

BioRID II Corridor Analysis for GTR7 TEG meeting

August 27, 2019

Agenda

- Background
- Review data from each test
 - Analysis approaches
 - Dummy Certification without Headrest Analysis
 - Jacket Analysis
 - Pelvis Analysis
 - Sled and Track Verification Analysis
- Corridor Summary

Background

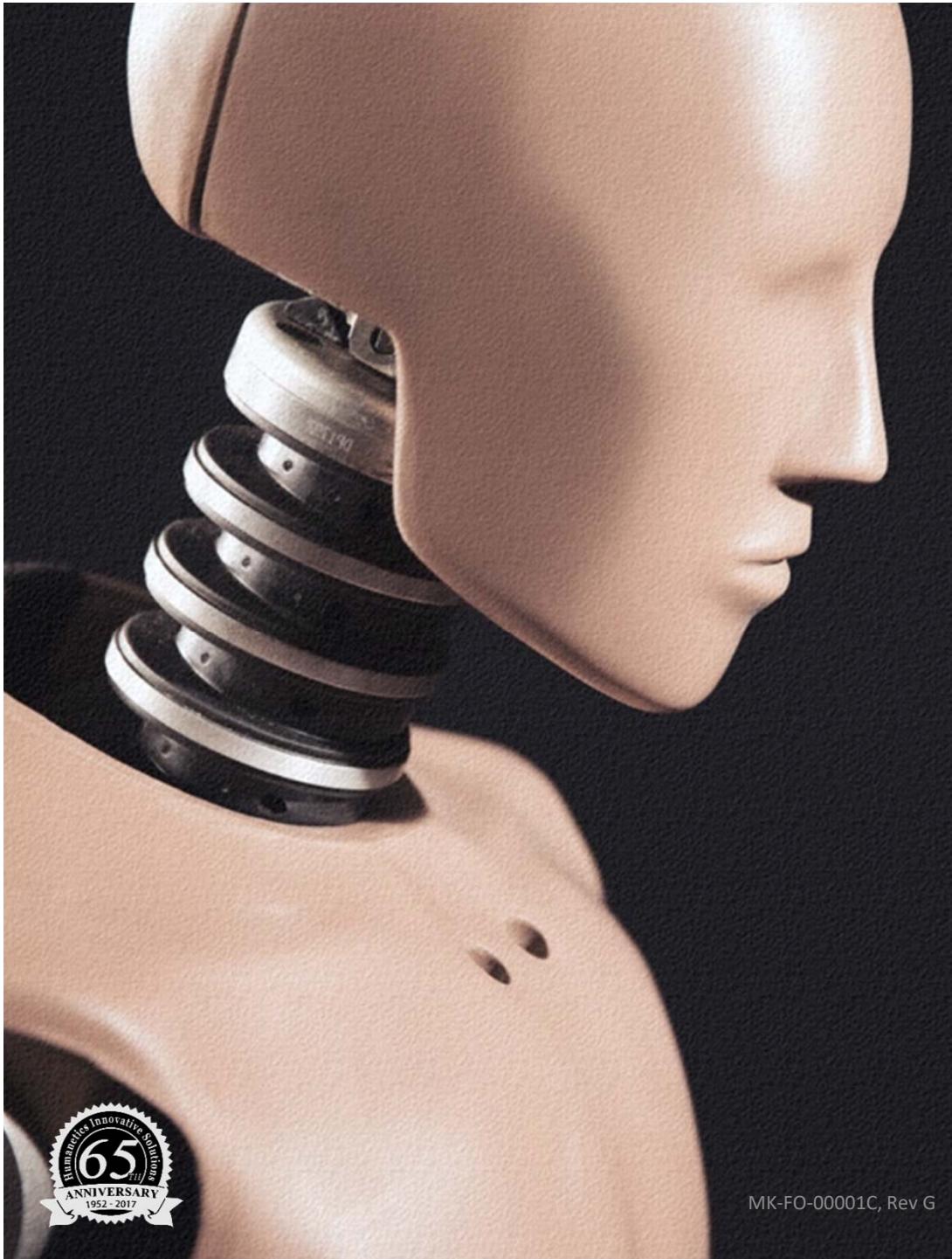
- Request to review all BioRID II certification corridors
 - At the May 6 GTR7 TEG meeting
 - » it was proposed by Humanetics that there are problems with the Pot A corridor and generally agreed a change is needed
 - » It was proposed by JAMA/JARI that Jacket, Pelvis, and Dummy corridors may be too narrow and should be reevaluated using more data
 - » It was agreed that current data should be collected (2015 and later) to evaluate what the current population of BioRID II dummies looks like for all test corridors
 - » It was suggested to
 - › Evaluate corridors like other dummies moving towards regulation
 - Average data by dummy
 - Look at +/- 2 * standard deviation of population
 - Look at +/- 10 % as a general limit on corridor width
 - Make sure corridors are practical for currently used population of dummies

Background

- Data collected from 6 labs
 - Ford
 - BASt
 - Toyota-Boshoku
 - Humanetics Heidelberg
 - Humanetics Huron
 - Humanetics Farmington Hills / Plymouth
- Tests
 - Dummy Certification without Headrest
 - Jacket Analysis
 - Pelvis Analysis
 - Sled and Track Verification Analysis

Background

- Options
 - Do not change anything – keep all corridors as is
 - Only change First Peak of Pot A corridor
 - Change all corridors based on collected dataset



MK-FO-00001C, Rev G

Dummy Certification without Headrest Analysis

Analysis Approach for Dummy Certification without Headrest

- Collected 1164 tests from 6 labs
 - 89 separate ATD's
 - 278 Test sequences
 - » A test sequence occurs each time a dummy comes into a lab for a new certification. This is particularly important since this usually entails doing maintenance such as resetting cables and damper, changing neck bumpers, other repairs. All of this can lead to changes in performance of the dummy.
 - Not all tests have all parameters
 - » Some software packages simply provide a pass/fail for "tunnel" corridors rather than max/min values within the corridors.
 - › There was variety in what was provided for "tunnel" parameter results.
 - › Even within Humanetics, the older software package used did not provide continuous max/min values for "tunnel" corridors, only pass/fail.
 - › There were obvious bad values which were deleted
 - » This led to far less samples for "tunnel" corridors on which statistical analysis could be run

Analysis Approach for Dummy Certification without Headrest

- Data reduction approach
 - Cleanup data
 - » Deleted all tests with failing input velocity
 - » Deleted obviously erroneous results from some parameters due to bad channels or calculation errors
 - » Kept remaining data for the test if it looked reasonable – try to keep as much data as possible
 - Do not want to have multiple tests per dummy weight statistics towards certain dummies
 - Average by dummy (ABP) or Average by test sequence (ABS)?
 - » Bumpers, damper settings, cable adjustment, and spine curvature all are critical to dummy performance in certification test.
 - » Changing any of these as well as some other maintenance can lead to a different performance in the certification tests like a different dummy
 - » Bumpers age over time if not changed leading to different performance
 - » Jackets are changed out over time and the jacket significantly influences performance
 - » These considerations led to the decision that “average by test sequence” (ABS) is better representative of the dummy population for setting certification test corridors

Analysis Approach for Dummy Certification without Headrest

- What to do about reduced sample size for “tunnel” parameters?
 - For most parameters there are 278 points for “Average by test sequence” (ABS)
 - For most “tunnel” parameters, there are only 58 points for ABS
 - » Number of points varies due to obvious calculation errors
 - Do we use just tests with everything, or use as many samples as possible for each parameter? Are the populations similar?
 - » It is preferable to have as many points as possible to evaluate populations to determine corridors
 - » It is undesirable to have imbalanced corridors (don’t match between parameters)

Analysis Approach for Dummy Certification without Headrest

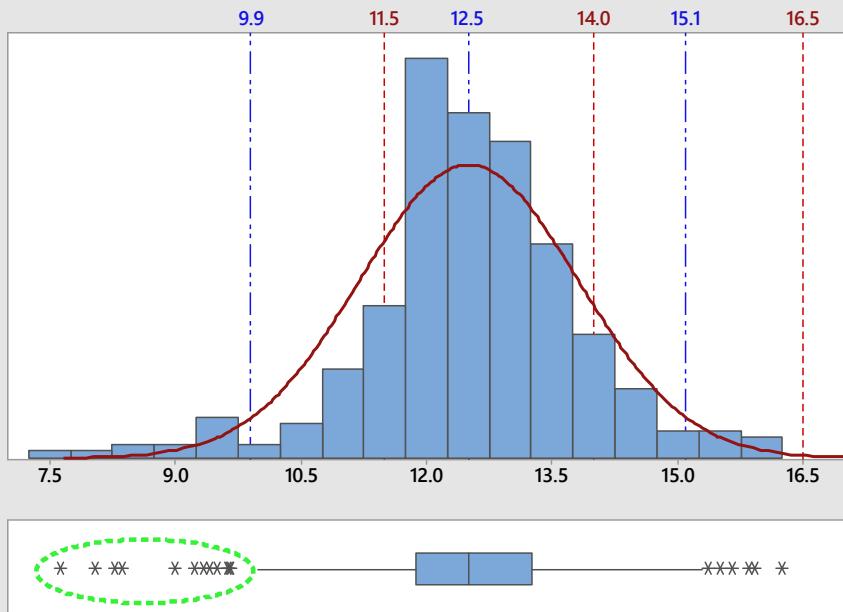
- What to do about reduced sample size for “tunnel” parameters? (*continued*)
 - Proposal: if populations are similar for key dummy performance parameters between group with all values (52 points) vs group where many “tunnel” results are missing (228 points), then all results are used that are available to evaluate each parameter
 - » This leads to different population sizes – i.e. combinations of tests – to evaluate each parameter.
 - » To check this, 2-sample t-tests were done for critical performance parameters comparing means for ABS with all results vs those where “Max Pot B in tunnel 98-108 ms” was present.
 - » Conclusion: populations are close enough to use all data

Analysis Approach for Dummy Certification without Headrest

- After creating ABS dataset
 - Apply generic lab labels
 - Create Histogram for each parameter with basic statistics
 - » Add lines for
 - > Current corridors
 - > Mean and +/- 2 standard deviations from mean
 - > Proposed corridors
 - » Add labels with current corridor, +/- 2 * std dev, proposed corridor as +/- %
 - Create individual value dot plots for each parameter by lab
 - » Add current corridors and proposed corridors
 - Proposing corridor widths
 - » Is original reasonable looking at histogram, +/- 2 * std dev, % width?
 - > If yes, then no change
 - » If no, then look at +/- 2 * standard deviation, +/- 10%, histogram distribution
 - > Come up with a proposed corridor that looks reasonable

Analysis Dummy Certification - First Peak Pot A

Summary Report for ABS Pk1 Pot A (deg)

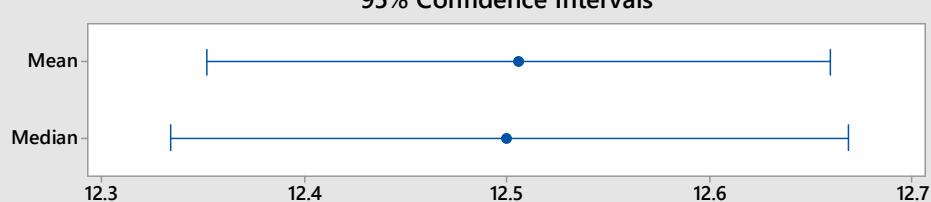


Anderson-Darling Normality Test	
A-Squared	2.60
P-Value	<0.005
Mean	12.506
StDev	1.303
Variance	1.699
Skewness	-0.45458
Kurtosis	1.76871
N	278
Minimum	7.625
1st Quartile	11.869
Median	12.500
3rd Quartile	13.264
Maximum	16.245
95% Confidence Interval for Mean	
12.352	12.660
95% Confidence Interval for Median	
12.334	12.669
95% Confidence Interval for StDev	
1.203	1.422

Current Corridors: red - width +/- 18%

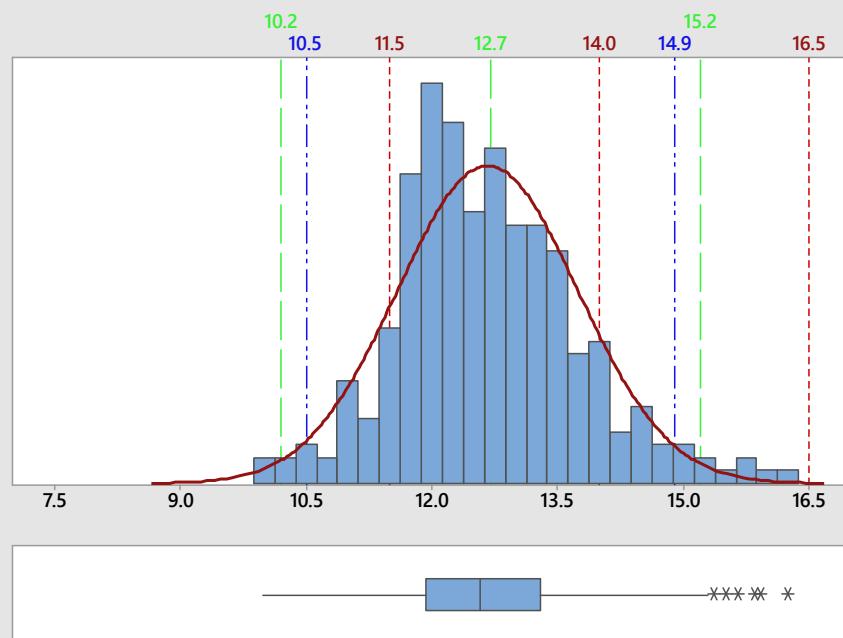
+/- 2 std dev: blue (+/- 21%)

Proposal: delete outliers on low end (below 9.7 deg) and then re-evaluate distribution before creating corridor. Want to not throw out too many high end ATD that would have passed with existing corridor.

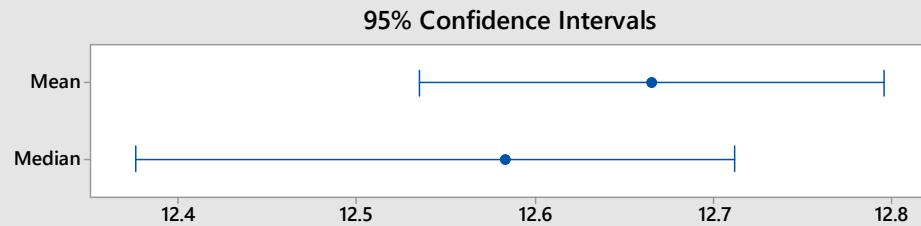


Analysis Dummy Certification - First Peak Pot A

Summary Report for ABS Pk1 Pot A (deg) [outliers <9.7 deleted]

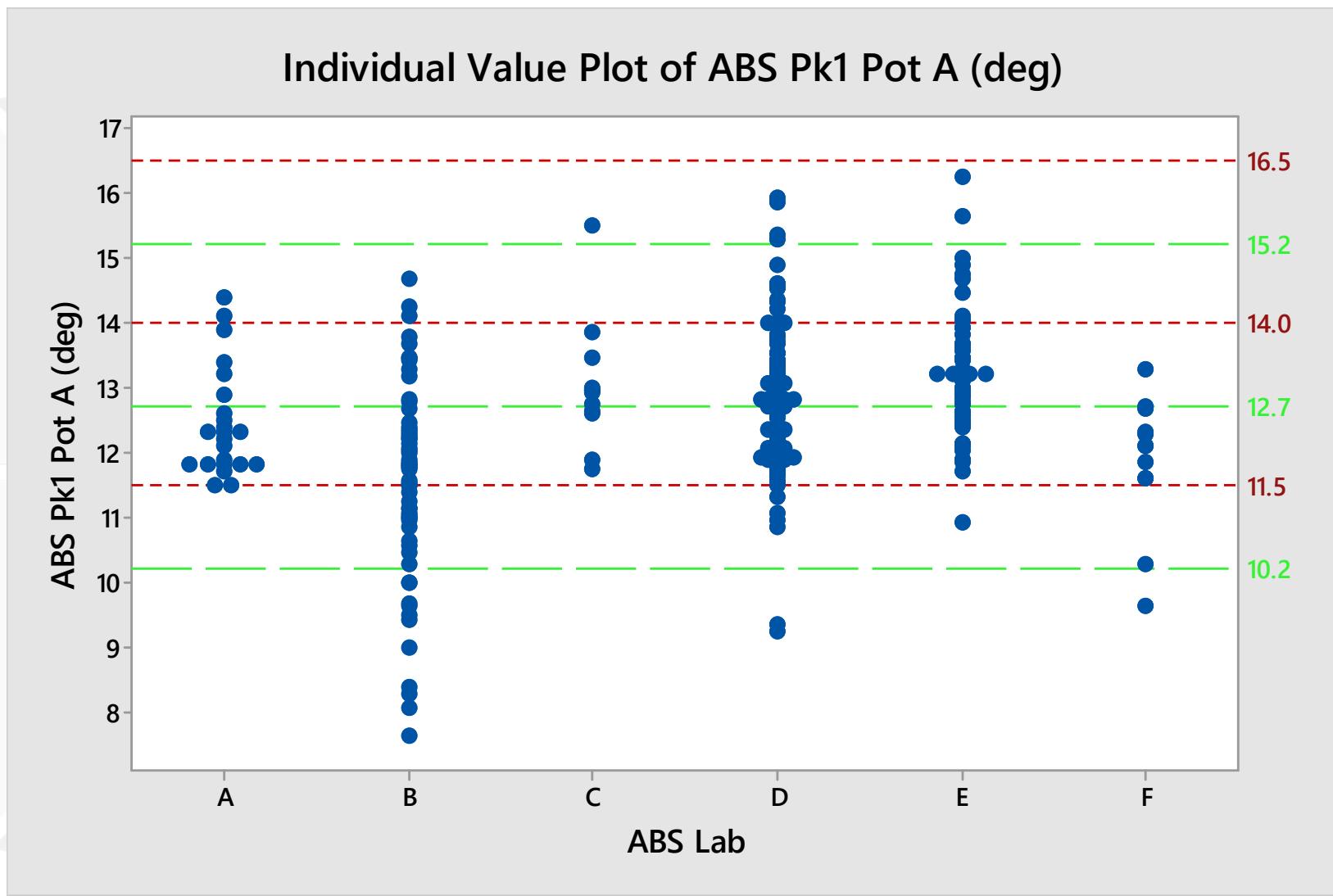


Anderson-Darling Normality Test	
A-Squared	1.42
P-Value	<0.005
Mean	12.665
StDev	1.080
Variance	1.166
Skewness	0.493528
Kurtosis	0.623805
N	266
Minimum	9.990
1st Quartile	11.923
Median	12.583
3rd Quartile	13.293
Maximum	16.245
95% Confidence Interval for Mean	
12.535	12.796
95% Confidence Interval for Median	
12.376	12.712
95% Confidence Interval for StDev	
0.995	1.180

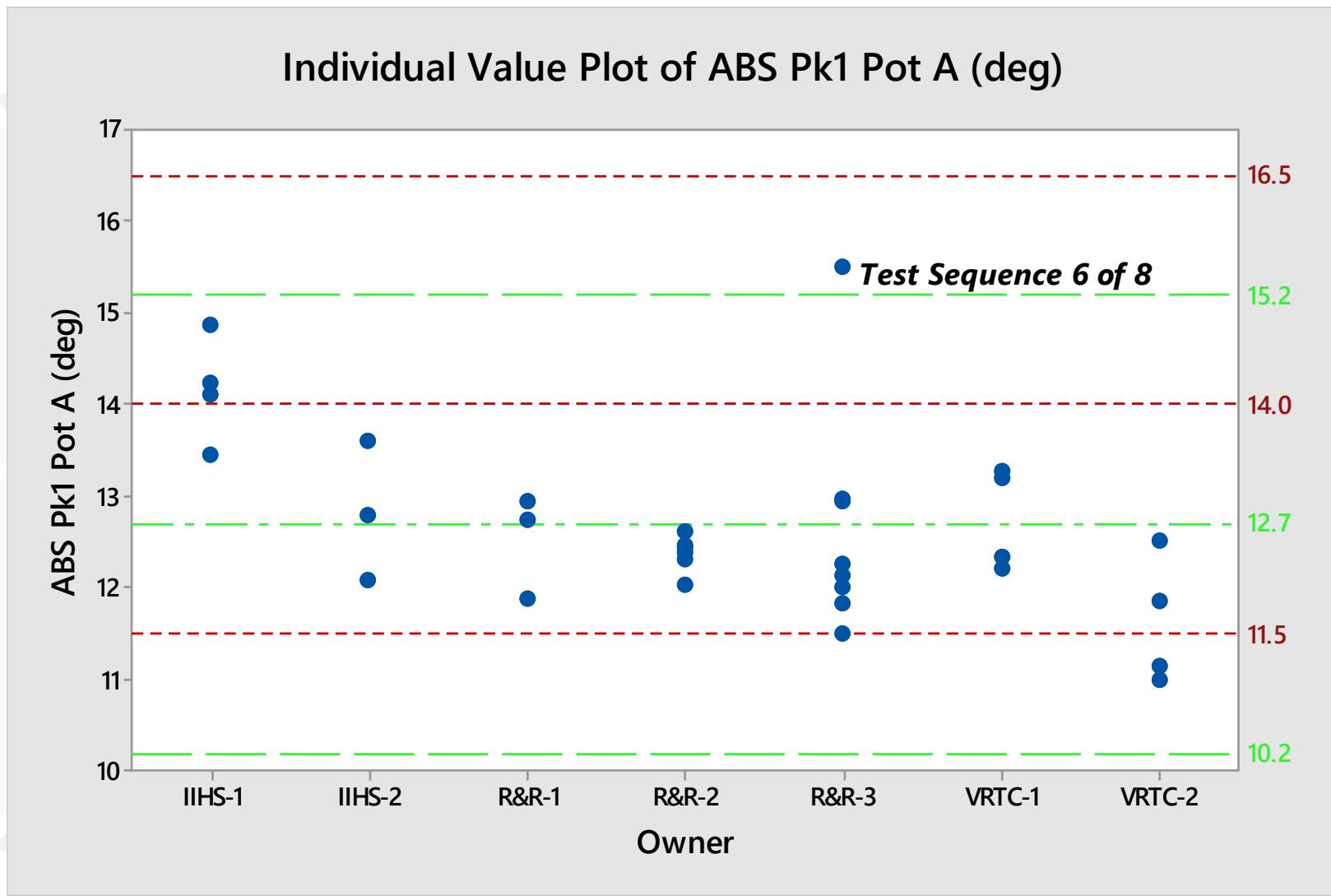


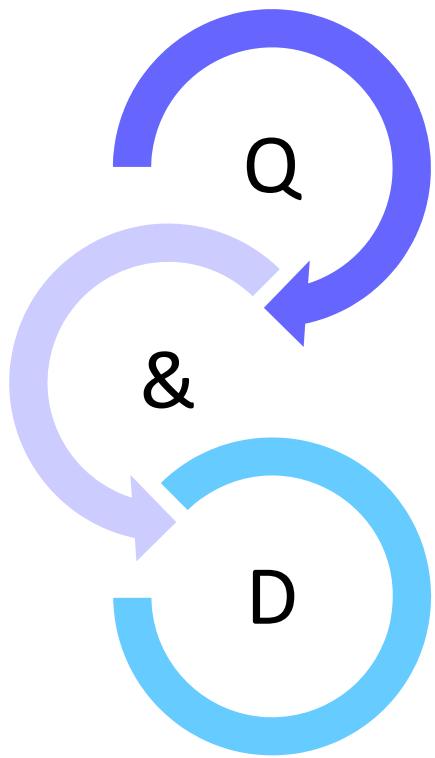
Current Corridors: red - width +/- 18%
 after deleting outliers <9.7 deg
 +/- 2 std dev: blue (+/- 17%)
 Proposal: green - keep same corridor width
 10.2 +/- 2.5 (10.2 - 15.2)

Analysis Dummy Certification - First Peak Pot A



Analysis Dummy Certification - First Peak Pot A



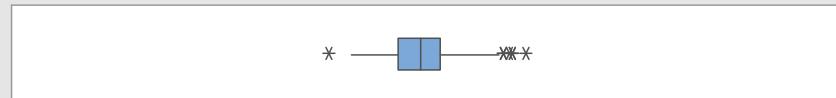
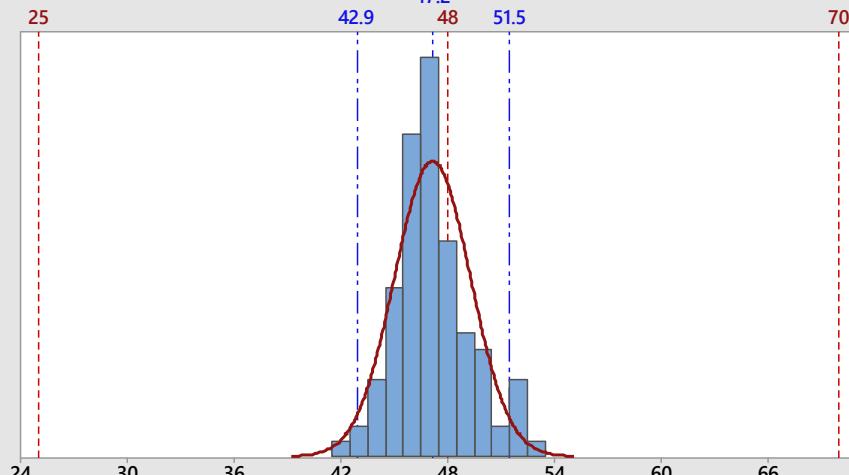


Discussion:

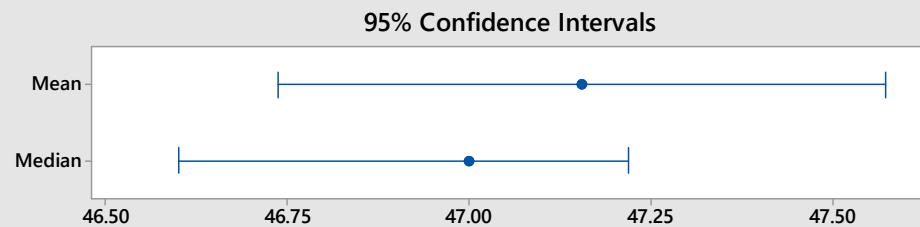
- 1) Do we agree to change Pot A?
- 2) Should we re-evaluate all other corridors?

Analysis Dummy Certification - First Peak Pot A time

Summary Report for ABS Pk1 Pot A (ms)



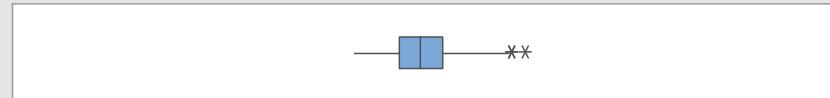
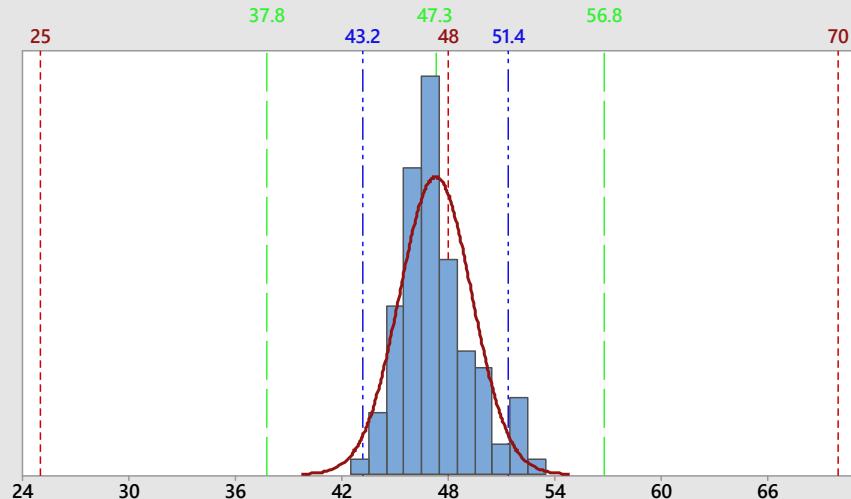
Anderson-Darling Normality Test	
A-Squared	1.32
P-Value	<0.005
Mean	47.155
StDev	2.139
Variance	4.574
Skewness	0.519520
Kurtosis	0.337572
N	103
Minimum	41.800
1st Quartile	45.743
Median	47.000
3rd Quartile	48.060
Maximum	52.900
95% Confidence Interval for Mean	
46.737	47.573
95% Confidence Interval for Median	
46.600	47.219
95% Confidence Interval for StDev	
1.881	2.478



If the Peak Pot A was deleted as an outlier, also delete the time.

Analysis Dummy Certification - First Peak Pot A time [outliers deleted]

Summary Report for ABS Pk1 Pot A (ms)



Anderson-Darling Normality Test

A-Squared	1.68
P-Value	<0.005

Mean	47.298
StDev	2.034
Variance	4.139
Skewness	0.739134
Kurtosis	0.239735
N	99

Minimum	43.270
1st Quartile	45.770
Median	47.000
3rd Quartile	48.300
Maximum	52.900

95% Confidence Interval for Mean

46.892	47.704
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95% Confidence Interval for Median

46.613	47.337
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95% Confidence Interval for StDev

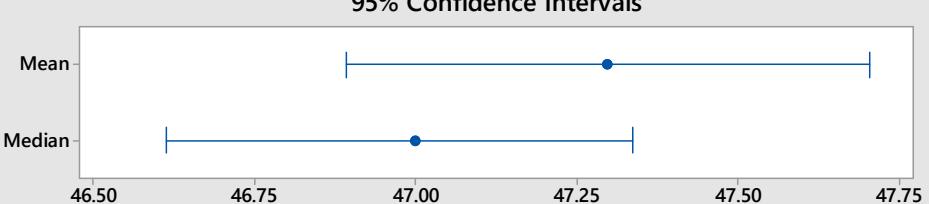
1.785	2.365
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Current Corridors: red - width +/- 47%

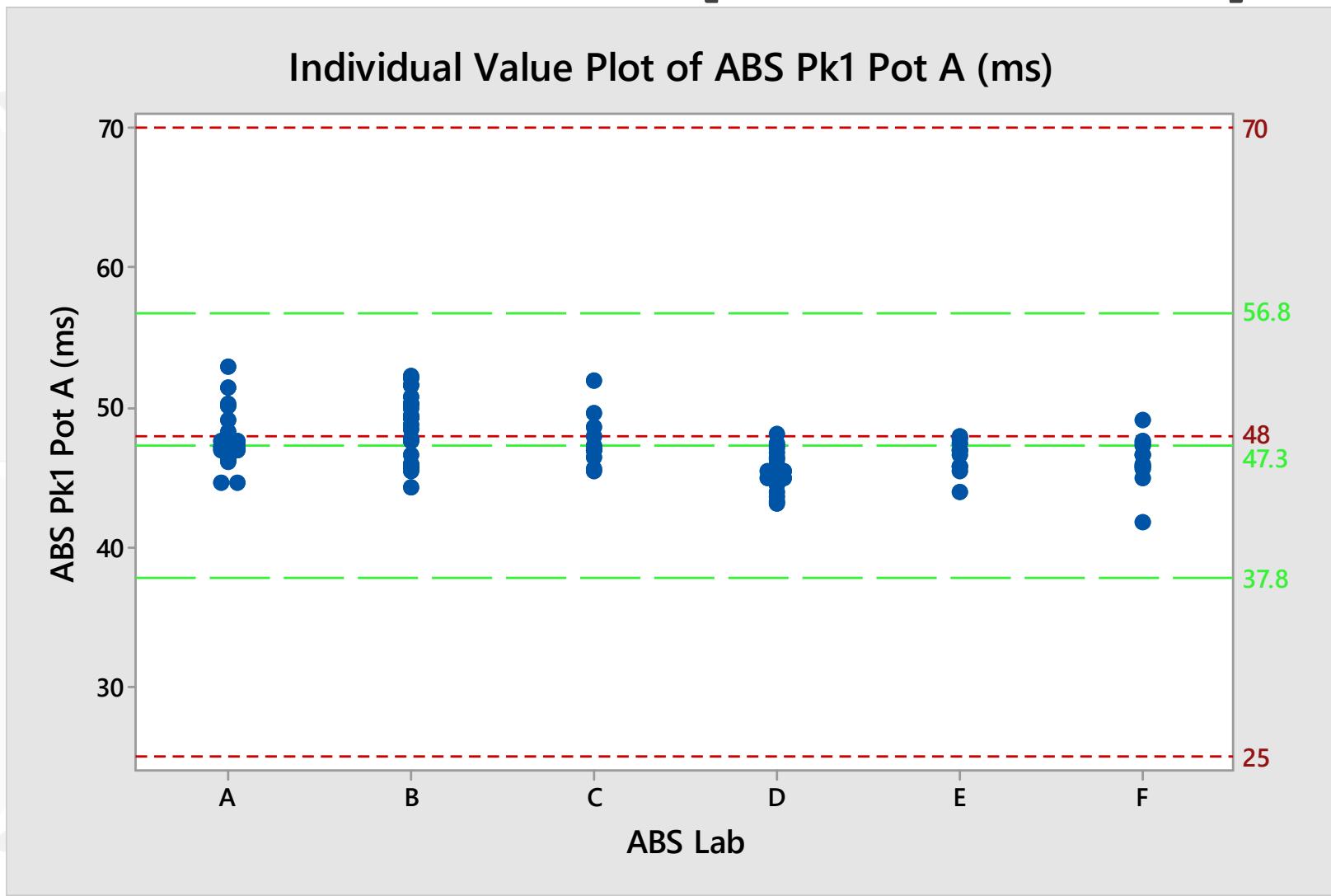
**after deleting outliers first
peak Pot A <9.7 deg**

+/- 2 std dev: blue (+/- 8.7%)

**Proposal: green -
since it is a time corridor, tighten
to +/- 20% width
47.3 /- 9.5 (37.8 - 56.8)**

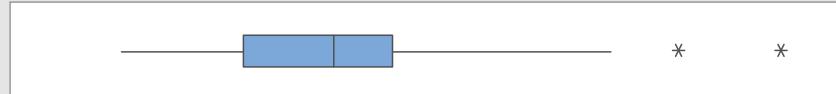
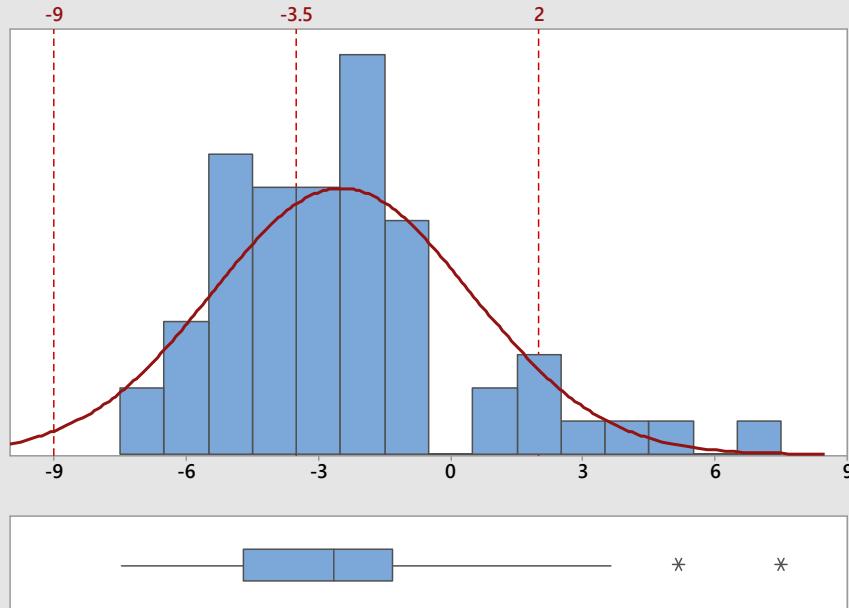


Analysis Dummy Certification - First Peak Pot A time [outliers deleted]



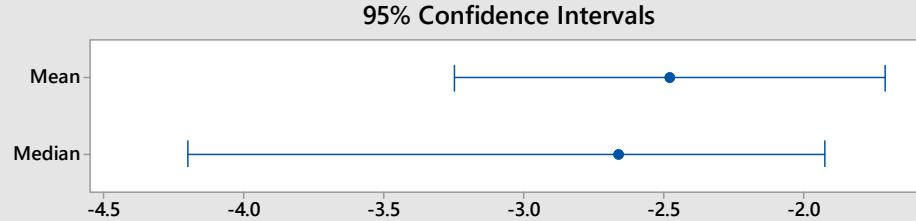
Analysis Dummy Certification - Pot A tunnel 125-135 ms MAX

Summary Report for ABS Max Pot A 125-135 ms



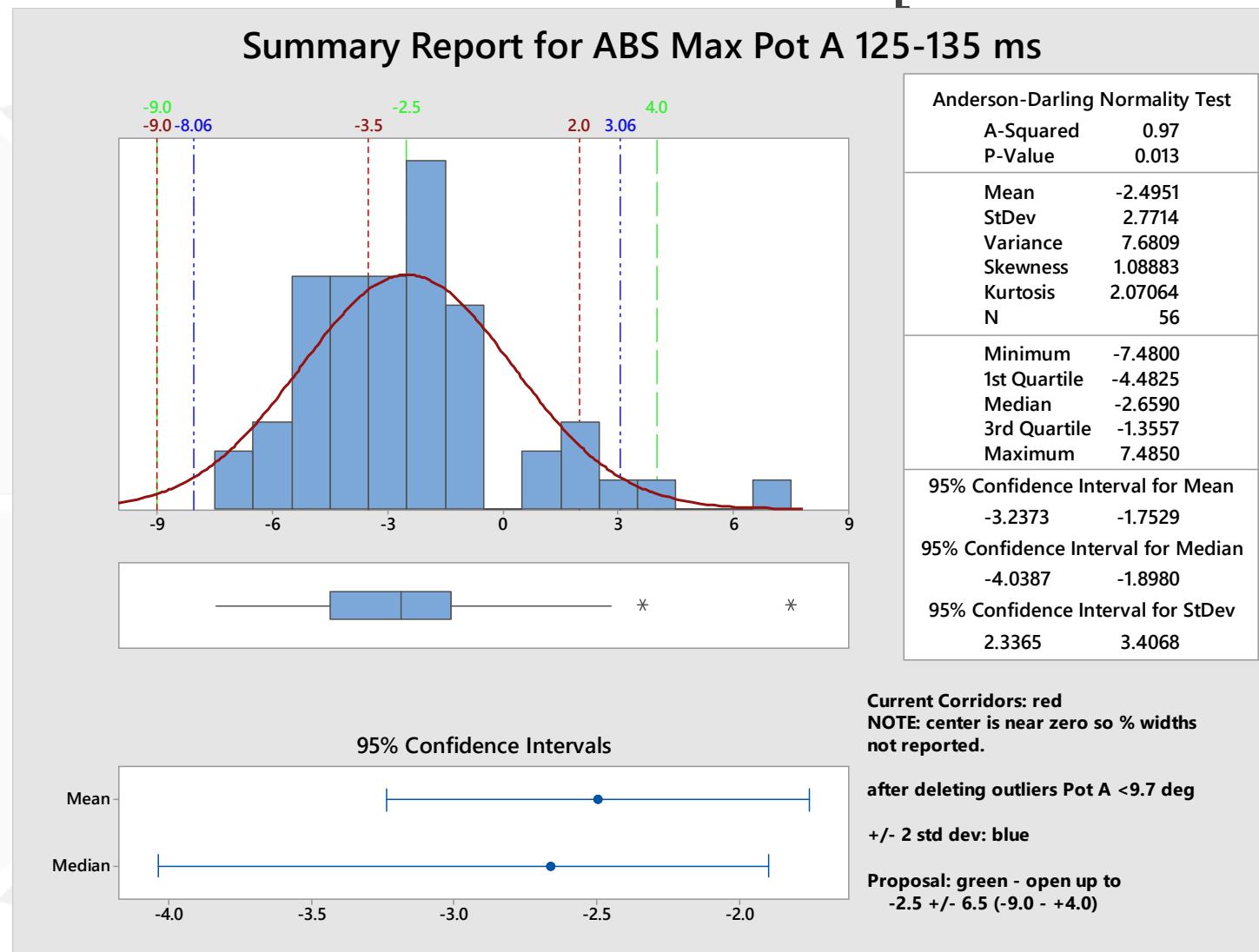
Anderson-Darling Normality Test

A-Squared	1.18
P-Value	<0.005
Mean	-2.4775
StDev	2.9486
Variance	8.6942
Skewness	1.09492
Kurtosis	1.62173
N	59
Minimum	-7.4800
1st Quartile	-4.6863
Median	-2.6600
3rd Quartile	-1.3343
Maximum	7.4850
95% Confidence Interval for Mean	
-3.2459 -1.7091	
95% Confidence Interval for Median	
-4.2017 -1.9241	
95% Confidence Interval for StDev	
2.4961 3.6031	



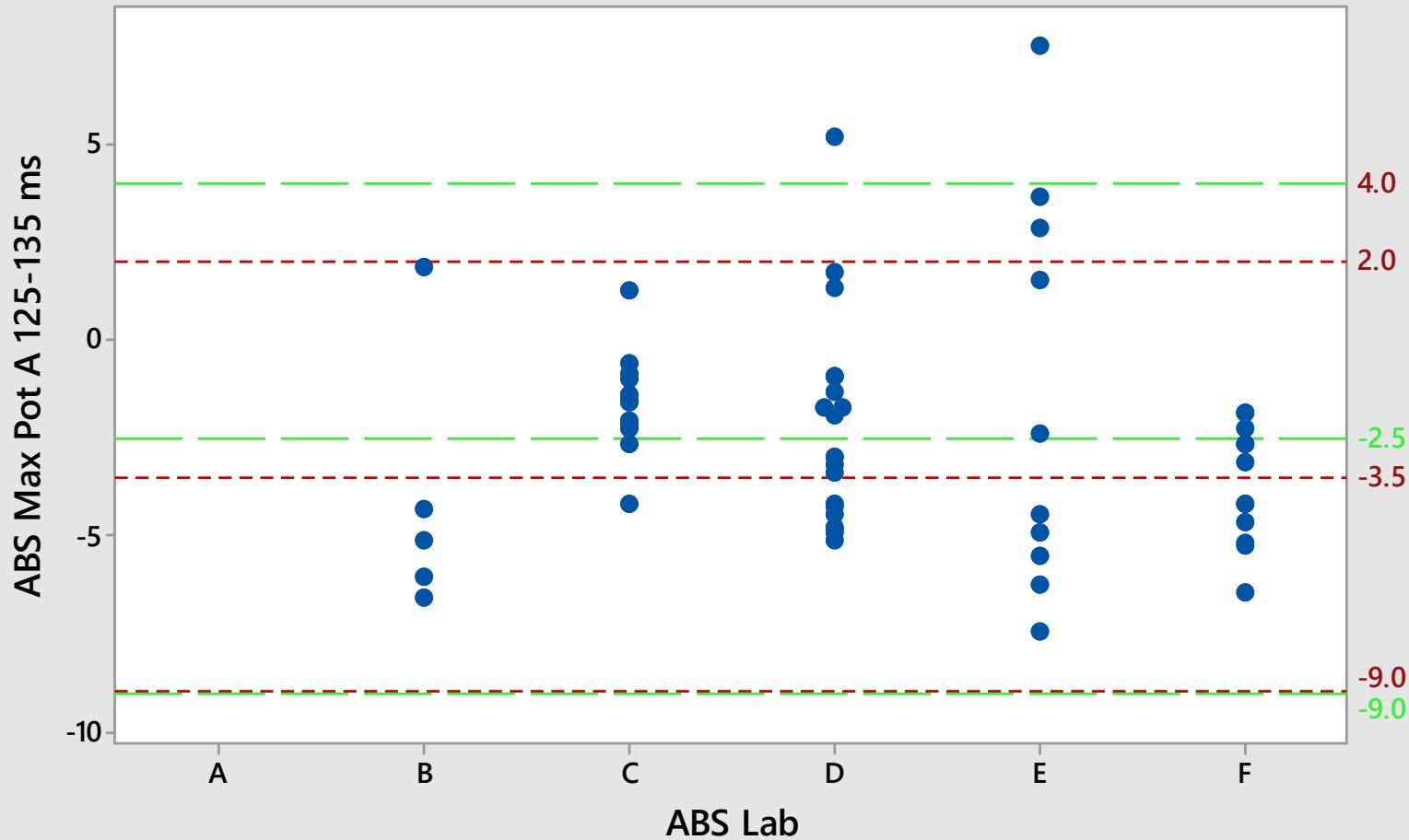
If the Peak Pot A was deleted as an outlier, also this value.

