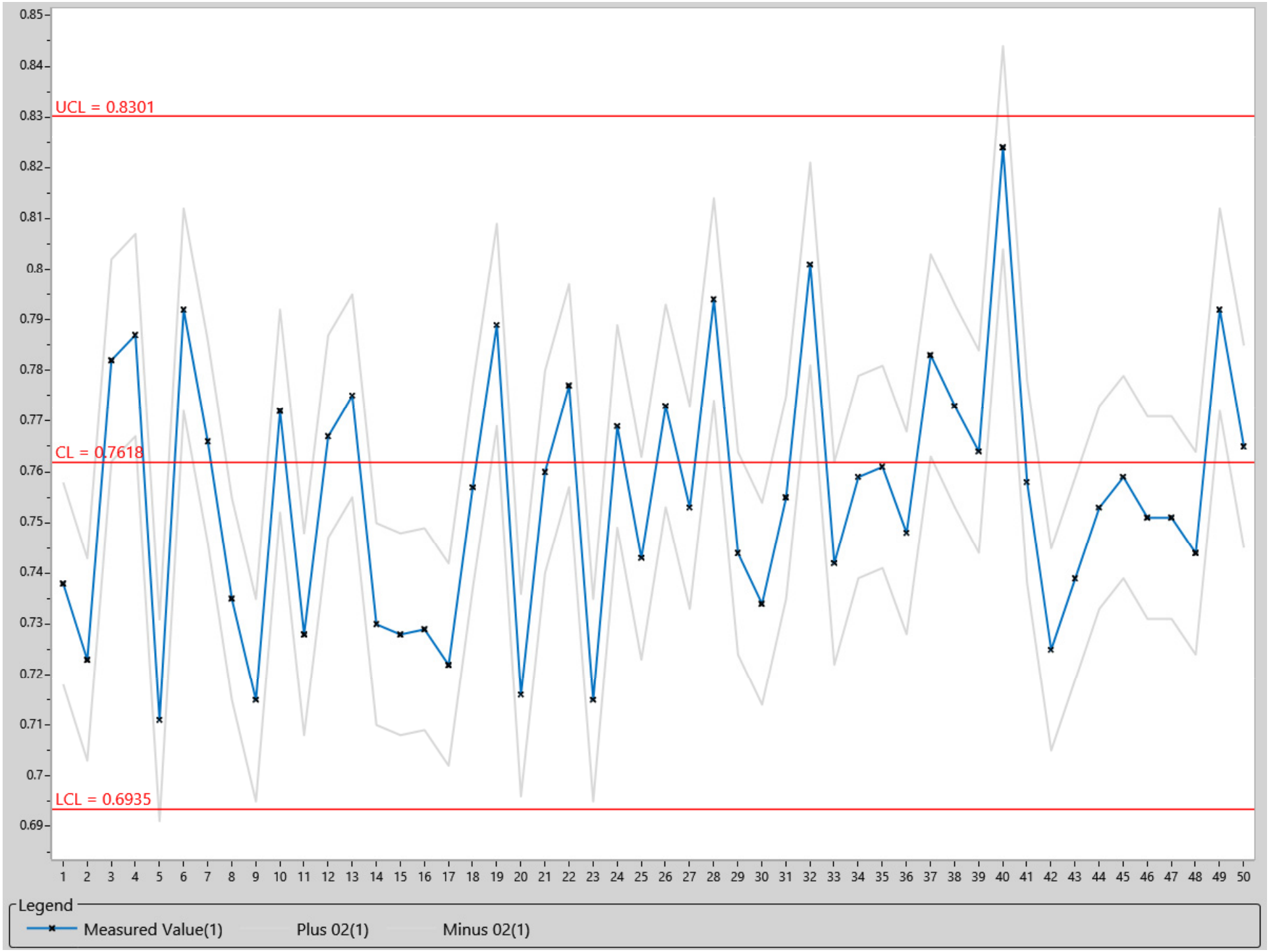
Part Variation (PV)
AV = 1.1044 %AV = 96.37

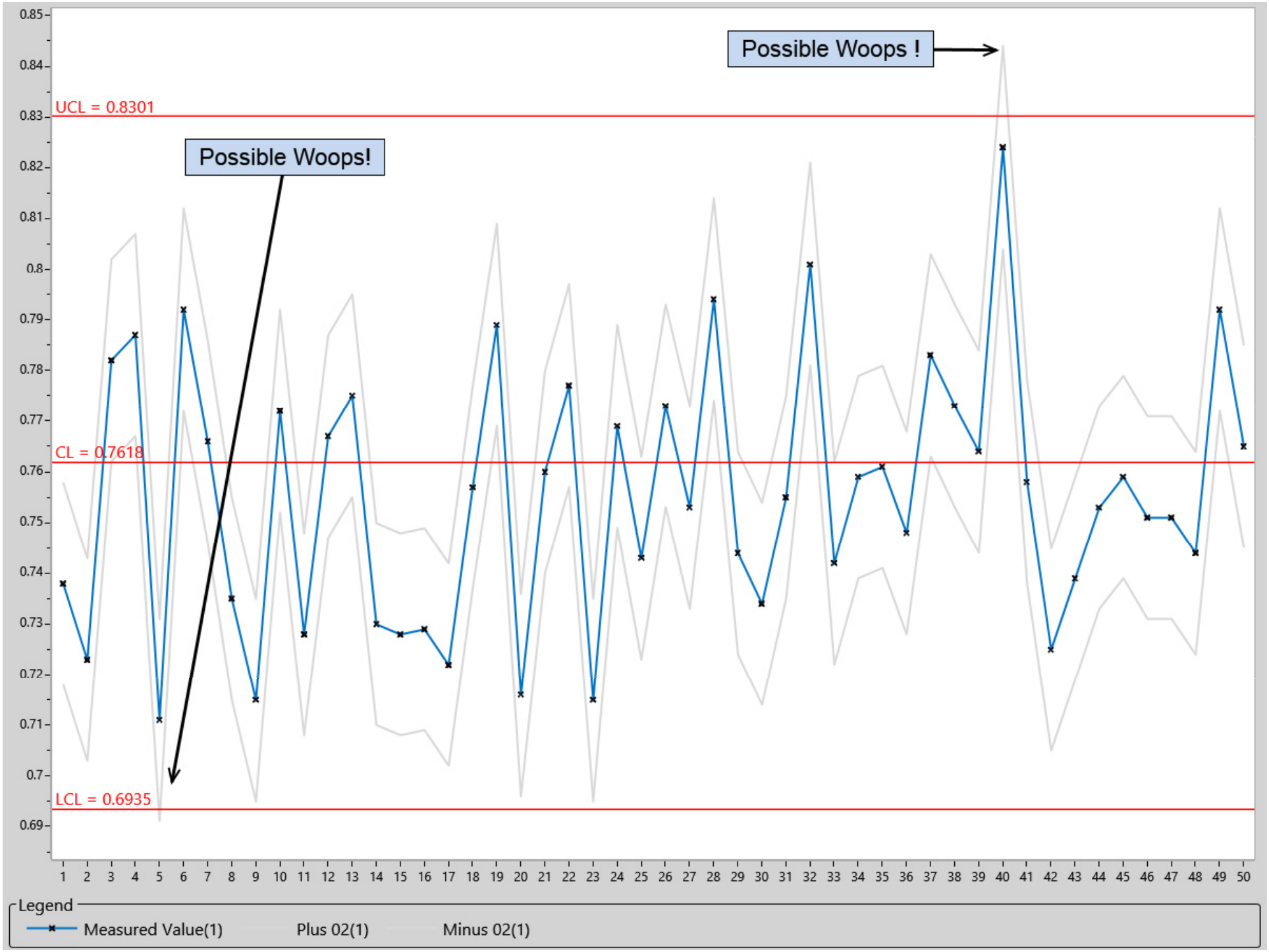
Total Variation (TV)
TV = 1.1460

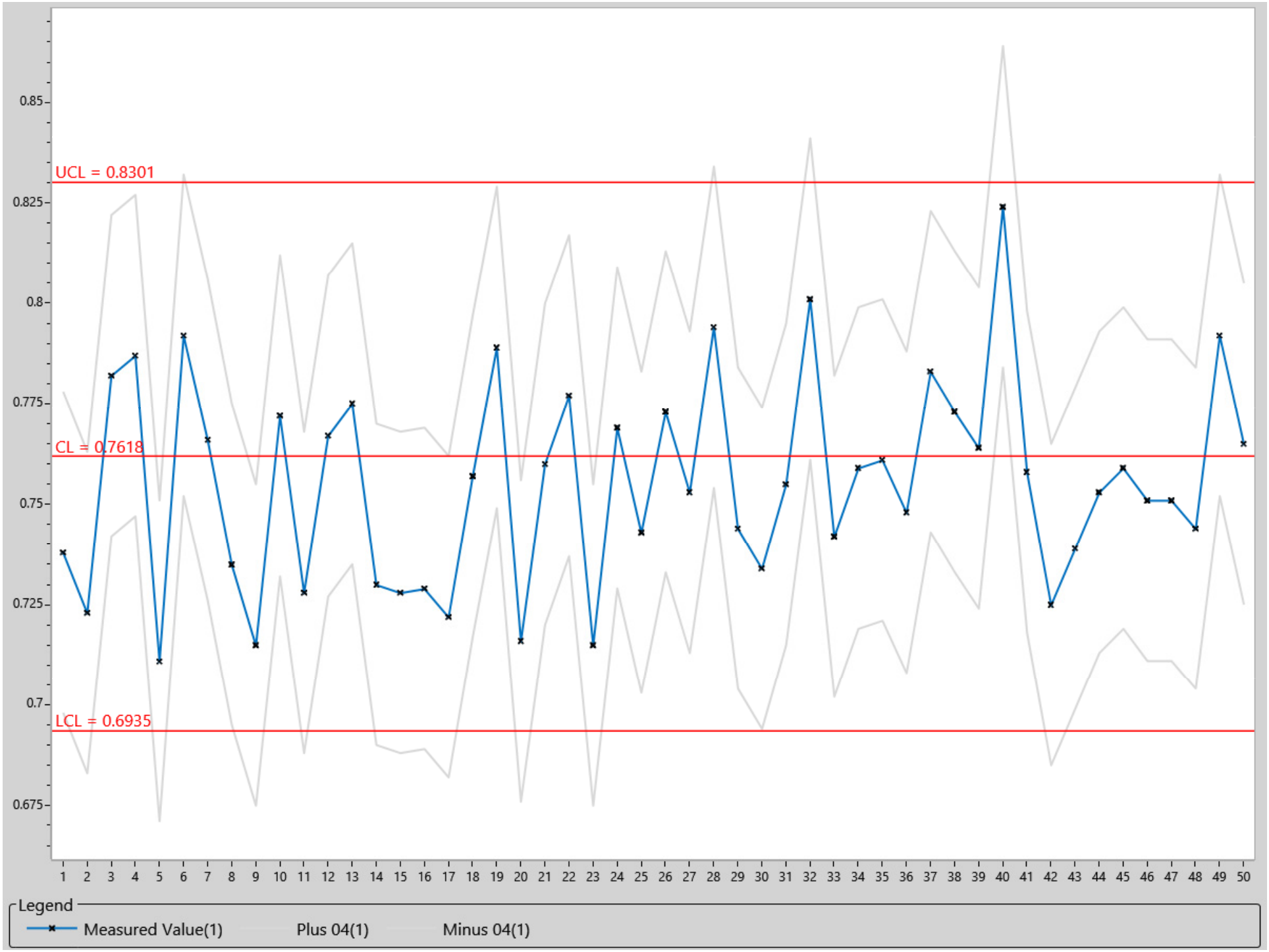


Blue = Measured Value
Gray = zone of uncertainty


UCL = 0.8301
CL = 0.7618
LCL = 0.6935
0.83
0.82
0.81
0.8
0.79
0.78
0.77
0.76
0.75
0.74
0.73
0.72
0.71
0.7
0.69
Legend
Measured Value(1)


UCL = 0.8301
CL = 0.7618
LCL = 0.6935
0.85
0.84
0.83
0.82
0.81
0.8
0.79
0.78
0.77
0.76
0.75
0.74
0.73
0.72
0.71
0.7
0.69
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
Legend
Measured Value(1)
Plus 02(1)
Minus 02(1)


Possible Woops !
Possible Woops!
UCL = 0.8301
CL = 0.7618
LCL = 0.6935
0.85
0.84
0.83
0.82
0.81
0.8
0.79
0.78
0.77
0.76
0.75
0.74
0.73
0.72
0.71
0.7
0.69
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
Legend
Measured Value(1)
Plus 02(1)
Minus 02(1)


UCL = 0.8301
CL = 0.7618
LCL = 0.6935
0.85
0.825
0.8
0.775
0.75
0.725
0.7
0.675
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
Legend
Measured Value(1)
Plus 04(1)
Minus 04(1)

#3 Not assessing the measurement system

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To avoid Mistake #3

- Assess the measurement system
- Re-assess the measurement system
- When looking at a control chart - ask the question “are we assessing this measurement system?”