Analysis Dummy Certification - Pot A tunnel 125-135 ms MAX [outliers deleted]



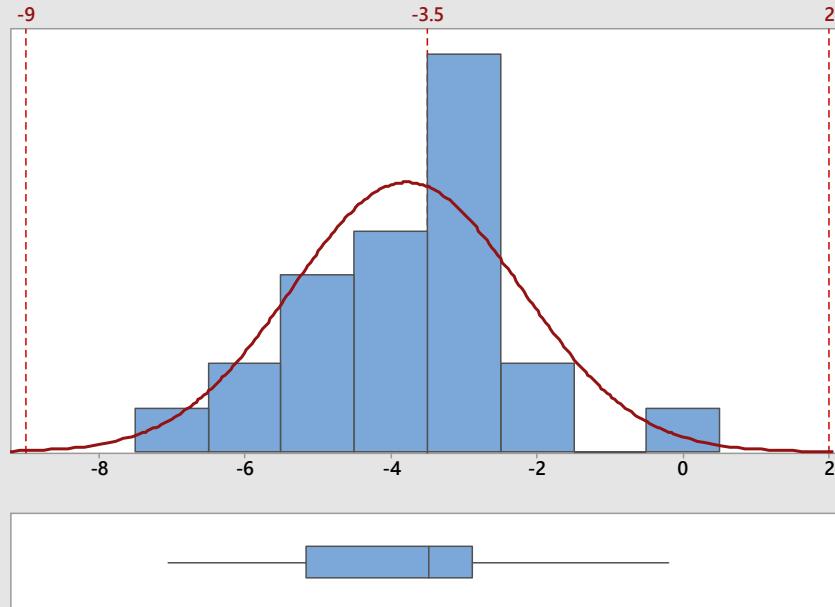
Analysis Dummy Certification - Pot A tunnel 125-135 ms MAX

Individual Value Plot of ABS Max Pot A 125-135 ms



Analysis Dummy Certification - Pot A tunnel 125-135 ms MIN

Summary Report for ABS Min Pot A 125-135 ms



Anderson-Darling Normality Test

A-Squared	0.32
P-Value	0.517

Mean	-3.7818
StDev	1.5700
Variance	2.4648
Skewness	0.000365
Kurtosis	0.238351
N	24

Minimum	-7.0558
1st Quartile	-5.1601
Median	-3.4725
3rd Quartile	-2.8790
Maximum	-0.1900

95% Confidence Interval for Mean

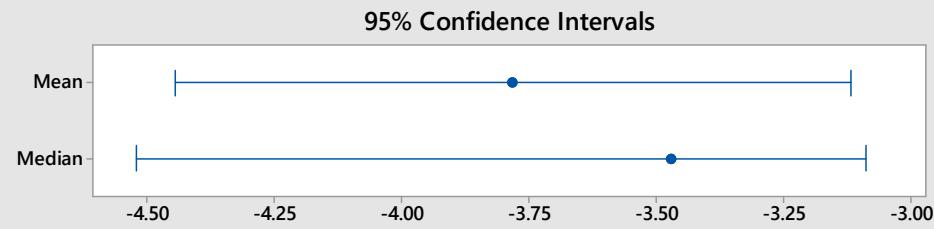
-4.4447 -3.1189

95% Confidence Interval for Median

-4.5208 -3.0902

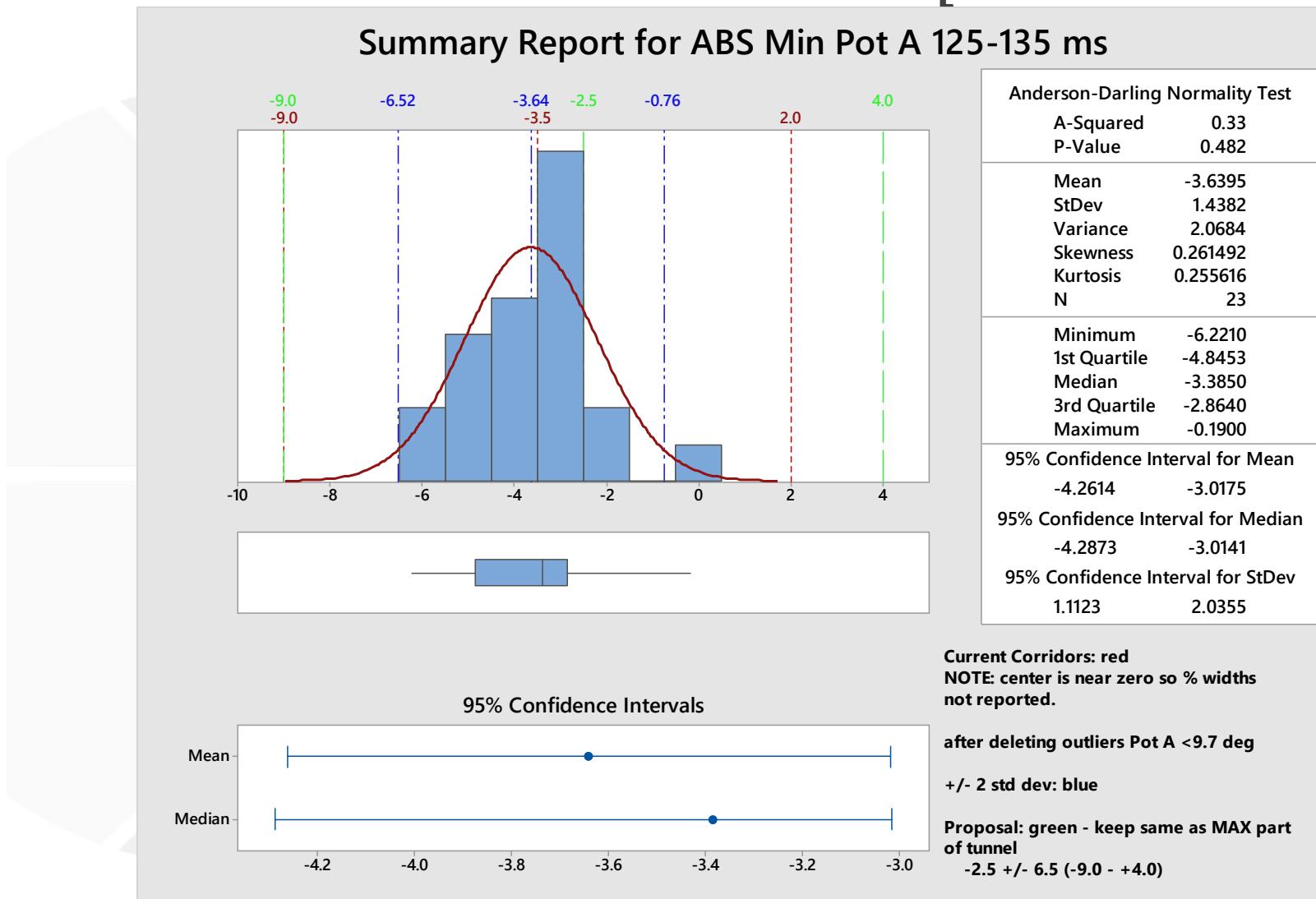
95% Confidence Interval for StDev

1.2202 2.2023

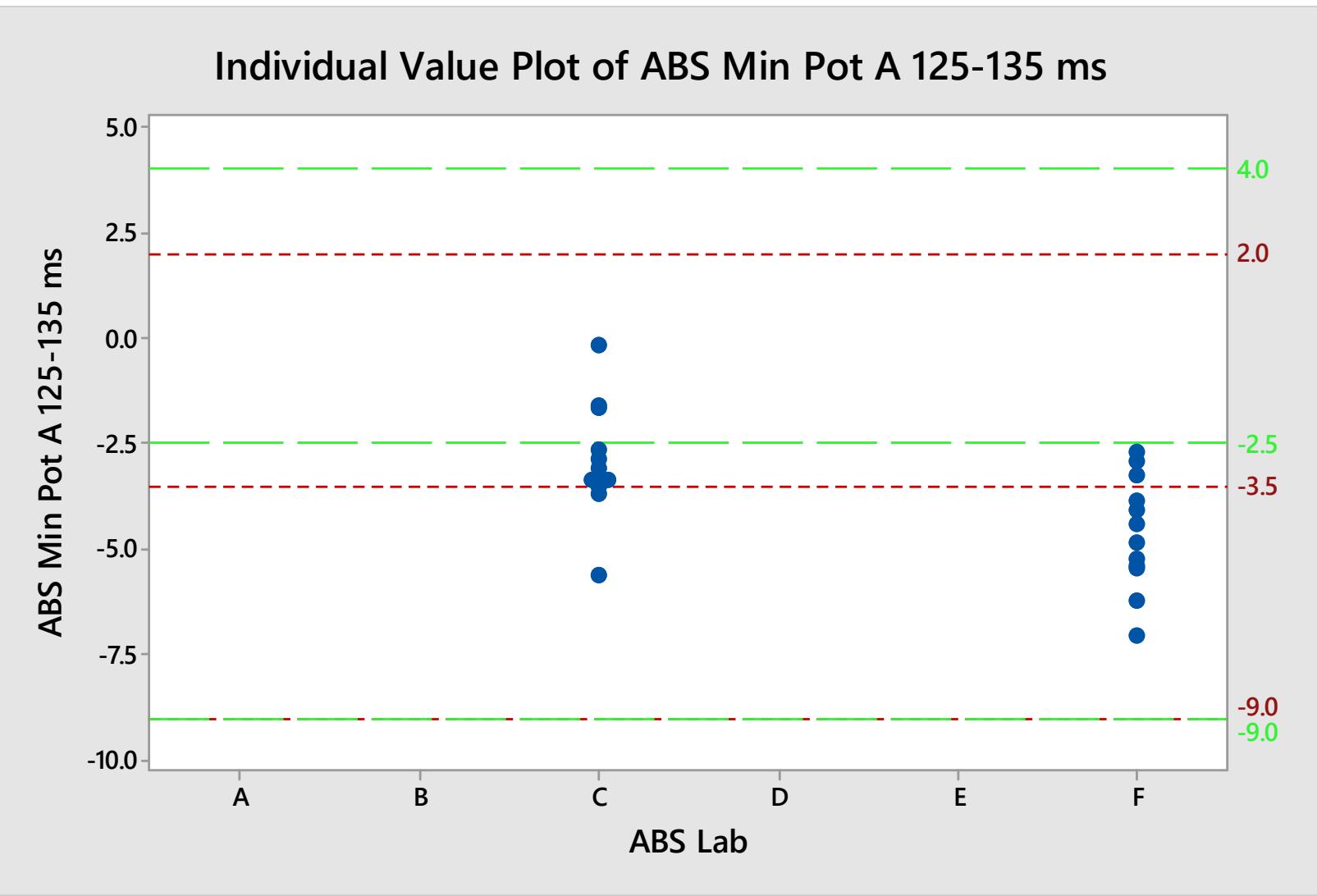


If the Peak Pot A was deleted as an outlier, also delete this value.

Analysis Dummy Certification - Pot A tunnel 125-135 ms MIN [outliers deleted]

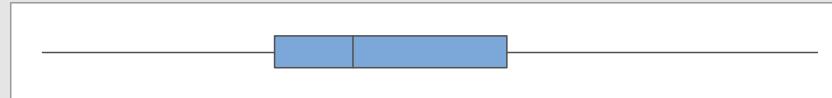
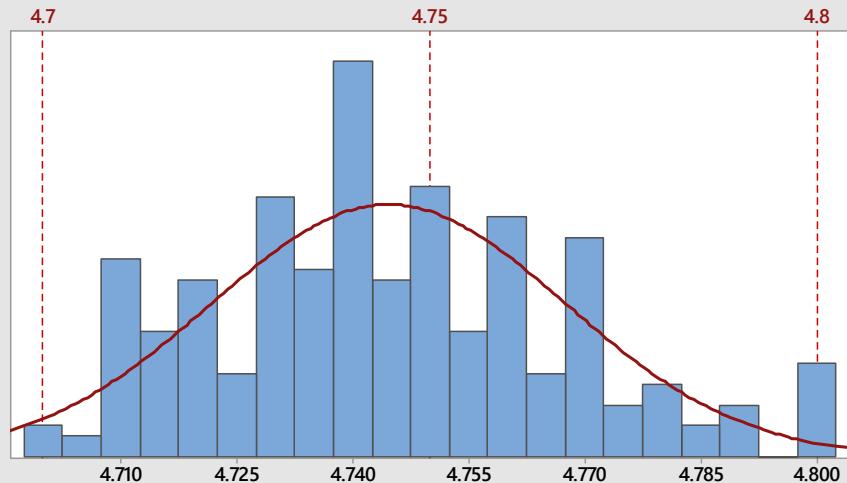


Analysis Dummy Certification - Pot A tunnel 125-135 ms MIN



Analysis Dummy Certification - Impact Velocity

Summary Report for ABS Vel (m/s)



Anderson-Darling Normality Test

A-Squared	1.45
P-Value	<0.005
Mean	4.7446
StDev	0.0229
Variance	0.0005
Skewness	0.364842
Kurtosis	-0.292580
N	278
Minimum	4.7000
1st Quartile	4.7300
Median	4.7400
3rd Quartile	4.7600
Maximum	4.8000

95% Confidence Interval for Mean

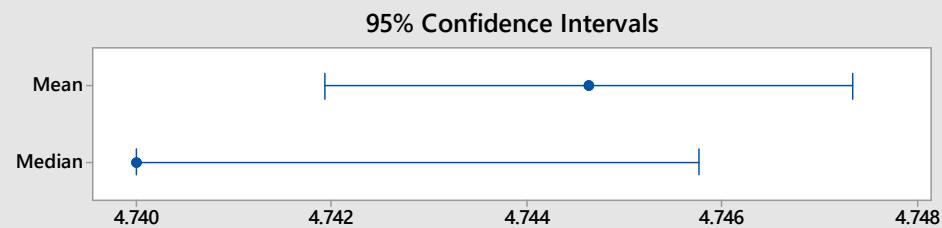
4.7419 4.7473

95% Confidence Interval for Median

4.7400 4.7458

95% Confidence Interval for StDev

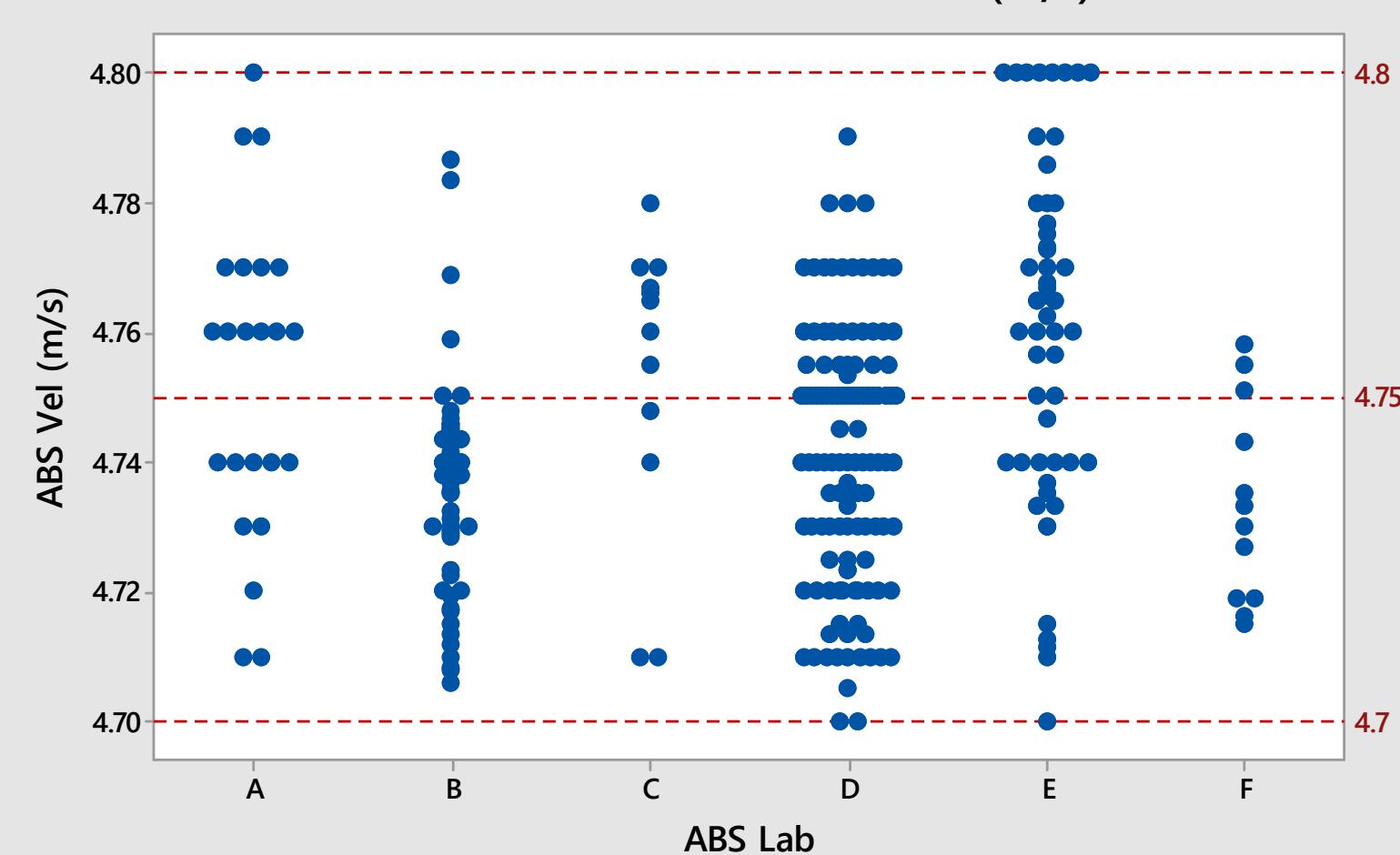
0.0211 0.0250



Current Corridors: red - width +/- 1.1%

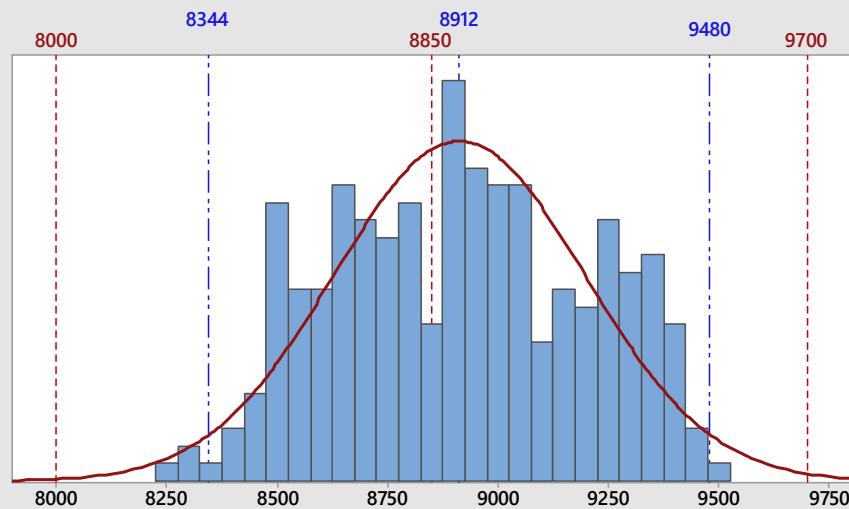
Proposal: no change

Analysis Dummy Certification - Impact Velocity

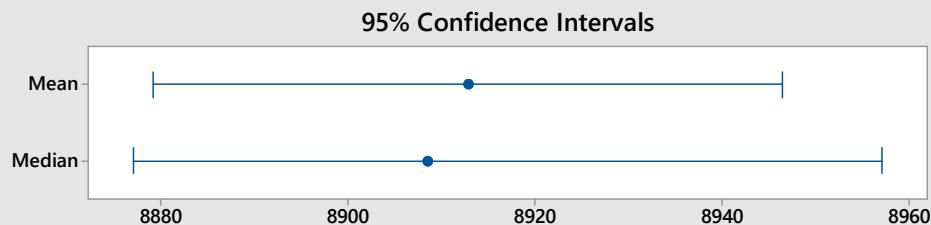


Analysis Dummy Certification - Pendulum Force

Summary Report for ABS Force (N)



Anderson-Darling Normality Test	
A-Squared	1.52
P-Value	<0.005
Mean	8912.8
StDev	284.2
Variance	80770.1
Skewness	-0.001911
Kurtosis	-0.926543
N	278
Minimum	8273.0
1st Quartile	8680.0
Median	8908.5
3rd Quartile	9141.4
Maximum	9480.0
95% Confidence Interval for Mean	
8879.2	8946.3
95% Confidence Interval for Median	
8877.0	8957.1
95% Confidence Interval for StDev	
262.4	310.0

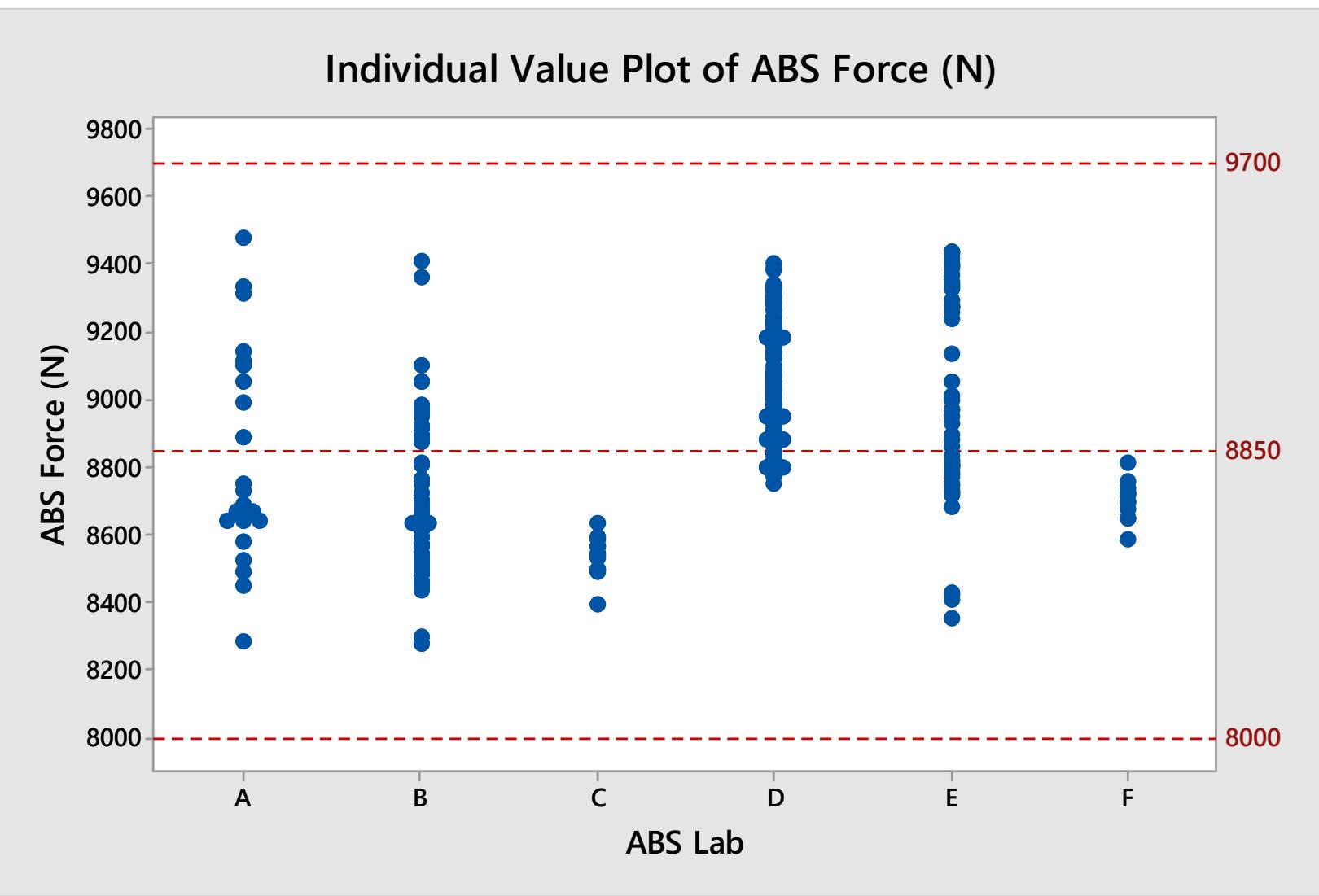


Current Corridors: red - width +/- 9.6%

+/- 2 std dev: blue (+/- 6.4%)

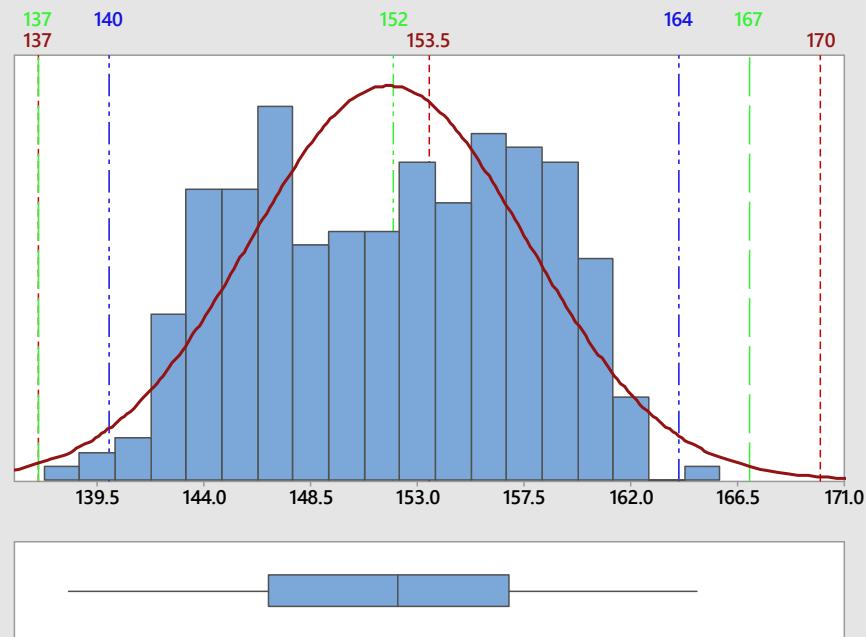
Proposal: no change

Analysis Dummy Certification - Pendulum Force

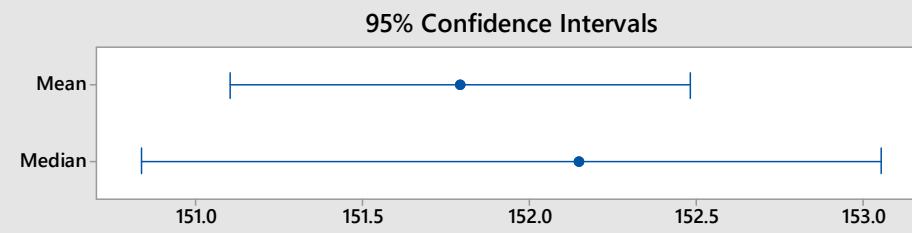


Analysis Dummy Certification - Peak Sled Acceleration (m/s^2)

Summary Report for ABS Sled (m/s^2)



Anderson-Darling Normality Test	
A-Squared	3.01
P-Value	<0.005
Mean	151.79
StDev	5.84
Variance	34.16
Skewness	-0.07820
Kurtosis	-1.08112
N	278
Minimum	138.30
1st Quartile	146.70
Median	152.15
3rd Quartile	156.83
Maximum	164.80
95% Confidence Interval for Mean	
151.10	152.48
95% Confidence Interval for Median	
150.84	153.05
95% Confidence Interval for StDev	
5.40	6.38

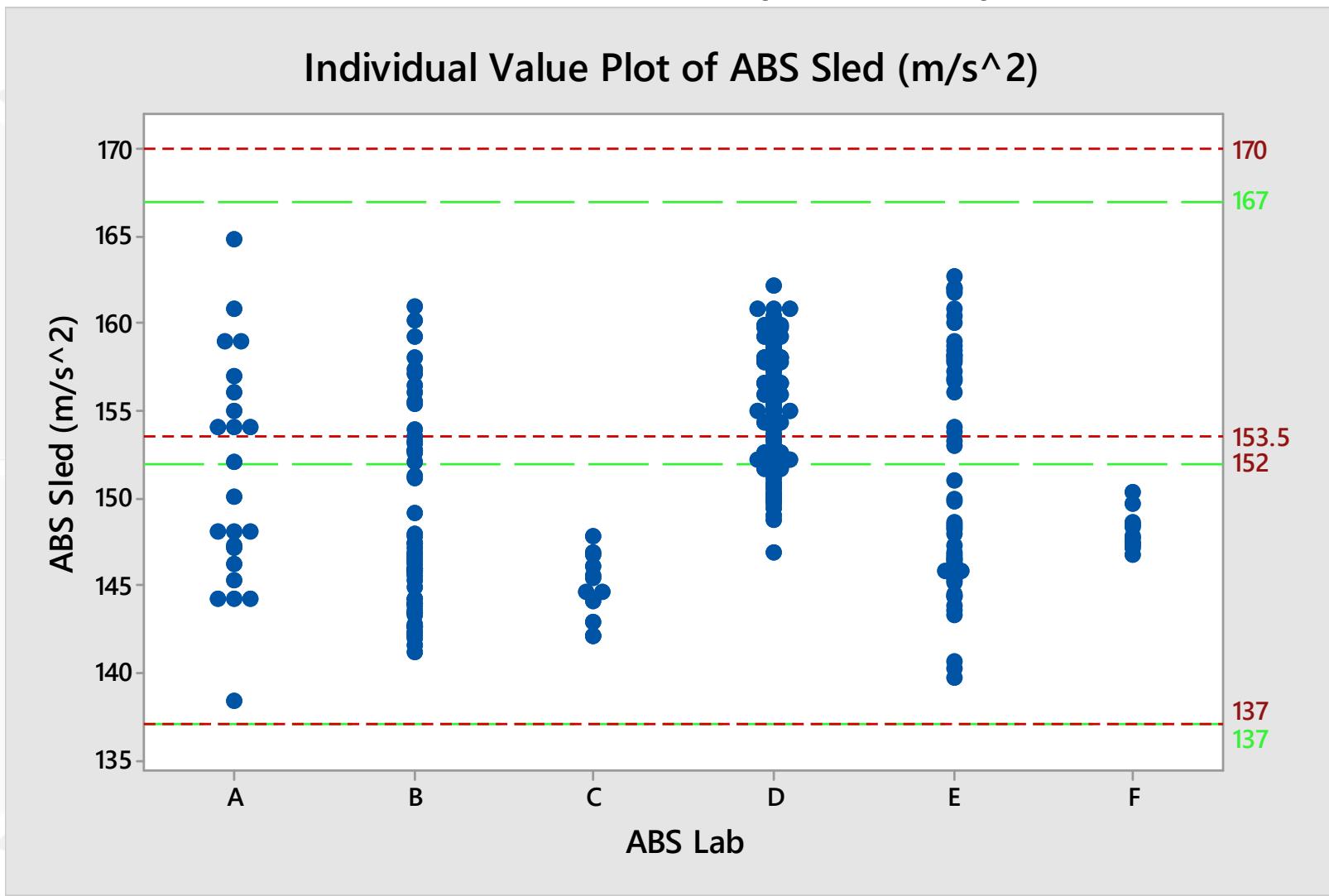


Current Corridors: red - width +/- 10.7%

+/- 2 std dev: blue (+/- 7.7%)

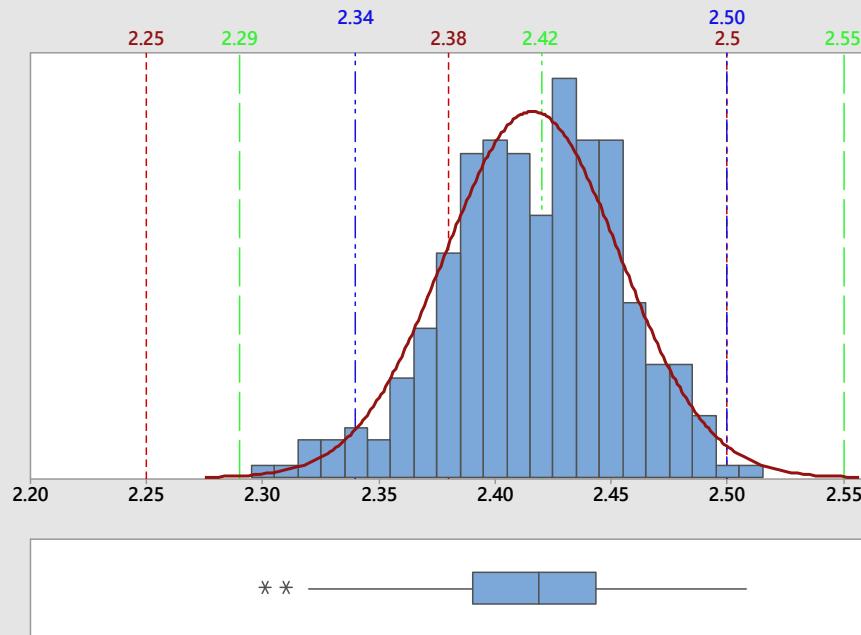
Proposal: green -
use +/- 10% corridor width
 152 ± 15 (137 - 167)

Analysis Dummy Certification - Peak Sled Acceleration (m/s^2)

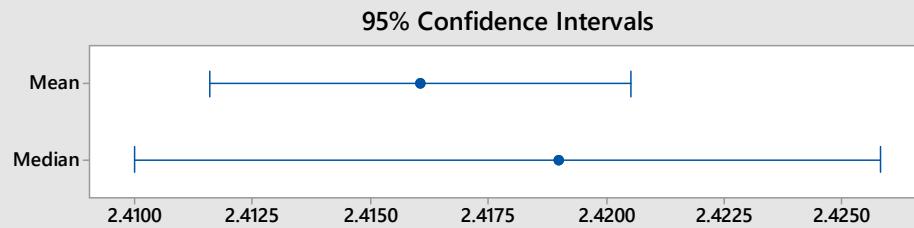


Analysis Dummy Certification - Sled Velocity Peak 1 (m/s)

Summary Report for ABS Sled Vel1 (m/s)



Anderson-Darling Normality Test	
A-Squared	0.62
P-Value	0.108
Mean	2.4161
StDev	0.0378
Variance	0.0014
Skewness	-0.290382
Kurtosis	-0.049943
N	278
Minimum	2.3013
1st Quartile	2.3903
Median	2.4190
3rd Quartile	2.4435
Maximum	2.5083
95% Confidence Interval for Mean	
2.4116	2.4205
95% Confidence Interval for Median	
2.4100	2.4258
95% Confidence Interval for StDev	
0.0349	0.0413

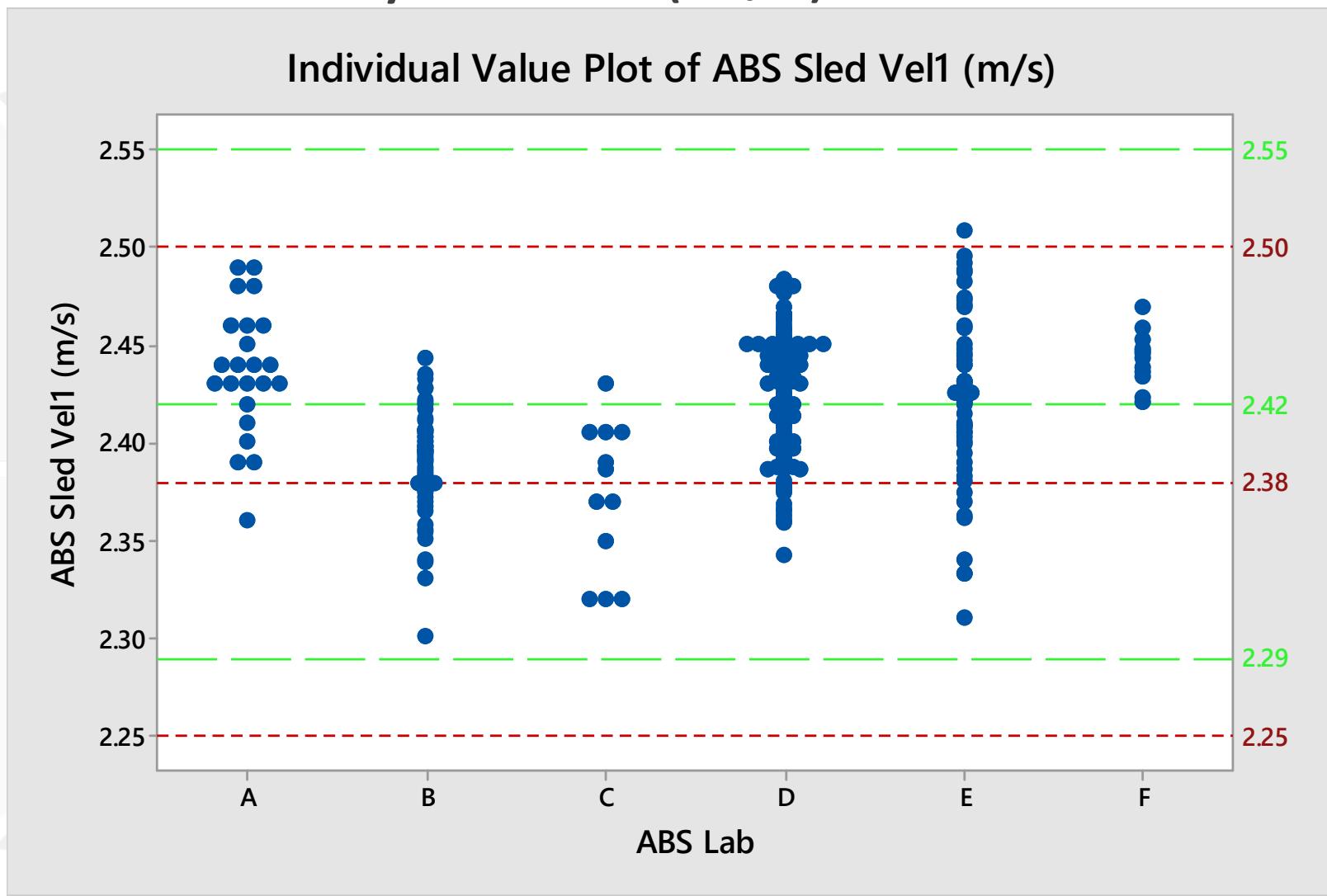


Current Corridors: red - width +/- 5.3%

+/- 2 std dev: blue (+/- 1.6%)

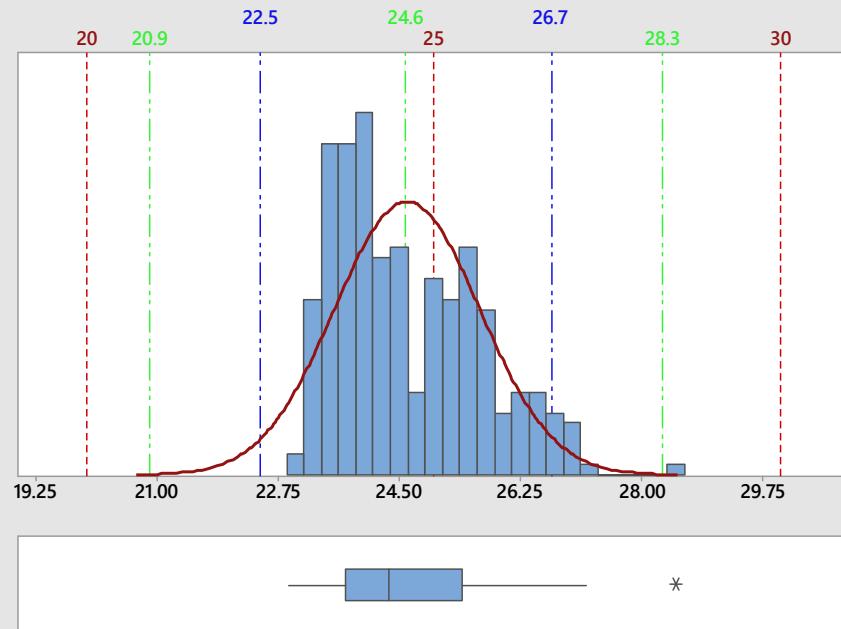
Proposal: green - use about same
% width (+/- 5.4%)
2.42 +/- .13 (2.29 - 2.55)

Analysis Dummy Certification - Sled Velocity Peak 1 (m/s)

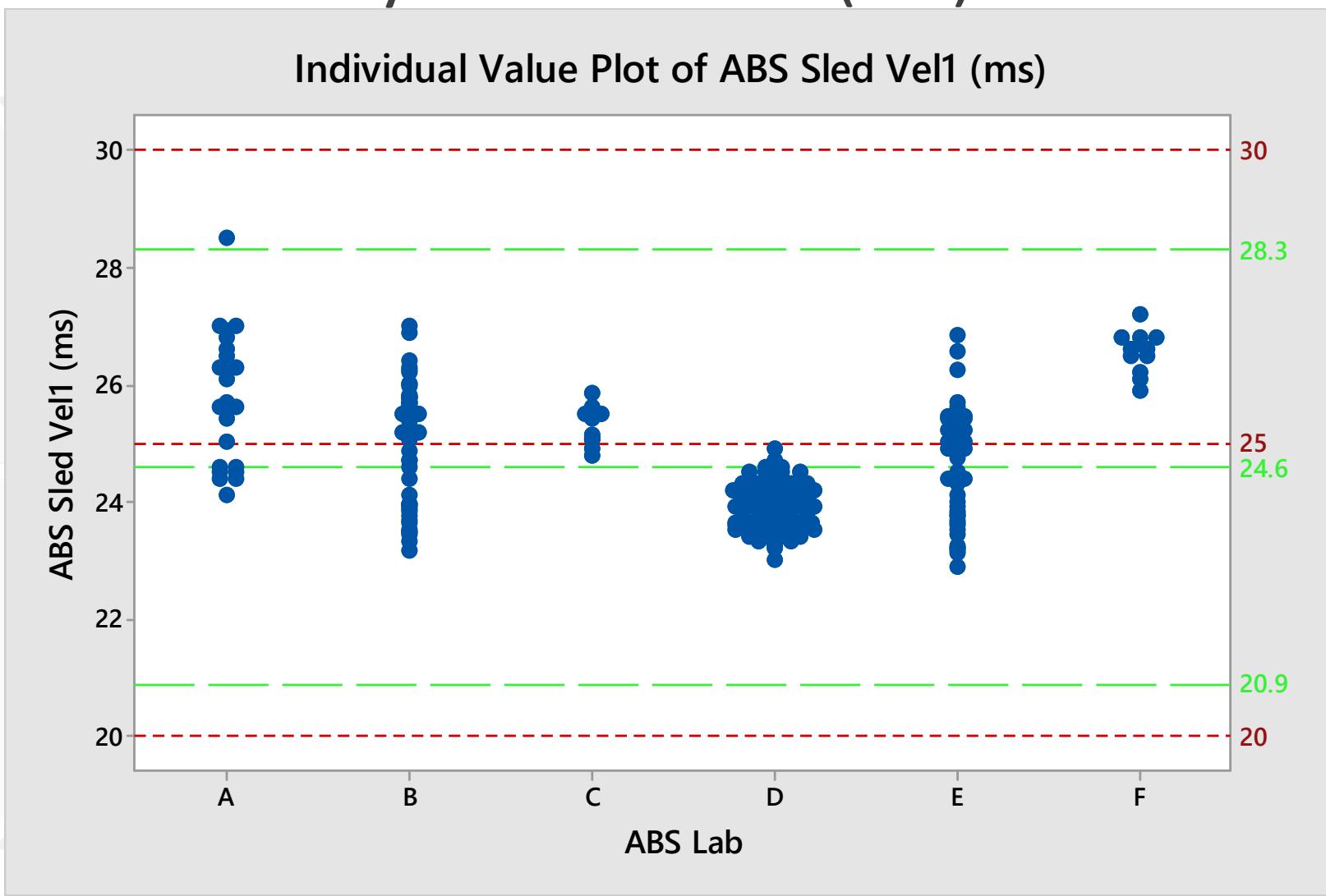


Analysis Dummy Certification - Sled Velocity Peak 1 Time (ms)

Summary Report for ABS Sled Vel1 (ms)

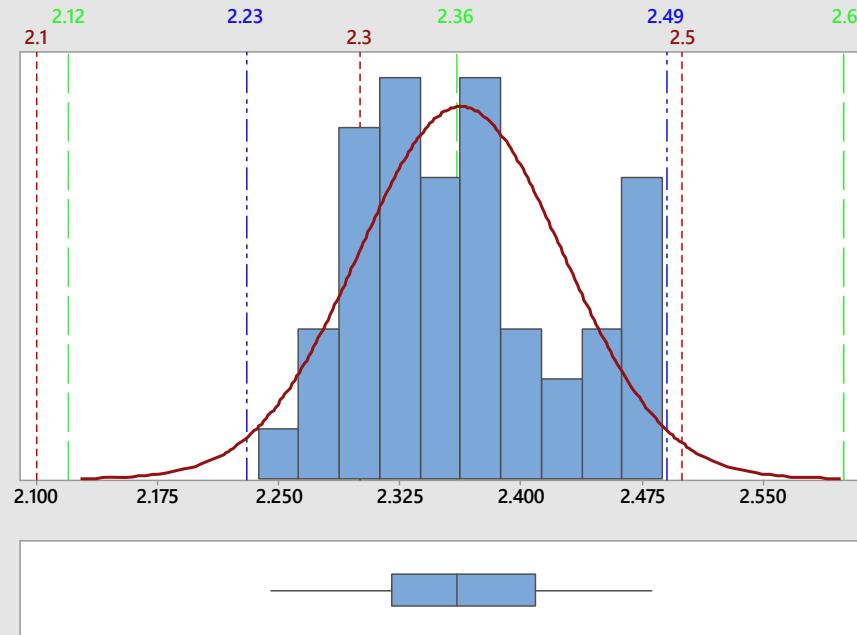


Analysis Dummy Certification - Sled Velocity Peak 1 Time (ms)