#4 Not managing the measurement system

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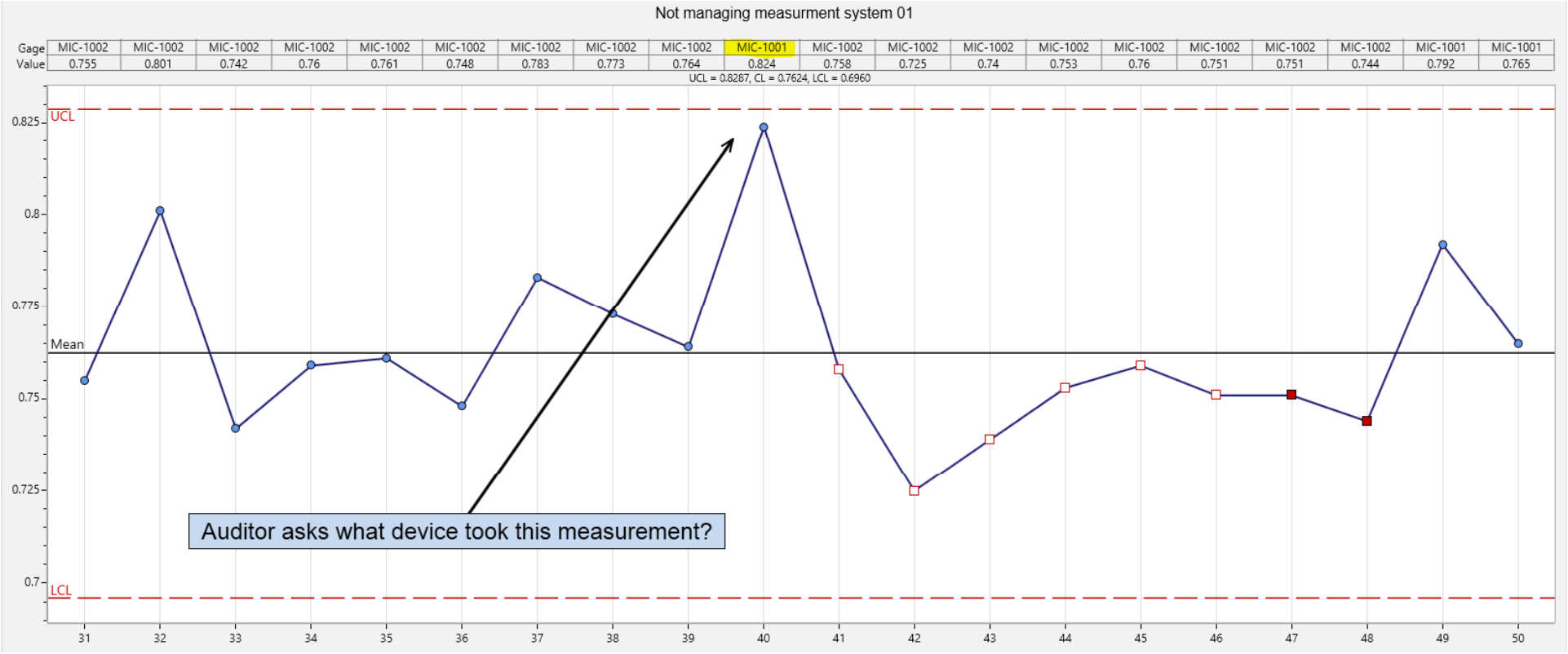

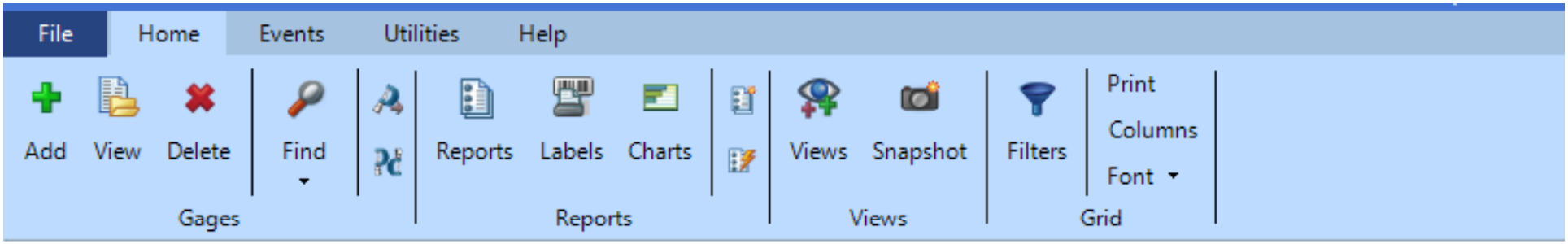

Gages

Tasks

History

Archive

Audit

Dashboard

Gage number	Gage type	Calib due date	Status
DEP-823	Depth	2/23/2016	Storage
DEP-826	Depth	3/17/2016	Storage
DEP-832	Depth	4/21/2016	Storage
MIC-1001	Micrometer	8/4/2015	Past Due Calibration
MIC-1002	Micrometer	1/13/2016	In use
MIC-1003	Micrometer	1/30/2016	In use
MIC-1004	Micrometer	2/10/2016	Storage
RING-101	Ring	3/17/2016	Storage
RING-106	Ring	3/18/2016	Storage

#4 Not managing the measurement system

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To avoid Mistake #4

- Use software tools – to manage measurement devices systematically
- Implement feedback from audits