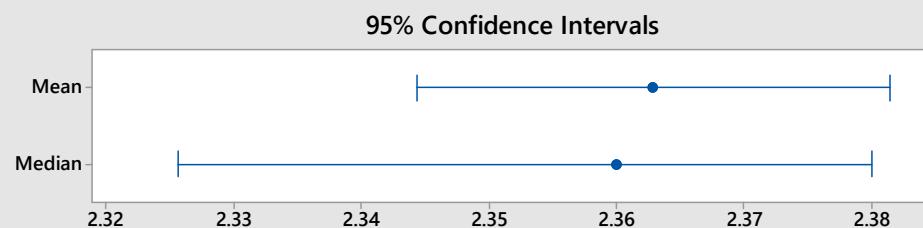


Analysis Dummy Certification - Sled Velocity Tunnel @ 135 ms (m/s)

Summary Report for ABS SledVel@135 (m/s)

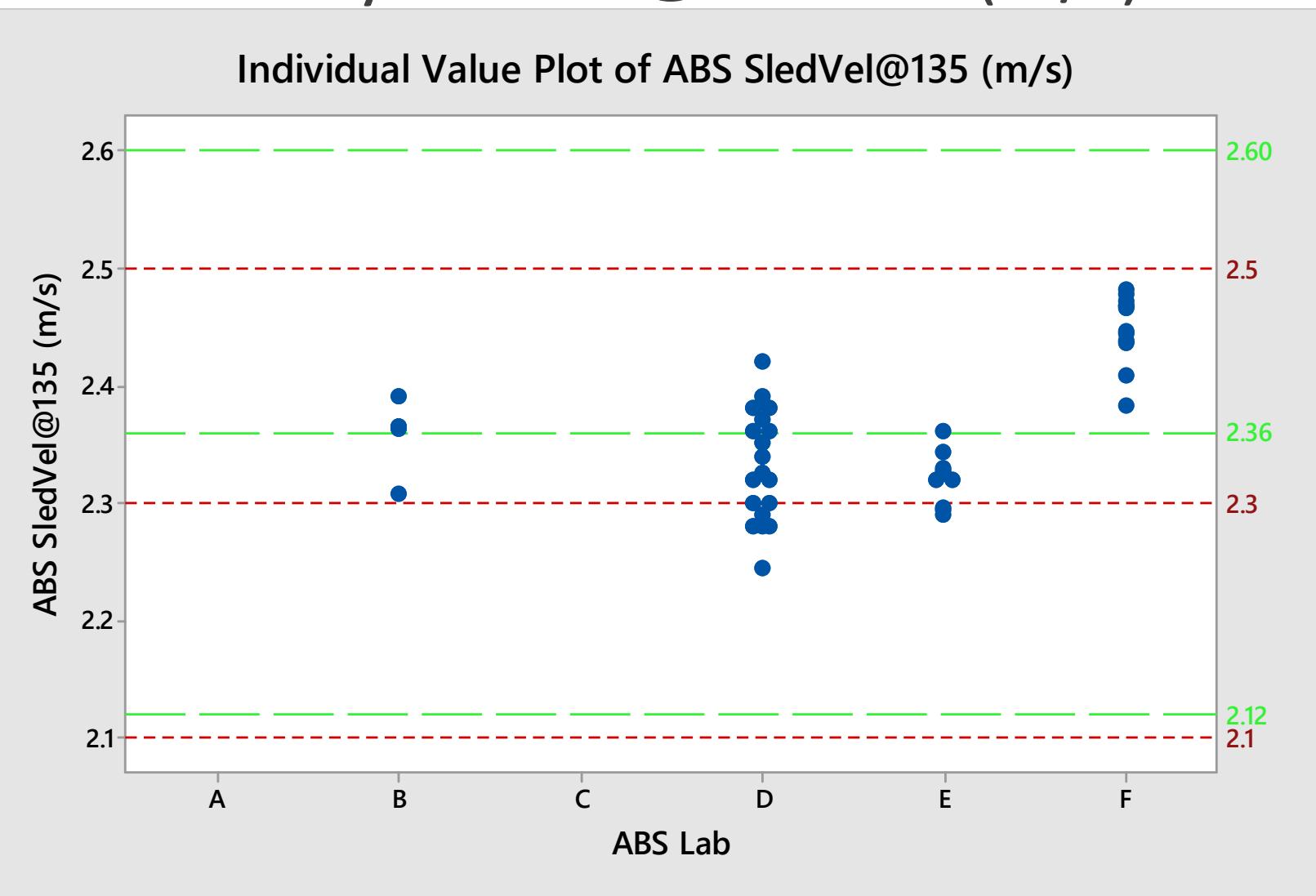


Anderson-Darling Normality Test	
A-Squared	0.75
P-Value	0.047
Mean	2.3629
StDev	0.0632
Variance	0.0040
Skewness	0.376411
Kurtosis	-0.826902
N	47
Minimum	2.2450
1st Quartile	2.3200
Median	2.3600
3rd Quartile	2.4090
Maximum	2.4811
95% Confidence Interval for Mean	
2.3443	2.3814
95% Confidence Interval for Median	
2.3256	2.3800
95% Confidence Interval for StDev	
0.0525	0.0794



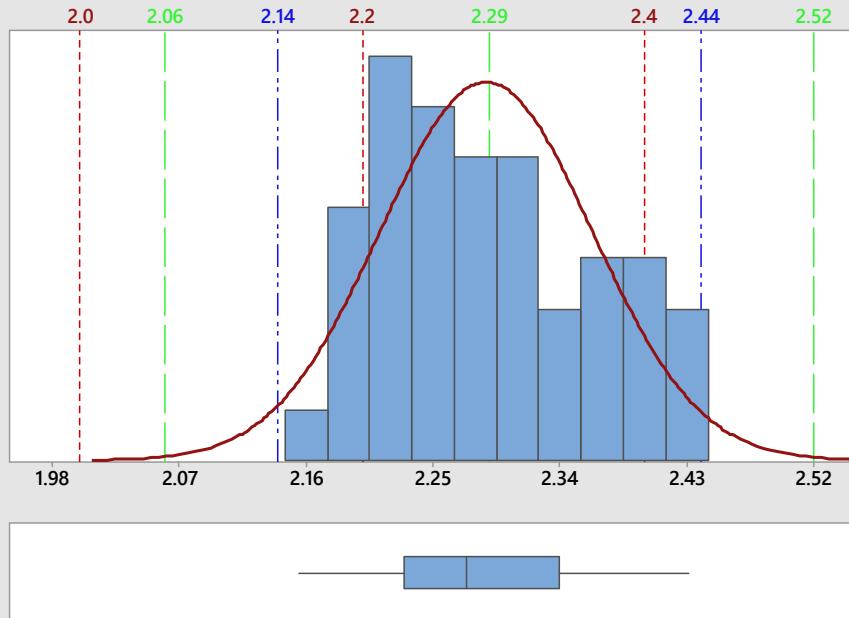
Current Corridors: red - width +/- 8.7%
 +/- 2 std dev: blue (+/- 5.3%)
 Proposal: green -
 use +/- 10% corridor
 2.36 +/- .24 (2.12 - 2.60)

Analysis Dummy Certification - Sled Velocity Tunnel @ 135 ms (m/s)

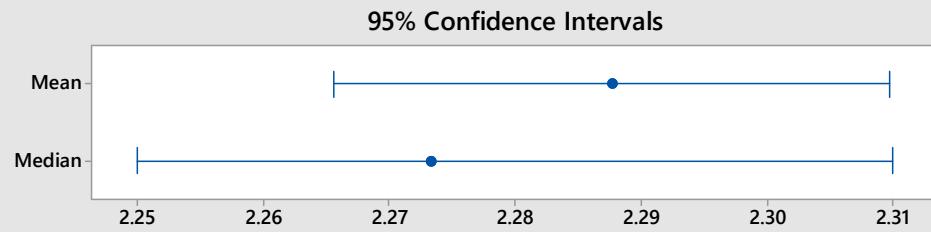


Analysis Dummy Certification - Sled Velocity Tunnel @ 140 ms (m/s)

Summary Report for ABS SledVel@140 (m/s)



Anderson-Darling Normality Test	
A-Squared	0.77
P-Value	0.043
Mean	2.2877
StDev	0.0751
Variance	0.0056
Skewness	0.402043
Kurtosis	-0.891026
N	47
Minimum	2.1550
1st Quartile	2.2300
Median	2.2733
3rd Quartile	2.3398
Maximum	2.4313
95% Confidence Interval for Mean	
2.2657	2.3098
95% Confidence Interval for Median	
2.2500	2.3100
95% Confidence Interval for StDev	
0.0624	0.0944

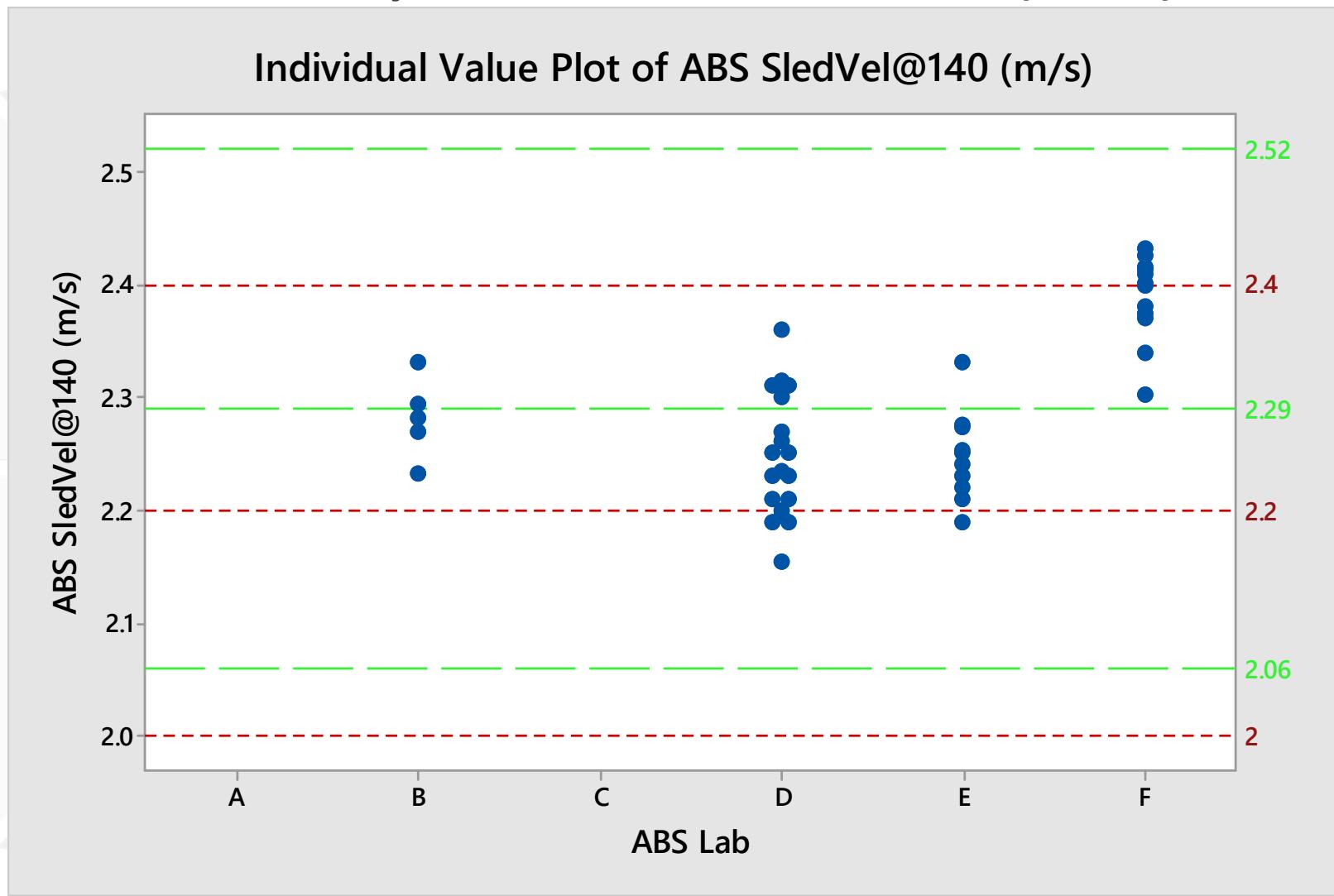


Current Corridors: red - width +/- 9.1%

+/- 2 std dev: blue (+/- 6.5%)

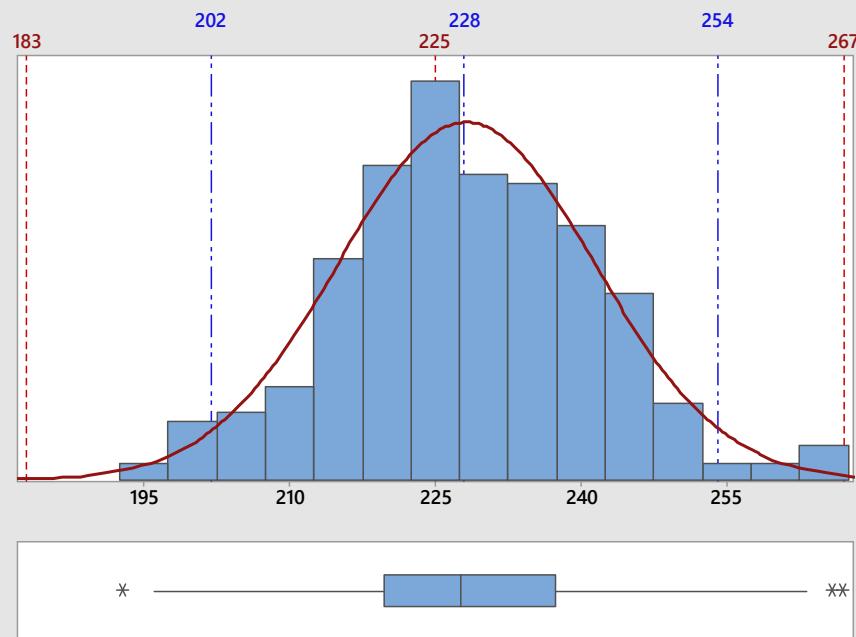
Proposal: green -
use +/- 10% corridor
2.29 +/- .23 (2.12 - 2.52)

Analysis Dummy Certification - Sled Velocity Tunnel @ 140 ms (m/s)

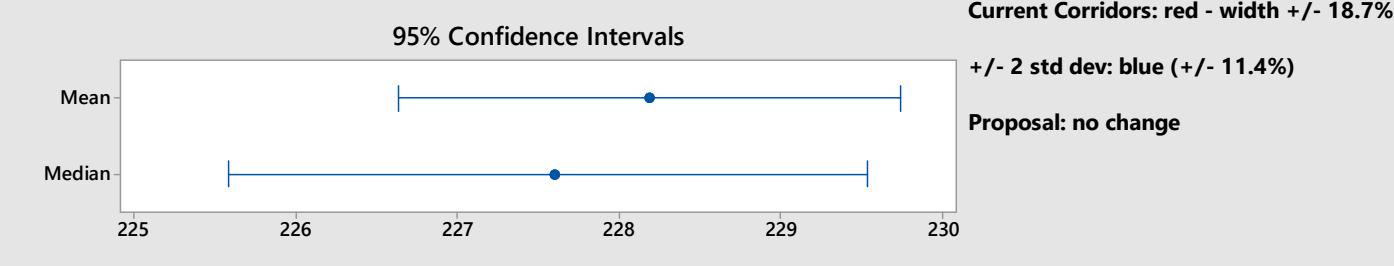


Analysis Dummy Certification - T1 Acceleration (m/s²)

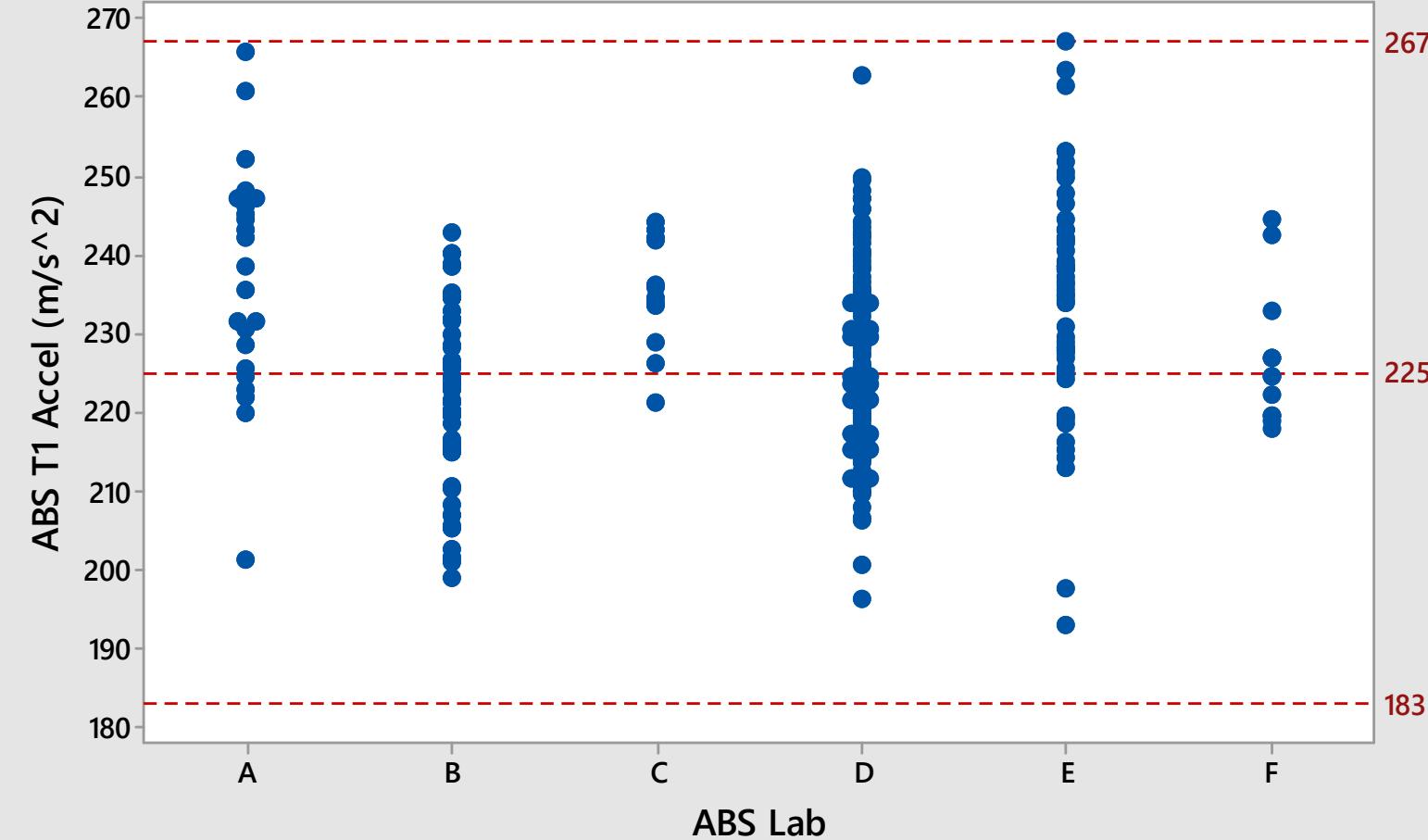
Summary Report for ABS T1 Accel (m/s²)



Anderson-Darling Normality Test	
A-Squared	0.33
P-Value	0.521
Mean	228.19
StDev	13.16
Variance	173.07
Skewness	0.125804
Kurtosis	0.173396
N	278
Minimum	192.90
1st Quartile	219.67
Median	227.60
3rd Quartile	237.45
Maximum	266.93
95% Confidence Interval for Mean	
226.64	229.74
95% Confidence Interval for Median	
225.59	229.53
95% Confidence Interval for StDev	
12.15	14.35

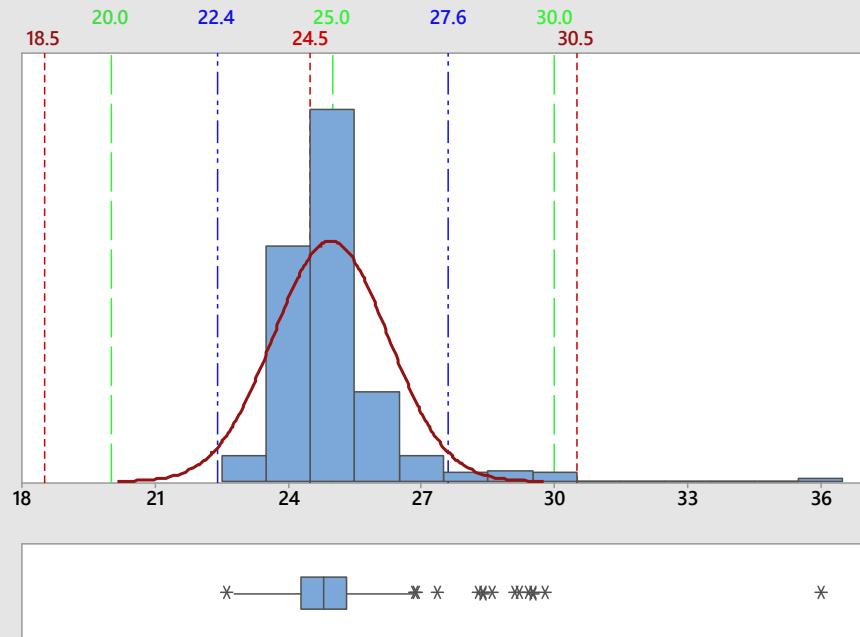


Analysis Dummy Certification - T1 Acceleration (m/s²)

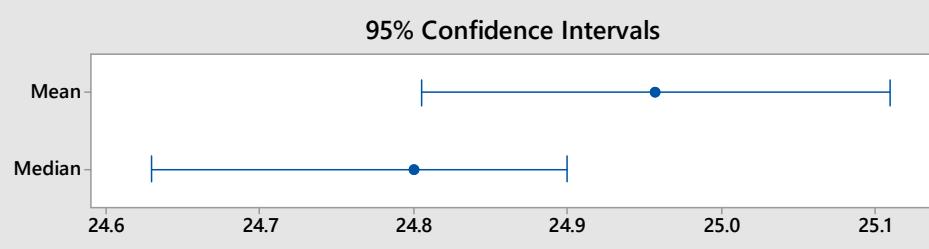


Analysis Dummy Certification - T1 Acceleration Time (ms)

Summary Report for ABS T1 Accel (ms)



Anderson-Darling Normality Test	
A-Squared	13.13
P-Value	<0.005
Mean	24.957
StDev	1.290
Variance	1.665
Skewness	3.3710
Kurtosis	21.1937
N	278
Minimum	22.600
1st Quartile	24.294
Median	24.800
3rd Quartile	25.310
Maximum	36.000
95% Confidence Interval for Mean	
24.805	25.110
95% Confidence Interval for Median	
24.629	24.900
95% Confidence Interval for StDev	
1.191	1.408

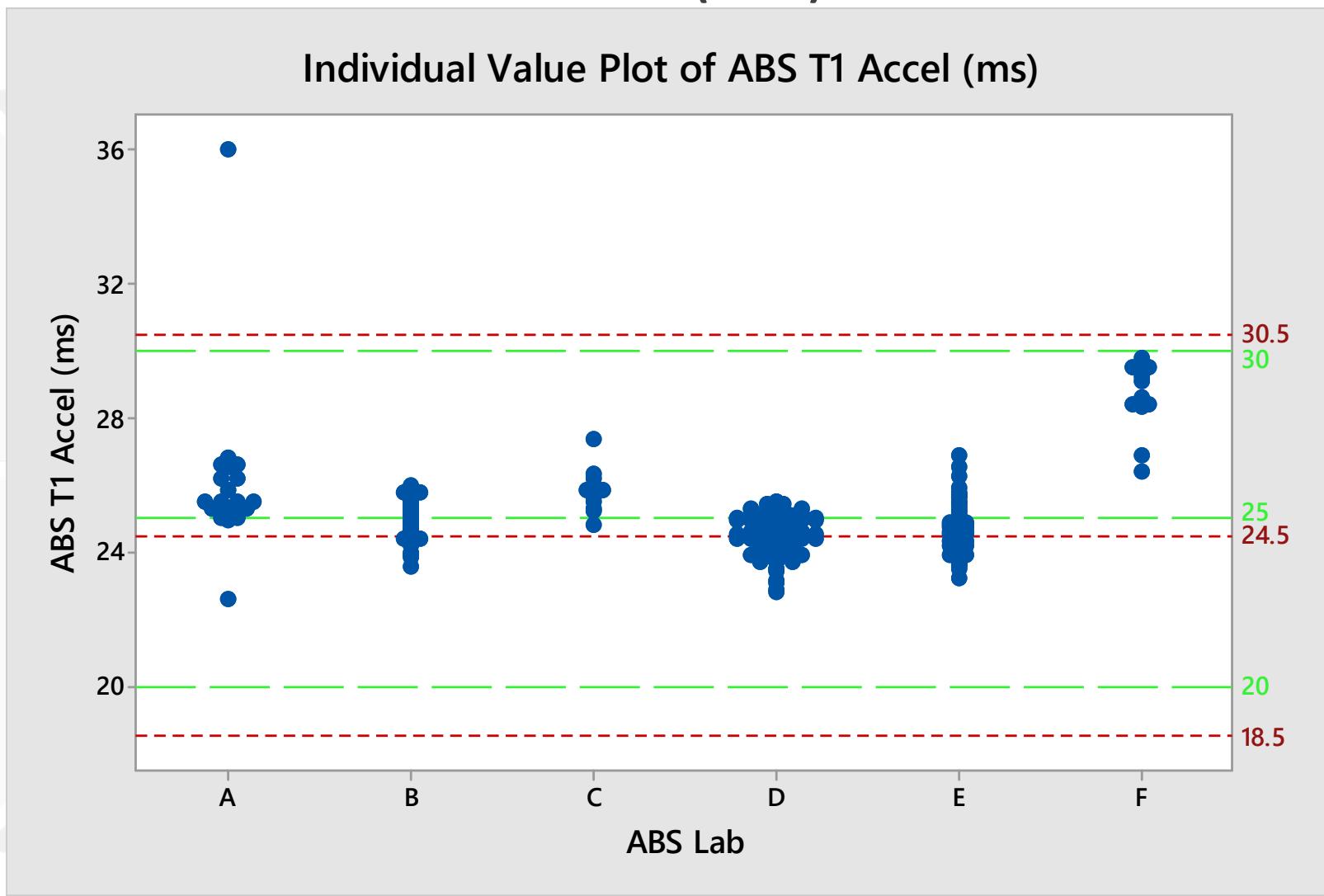


Current Corridors: red - width +/- 24.5%

+/- 2 std dev: blue (+/- 10.4%)

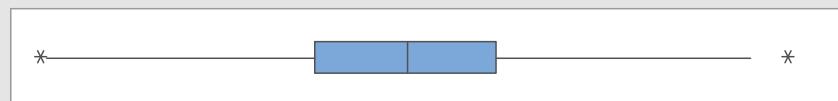
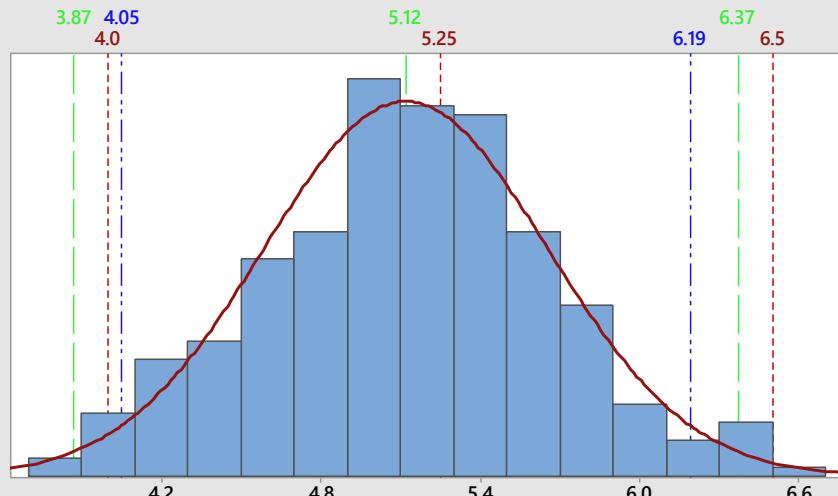
Proposal: green - since time
use +/- 20% corridor
25.0 +/- 5.0 (20.0 - 30.0)

Analysis Dummy Certification - T1 Acceleration Time (ms)

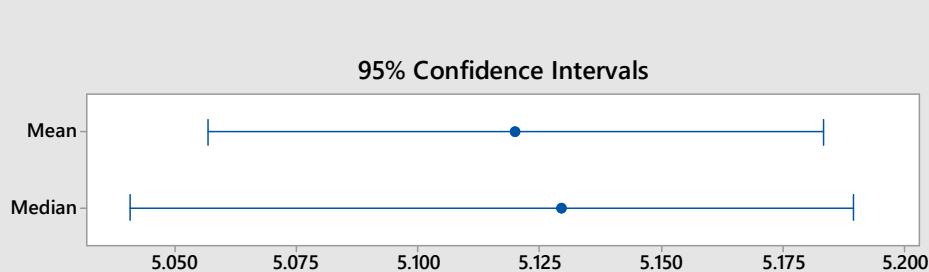


Analysis Dummy Certification - First Peak Pot B (deg)

Summary Report for ABS Pk1 Pot B (deg)



Anderson-Darling Normality Test	
A-Squared	0.33
P-Value	0.508
Mean	5.1201
StDev	0.5349
Variance	0.2861
Skewness	0.0345607
Kurtosis	-0.0474798
N	278
Minimum	3.7445
1st Quartile	4.7800
Median	5.1294
3rd Quartile	5.4600
Maximum	6.5587
95% Confidence Interval for Mean	
5.0569	5.1832
95% Confidence Interval for Median	
5.0409	5.1894
95% Confidence Interval for StDev	
0.4938	0.5835



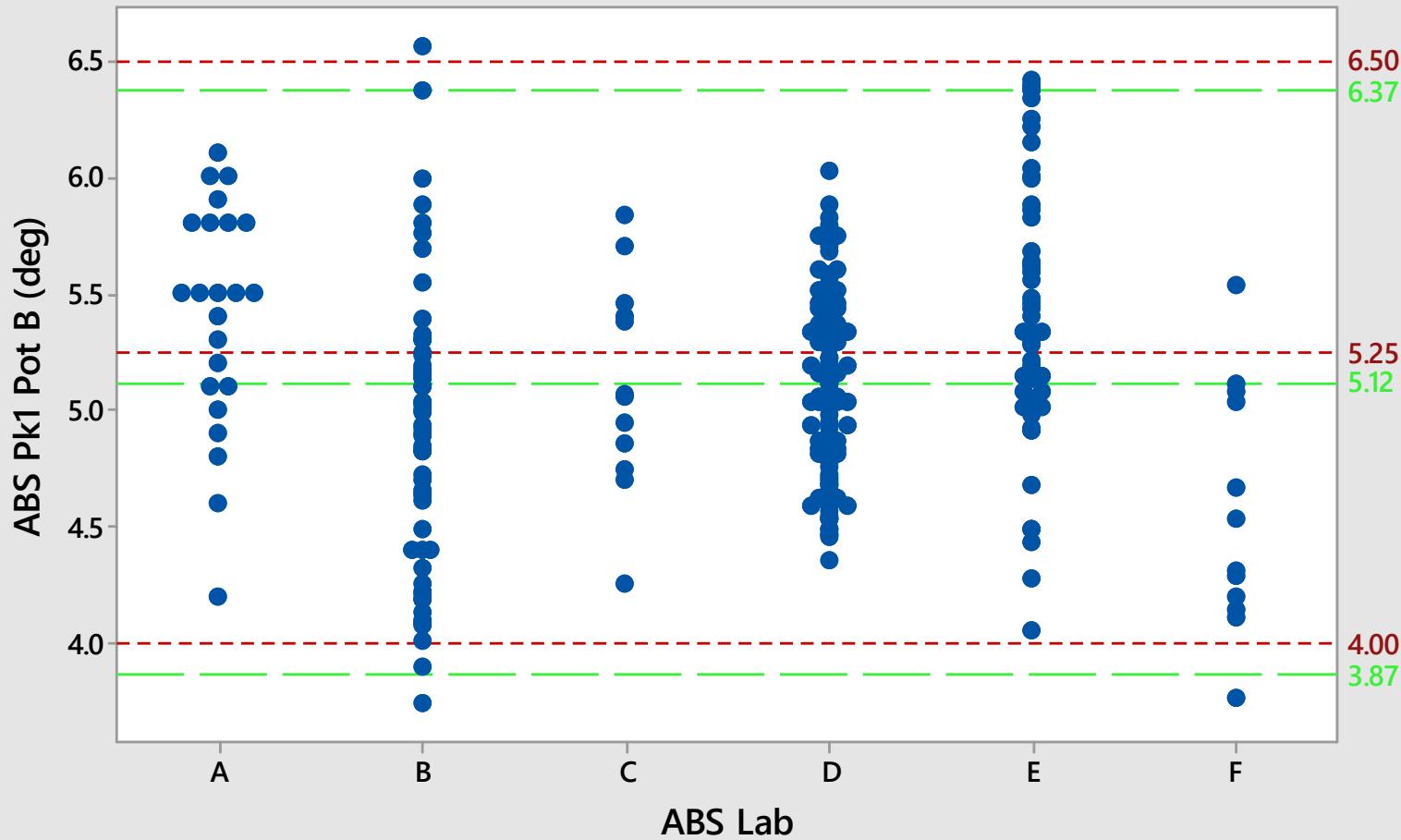
Current Corridors: red - width +/- 23.8%

+/- 2 std dev: blue (+/- 21%)

Proposal: green - keep same width
+/- 24% corridor
5.12 +/- 1.25 (3.87 - 6.37)

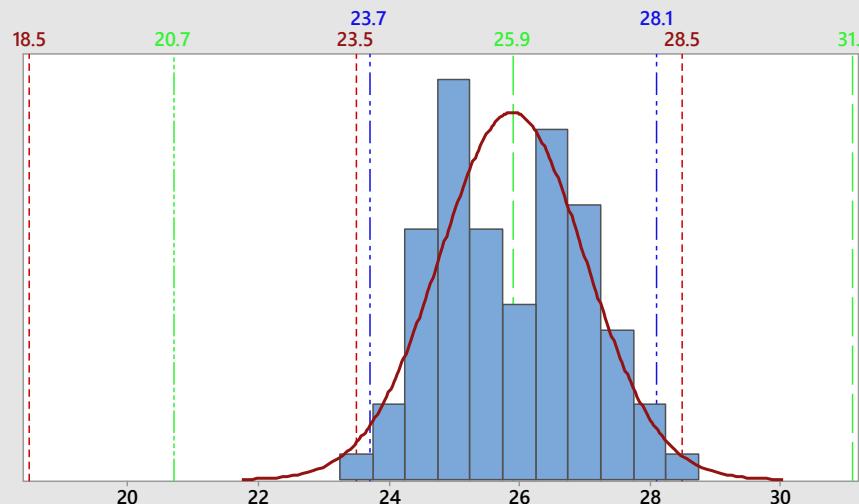
Analysis Dummy Certification - First Peak Pot B (deg)

Individual Value Plot of ABS Pk1 Pot B (deg)

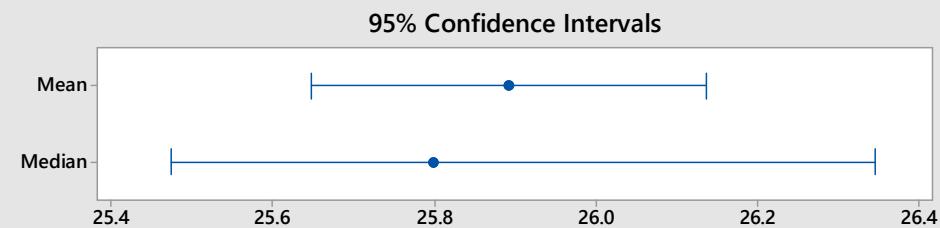
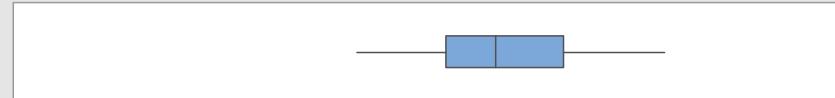


Analysis Dummy Certification - First Peak Pot B Time (ms)

Summary Report for ABS Pk1 Pot B (ms)



Anderson-Darling Normality Test	
A-Squared	0.65
P-Value	0.084
Mean	25.892
StDev	1.114
Variance	1.240
Skewness	0.039418
Kurtosis	-0.892876
N	82
Minimum	23.670
1st Quartile	25.030
Median	25.800
3rd Quartile	26.825
Maximum	28.390
95% Confidence Interval for Mean	
25.647	26.137
95% Confidence Interval for Median	
25.475	26.346
95% Confidence Interval for StDev	
0.965	1.316

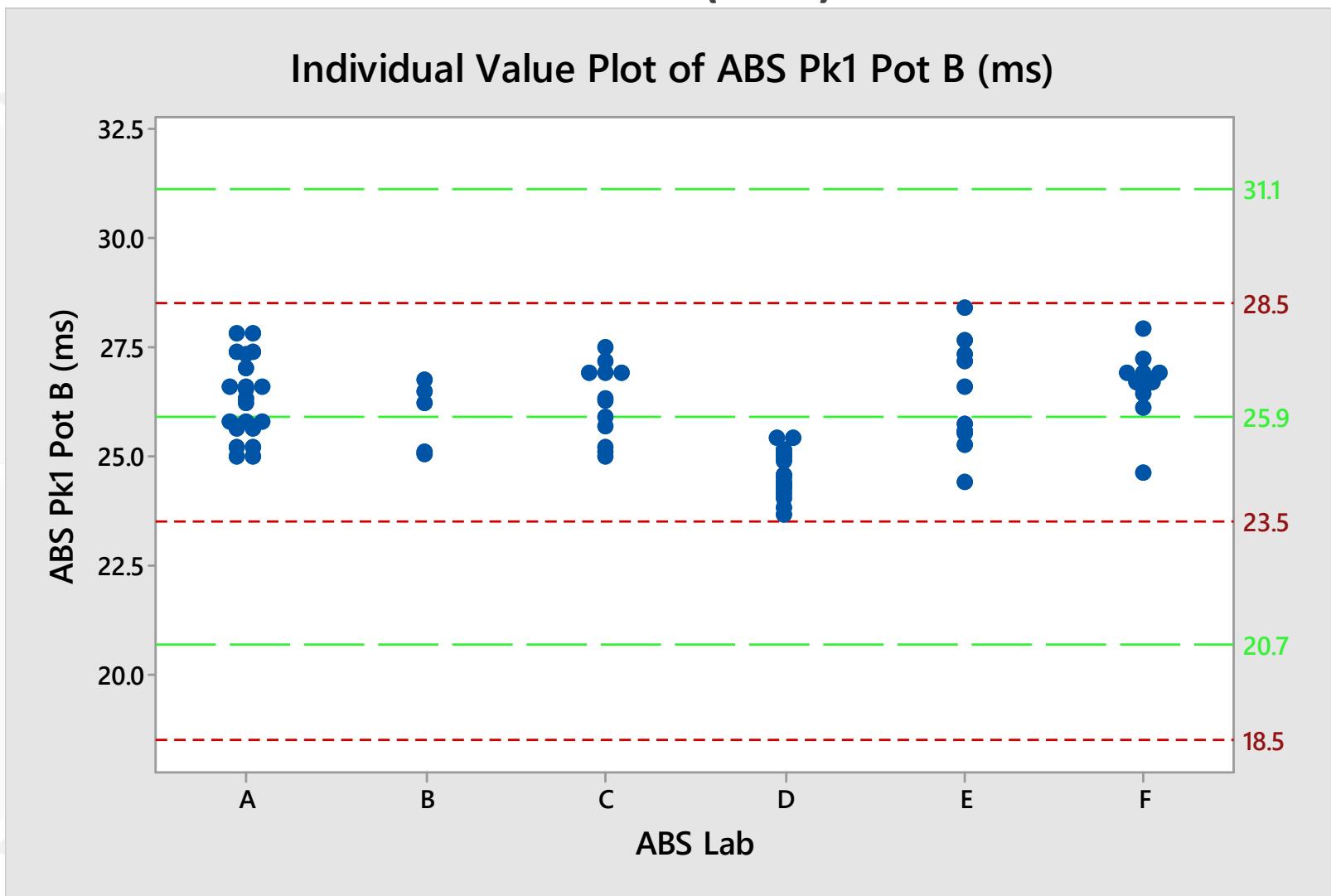


Current Corridors: red - width +/- 21.3%

+/- 2 std dev: blue (+/- 8.5%)

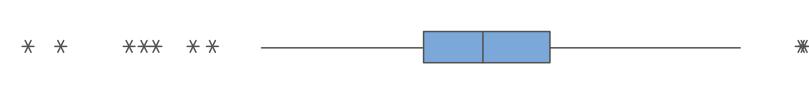
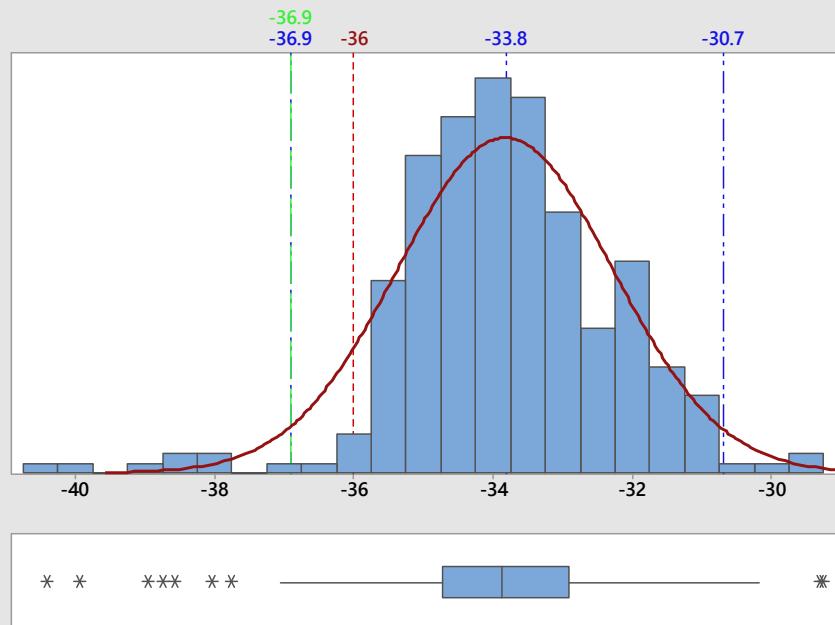
Proposal: green - since time
use +/- 20% corridor
 $25.9 \pm 5.2 (20.7 - 31.1)$

Analysis Dummy Certification - First Peak Pot B Time (ms)

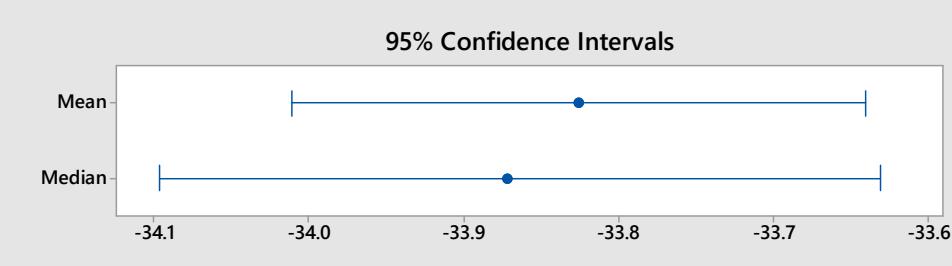


Analysis Dummy Certification - Min Pot B (deg)

Summary Report for ABS Min Pot B (deg)



Anderson-Darling Normality Test	
A-Squared	1.77
P-Value	<0.005
Mean	-33.826
StDev	1.548
Variance	2.395
Skewness	-0.53584
Kurtosis	2.42299
N	270
Minimum	-40.397
1st Quartile	-34.731
Median	-33.872
3rd Quartile	-32.905
Maximum	-29.270
95% Confidence Interval for Mean	
-34.011	-33.640
95% Confidence Interval for Median	
-34.096	-33.631
95% Confidence Interval for StDev	
1.427	1.690