#5 Wasting time

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#5 Wasting time

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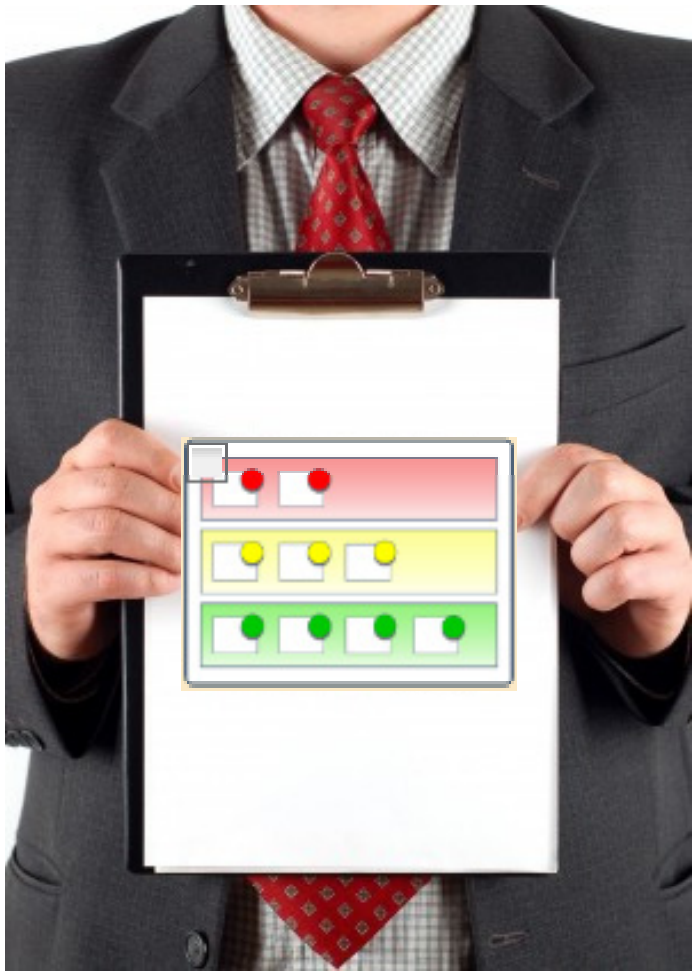
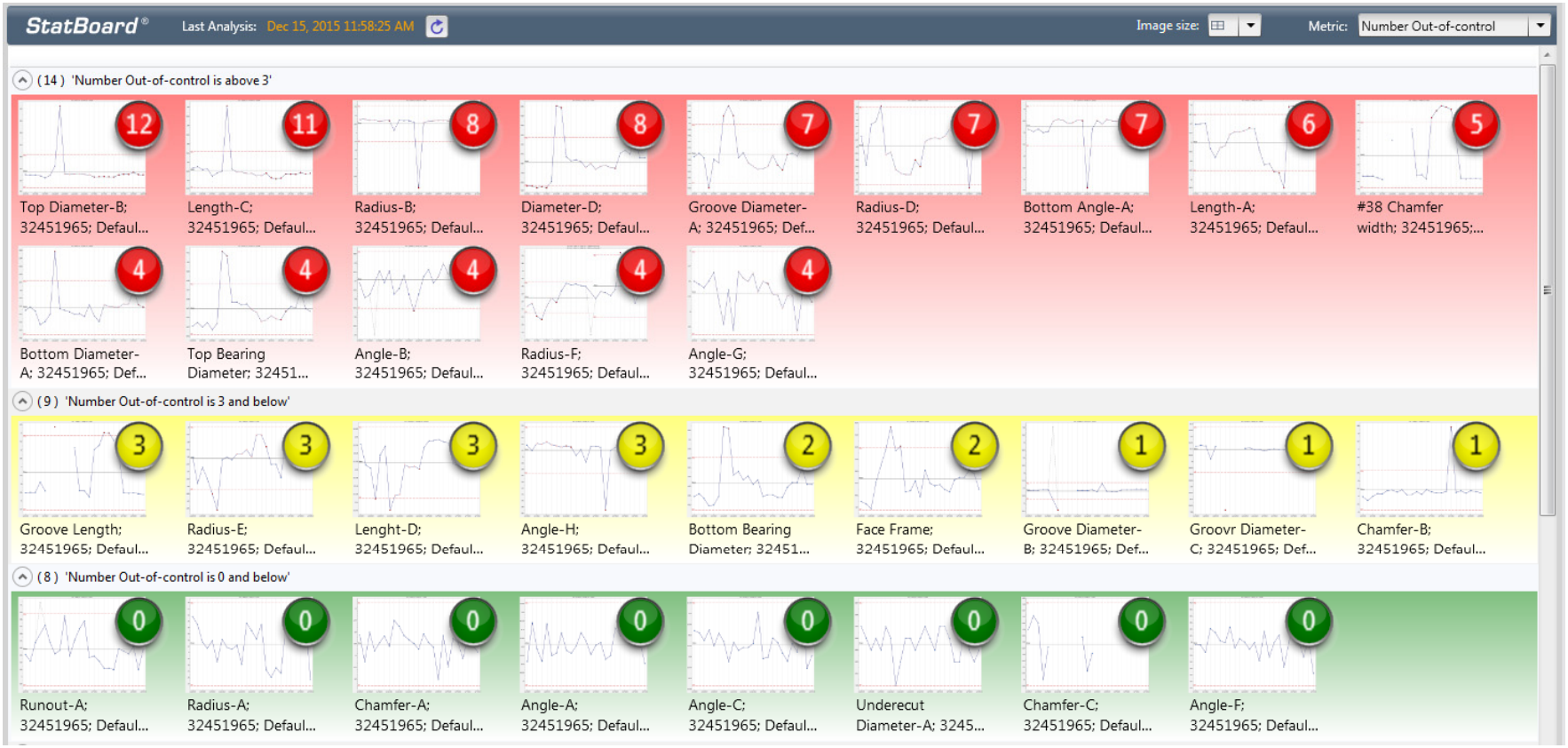


SQCpack StatBoard®

PQ Systems

Proof of quality.™



#5 Wasting time

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To avoid Mistake #5

- Use software tools
- Focus on the vital few
- Adapt Continuous Improvement

References

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- *Statistical Process Control: SPC* (second edition), Automotive Industry Action Group, 2005

- *Understanding Statistical Process Control* (second edition), Donald J. Wheeler, David S. Chambers, 1992, SPC Press, Inc.

- PQ Systems – Quality Advisor
  www.pqsystems.com/qualityadvisor/

Thank you!

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Questions?

Matt Savage – matt@pqsystems.com
Steve Daum – steved@pqsystems.com

Request the white paper

Five Costly Mistakes Applying SPC (and how to avoid them)

www.pqsystems.com/ApplyingSPC

Get a free trial of *SQCpack*

www.pqsystems.com