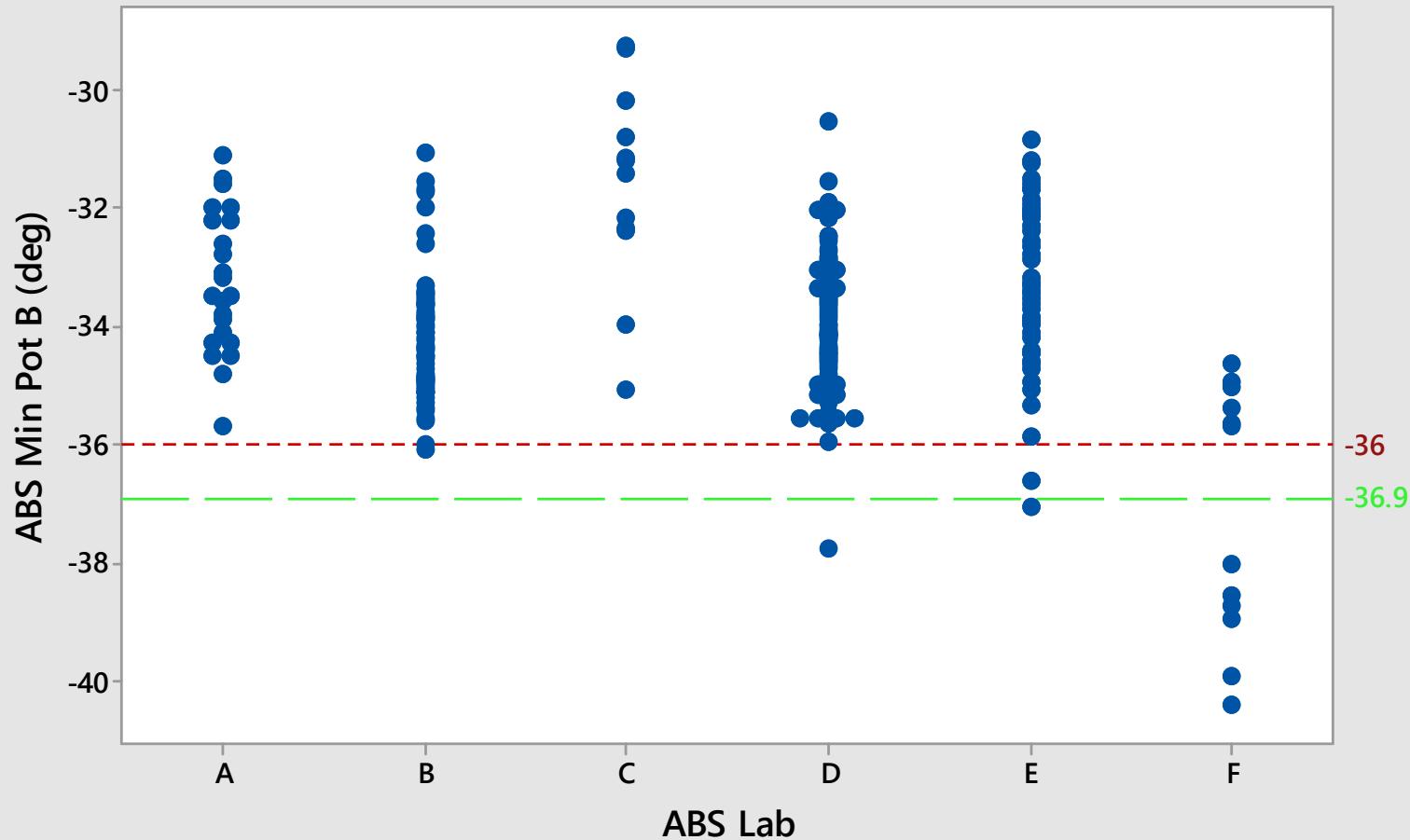
Current Corridors: red - (min)

+/- 2 std dev: blue

Proposal: green -
move to -2 * std dev
>=-36.9

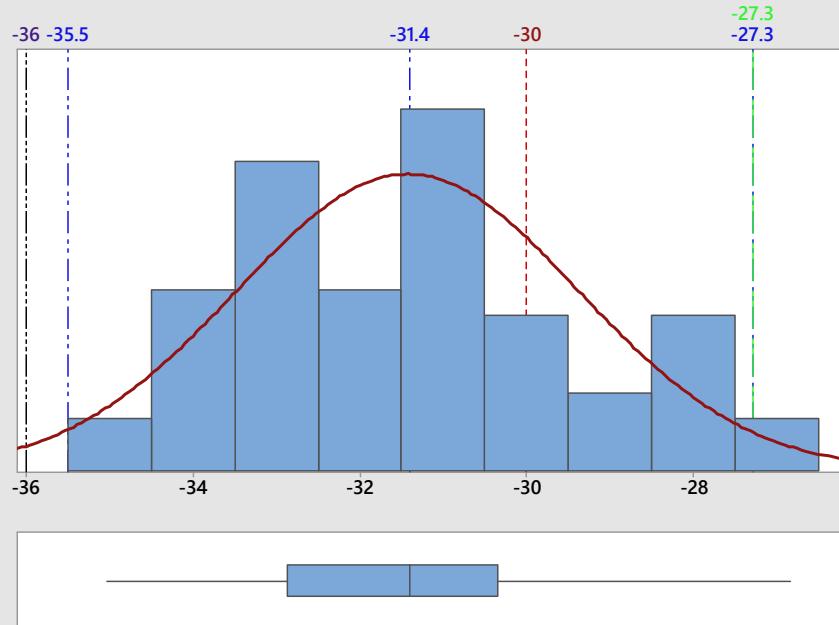
Analysis Dummy Certification - Min Pot B (deg)

Individual Value Plot of ABS Min Pot B (deg)



Analysis Dummy Certification - Max Pot B in tunnel 1 98-108 ms (deg)

Summary Report for ABS Max Pot B 98-108 (deg)



Anderson-Darling Normality Test

A-Squared	0.67
P-Value	0.078

Mean	-31.427
StDev	2.046
Variance	4.187
Skewness	0.467947
Kurtosis	-0.385044
N	59

Minimum	-35.020
1st Quartile	-32.870
Median	-31.410
3rd Quartile	-30.343
Maximum	-26.849

95% Confidence Interval for Mean

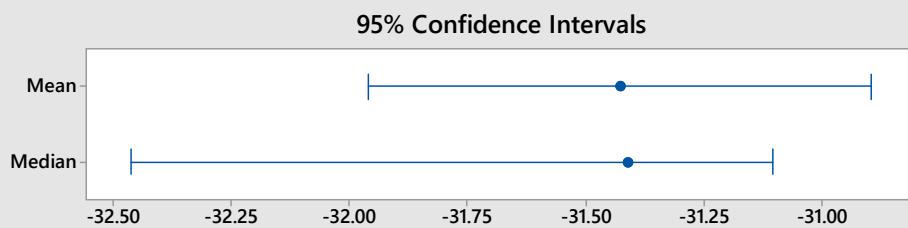
-31.960 -30.894

95% Confidence Interval for Median

-32.464 -31.102

95% Confidence Interval for StDev

1.732 2.500

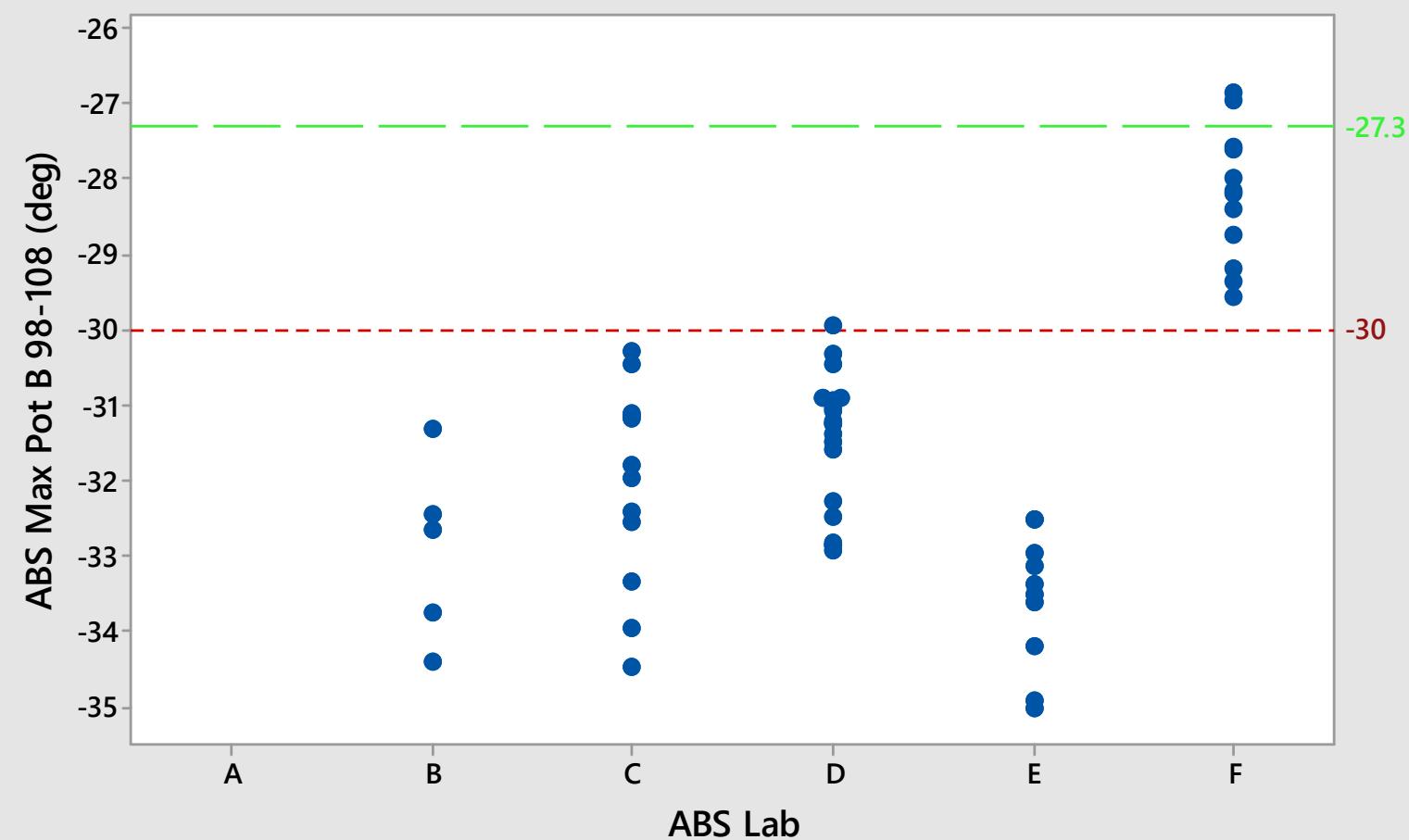


Current Corridors: red - tunnel upper

+/- 2 std dev: blue

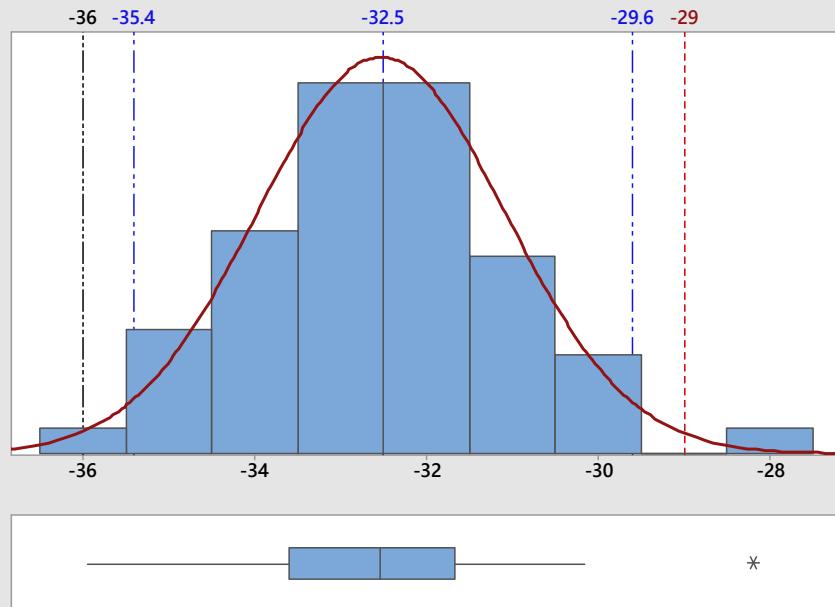
Proposal: green -
change to + 2 * std dev
<= -27.3

Analysis Dummy Certification - Max Pot B in tunnel 1 98-108 ms (deg)

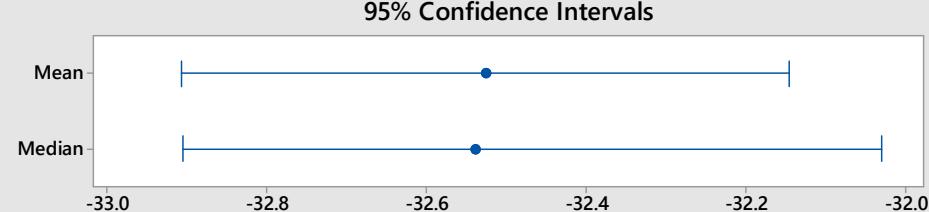


Analysis Dummy Certification - Max Pot B in tunnel 1 165-175 ms (deg)

Summary Report for ABS Max Pot B 165-175 (deg)



Anderson-Darling Normality Test	
A-Squared	0.14
P-Value	0.971
Mean	-32.526
StDev	1.446
Variance	2.090
Skewness	0.177067
Kurtosis	0.498161
N	58
Minimum	-35.950
1st Quartile	-33.608
Median	-32.539
3rd Quartile	-31.670
Maximum	-28.187
95% Confidence Interval for Mean	
-32.906	-32.146
95% Confidence Interval for Median	
-32.906	-32.031
95% Confidence Interval for StDev	
1.222	1.770

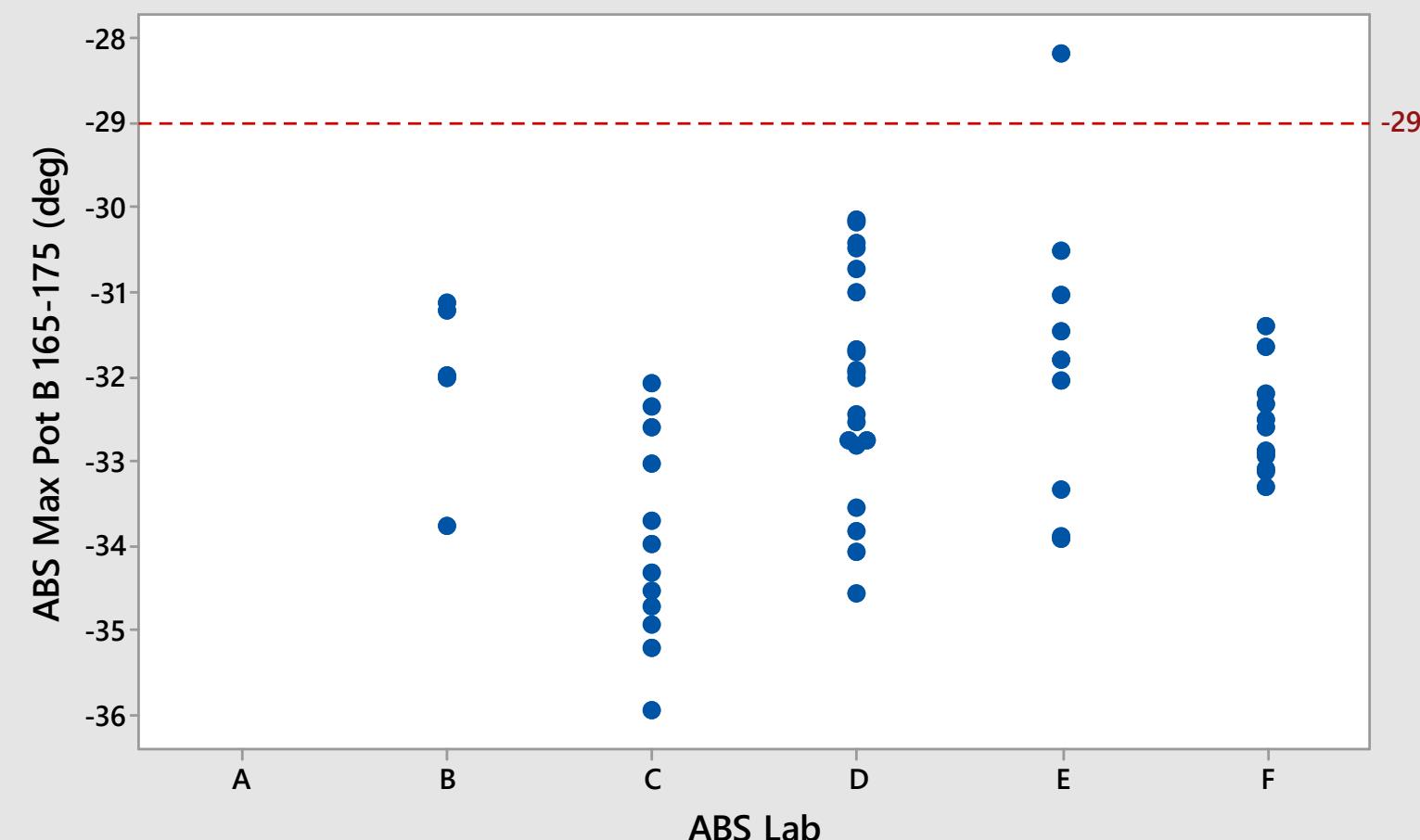


Current Corridors: red - tunnel upper

+/- 2 std dev: blue

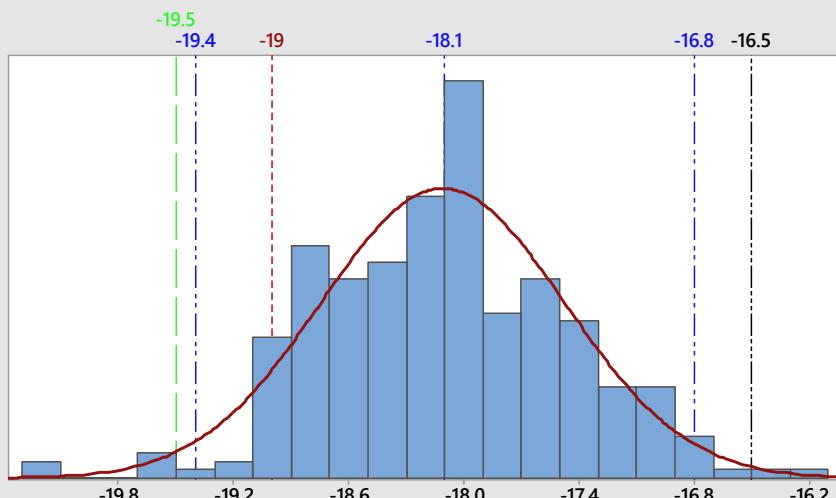
Proposal: green - no change

Analysis Dummy Certification - Max Pot B in tunnel 1 165-175 ms (deg)

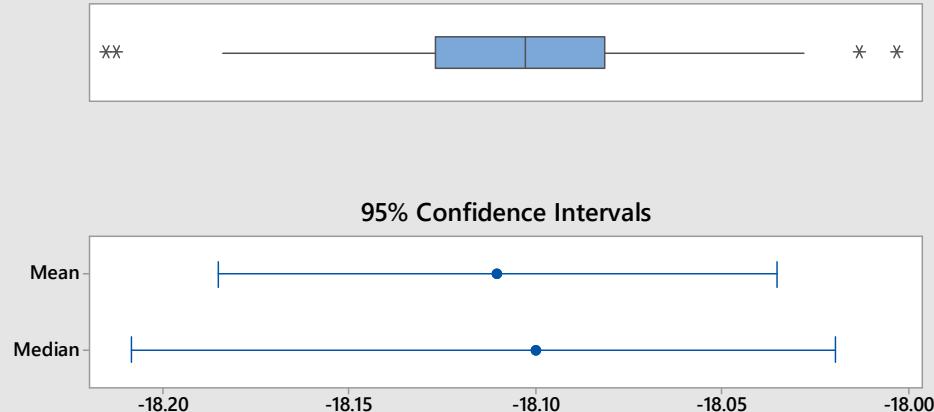


Analysis Dummy Certification - Min Pot C (deg)

Summary Report for ABS Min Pot C (deg)



Anderson-Darling Normality Test	
A-Squared	0.48
P-Value	0.234
Mean	-18.110
StDev	0.634
Variance	0.403
Skewness	-0.024184
Kurtosis	0.400663
N	278
Minimum	-20.291
1st Quartile	-18.570
Median	-18.100
3rd Quartile	-17.690
Maximum	-16.163
95% Confidence Interval for Mean	
-18.185	-18.035
95% Confidence Interval for Median	
-18.208	-18.020
95% Confidence Interval for StDev	
0.586	0.692

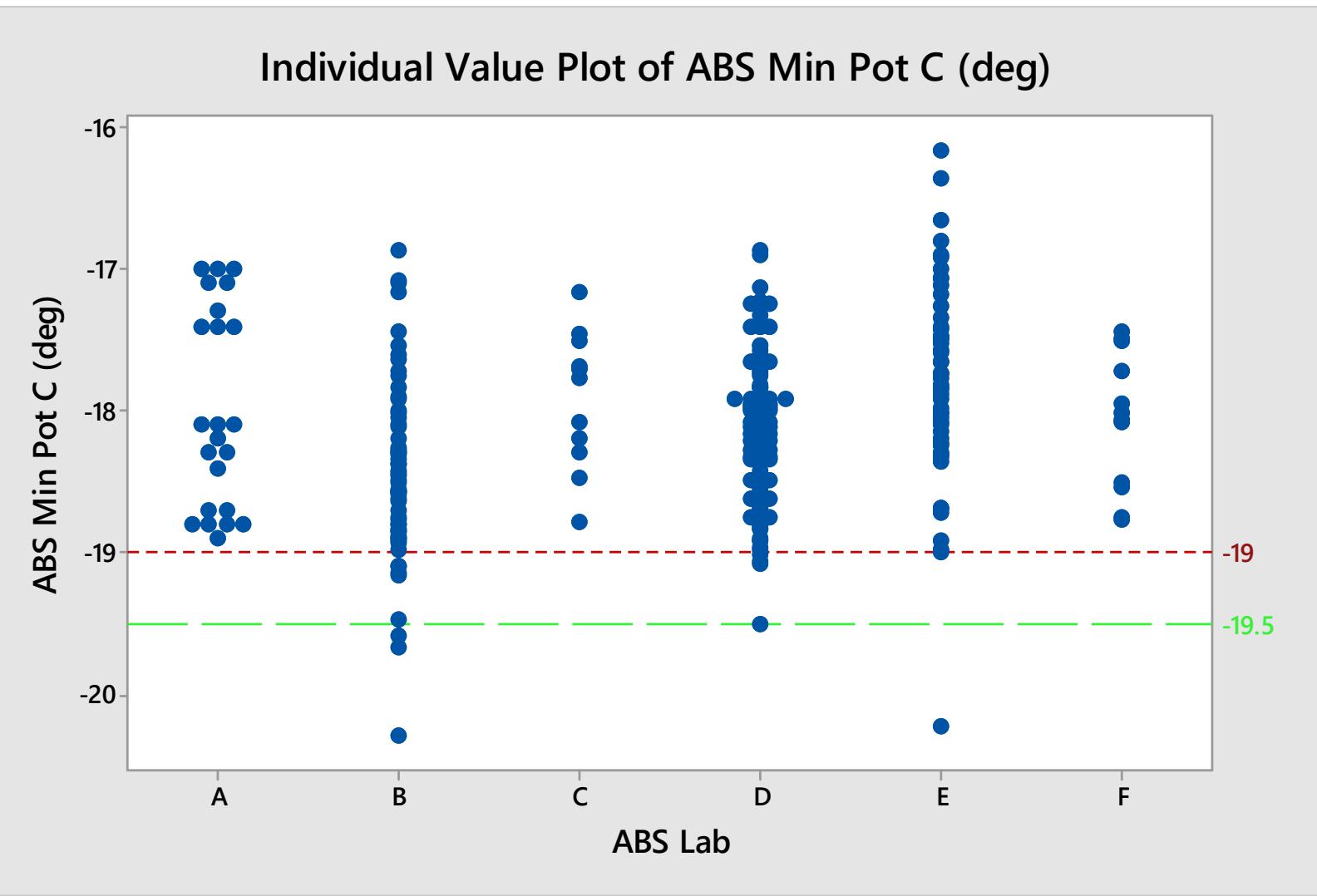


Current Corridors: red - (min)

+/- 2 std dev: blue

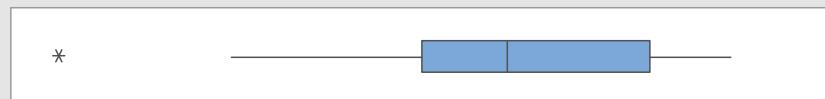
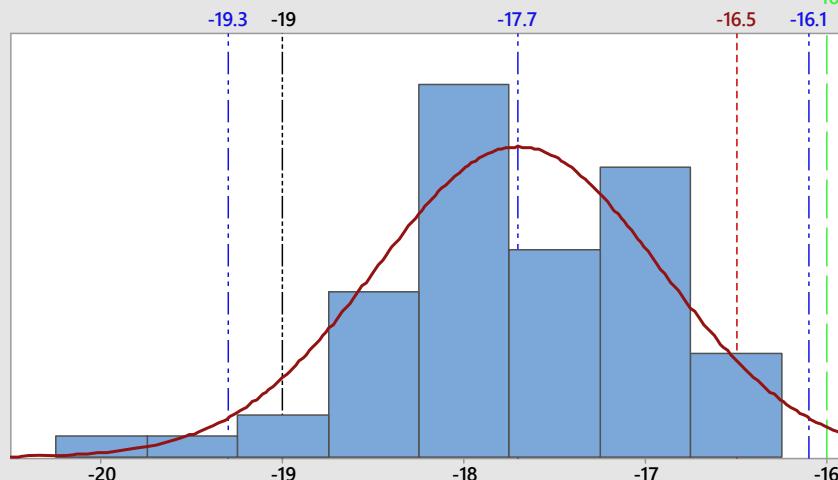
Proposal: green -
move to >=-19.5
(makes the overall tunnel 3.5 deg
or +/- 10% wide)

Analysis Dummy Certification - Min Pot C (deg)

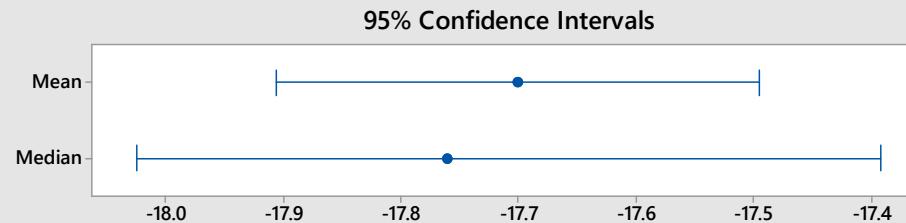


Analysis Dummy Certification - Max Pot C in tunnel 73-78 ms (deg)

Summary Report for ABS Max Pot C 73-78 (deg)



Anderson-Darling Normality Test	
A-Squared	0.62
P-Value	0.099
Mean	-17.701
StDev	0.787
Variance	0.619
Skewness	-0.579625
Kurtosis	0.426501
N	59
Minimum	-20.235
1st Quartile	-18.230
Median	-17.760
3rd Quartile	-16.973
Maximum	-16.530
95% Confidence Interval for Mean	
-17.906	-17.496
95% Confidence Interval for Median	
-18.025	-17.392
95% Confidence Interval for StDev	
0.666	0.961

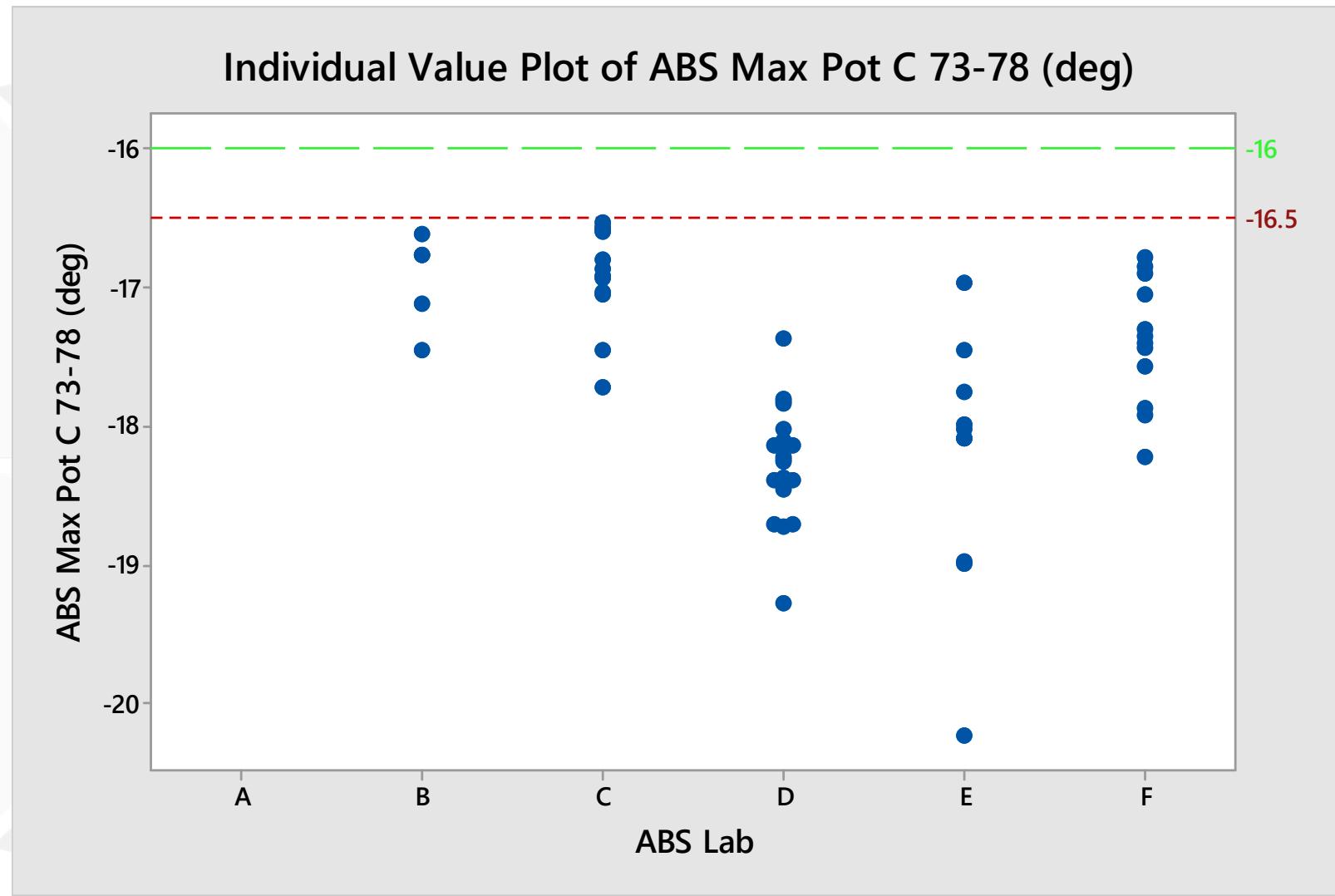


Current Corridors: red - (max)

+/- 2 std dev: blue

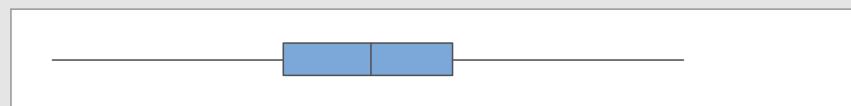
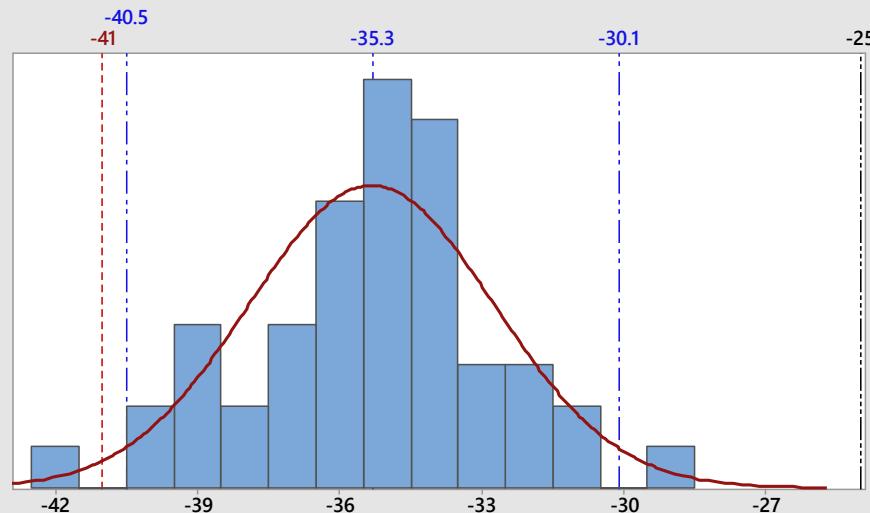
Proposal: green -
move to <=-16.0
(makes the overall tunnel 3.5 deg
or +/- 10% wide)

Analysis Dummy Certification - Max Pot C in tunnel 73-78 ms (deg)



Analysis Dummy Certification - Min Total Head Rot. in tunnel 100-190 ms (deg)

Summary Report for ABS Min TotHead 100-190 (deg)



Anderson-Darling Normality Test

A-Squared	0.31
P-Value	0.536

Mean	-35.324
StDev	2.588
Variance	6.697
Skewness	-0.223834
Kurtosis	0.445528
N	48

Minimum	-42.025
1st Quartile	-37.144
Median	-35.290
3rd Quartile	-33.589
Maximum	-28.690

95% Confidence Interval for Mean

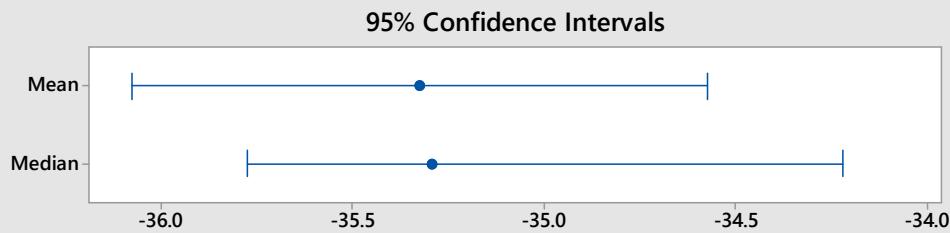
-36.076 -34.573

95% Confidence Interval for Median

-35.775 -34.219

95% Confidence Interval for StDev

2.154 3.241



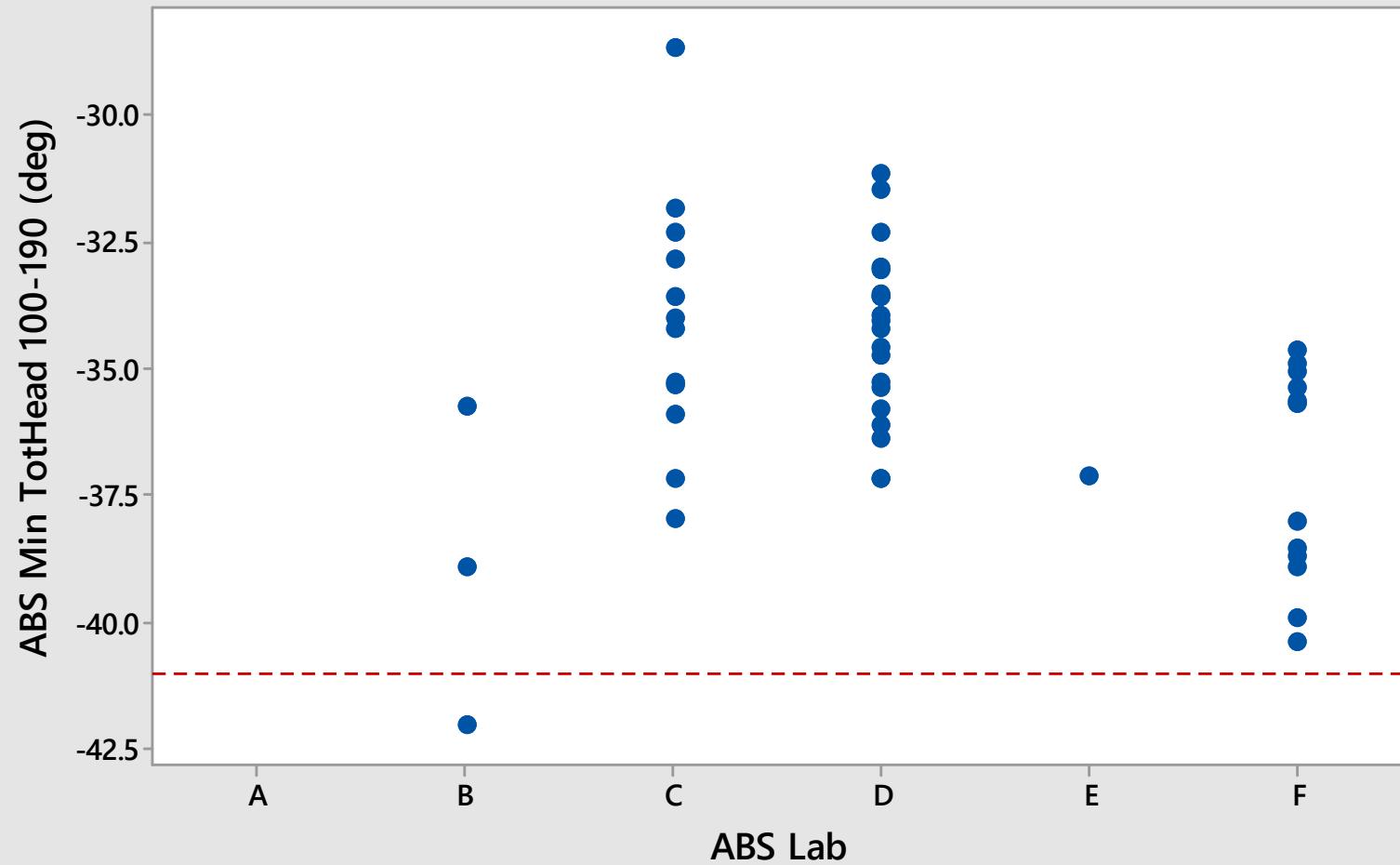
Current Corridors: red - (min)

+/- 2 std dev: blue

Proposal: green - no change

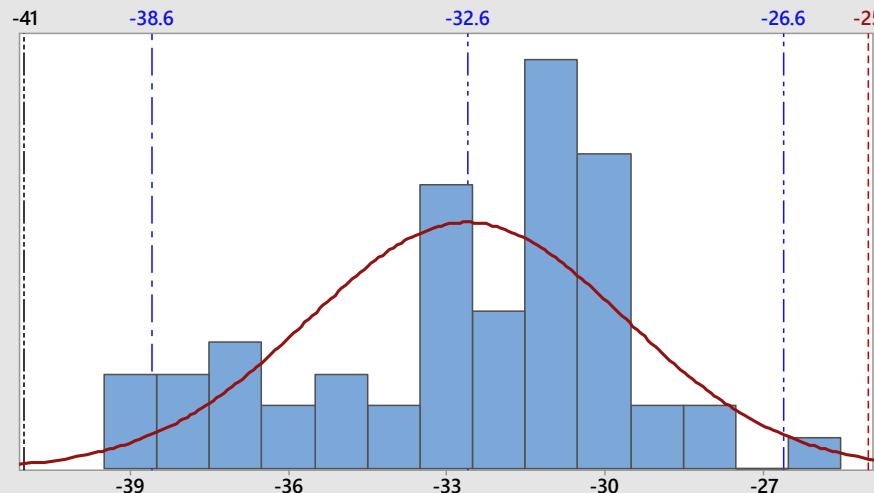
Analysis Dummy Certification - Min Total Head Rot. in tunnel 100-190 ms (deg)

Individual Value Plot of ABS Min TotHead 100-190 (deg)

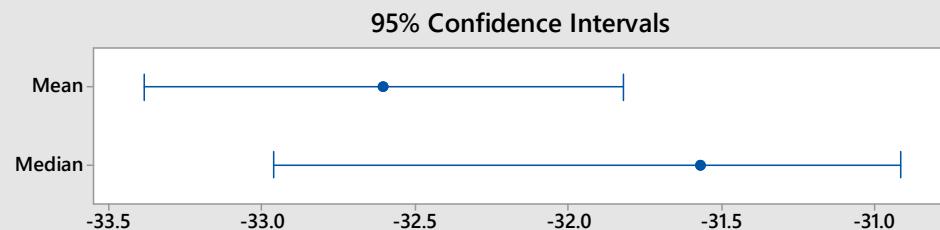
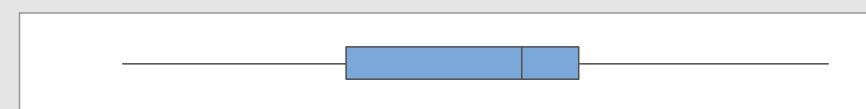


Analysis Dummy Certification - Max Total Head Rot. in tunnel 100-110 ms (deg)

Summary Report for ABS Max TotHead 100-110 (deg)



Anderson-Darling Normality Test	
A-Squared	1.63
P-Value	<0.005
Mean	-32.601
StDev	3.008
Variance	9.047
Skewness	-0.538362
Kurtosis	-0.317987
N	59
Minimum	-39.140
1st Quartile	-34.900
Median	-31.564
3rd Quartile	-30.485
Maximum	-25.760
95% Confidence Interval for Mean	
-33.385	-31.817
95% Confidence Interval for Median	
-32.958	-30.910
95% Confidence Interval for StDev	
2.546	3.675

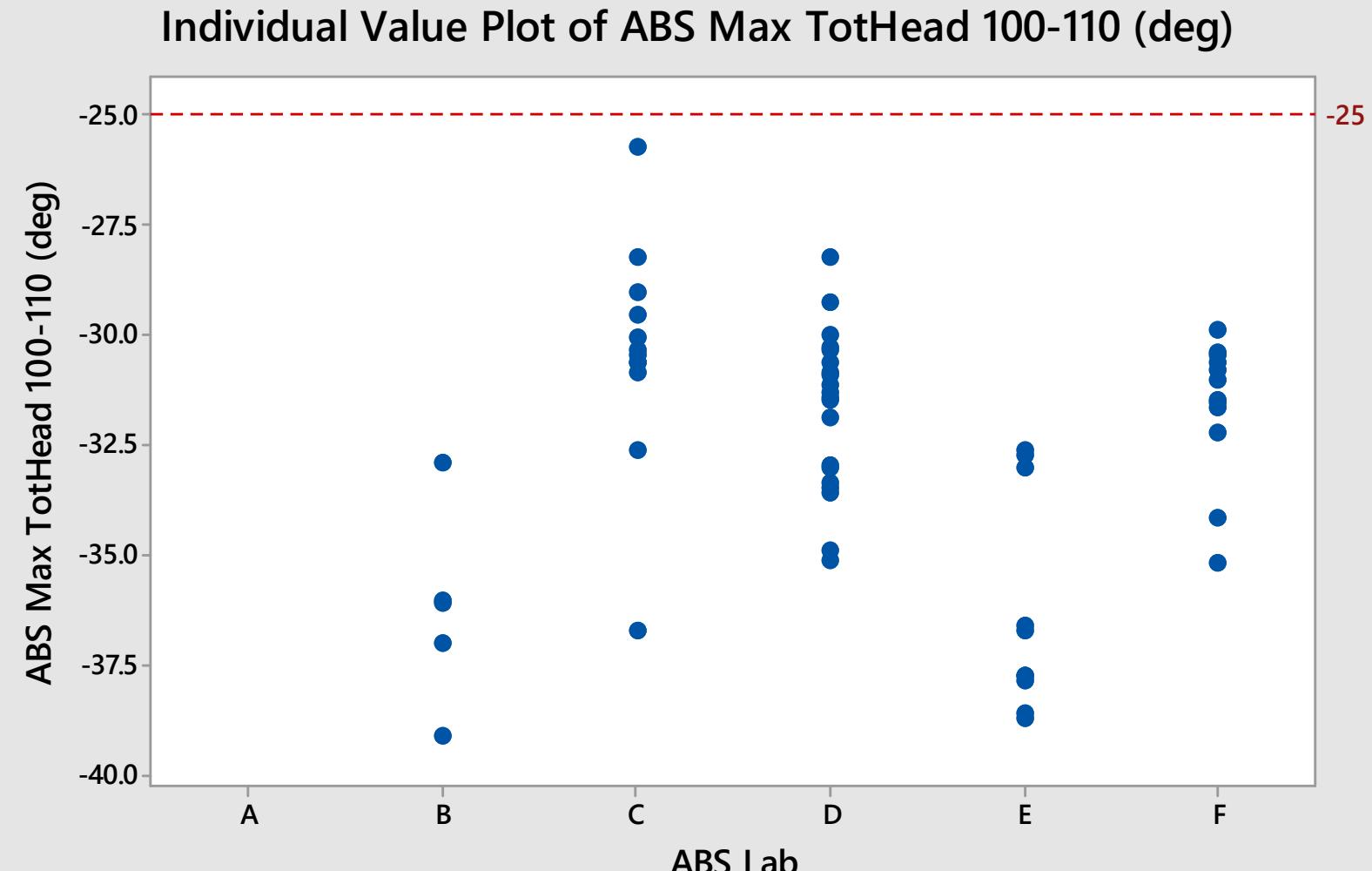


Current Corridors: red - (max)

+/- 2 std dev: blue

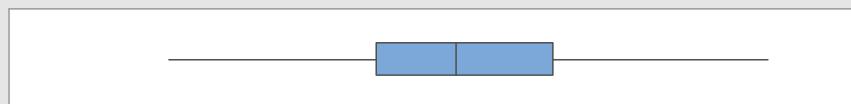
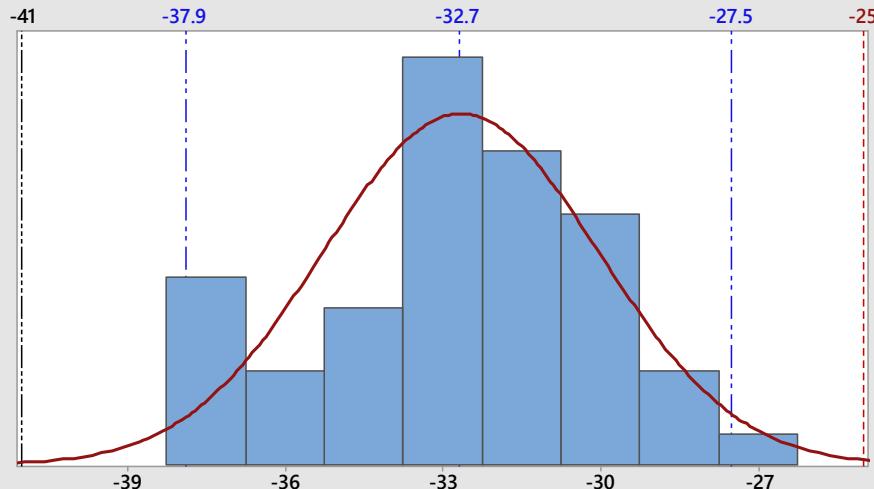
Proposal: green - no change

Analysis Dummy Certification - Max Total Head Rot. in tunnel 100-110 ms (deg)

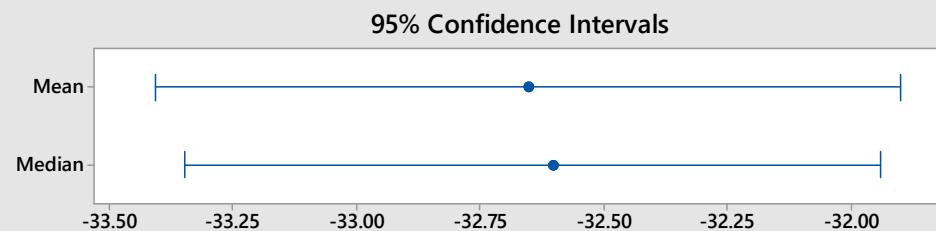


Analysis Dummy Certification - Max Total Head Rot. in tunnel 170-180 ms (deg)

Summary Report for ABS Max TotHead 170-180 (deg)



Anderson-Darling Normality Test	
A-Squared	0.26
P-Value	0.705
Mean	-32.652
StDev	2.622
Variance	6.874
Skewness	-0.122399
Kurtosis	-0.190967
N	49
Minimum	-38.047
1st Quartile	-34.109
Median	-32.600
3rd Quartile	-30.762
Maximum	-26.650
95% Confidence Interval for Mean	
-33.405	-31.899
95% Confidence Interval for Median	
-33.346	-31.940
95% Confidence Interval for StDev	
2.186	3.275



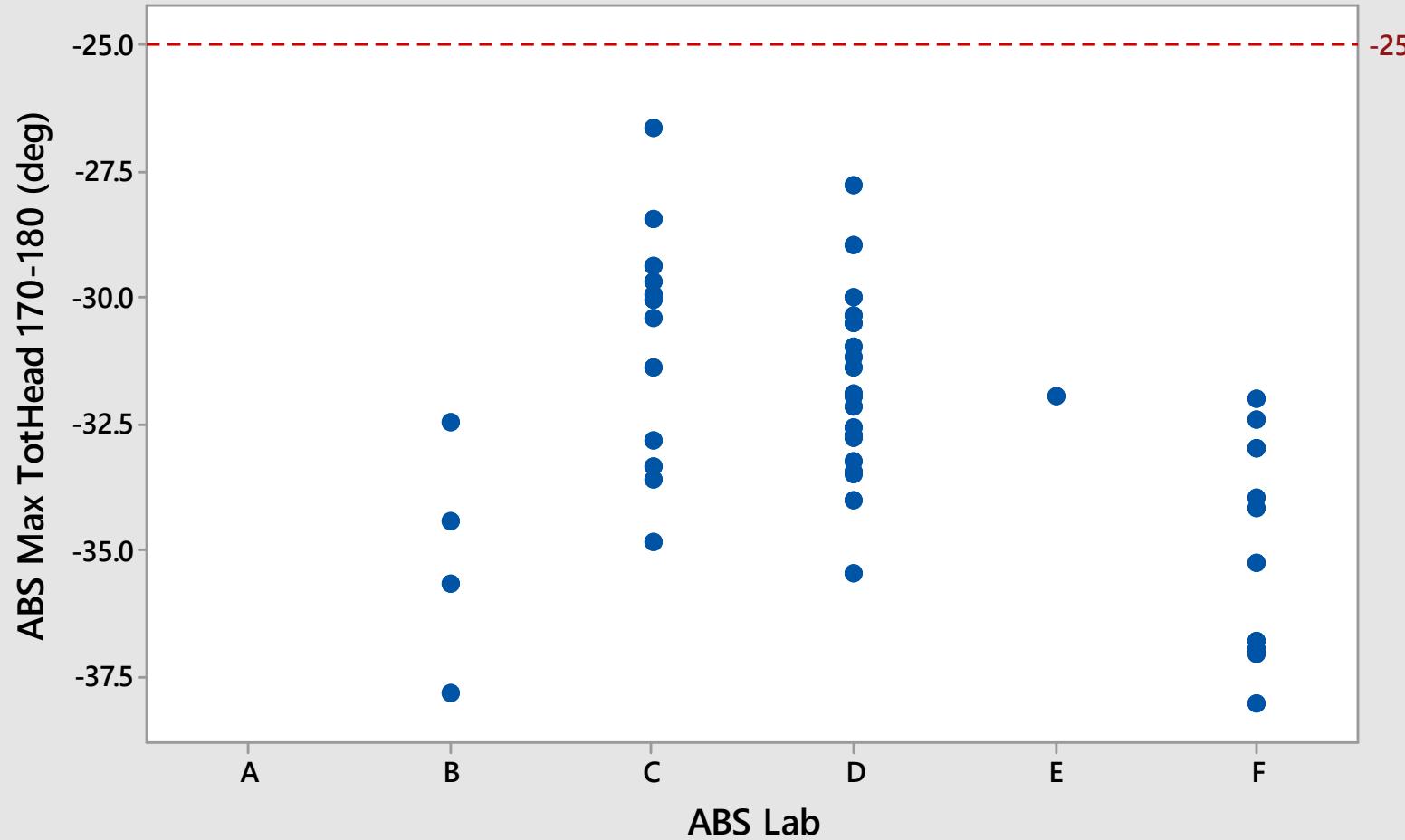
Current Corridors: red - (max)

+/- 2 std dev: blue

Proposal: green - no change

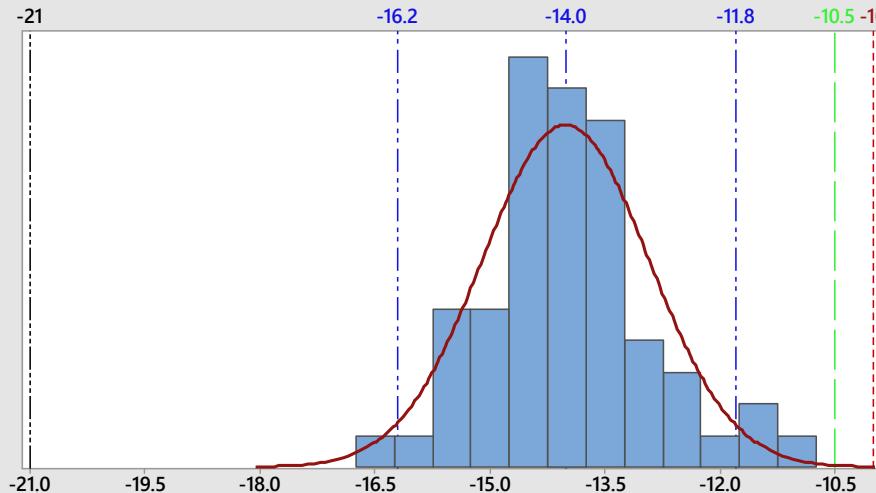
Analysis Dummy Certification - Max Total Head Rot. in tunnel 170-180 ms (deg)

Individual Value Plot of ABS Max TotHead 170-180 (deg)

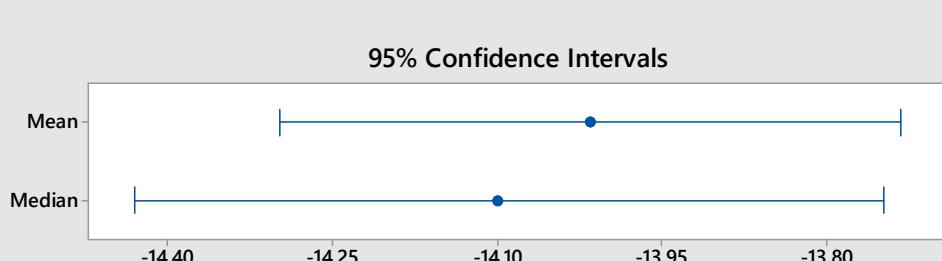


Analysis Dummy Certification - Max Thoracic Rot. in tunnel 125-135 ms (deg)

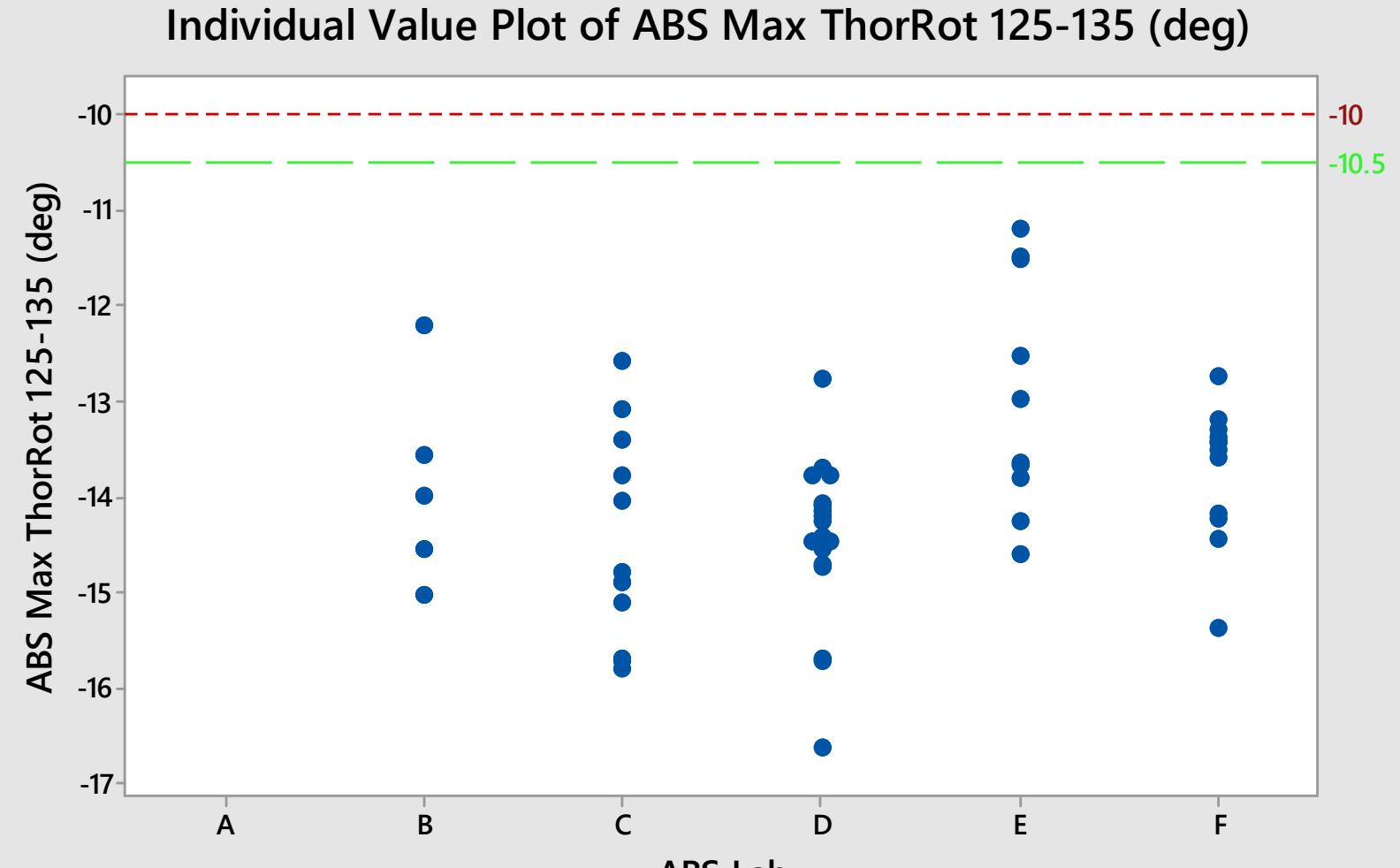
Summary Report for ABS Max ThorRot 125-135 (deg)



Anderson-Darling Normality Test	
A-Squared	0.40
P-Value	0.355
Mean	-14.015
StDev	1.085
Variance	1.176
Skewness	0.311067
Kurtosis	0.547105
N	59
Minimum	-16.640
1st Quartile	-14.607
Median	-14.100
3rd Quartile	-13.421
Maximum	-11.200
95% Confidence Interval for Mean	
-14.297	-13.732
95% Confidence Interval for Median	
-14.430	-13.748
95% Confidence Interval for StDev	
0.918	1.325

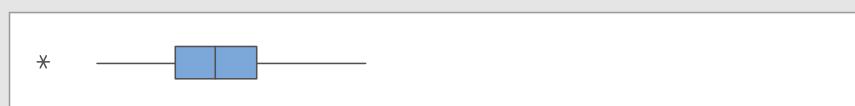
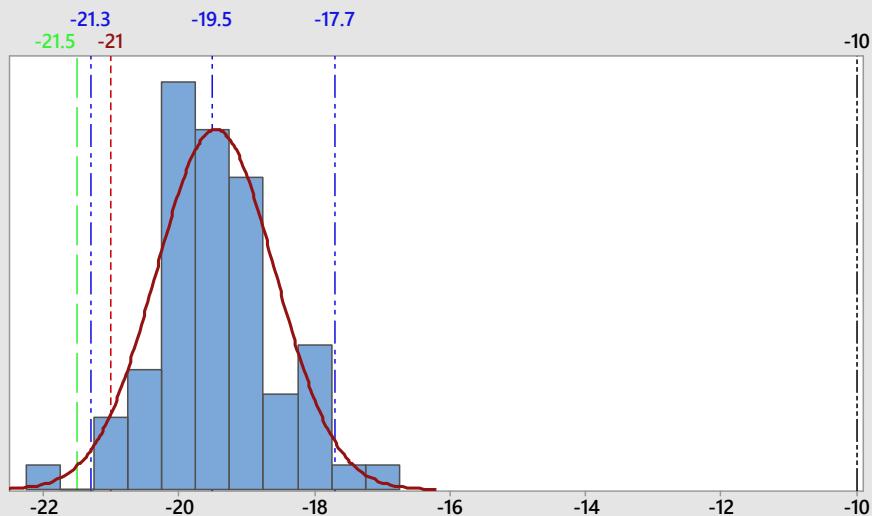


Analysis Dummy Certification - Max Thoracic Rot. in tunnel 125-135 ms (deg)

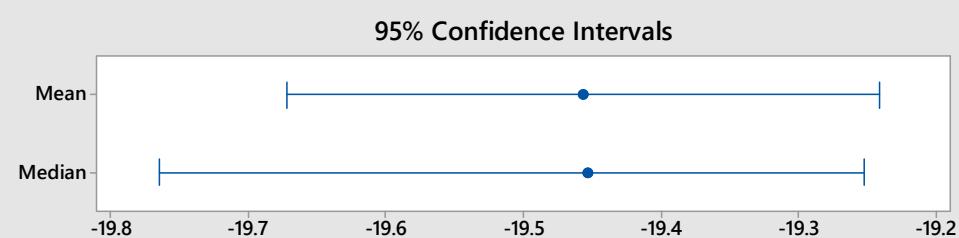


Analysis Dummy Certification - Min Thoracic Rotation in tunnel (deg)

Summary Report for ABS Min ThorRot (deg)



Anderson-Darling Normality Test	
A-Squared	0.28
P-Value	0.625
Mean	-19.456
StDev	0.876
Variance	0.767
Skewness	-0.047907
Kurtosis	0.536693
N	66
Minimum	-22.003
1st Quartile	-20.050
Median	-19.453
3rd Quartile	-18.848
Maximum	-17.238
95% Confidence Interval for Mean	
-19.672	-19.241
95% Confidence Interval for Median	
-19.765	-19.252
95% Confidence Interval for StDev	
0.748	1.057

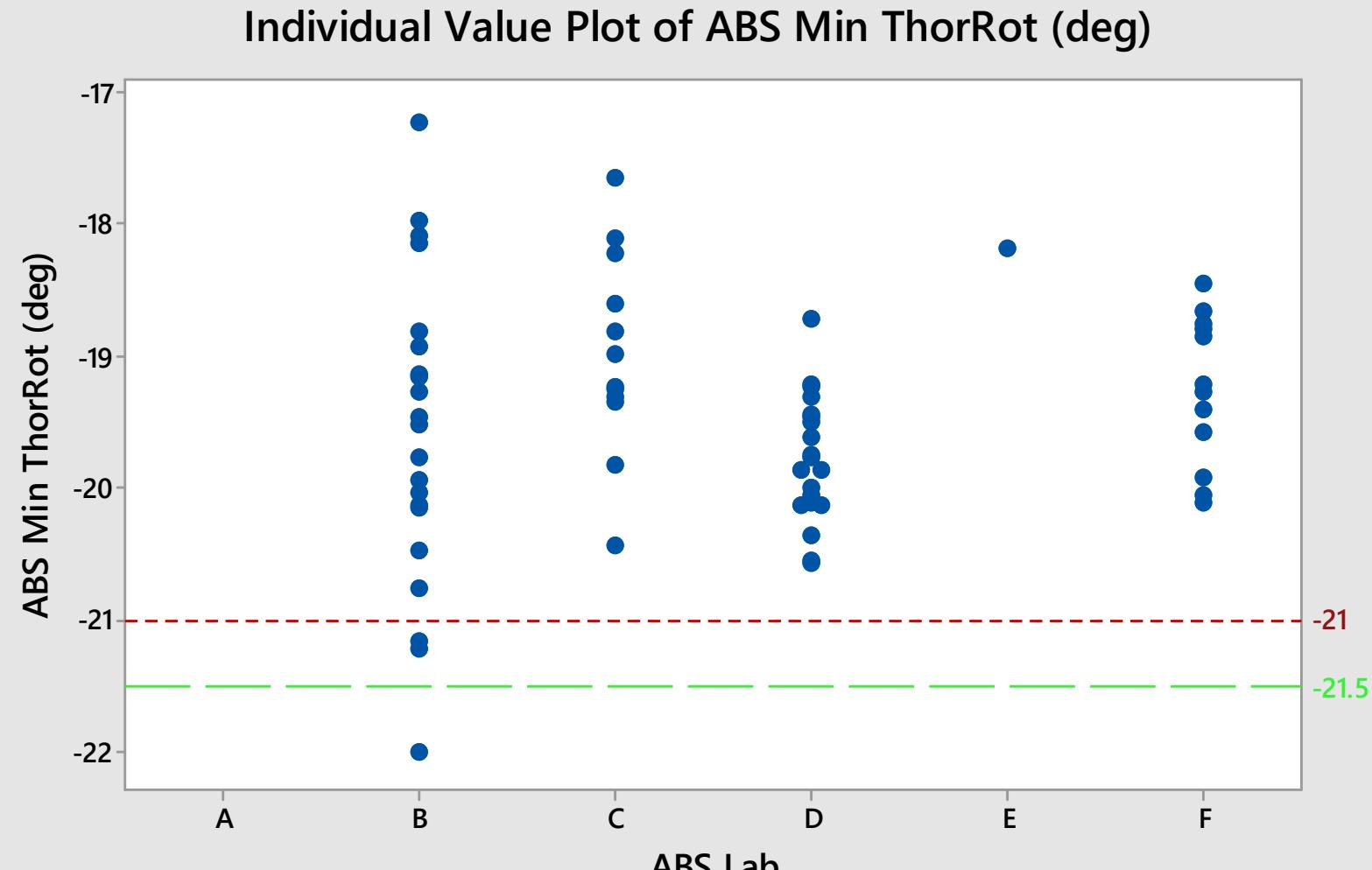


Current Corridors: red - tunnel lower

+/- 2 std dev: blue

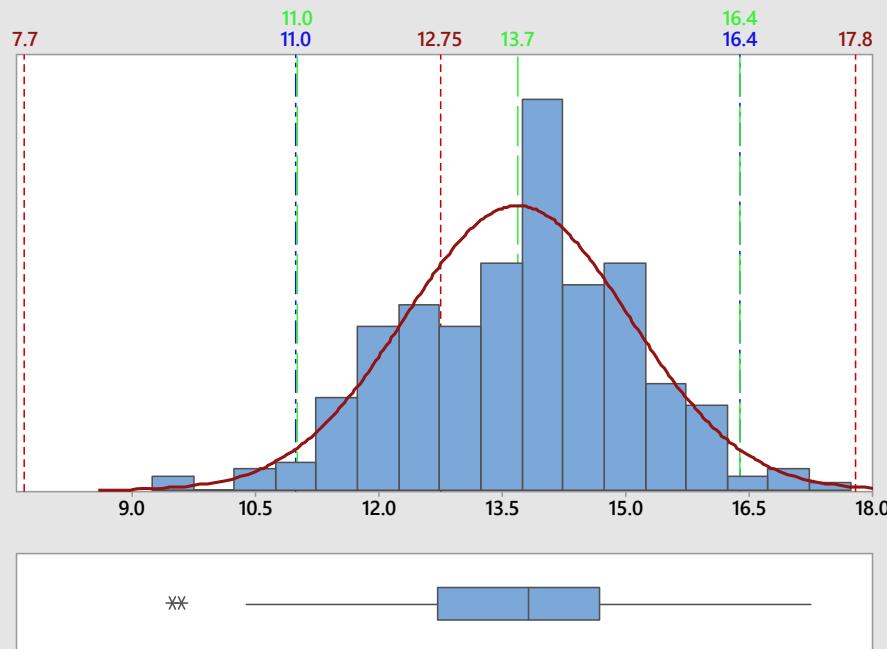
Proposal: green -
change to >= -21.5

Analysis Dummy Certification - Min Thoracic Rotation in tunnel (deg)

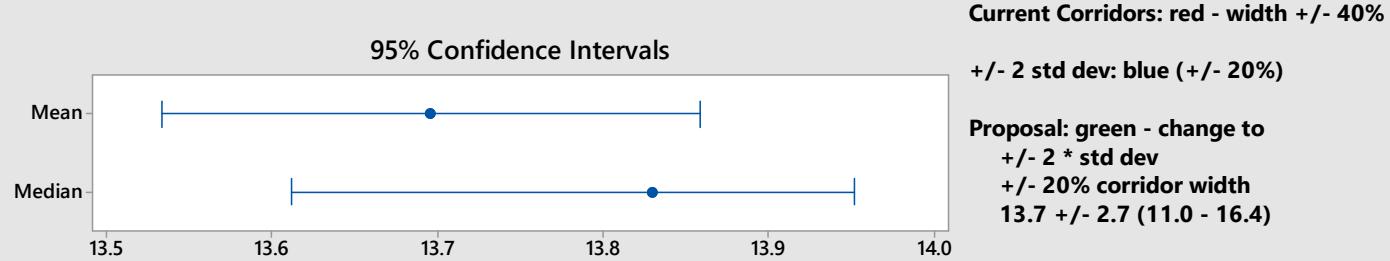


Analysis Dummy Certification - Max Upper Neck My (Nm)

Summary Report for ABS Max UpMy (Nm)

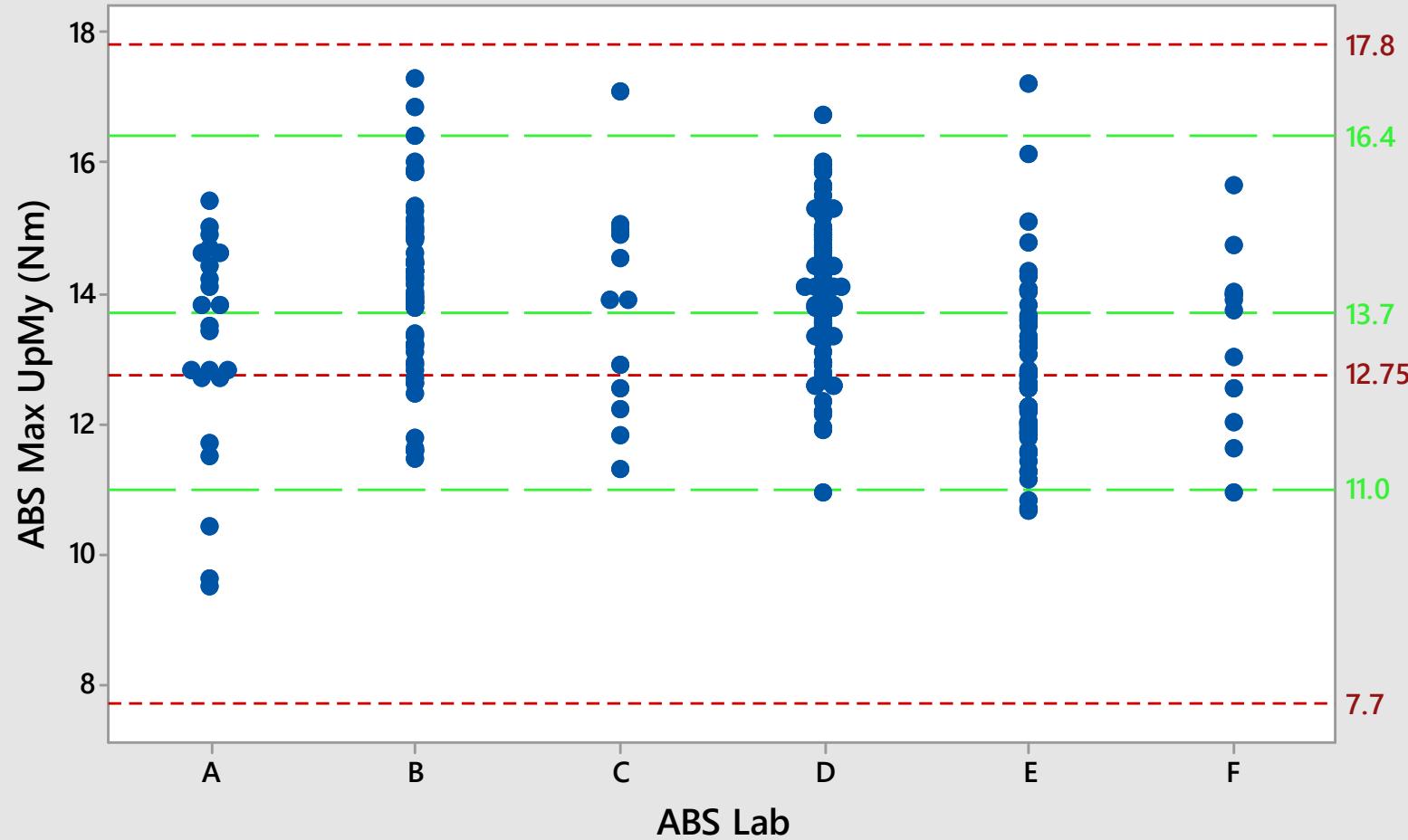


Anderson-Darling Normality Test	
A-Squared	0.55
P-Value	0.151
Mean	13.696
StDev	1.371
Variance	1.878
Skewness	-0.176931
Kurtosis	0.021236
N	275
Minimum	9.500
1st Quartile	12.720
Median	13.830
3rd Quartile	14.690
Maximum	17.277
95% Confidence Interval for Mean	
13.533	13.859
95% Confidence Interval for Median	
13.612	13.952
95% Confidence Interval for StDev	
1.265	1.496



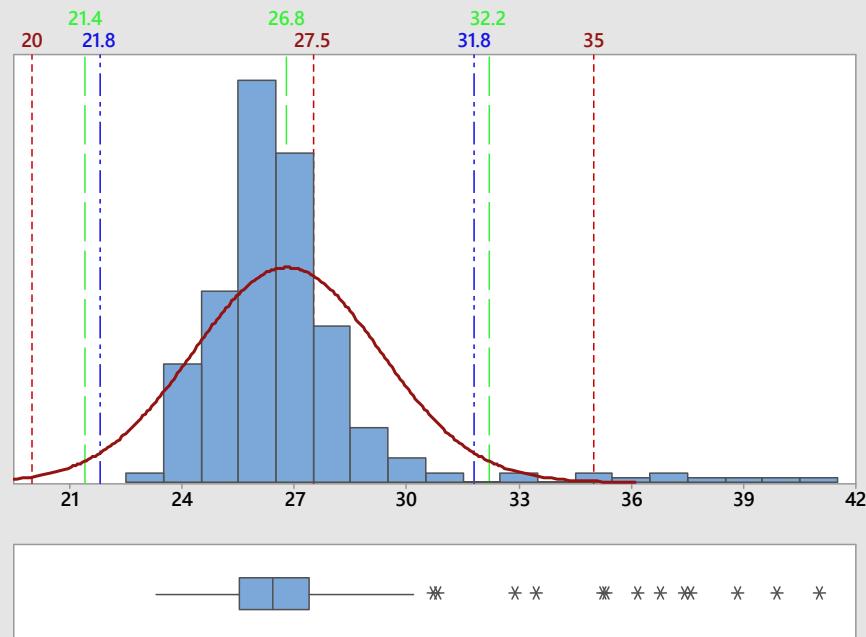
Analysis Dummy Certification - Max Upper Neck My (Nm)

Individual Value Plot of ABS Max UpMy (Nm)

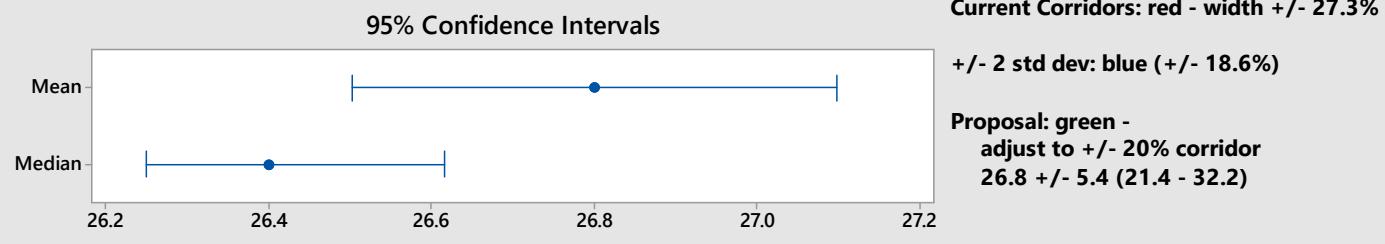


Analysis Dummy Certification - Time at Max Upper Neck My (ms)

Summary Report for ABS Max UpMy (ms)

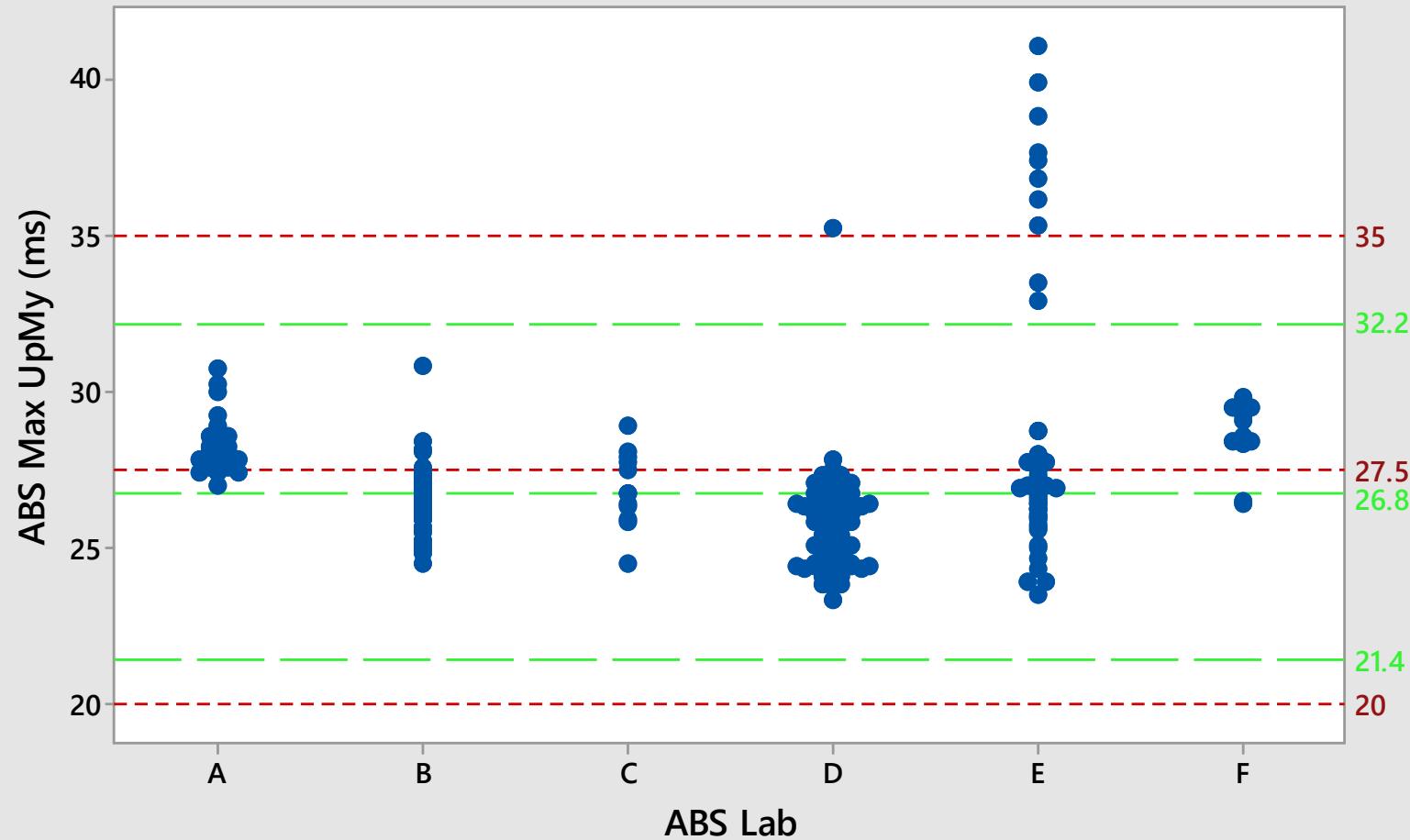


Anderson-Darling Normality Test	
A-Squared	16.97
P-Value	<0.005
Mean	26.801
StDev	2.504
Variance	6.270
Skewness	2.9190
Kurtosis	11.4190
N	275
Minimum	23.290
1st Quartile	25.533
Median	26.400
3rd Quartile	27.400
Maximum	41.040
95% Confidence Interval for Mean	
26.504	27.098
95% Confidence Interval for Median	
26.250	26.616
95% Confidence Interval for StDev	
2.311	2.733



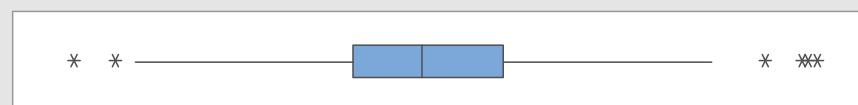
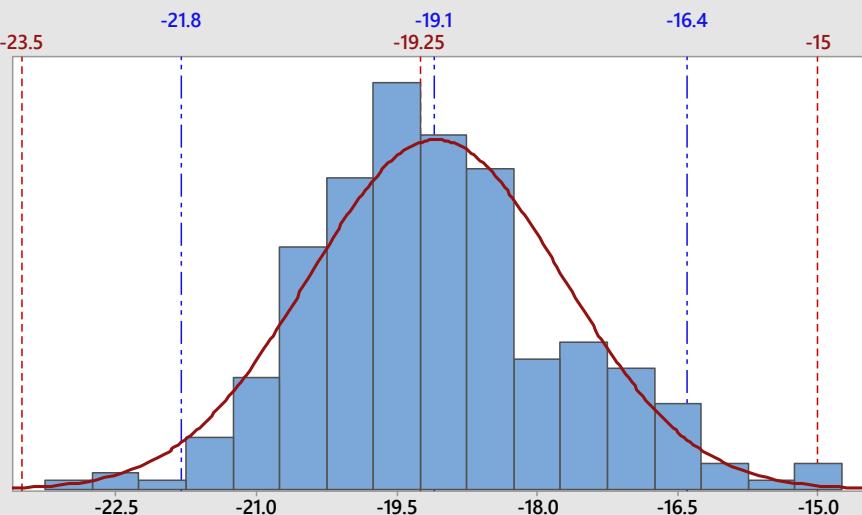
Analysis Dummy Certification - Time at Max Upper Neck My (ms)

Individual Value Plot of ABS Max UpMy (ms)

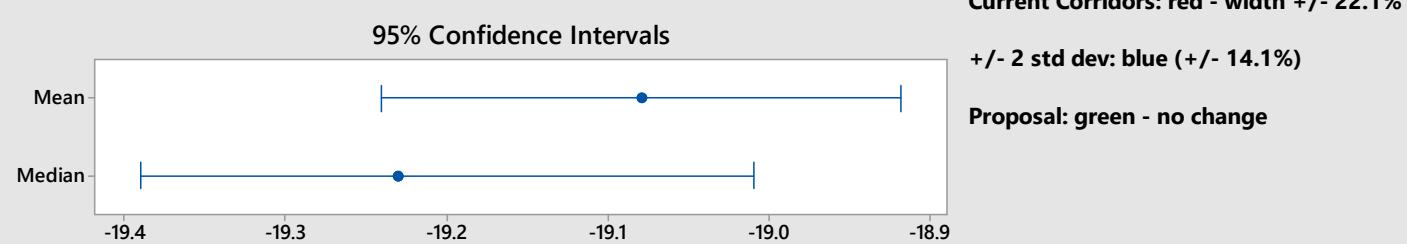


Analysis Dummy Certification - Min Upper Neck My (Nm)

Summary Report for ABS Min UpMy (Nm)

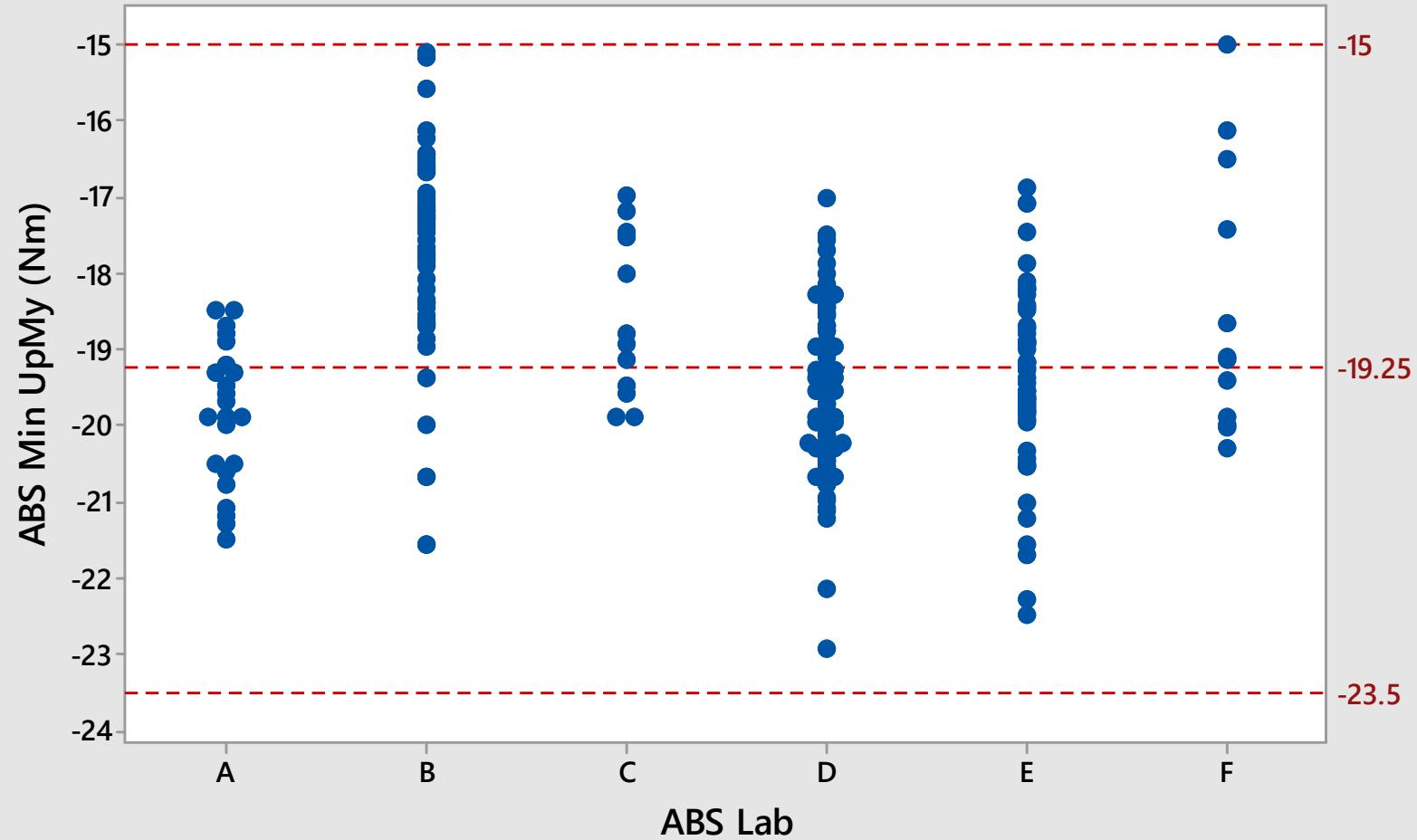


Anderson-Darling Normality Test	
A-Squared	1.22
P-Value	<0.005
Mean	-19.079
StDev	1.358
Variance	1.844
Skewness	0.322888
Kurtosis	0.262446
N	275
Minimum	-22.945
1st Quartile	-19.960
Median	-19.230
3rd Quartile	-18.360
Maximum	-14.999
95% Confidence Interval for Mean	
-19.240	-18.918
95% Confidence Interval for Median	
-19.390	-19.009
95% Confidence Interval for StDev	
1.253	1.482



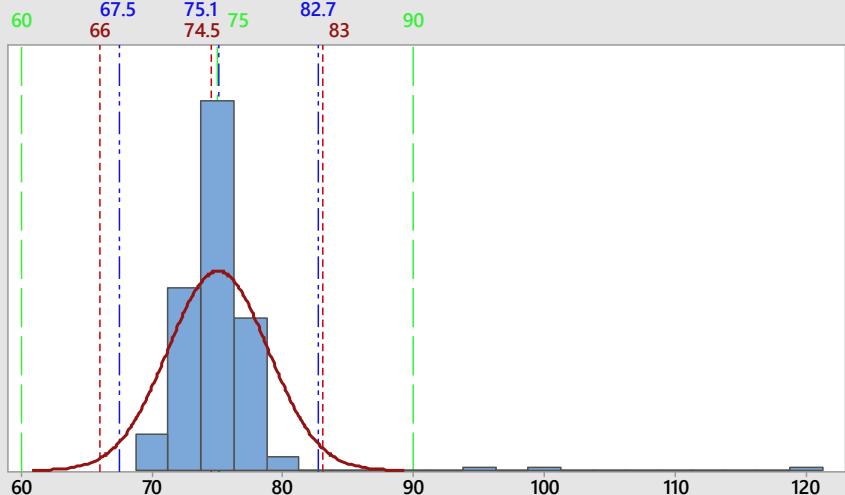
Analysis Dummy Certification - Min Upper Neck My (Nm)

Individual Value Plot of ABS Min UpMy (Nm)

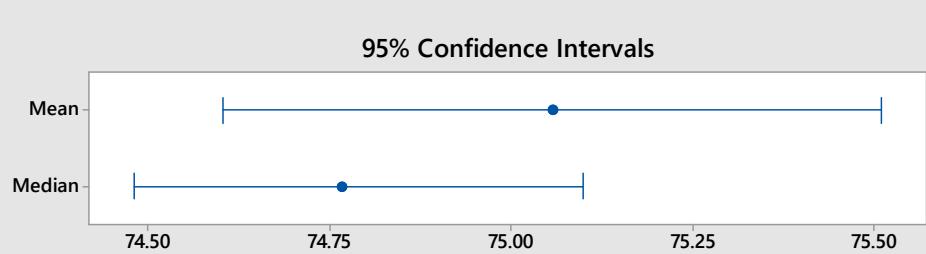


Analysis Dummy Certification - Time at Min Upper Neck My (ms)

Summary Report for ABS Min UpMy (ms)



Anderson-Darling Normality Test	
A-Squared	21.09
P-Value	<0.005
Mean	75.057
StDev	3.820
Variance	14.590
Skewness	7.0096
Kurtosis	72.5986
N	275
Minimum	68.800
1st Quartile	73.600
Median	74.767
3rd Quartile	76.150
Maximum	119.300
95% Confidence Interval for Mean	
74.604	75.511
95% Confidence Interval for Median	
74.481	75.100
95% Confidence Interval for StDev	
3.525	4.169



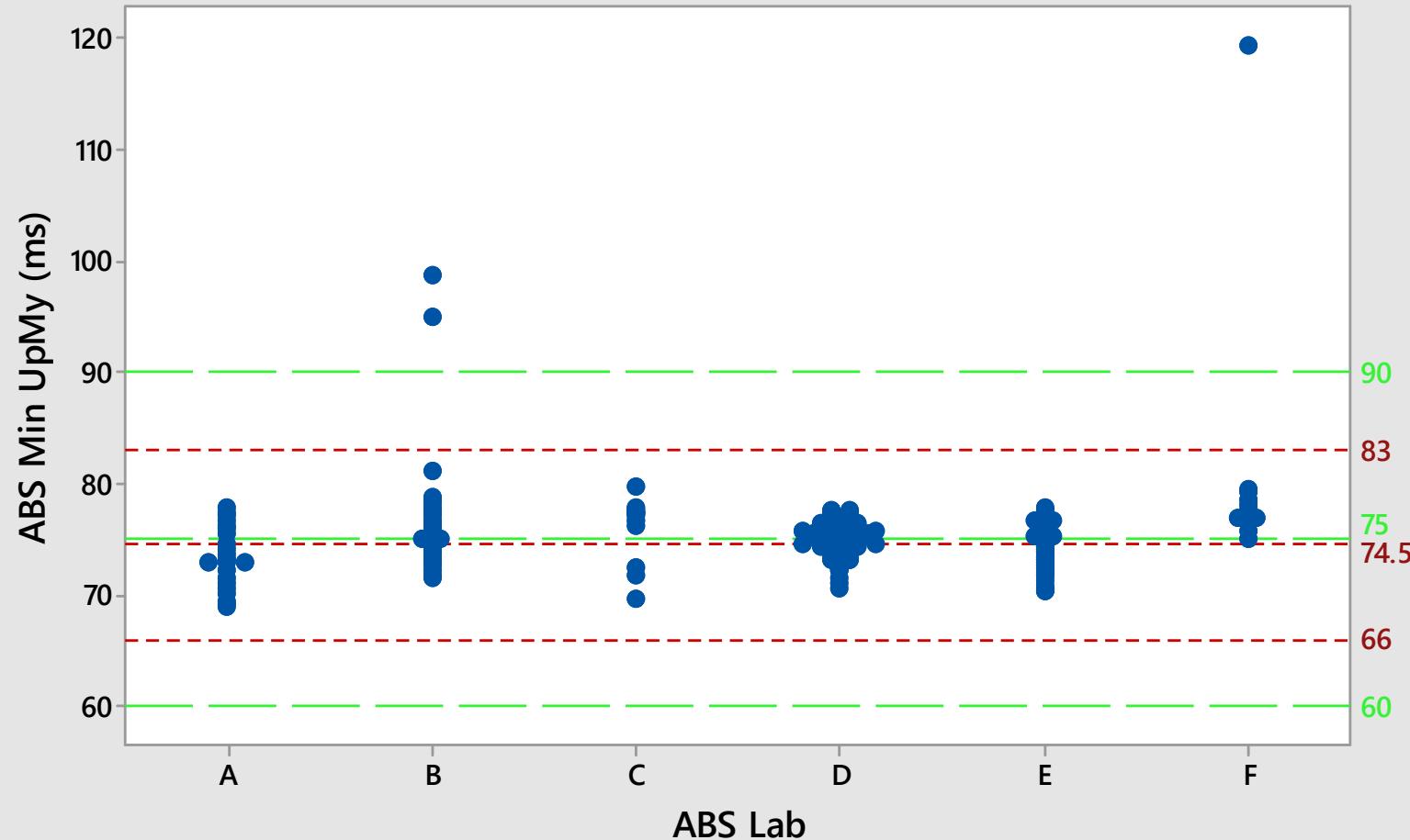
Current Corridors: red - width +/- 11.4%

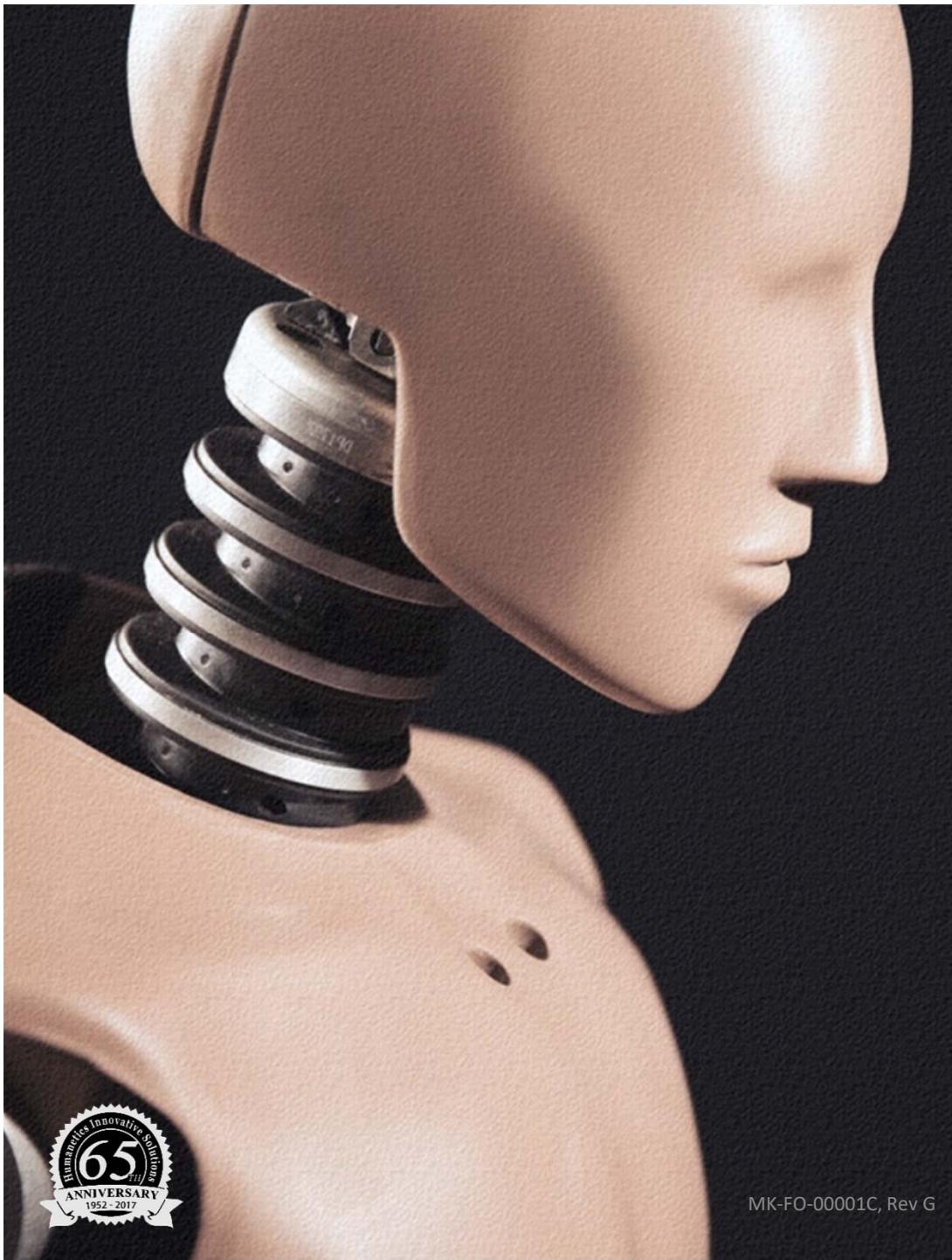
+/- 2 std dev: blue (+/- 10.1%)

Proposal: green - time so make +/- 20% corridor
75 +/- 15 (60 - 90)

Analysis Dummy Certification - Time at Min Upper Neck My (ms)

Individual Value Plot of ABS Min UpMy (ms)





Jacket Test Analysis

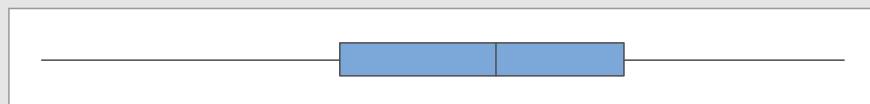
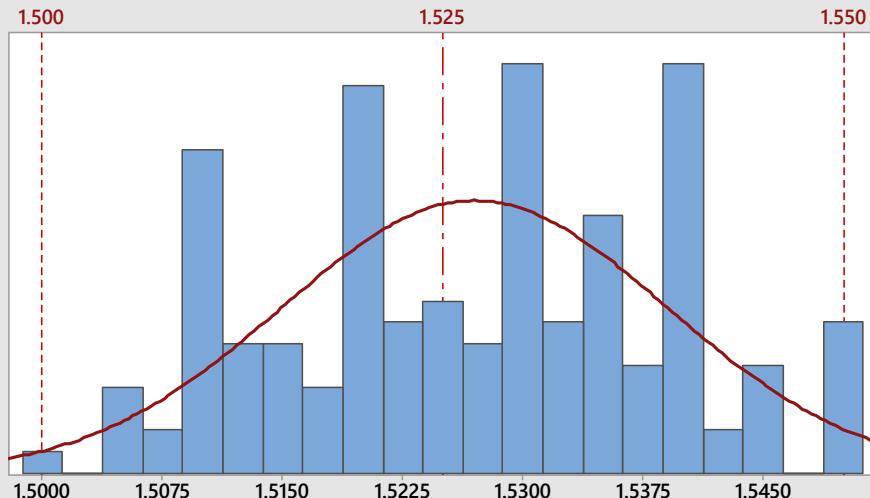
MK-FO-00001C, Rev G

Analysis Approach for Jacket, Pelvis, Sled tests

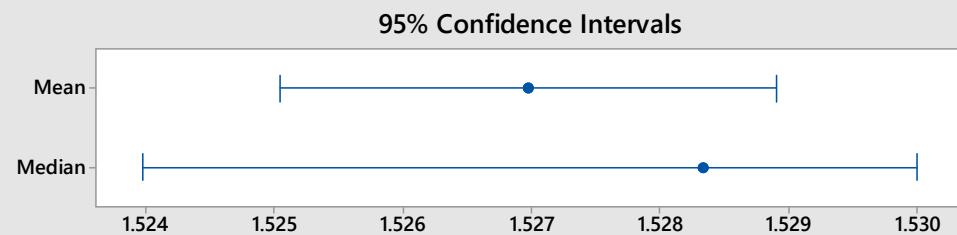
- Removed all tests with failing impact velocity
- Average all tests for each part serial number (ABP)
- Apply generic lab labels
- Create Histogram for each parameter with basic statistics
 - Add lines for
 - » Current corridors
 - » Mean and +/- 2 standard deviations from mean
 - » Proposed corridors of mean +/- 10%
 - Add labels with current corridor widths as %
- Create individual value dot plots for each parameter by lab
 - Add current corridors and proposed corridors
- Because of problems with getting single and double integration to work consistently amongst labs, propose opening the sled velocity and part compression corridors up to at least +/- 10%.
 - Original corridors were mainly +/- 2 * standard deviation of data at the time from one lab

Jacket Analysis – Impact Velocity

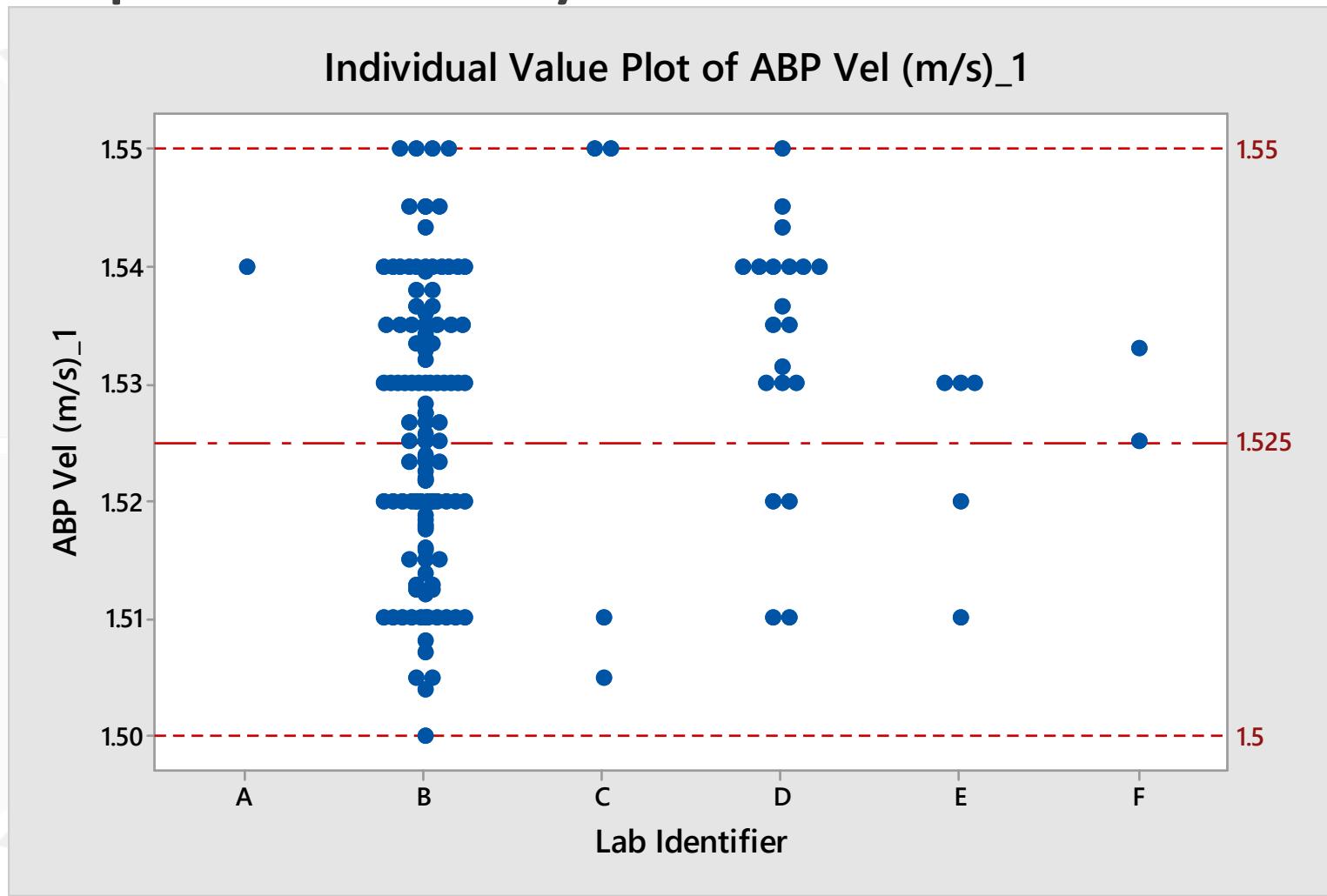
Summary Report for ABP Vel (m/s)_1



Anderson-Darling Normality Test	
A-Squared	1.30
P-Value	<0.005
Mean	1.5270
StDev	0.0121
Variance	0.0001
Skewness	-0.041206
Kurtosis	-0.857734
N	153
Minimum	1.5000
1st Quartile	1.5185
Median	1.5283
3rd Quartile	1.5363
Maximum	1.5500
95% Confidence Interval for Mean	
1.5250	1.5289
95% Confidence Interval for Median	
1.5240	1.5300
95% Confidence Interval for StDev	
0.0108	0.0136

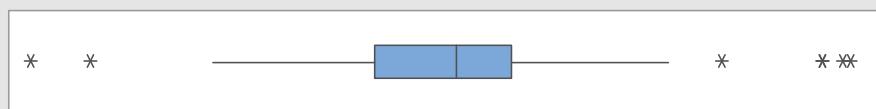
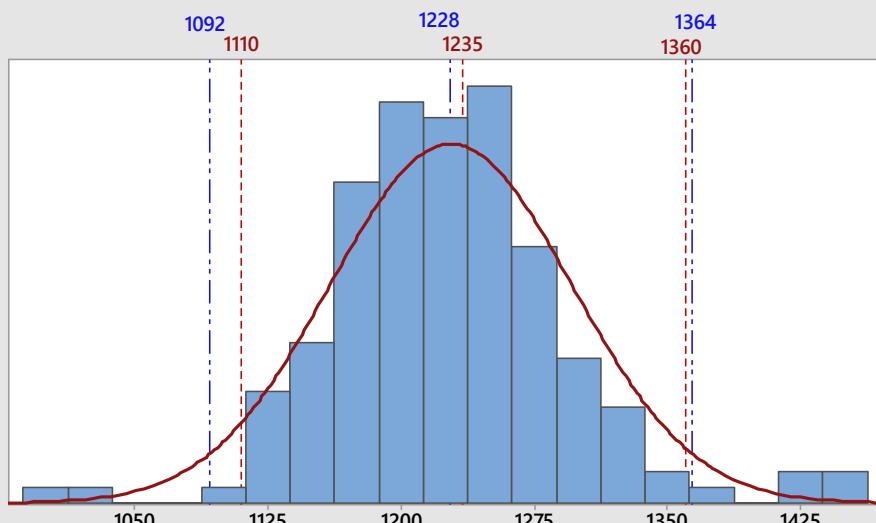


Jacket Analysis – Individual Value Plot Impact Velocity



Jacket Analysis – Pendulum Force

Summary Report for ABP Pend (N)_1



Anderson-Darling Normality Test

A-Squared	1.35
P-Value	<0.005

Mean	1228.1
StDev	68.2
Variance	4645.7
Skewness	0.38532
Kurtosis	2.31983
N	153

Minimum	991.3
1st Quartile	1184.8
Median	1231.5
3rd Quartile	1262.3
Maximum	1453.5

95% Confidence Interval for Mean

1217.3	1239.0
--------	--------

95% Confidence Interval for Median

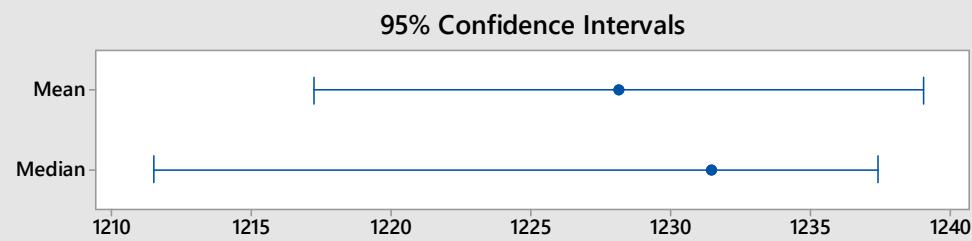
1211.5	1237.4
--------	--------

95% Confidence Interval for StDev

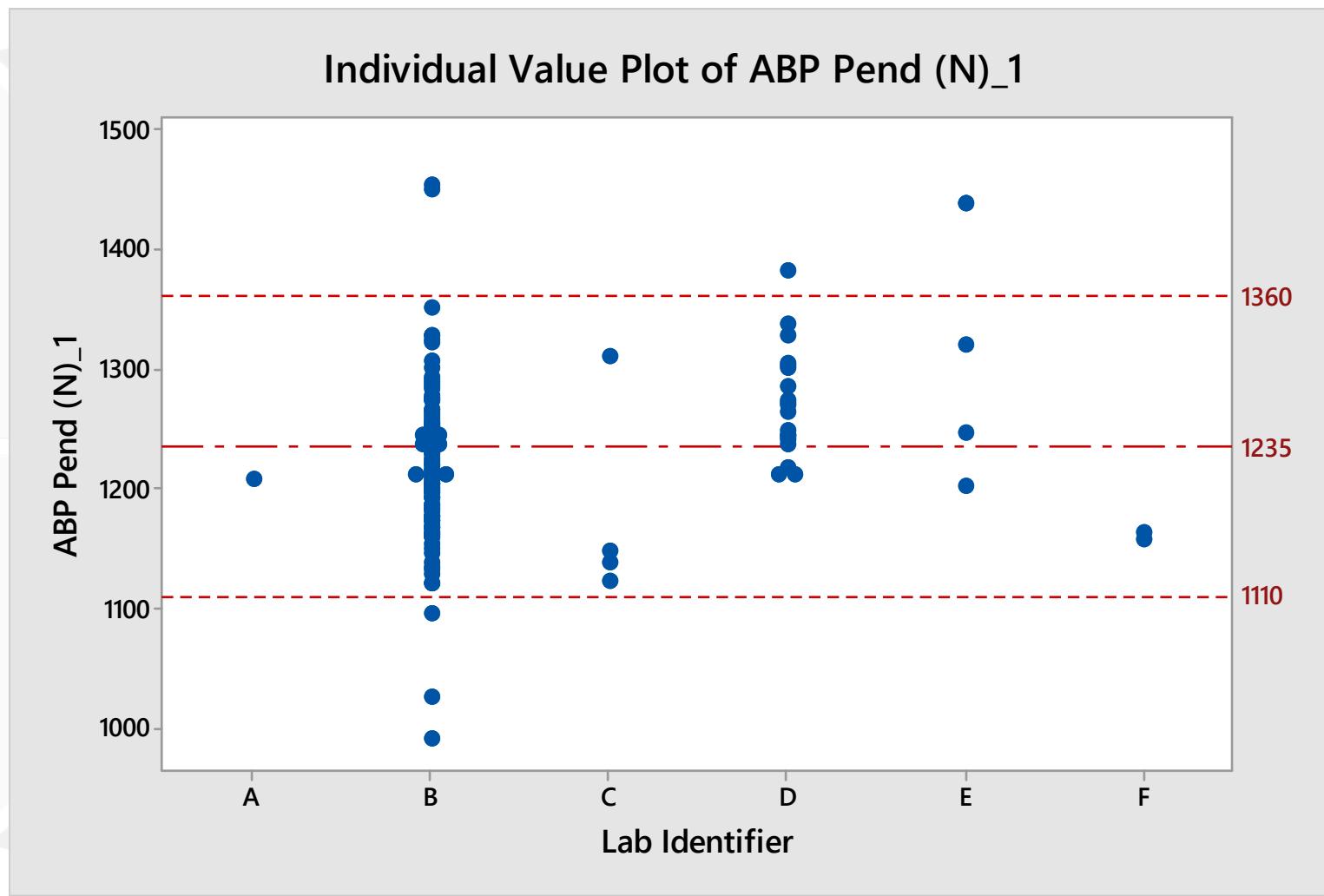
61.3	76.8
------	------

Current Corridors: red - width +/- 10%
+/- 2 std dev: blue

Proposal: do not change corridor

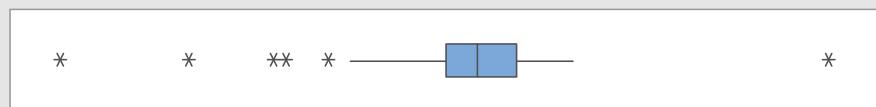
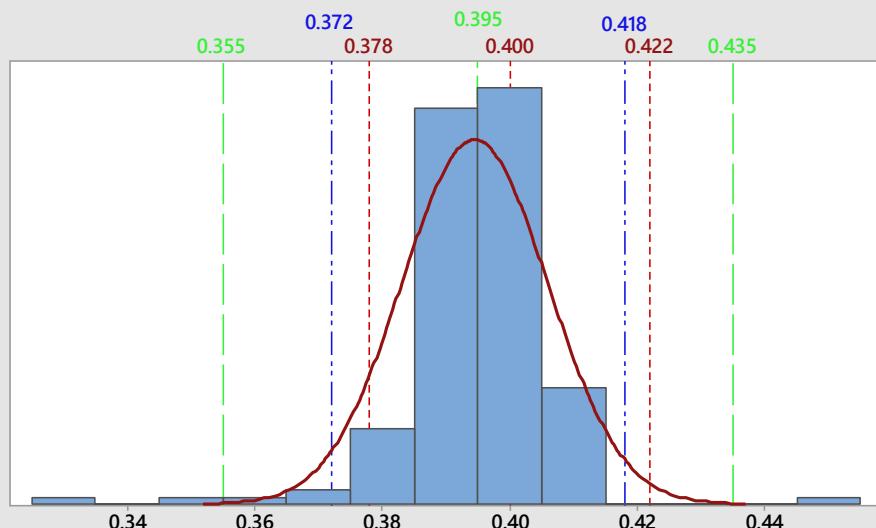


Jacket Analysis – Individual Value Plot Pendulum Force



Jacket Analysis – Sled Velocity

Summary Report for ABP Sled (m/s)_1



Anderson-Darling Normality Test

A-Squared	4.56
P-Value	<0.005

Mean	0.39450
StDev	0.01144
Variance	0.00013
Skewness	-1.1658
Kurtosis	10.6868
N	153

Minimum	0.32960
1st Quartile	0.39000
Median	0.39500
3rd Quartile	0.40100
Maximum	0.45000

95% Confidence Interval for Mean

0.39268	0.39633
---------	---------

95% Confidence Interval for Median

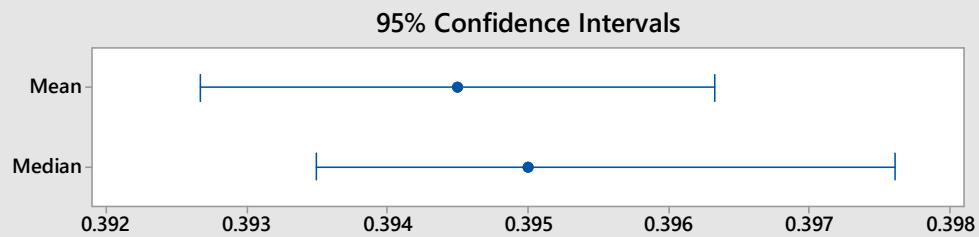
0.39350	0.39761
---------	---------

95% Confidence Interval for StDev

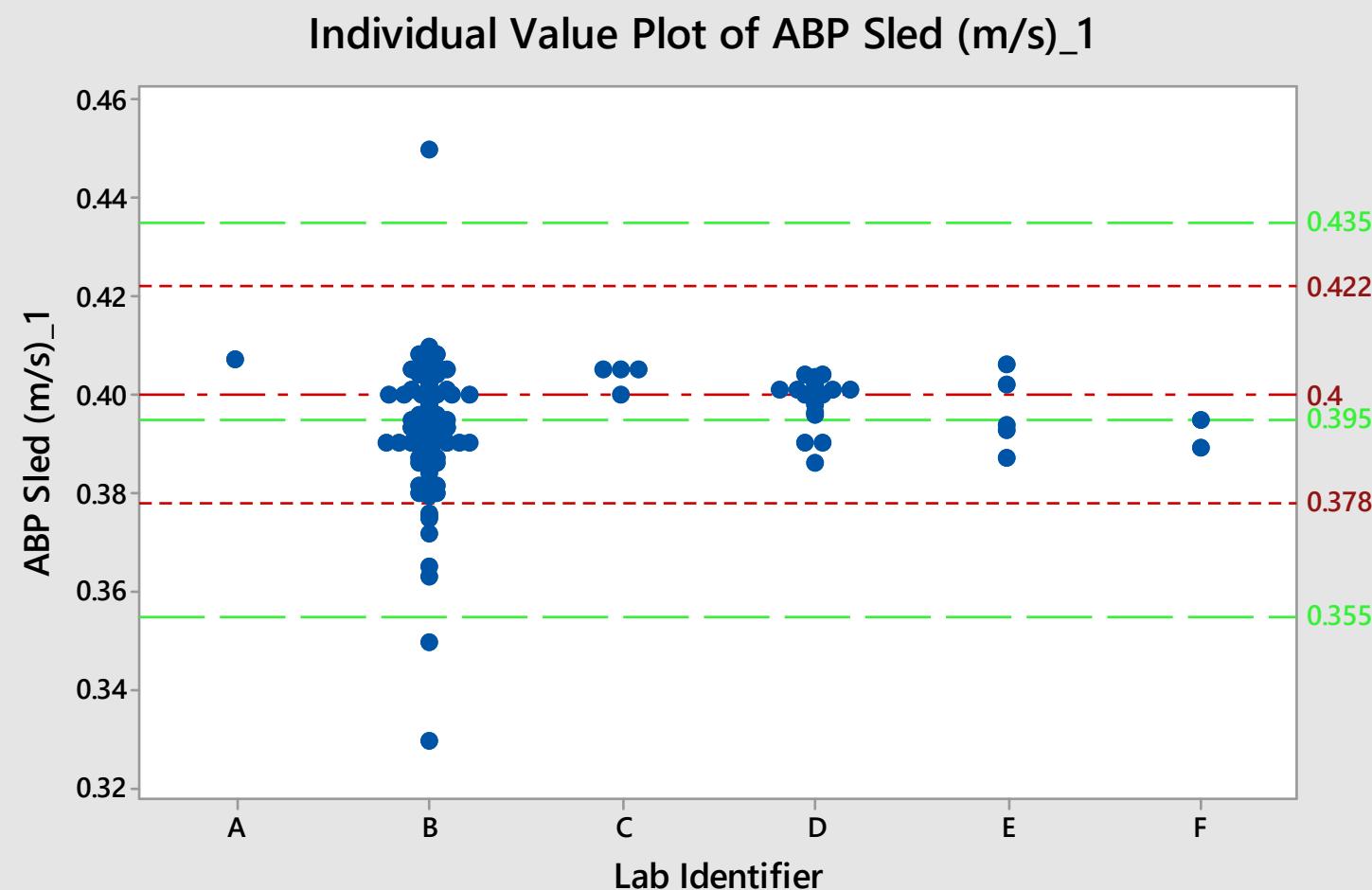
0.01029	0.01289
---------	---------

Current Corridors: red - width +/- 5.5%
+/- 2 std dev: blue

Proposal: green - width +/- 10%
.395 +/- 0.40 (.355 - .435)

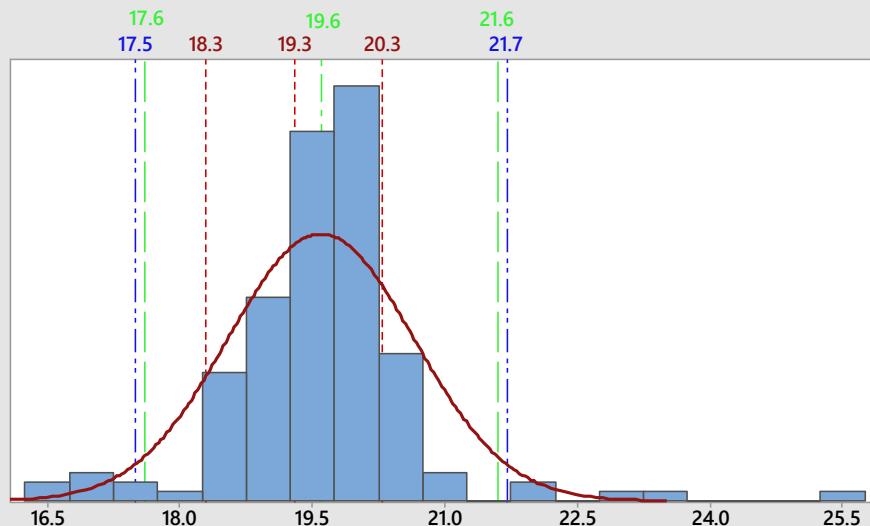


Jacket Analysis – Individual Value Plot Sled Velocity



Jacket Analysis – Jacket Compression

Summary Report for ABP Comp (mm)_1



Anderson-Darling Normality Test

A-Squared 3.93

P-Value <0.005

Mean 19.598

StDev 1.054

Variance 1.112

Skewness 1.09113

Kurtosis 8.05526

N 153

Minimum 16.275

1st Quartile 19.100

Median 19.600

3rd Quartile 20.108

Maximum 25.550

95% Confidence Interval for Mean

19.430 19.767

95% Confidence Interval for Median

19.436 19.769

95% Confidence Interval for StDev

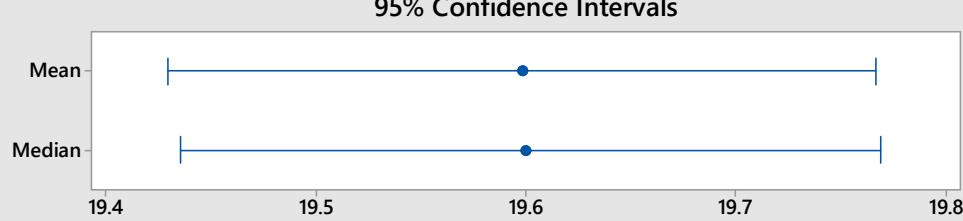
0.948 1.188

Current Corridors: red - width +/- 5.2%

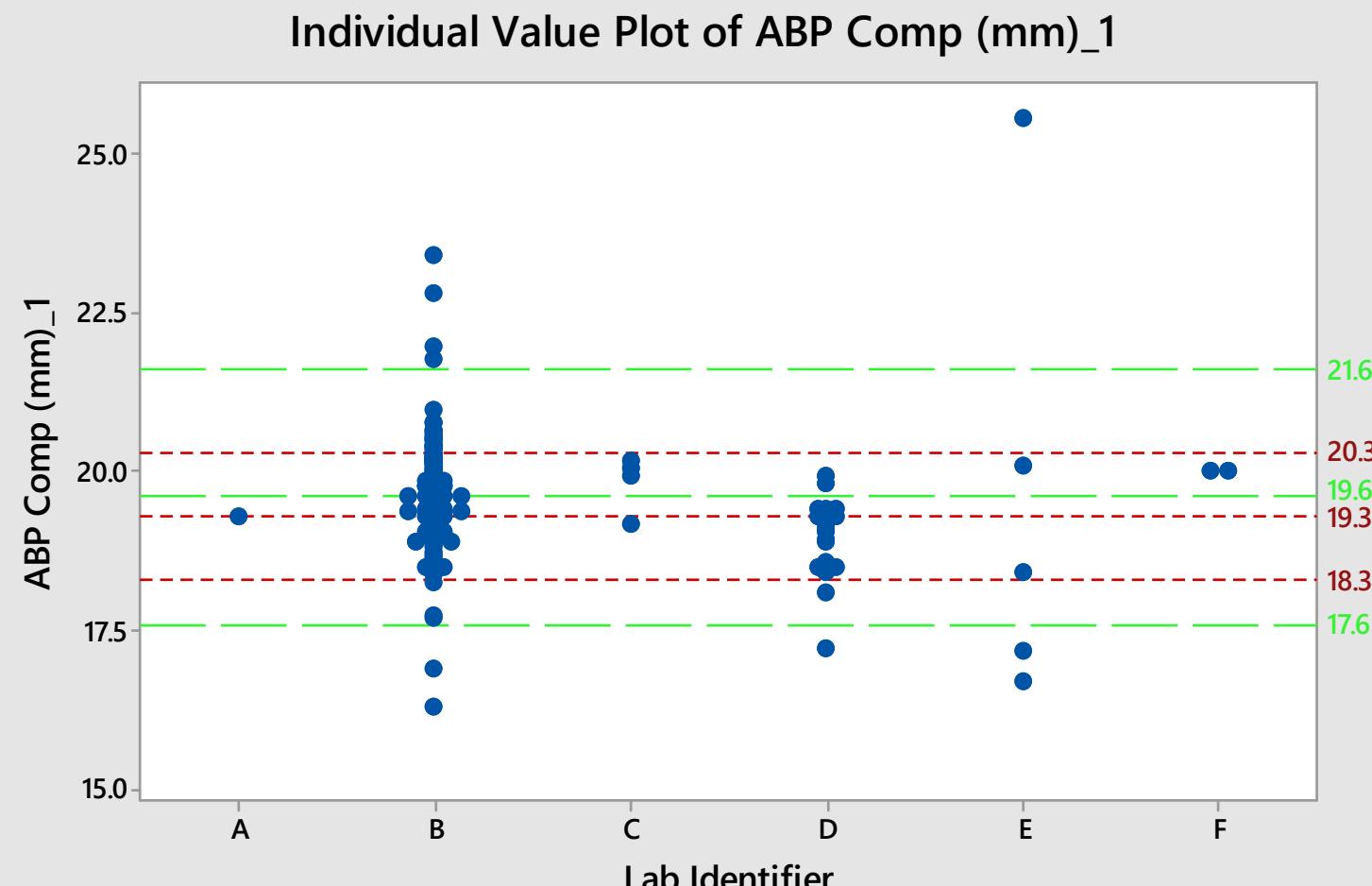
+/- 2 std dev: blue

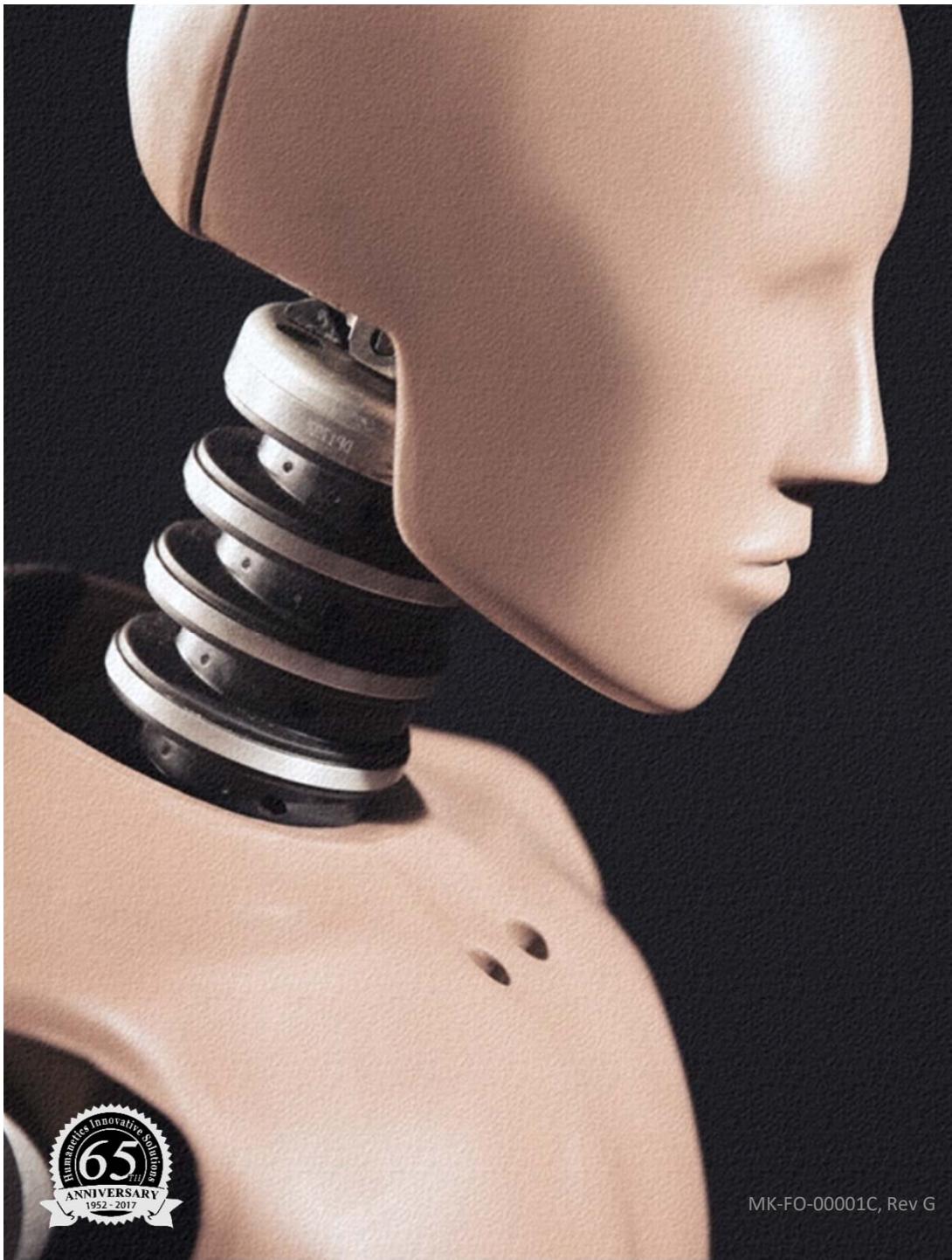
Proposal: green - width +/- 10%

19.6 +/- 2.0 (17.6-21.6)



Jacket Analysis – Individual Value Plot Jacket Compression



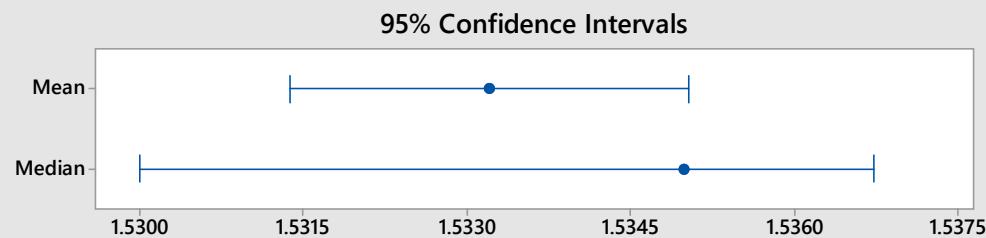
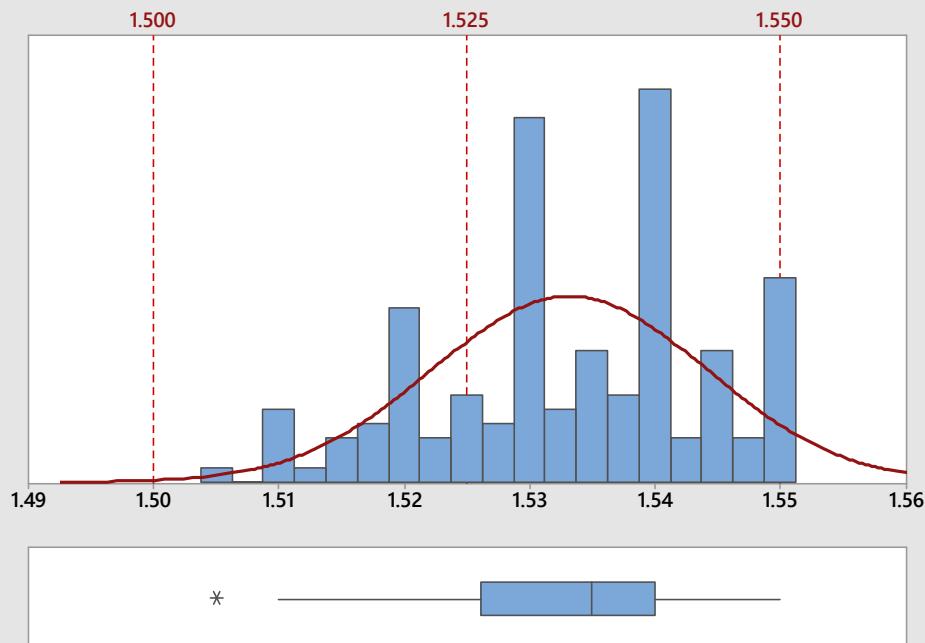


Pelvis Test Analysis

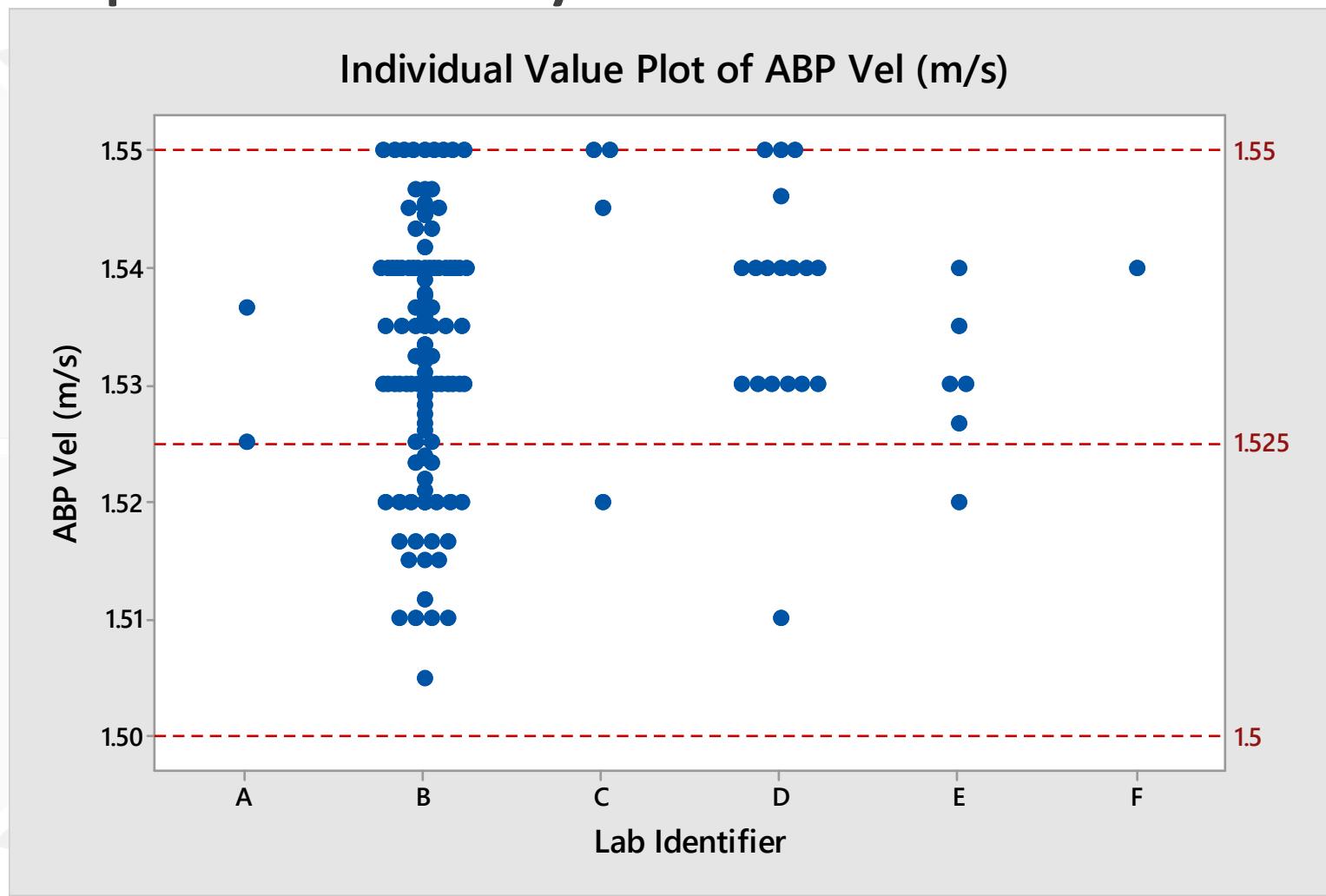
MK-FO-00001C, Rev G

Pelvis Analysis – Impact Velocity

Summary Report for ABP Vel (m/s)

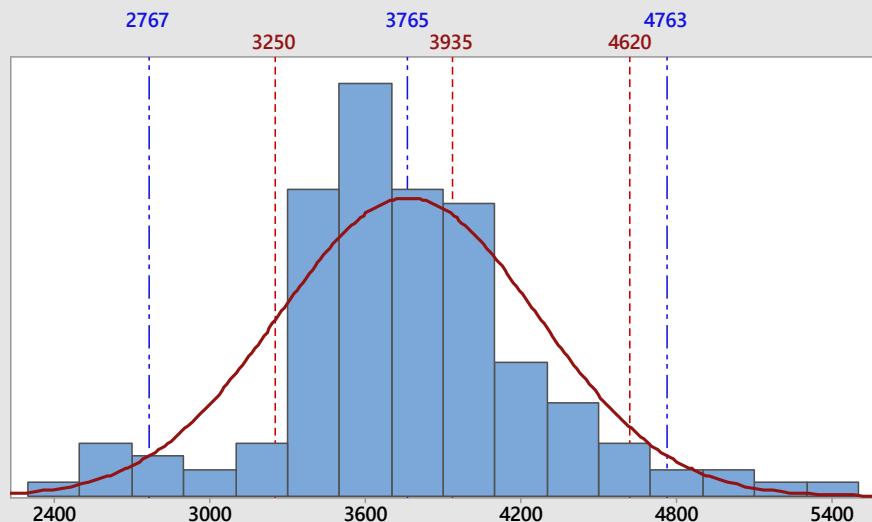


Pelvis Analysis – Individual Value Plot Impact Velocity

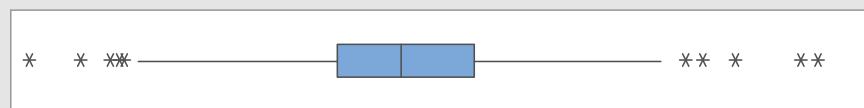


Pelvis Analysis – Pendulum Force

Summary Report for ABP Pend (N)

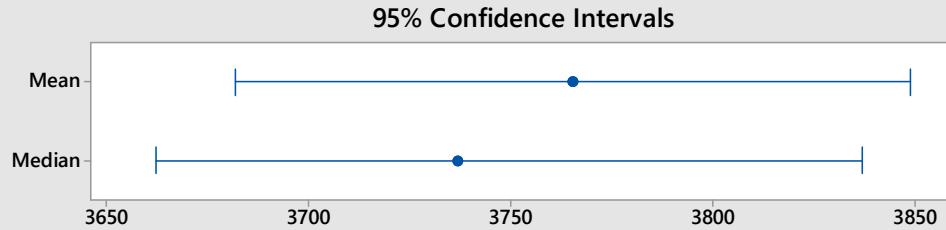


Anderson-Darling Normality Test	
A-Squared	1.45
P-Value	<0.005
Mean	3765.4
StDev	499.0
Variance	248985.3
Skewness	0.20095
Kurtosis	1.43386
N	140
Minimum	2303.0
1st Quartile	3489.4
Median	3737.0
3rd Quartile	4019.3
Maximum	5345.7
95% Confidence Interval for Mean	
3682.1	3848.8
95% Confidence Interval for Median	
3662.4	3837.1
95% Confidence Interval for StDev	
446.6	565.4



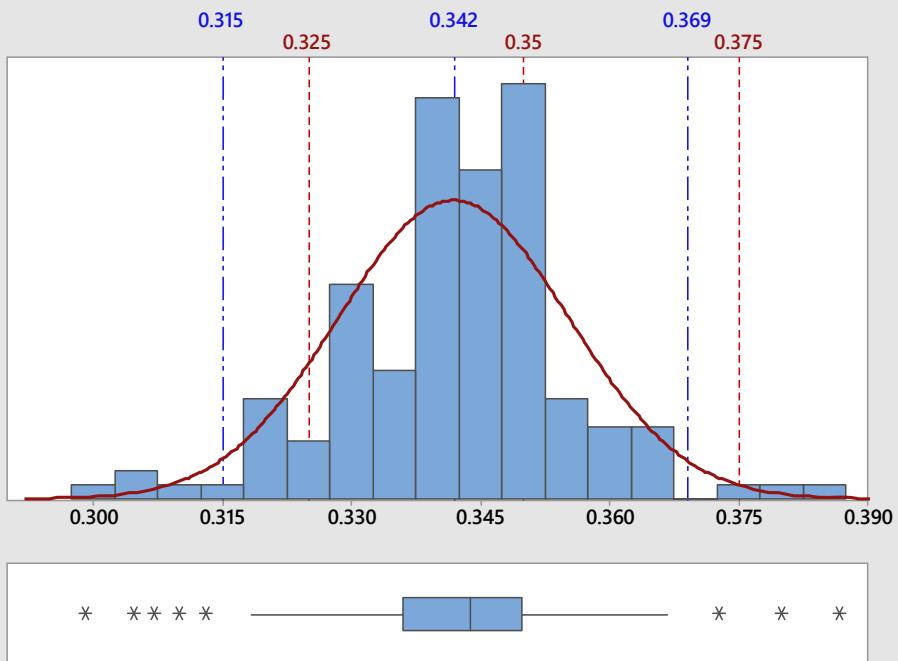
Current Corridors: red - width +/- 17.4%

+/- 2 std dev: blue (+/- 26.5%)



Pelvis Analysis – Sled Velocity

Summary Report for ABP Sled (m/s)



Anderson-Darling Normality Test

A-Squared 1.69

P-Value <0.005

Mean 0.34188

StDev 0.01339

Variance 0.00018

Skewness -0.20923

Kurtosis 1.55587

N 140

Minimum 0.29900

1st Quartile 0.33608

Median 0.34375

3rd Quartile 0.34981

Maximum 0.38667

95% Confidence Interval for Mean

0.33964 0.34411

95% Confidence Interval for Median

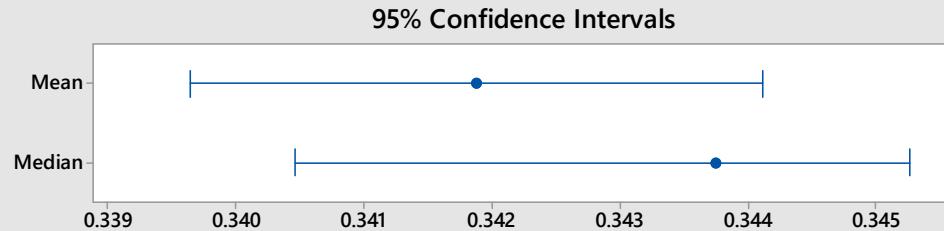
0.34046 0.34527

95% Confidence Interval for StDev

0.01198 0.01517

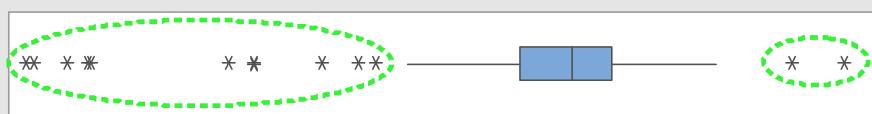
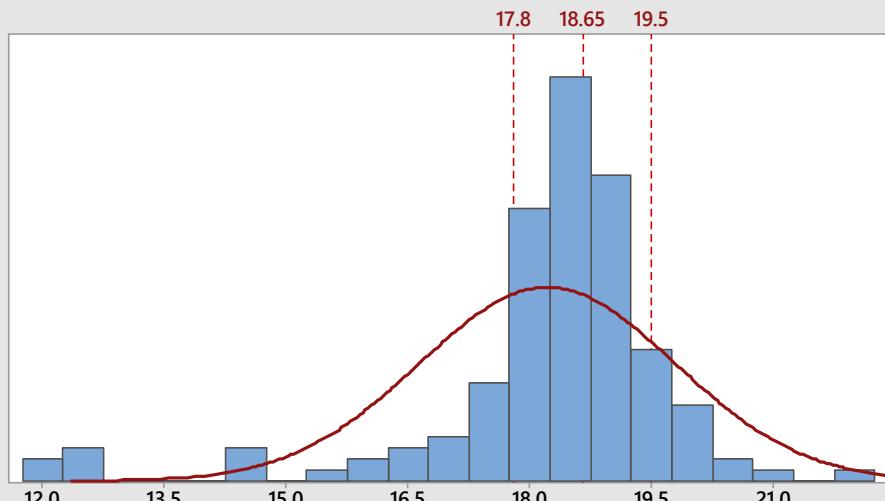
Current Corridors: red - width +/- 7.1%

+/- 2 std dev: blue (+/- 7.8%)



Pelvis Analysis – Pelvis Compression

Summary Report for ABP Comp (mm)



Anderson-Darling Normality Test

A-Squared	9.15
P-Value	<0.005

Mean	18.213
StDev	1.576
Variance	2.484
Skewness	-2.11351
Kurtosis	6.21308
N	140

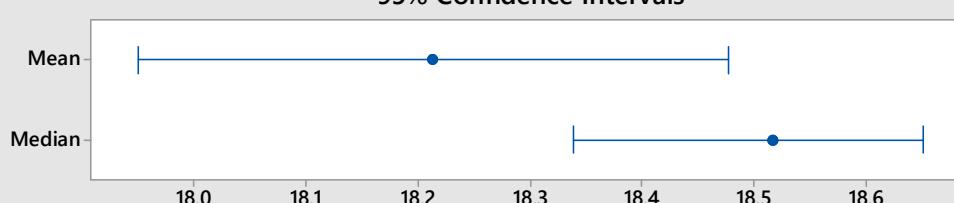
Minimum	11.800
1st Quartile	17.882
Median	18.517
3rd Quartile	19.000
Maximum	21.867

95% Confidence Interval for Mean
17.950 18.477

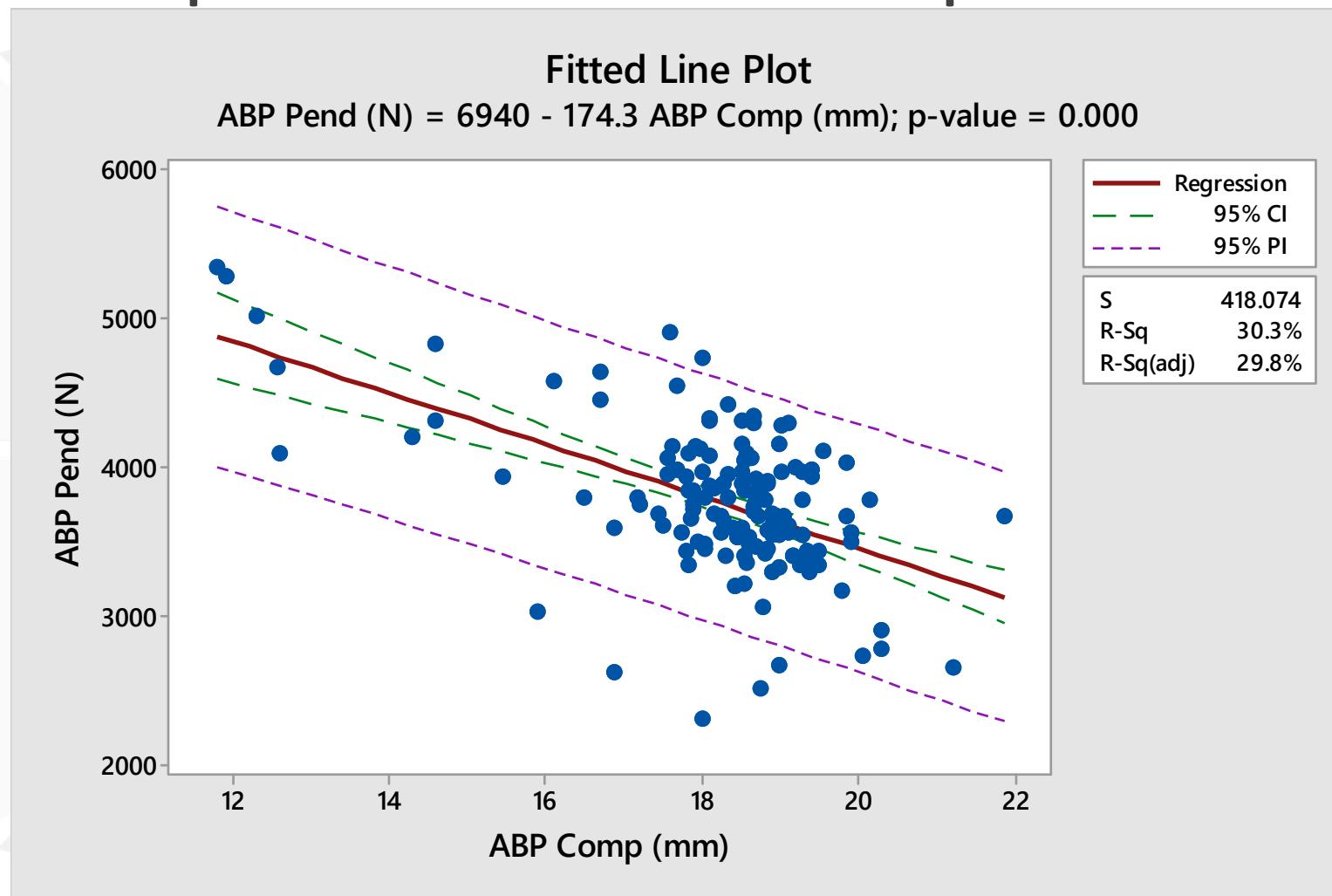
95% Confidence Interval for Median
18.339 18.651

95% Confidence Interval for StDev
1.411 1.786

Distribution is shifted from histogram due to large numbers of extreme outliers. Delete all outliers - everything below 16.2 and above 21.1 before calculating corridors.



Pelvis Analysis – Pendulum Force vs Compression Relationship

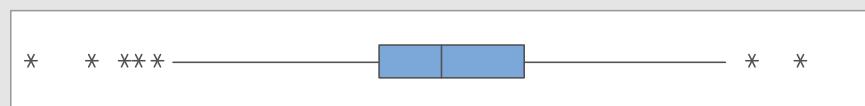
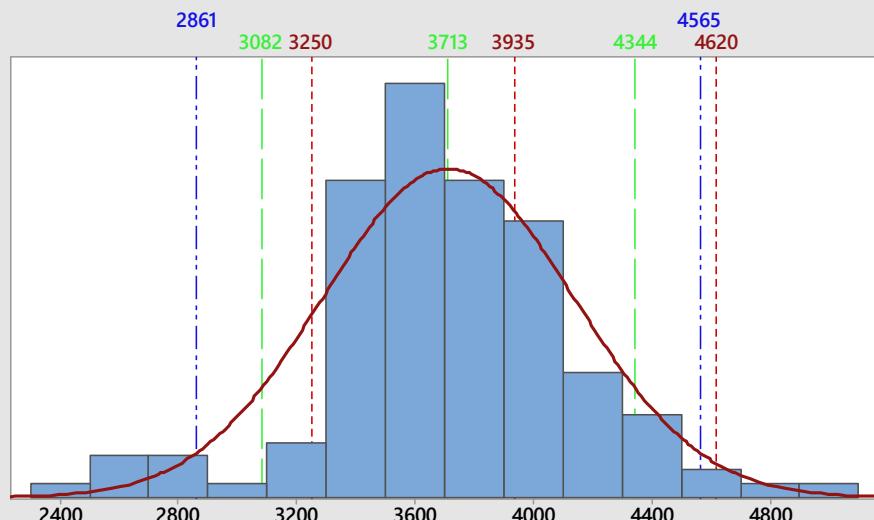


Pelvis Analysis

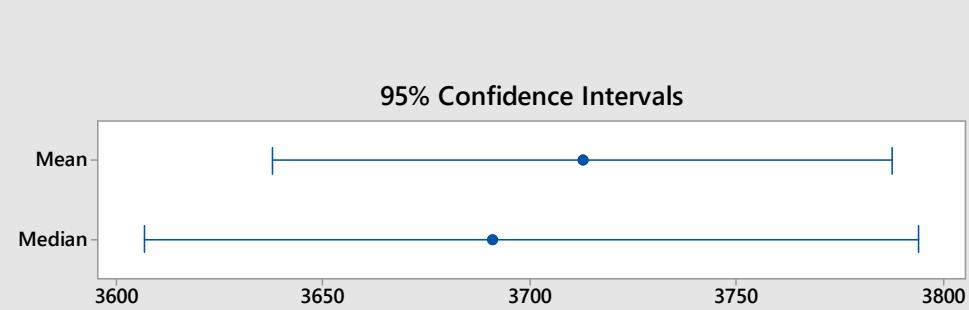
- The intention of the test is to tighten the population to reduce R&R issues with using the dummy in a vehicle seat.
- All statistical outliers (13 points) which were eliminated from the dataset. This removes all points below 16.2 and above 21.1.
 - This removed extreme parts.
 - Force, sled velocity, pelvis compression were all recalculated with the reduced dataset to create corridors.

Pelvis Analysis – Pendulum Force

Summary Report for ABP Pend (N) [deleted outliers]



Anderson-Darling Normality Test	
A-Squared	1.05
P-Value	0.009
Mean	3712.7
StDev	425.8
Variance	181327.3
Skewness	-0.35446
Kurtosis	1.40375
N	127
Minimum	2303.0
1st Quartile	3476.9
Median	3691.0
3rd Quartile	3971.0
Maximum	4904.0
95% Confidence Interval for Mean	
3638.0	3787.5
95% Confidence Interval for Median	
3606.8	3794.1
95% Confidence Interval for StDev	
379.1	485.8



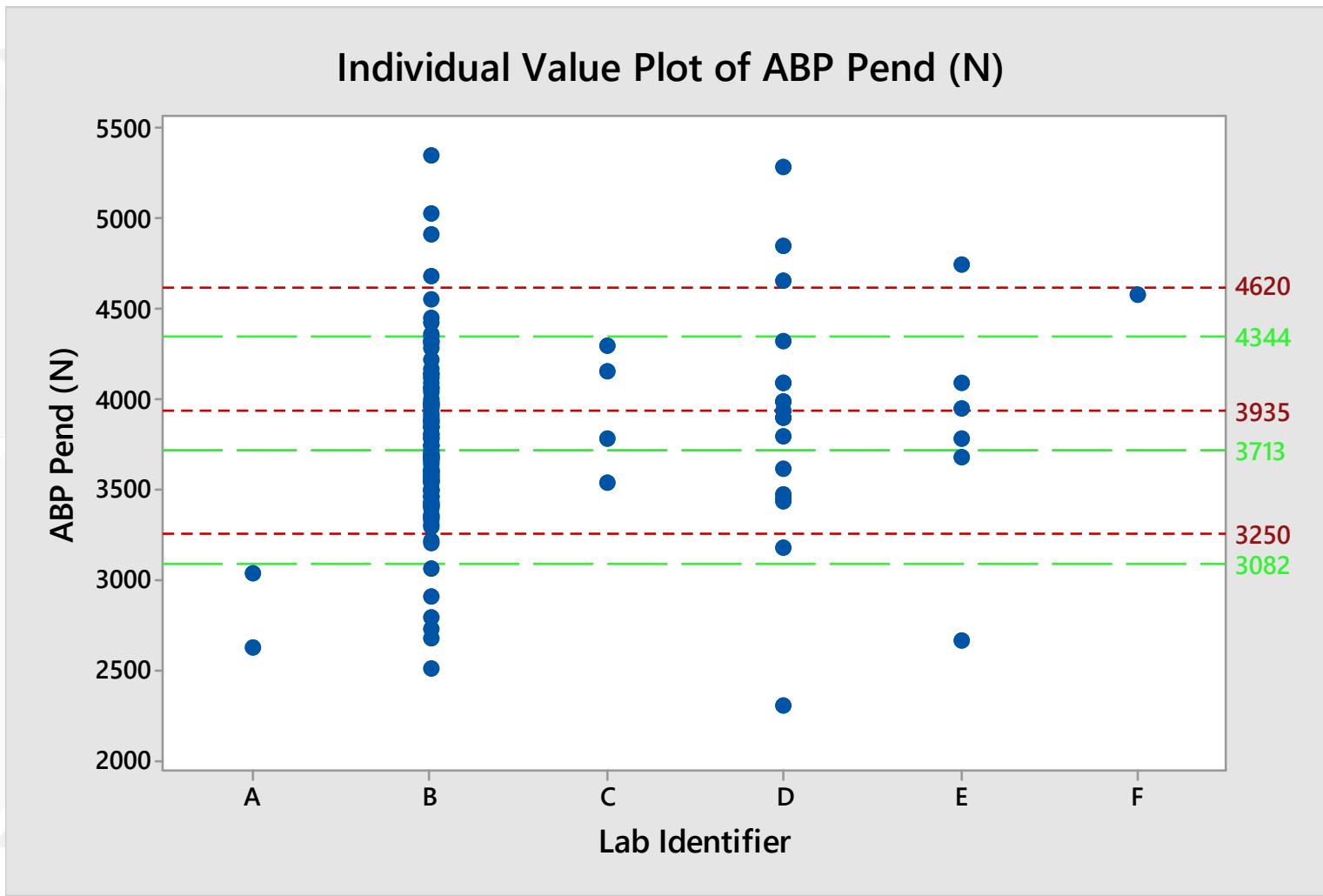
Data points below 16.2 and above 21.1 deleted (13 points).

Current Corridors: red - width +/- 17.4%

+/- 2 std dev: blue (+/- 22.9%)

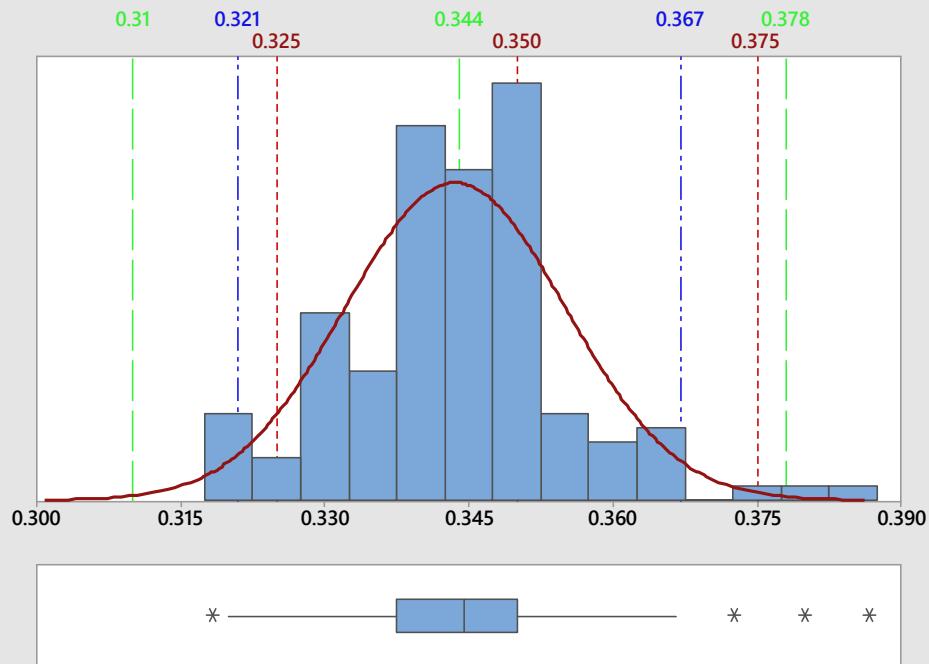
Proposal: green -
same +/-17% corridor width
3713 +/- 631 (3082 - 4344)

Pelvis Analysis – Individual Value Plot Pendulum Force



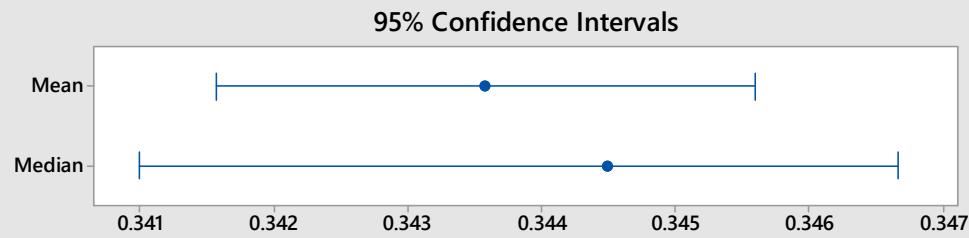
Pelvis Analysis – Sled Velocity

Summary Report for ABP Sled (m/s) [deleted outliers]



Anderson-Darling Normality Test	
A-Squared	1.24
P-Value	<0.005
Mean	0.34358
StDev	0.01148
Variance	0.00013
Skewness	0.45878
Kurtosis	1.65614
N	127
Minimum	0.31833
1st Quartile	0.33750
Median	0.34450
3rd Quartile	0.35000
Maximum	0.38667
95% Confidence Interval for Mean	
0.34156	0.34560
95% Confidence Interval for Median	
0.34099	0.34667
95% Confidence Interval for StDev	
0.01022	0.01310

Data points below 16.2 and above 21.1 deleted (13 points).

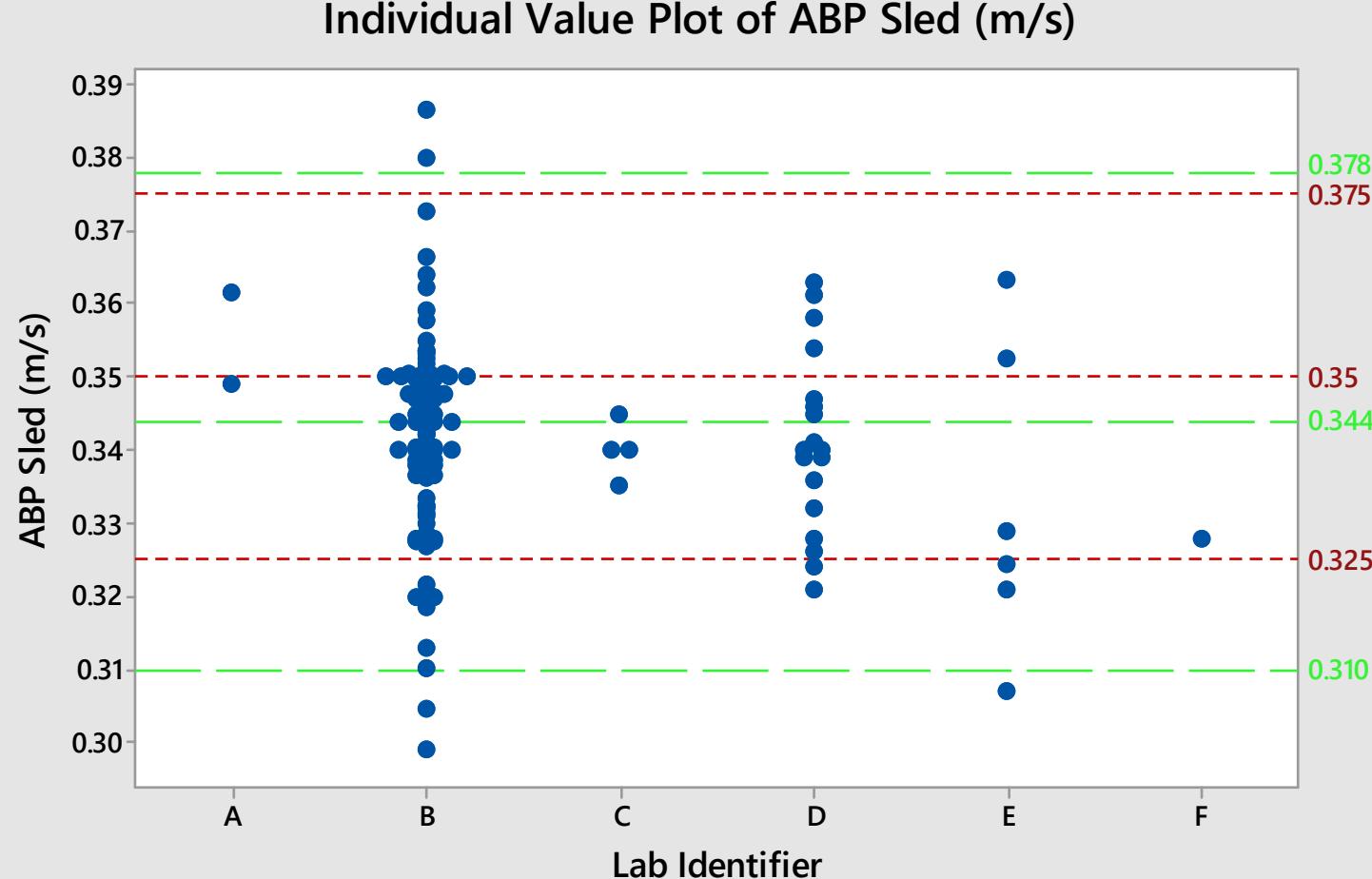


Current Corridors: red - width +/- 7.8%

+/- 2 std dev: blue (+/- 6.7%)

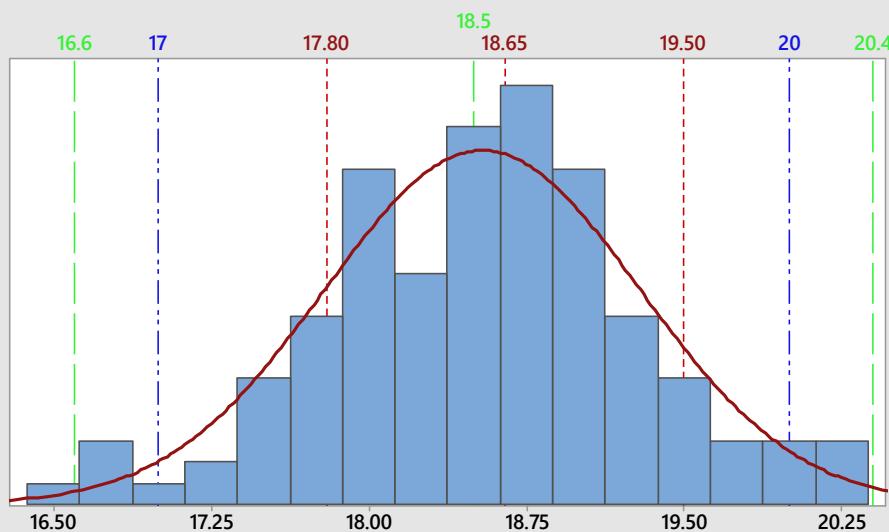
Proposal: green -
+/-10% corridor width
0.344 +/- 0.034 (0.310 - 0.378)

Pelvis Analysis – Individual Value Plot Sled Velocity



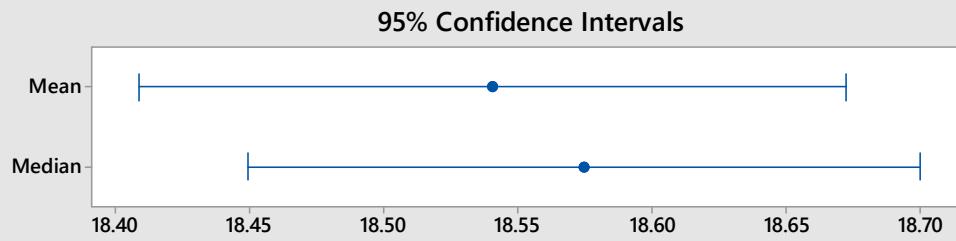
Pelvis Analysis – Pelvis Compression

Summary Report for ABP Comp (mm) [deleted outliers]



Anderson-Darling Normality Test	
A-Squared	0.32
P-Value	0.522
Mean	18.541
StDev	0.750
Variance	0.563
Skewness	-0.143051
Kurtosis	0.272404
N	127
Minimum	16.500
1st Quartile	18.035
Median	18.575
3rd Quartile	19.000
Maximum	20.300
95% Confidence Interval for Mean	
18.409	18.672
95% Confidence Interval for Median	
18.450	18.700
95% Confidence Interval for StDev	
0.668	0.856

Data points below 16.2 and above 21.1 deleted (13 points).



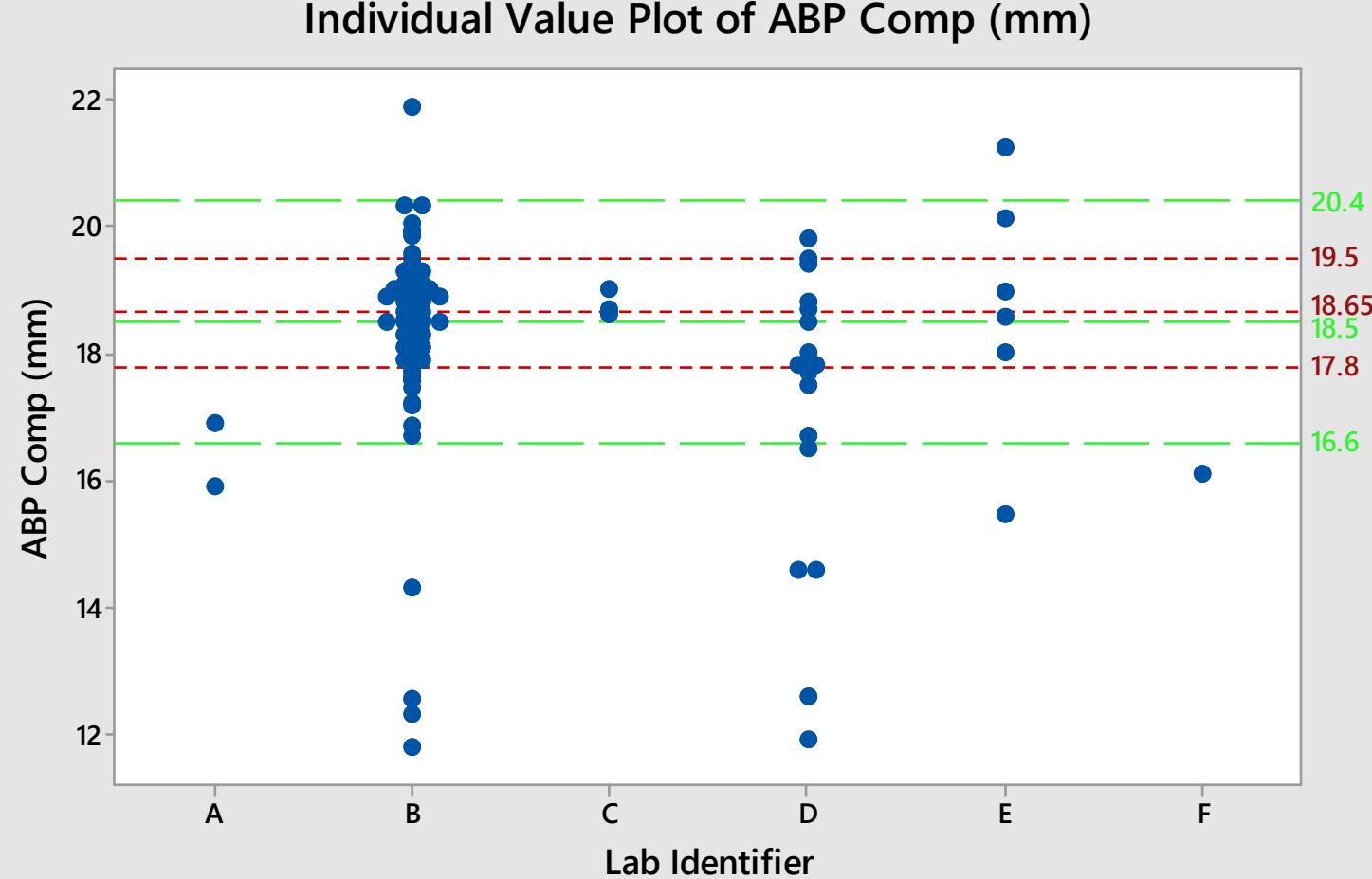
Current Corridors: red - width +/- 4.6%

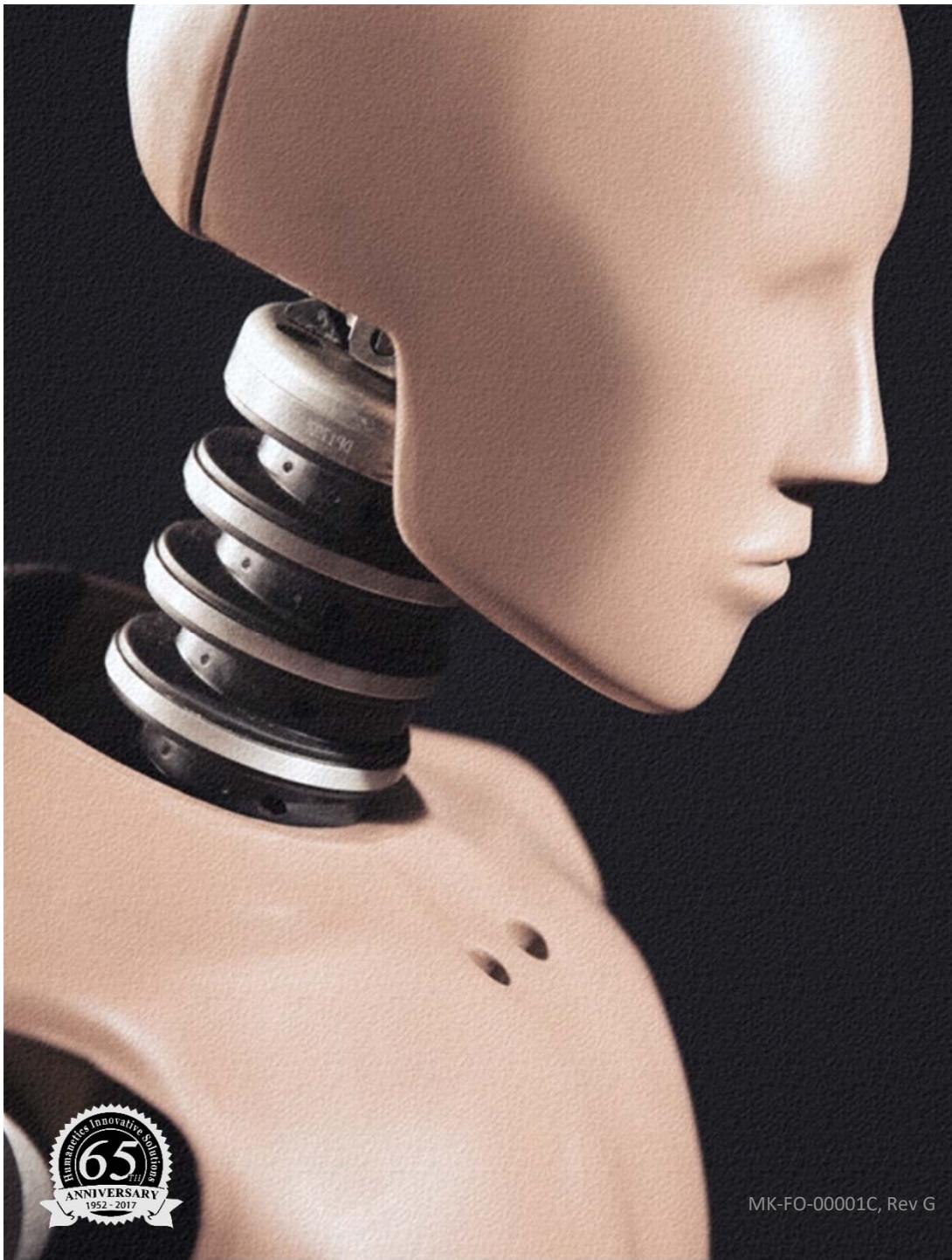
+/- 2 std dev: blue (+/- 8.1%)

Proposal: green -
+/-10% corridor width
18.5 +/- 1.9 (16.6 - 20.4)

Pelvis Analysis – Individual Value Plot

Pelvis Compression





MK-FO-00001C, Rev G

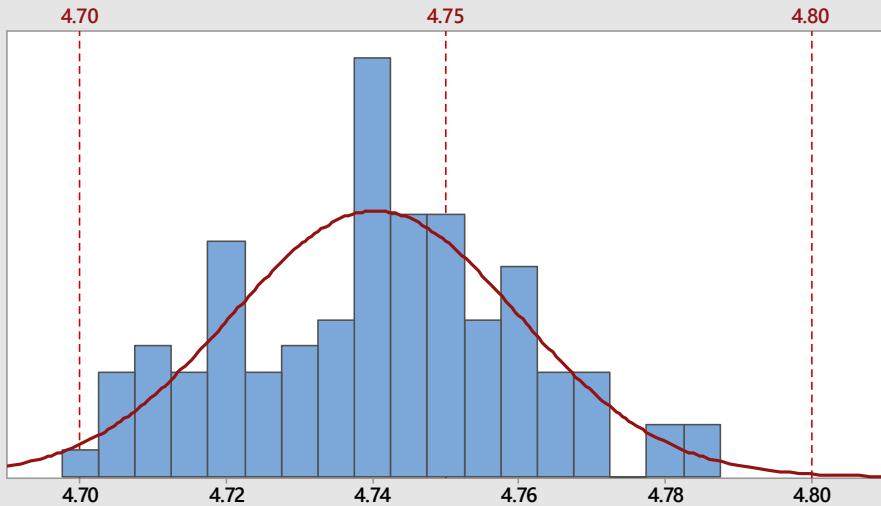
Sled and Track Certification Test Analysis

Analysis Notes

- Average By Part was done by Energy Transfer Device (ETD) serial number since this produces most of the variation.
 - Most labs only have 1 ETD. For labs that did not provide serial numbers, I assumed all tests were with 1 ETD.
 - One lab had several ETD
 - Production lab had many ETD serial numbers.
- Sled velocity and velocity decay had severe outliers
 - Different tests for outliers
 - Assuming calculation problem rather than actual test problems since Probe Force and Sled Acceleration data is normally distributed
 - » Delete outlier points from these parameters before calculating new corridors.
 - » Did NOT delete other parameters from these tests, only the outlier points

Sled Test Analysis – Impact Velocity

Summary Report for ABP Vel (m/s)



Anderson-Darling Normality Test

A-Squared	0.52
P-Value	0.187

Mean	4.7404
StDev	0.0197
Variance	0.0004
Skewness	-0.000846
Kurtosis	-0.486325
N	100

Minimum	4.7000
1st Quartile	4.7235
Median	4.7405
3rd Quartile	4.7546
Maximum	4.7850

95% Confidence Interval for Mean

4.7365 4.7443

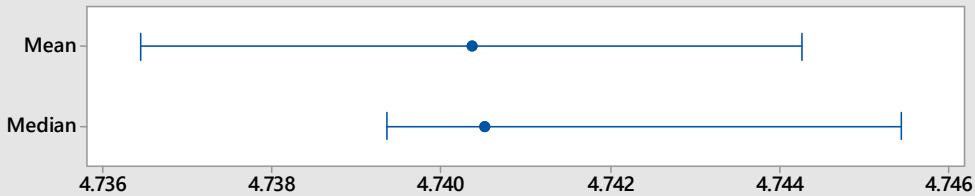
95% Confidence Interval for Median

4.7394 4.7454

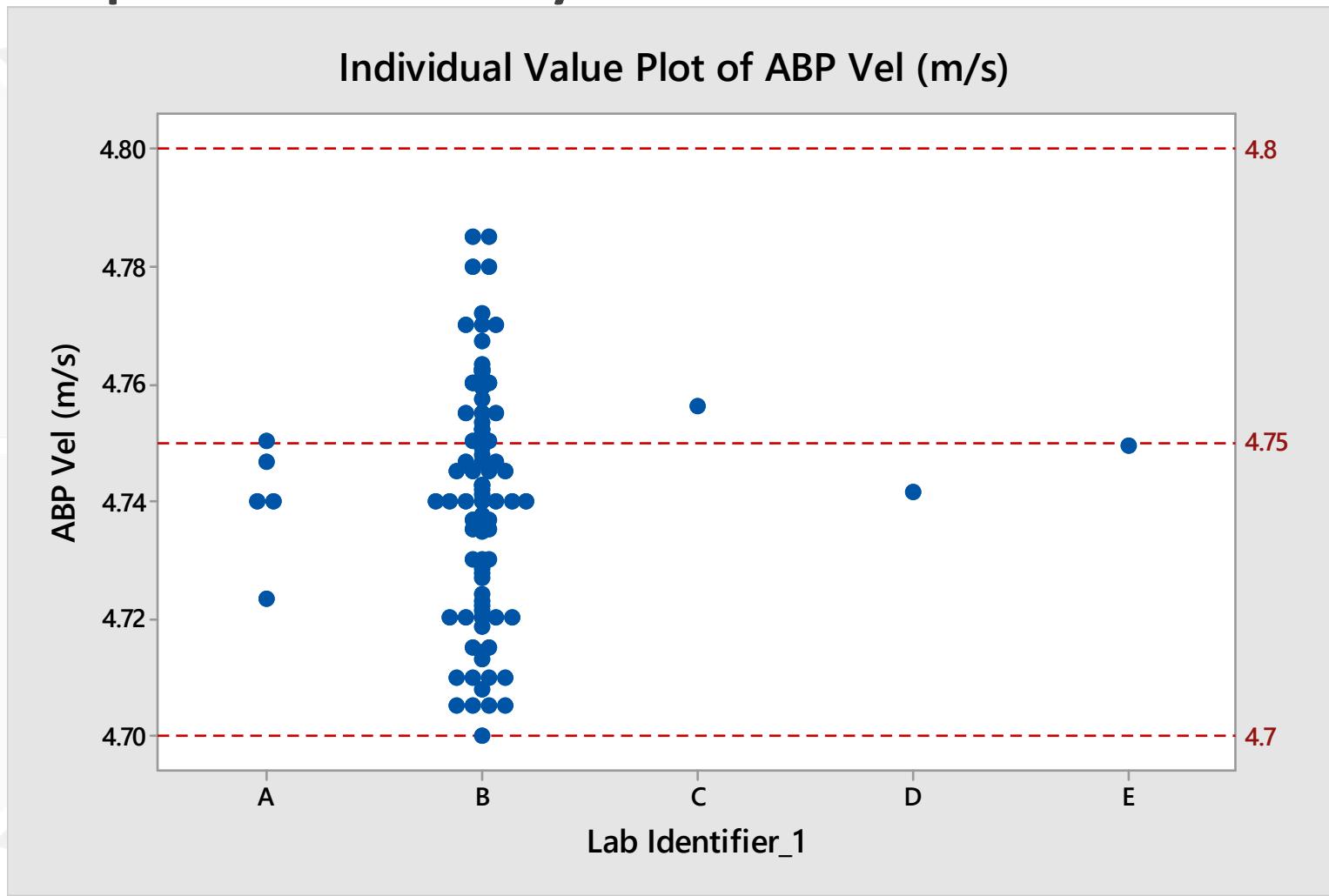
95% Confidence Interval for StDev

0.0173 0.0228

95% Confidence Intervals

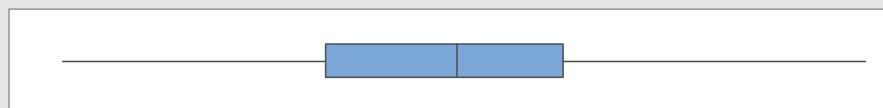
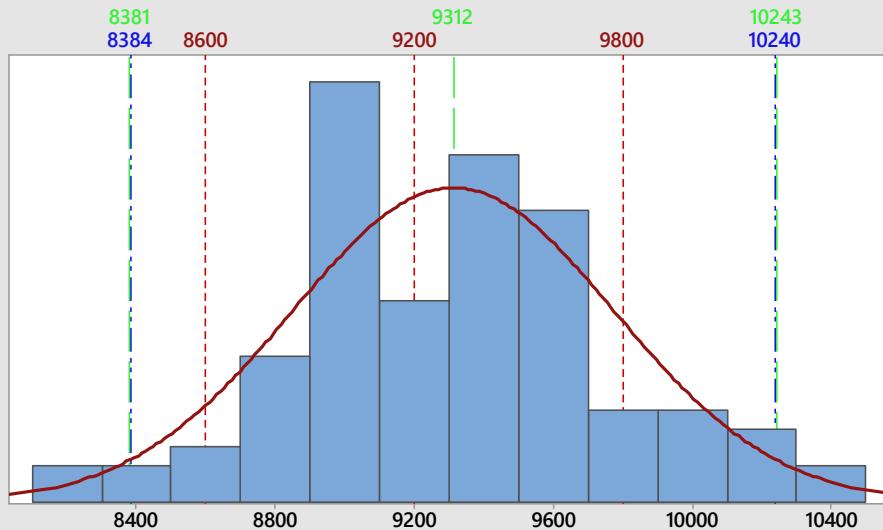


Sled Analysis – Individual Value Plot Impact Velocity



Sled Test Analysis – Pendulum Force

Summary Report for ABP Pend (N)

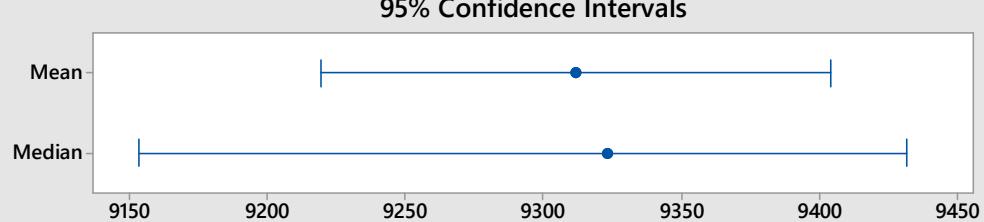


Anderson-Darling Normality Test	
A-Squared	0.39
P-Value	0.371
Mean	9311.9
StDev	464.1
Variance	215348.2
Skewness	0.199057
Kurtosis	-0.002146
N	100
Minimum	8188.4
1st Quartile	8946.4
Median	9323.3
3rd Quartile	9625.9
Maximum	10499.1
95% Confidence Interval for Mean	
9219.8	9404.0
95% Confidence Interval for Median	
9153.7	9431.6
95% Confidence Interval for StDev	
407.4	539.1

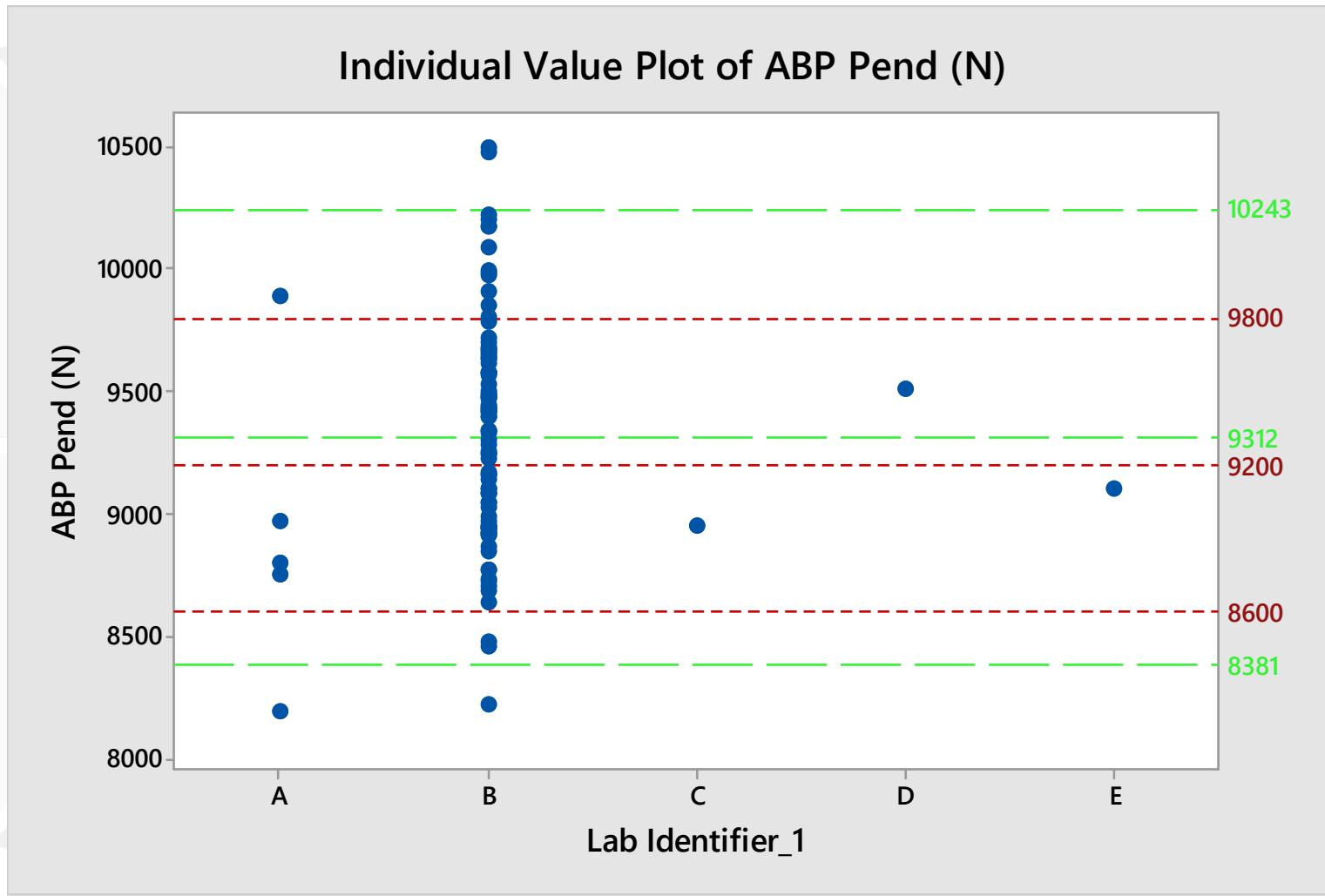
Current Corridors: red - width +/- 6.5%

+/- 2 std dev: blue (+/- 10%)

Proposal: green -
+/-10% corridor width
9312 +/- 931 (8381 - 10243)

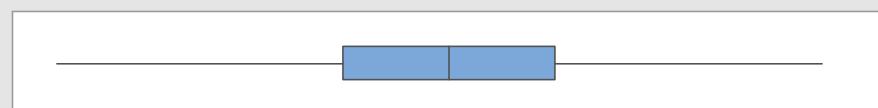
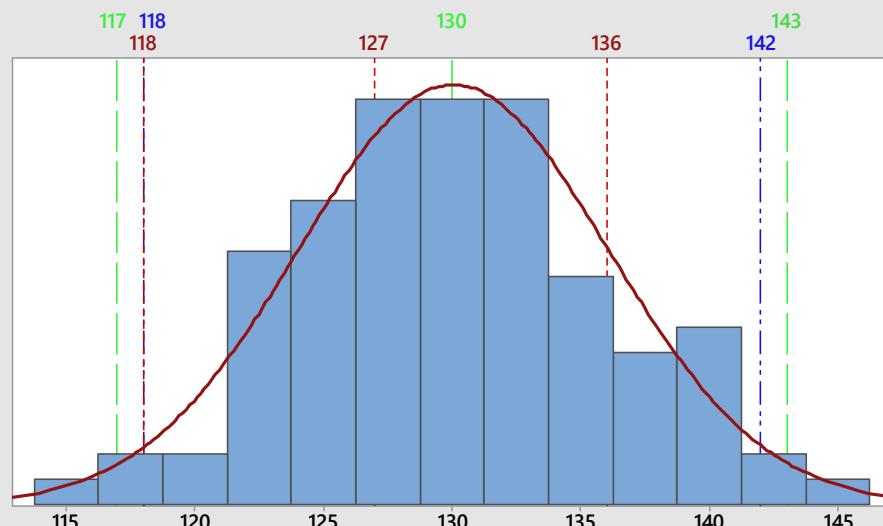


Pelvis Analysis – Individual Value Plot Pendulum Force

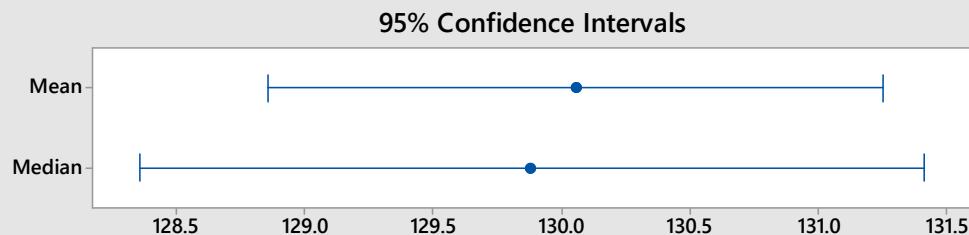


Sled Test Analysis – Sled Acceleration

Summary Report for ABP Sled Accel (m/s²)



Anderson-Darling Normality Test	
A-Squared	0.15
P-Value	0.968
Mean	130.06
StDev	6.03
Variance	36.33
Skewness	0.097921
Kurtosis	-0.264837
N	100
Minimum	114.63
1st Quartile	125.76
Median	129.88
3rd Quartile	133.98
Maximum	144.39
95% Confidence Interval for Mean	
128.86	131.25
95% Confidence Interval for Median	
128.36	131.41
95% Confidence Interval for StDev	
5.29	7.00



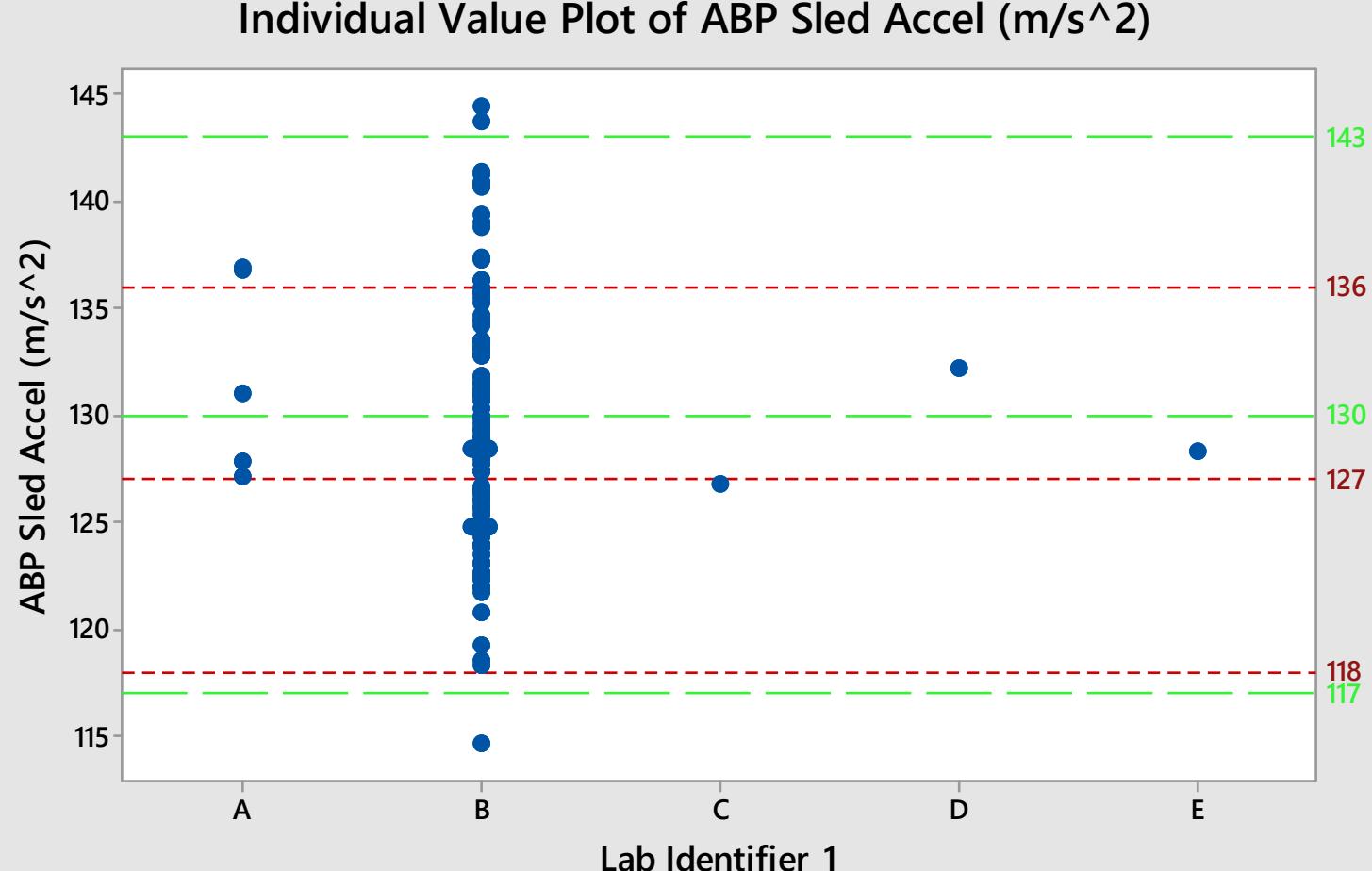
Current Corridors: red - width +/- 7.1%

+/- 2 std dev: blue (+/- 9.2%)

Proposal: green -
+/-10% corridor width
130 +/- 13 (117 - 143)

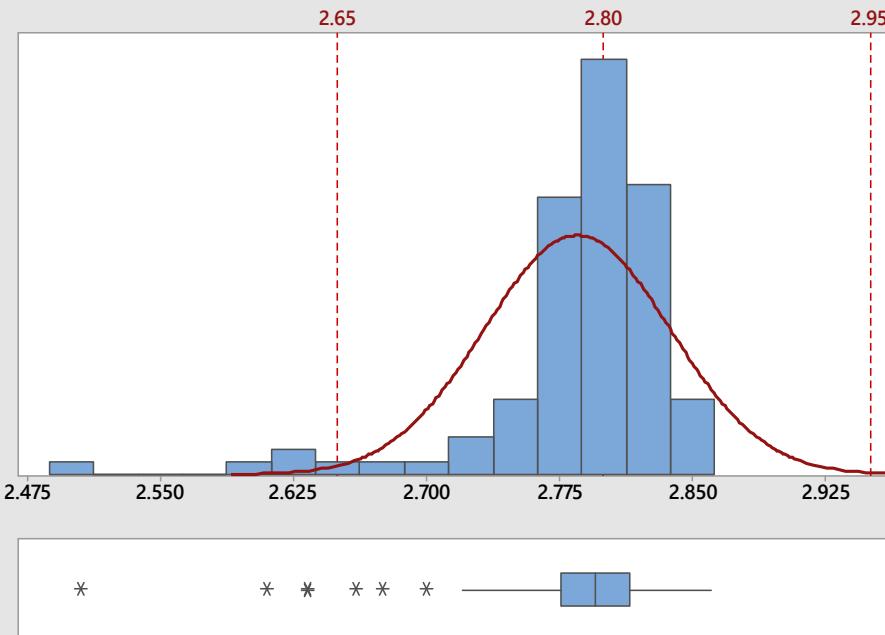
Sled Analysis – Individual Value Plot

Sled Acceleration

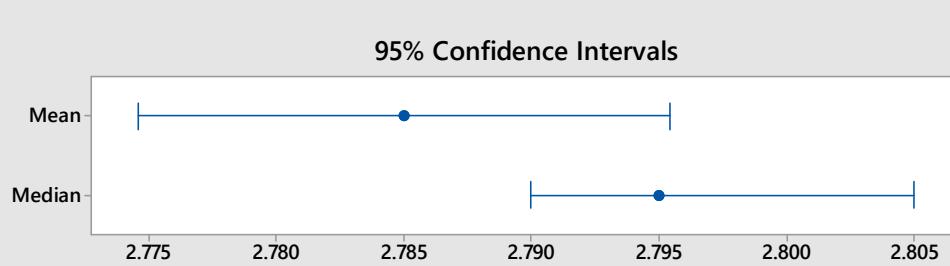


Sled Test Analysis – Sled Velocity

Summary Report for ABP Sled (m/s)



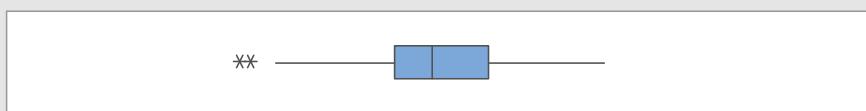
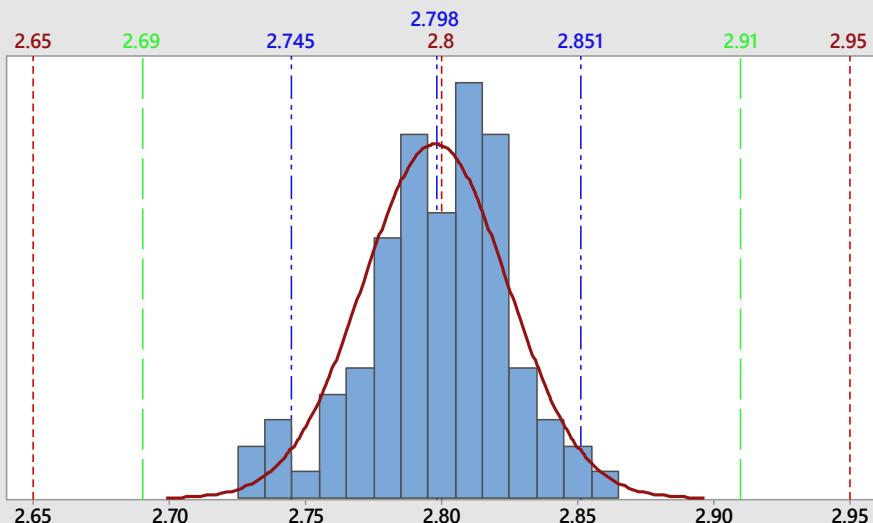
Anderson-Darling Normality Test	
A-Squared	6.40
P-Value	<0.005
Mean	2.7850
StDev	0.0525
Variance	0.0028
Skewness	-2.60072
Kurtosis	9.30282
N	100
Minimum	2.5050
1st Quartile	2.7754
Median	2.7950
3rd Quartile	2.8148
Maximum	2.8600
95% Confidence Interval for Mean	
2.7746	2.7954
95% Confidence Interval for Median	
2.7900	2.8050
95% Confidence Interval for StDev	
0.0461	0.0610



Severe outlier points, even though Force and Sled Acceleration are normally distributed would probably indicate a problem with the calculation. Delete these outliers (everything <= 2.700) before re-examining the corridor. However, do not delete other parameters, only this one from these tests.

Sled Test Analysis – Sled Velocity

Summary Report for ABP Sled (m/s) [outliers deleted]



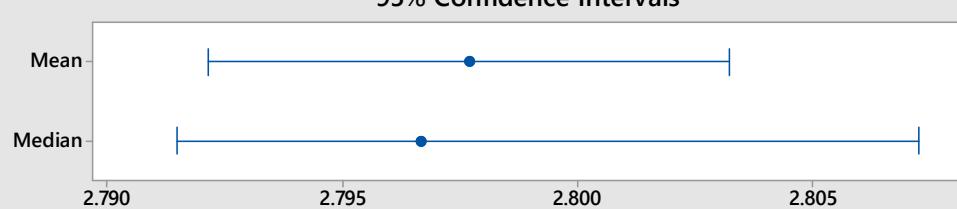
Anderson-Darling Normality Test	
A-Squared	0.45
P-Value	0.273
Mean	2.7977
StDev	0.0266
Variance	0.0007
Skewness	-0.404928
Kurtosis	0.269074
N	91
Minimum	2.7260
1st Quartile	2.7825
Median	2.7967
3rd Quartile	2.8170
Maximum	2.8600
95% Confidence Interval for Mean	
2.7922	2.8032
95% Confidence Interval for Median	
2.7915	2.8073
95% Confidence Interval for StDev	
0.0232	0.0312

All outliers in original data, values <= 2.700 deleted (9 points).

Current Corridors: red - width +/- 5.4%

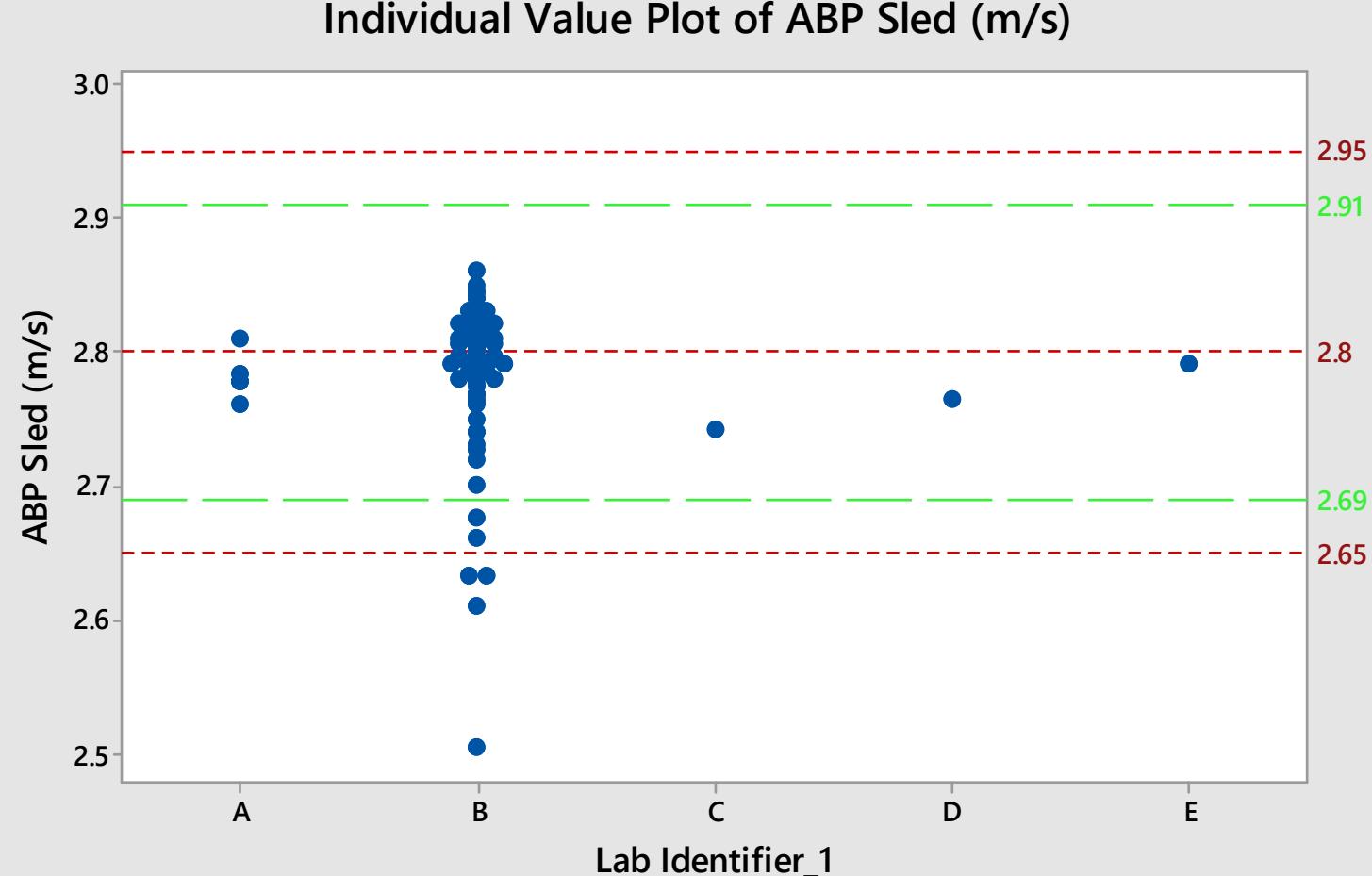
+/- 2 std dev: blue (+/- 1.9%)

Proposal: green - use existing center and +/- 4 * standard deviation
2.80 +/- 0.11 (2.69 - 2.91)
corridor width +/- 3.9%



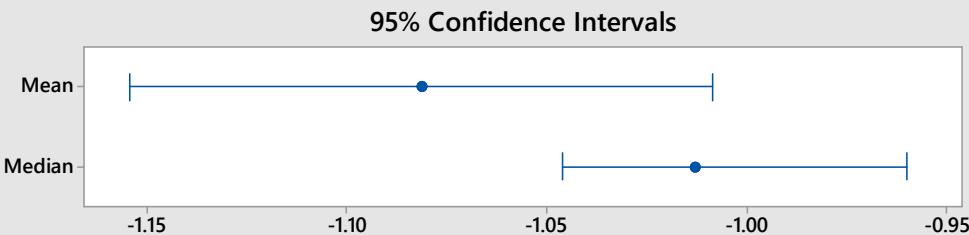
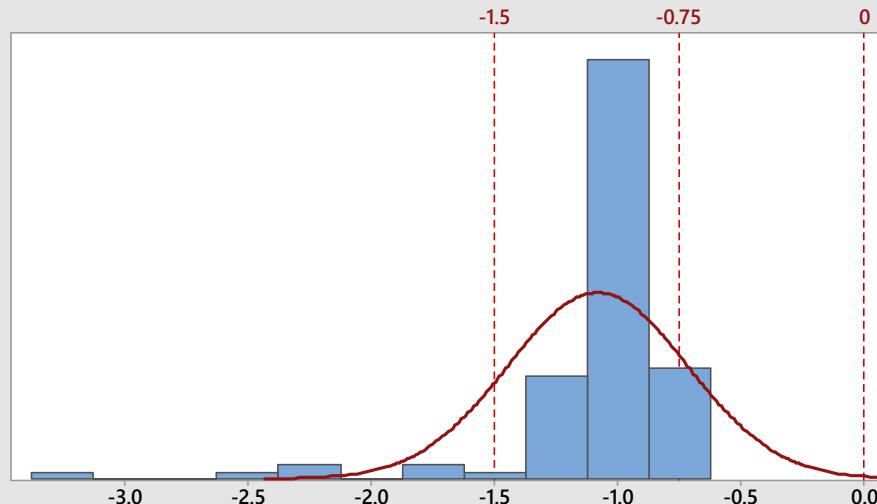
Sled Analysis – Individual Value Plot

Sled Velocity



Sled Test Analysis – Sled Velocity Decay

Summary Report for ABP Decay (m/s)/s

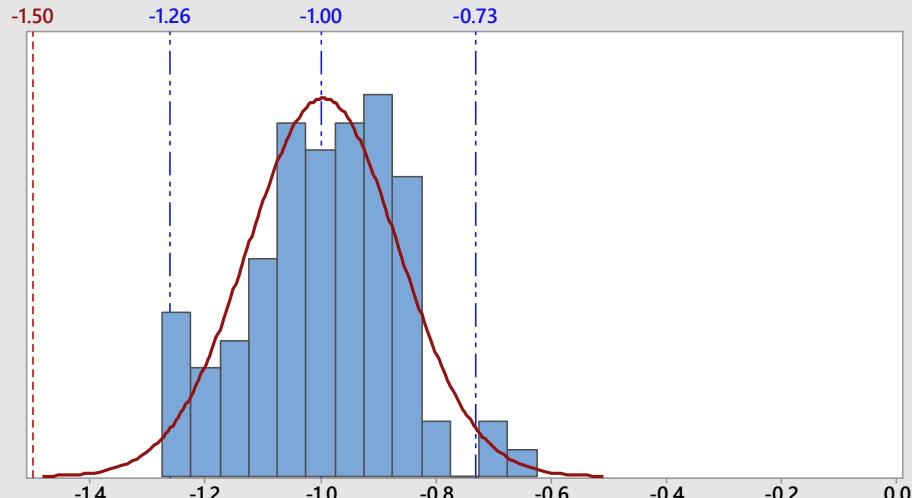


Anderson-Darling Normality Test	
A-Squared	11.45
P-Value	<0.005
Mean	-1.0813
StDev	0.3647
Variance	0.1330
Skewness	-3.6362
Kurtosis	15.7841
N	99
Minimum	-3.2100
1st Quartile	-1.1055
Median	-1.0128
3rd Quartile	-0.8932
Maximum	-0.6575
95% Confidence Interval for Mean	
-1.1541	-1.0086
95% Confidence Interval for Median	
-1.0462	-0.9601
95% Confidence Interval for StDev	
0.3200	0.4240

Severe outlier points, even though Force and Sled Acceleration are normally distributed would probably indicate a problem with the calculation. Delete these outliers (everything <-1.43) before re-examining the corridor. However, do not delete other parameters, only this one from these tests.

Sled Test Analysis – Sled Velocity Decay

Summary Report for ABP Decay (m/s)/s



Anderson-Darling Normality Test	
A-Squared	0.43
P-Value	0.300
Mean	-0.99545
StDev	0.13072
Variance	0.01709
Skewness	-0.053583
Kurtosis	-0.193444
N	91
Minimum	-1.27490
1st Quartile	-1.07540
Median	-0.99762
3rd Quartile	-0.89200
Maximum	-0.65750
95% Confidence Interval for Mean	
-1.02268	-0.96823
95% Confidence Interval for Median	
-1.02783	-0.95184
95% Confidence Interval for StDev	
0.11410	0.15306

All outliers in original data, values

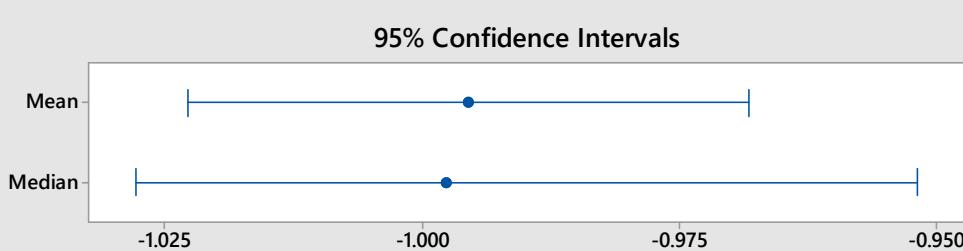
<=-1.43 deleted (8 points).

Current Corridors: red - capping limit

+/- 2 std dev: blue

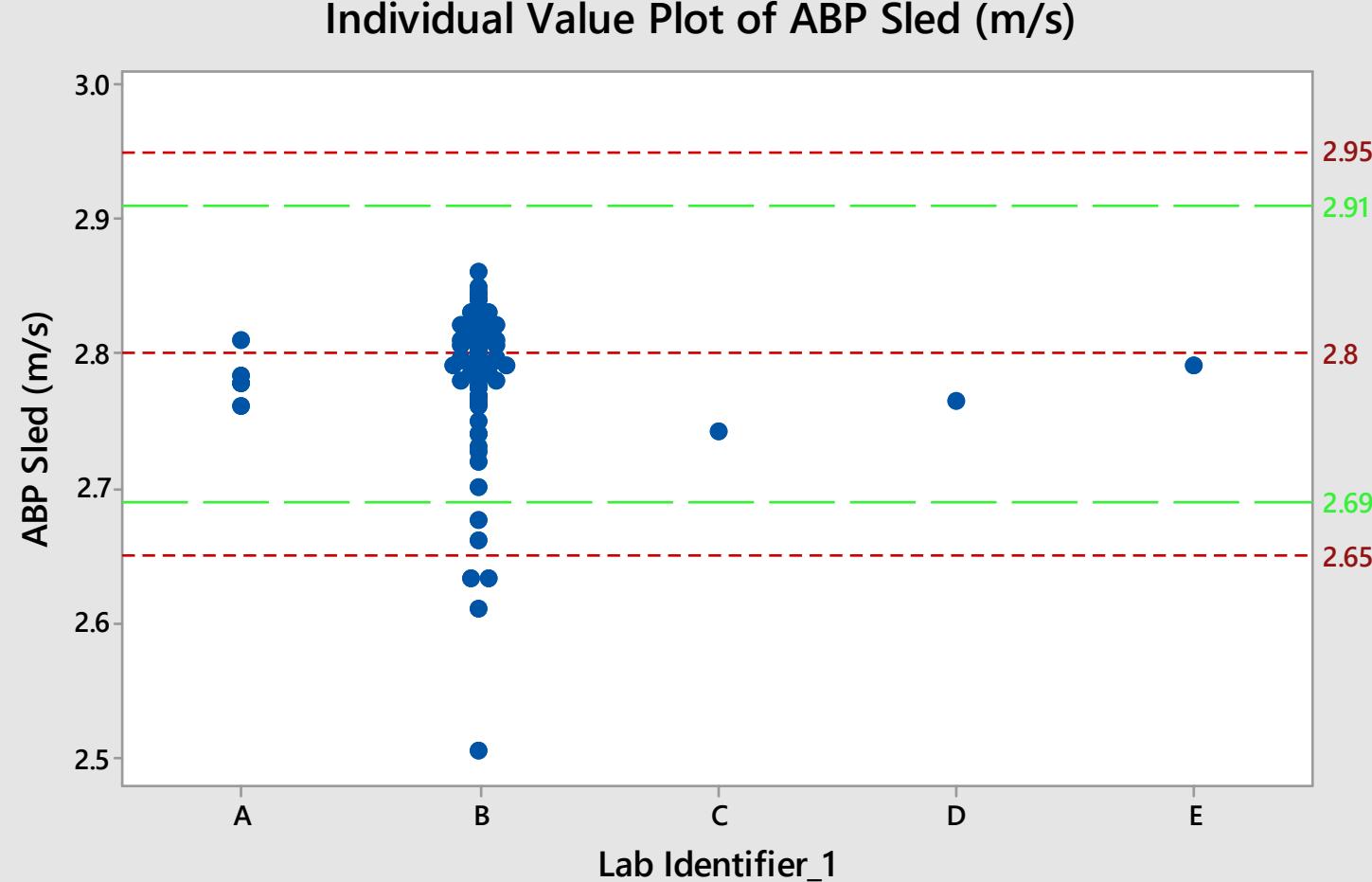
Proposal: no change

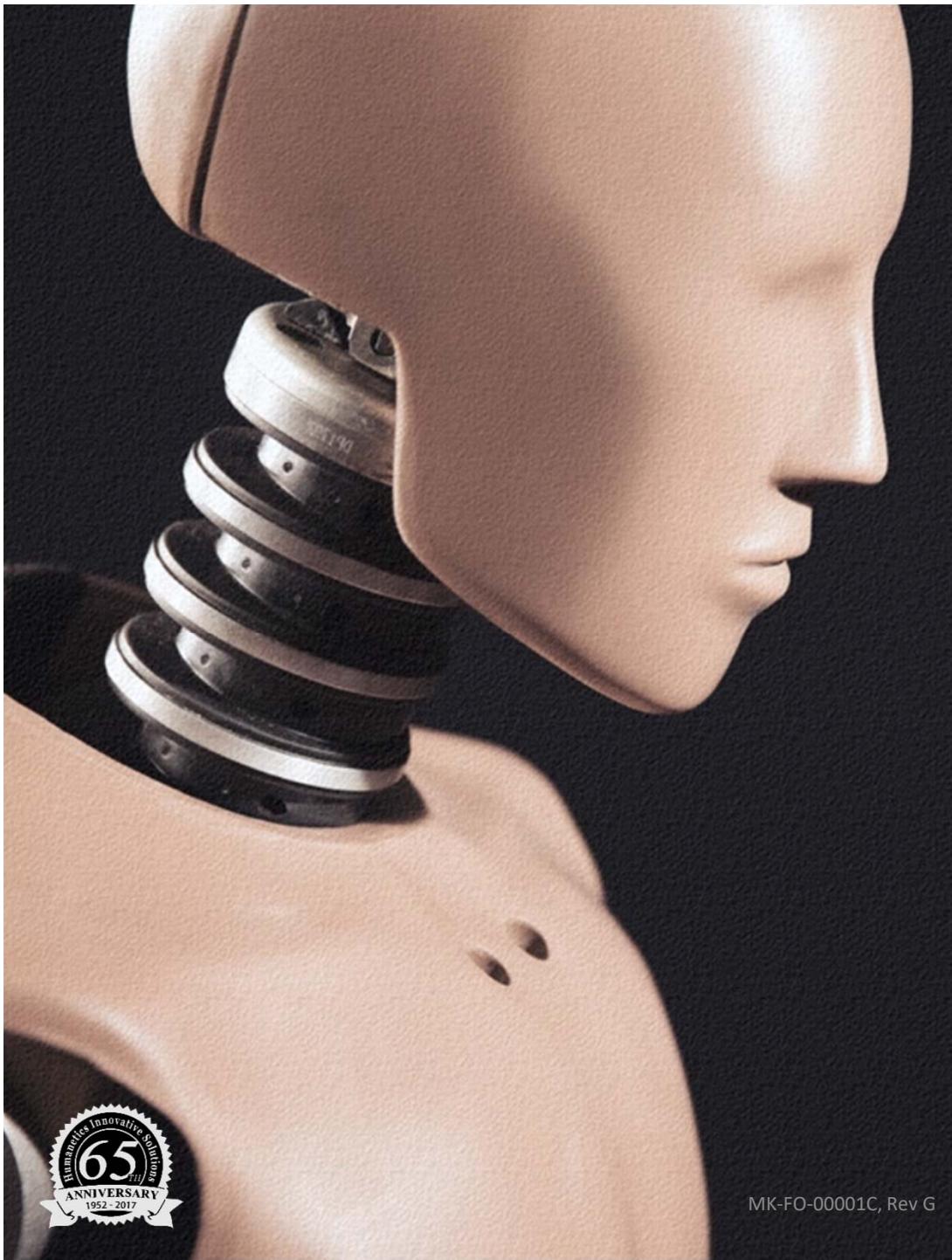
This is a capping limit to make sure the sled does not have too much friction or some type of binding. Also, there is a very limited number of sleds included in this dataset.



Sled Analysis – Individual Value Plot

Sled Velocity Decay





MK-FO-00001C, Rev G

Corridor Summary

Corridor Summary

- Jacket test

Parameter	Current Corridor	Proposed Corridor
Impact Velocity	1.500 – 1.550 m/s	No change
Pendulum Force	1110 – 1360 N	No change
Sled Velocity	0.378 – 0.422 m/s	0.355 – 0.435 m/s
Jacket Compression	18.3 – 20.3 mm	17.6 – 21.6 mm

- Pelvis test

Parameter	Current Corridor	Proposed Corridor
Impact Velocity	1.500 – 1.550 m/s	No change
Pendulum Force	3250 - 4620 N	3082 - 4344
Sled Velocity	0.325 – 0.375 m/s	0.310 – 0.378 m/s
Jacket Compression	17.8 – 19.5 mm	16.6 – 20.4 mm

Corridor Summary

- Sled and Track certification test

Parameter	Current Corridor	Proposed Corridor
Impact Velocity	4.70 – 4.80 m/s	No change
Pendulum Force	8600 – 9800 N	8381 – 10243 N
Sled Acceleration	118 - 136 m/s ²	117 - 143 m/s ²
Sled Velocity	2.65 – 2.95 m/s	2.69 – 2.91 m/s
Sled Velocity Decay	>= -1.50 (m/s)/s	No change

Corridor Summary

- Dummy Certification without Headrest

Parameter	Current Lower	Current Mid Point	Current Upper	+/- % Width		Proposed Lower	Proposed Mid Point	Proposed Upper	+/- % Width	
Temperature (deg C)	19	22	25	13.6%			<i>no change</i>			
Humidity (% RH)	10	40	70	75.0%			<i>no change</i>			
Impact Velocity (m/s)	4.70	4.75	4.80	1.1%			<i>no change</i>			
Peak Pendulum Force (N)	8000	8850	9700	9.6%			<i>no change</i>			
Peak Sled Acceleration (m/s ²)	137.0	153.5	170.0	10.7%		137	152	167	9.9%	
Sled Velocity Peak 1 (m/s)	2.25	2.38	2.50	5.3%		2.29	2.42	2.55	5.4%	
Sled Velocity Peak 1 Time (ms)	20	25	30	20.0%		20.9	24.6	28.3	15.0%	
Sled Velocity Tunnel	FAIL	n/a	PASS							
Sled Velocity @ 135 ms (m/s)	2.10	2.30	2.50	8.7%		2.12	2.36	2.60	10.2%	
Sled Velocity @ 140 ms (m/s)	2.00	2.20	2.40	9.1%		2.06	2.29	2.52	10.0%	
Peak T1 Acceleration (m/s ²)	183	225	267	18.7%			<i>no change</i>			
Peak T1 Acceleration Time (ms)	18.5	24.5	30.5	24.5%		20	25.0	30	20.0%	
First Peak Pot A (deg)	11.5	14.0	16.5	17.9%		10.2	12.7	15.2	19.7%	
First Peak Pot A Time (ms)	25	48	70	47.4%		37.8	47.3	56.8	20.1%	
Pot A tunnel	FAIL	n/a	PASS							
Max Pot A in tunnel 125-135 ms (deg)	-9.0	-3.5	2.0	157.1%			4.00		-260.0%	
Min Pot A in tunnel 125-135 ms (deg)	-9.0	-3.5	2.0	157.1%		-9.0			-260.0%	
First Peak Pot B (deg)	4.00	5.25	6.50	23.8%		3.87	5.12	6.37	24.4%	
First Peak Pot B Time (ms)	18.5	23.5	28.5	21.3%		20.7	25.9	31.1	20.1%	
Min Pot B (deg)	-36		1000			-36.9				
Pot B tunnel 1	FAIL	n/a	PASS							
Max Pot B in tunnel 198-108 ms (deg)	-1000		-30	9.1%				-27.3	15.0%	
Pot B tunnel 2	FAIL	n/a	PASS							
Max Pot B in tunnel 1165-175 ms (deg)	-1000		-29	10.8%			<i>no change</i>		12.0%	
Min Pot C (deg)	-19.00		1000.00			-19.5				
Pot C tunnel	FAIL	n/a	PASS							
Max Pot C in tunnel 73-78 ms (deg)	-1000		-16.5	7.0%				-16	9.9%	
Total Head Rotation Tunnel	FAIL	n/a	PASS							
Min Total Head Rotation in Tunnel 100-190 ms (deg)	-41		1000				<i>no change</i>			
Max Total Head Rotation in Tunnel 100-110 ms (deg)	-1000		-25	24.2%			<i>no change</i>			
Max Total Head Rotation in Tunnel 170-180 ms (deg)	-1000		-25	24.2%			<i>no change</i>			
Max Thoracic Rotation Tunnel	FAIL	n/a	PASS							
Max Thoracic Rotation in Tunnel 125-135 ms (deg)	-1000		-10	35.5%				-10.5	34.4%	
Min Thoracic Rotation in Tunnel (deg)	-21		1000			-21.5				
Max Upper Neck My	7.70	12.75	17.80	39.6%		11	13.70	16.4	19.7%	
Time at Max Upper Neck My	20.0	27.5	35.0	27.3%		21.4	26.8	32.2	20.1%	
Min Upper Neck My	-23.50	-19.25	-15.00	22.1%			<i>no change</i>			
Time at Min Upper Neck My	66.0	74.5	83.0	11.4%		60	75.0	90	20.0%	

Questions?

For additional information after meeting,
contact Paul Depinet
pdepinet@humaneticsatd.com

