Black to Basics
February 12-13, 2025
Columbia, MO

Pay Factors For Project Managers and Superintendents

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Material Acceptance Quality Level Analysis

Asphalt – Sec 403.19 & 403.23.7

- Density
- Air voids
- VMA
- Asphalt content

Performance (Future)

- Cracking
- Rutting

Material Acceptance Quality Level Analysis

Evaluated on a lot by lot basis

Favorable Comparison:

Is when QA test result is within 2 standard deviations of the QC test results or half of spec limit

Percent-Within-Limits (PWL)

- Statistically Based Acceptance
- PWL Estimated by Fit of Bell (Normal Distribution) Curve
- Element of Risk Involved
  - Eliminate Risk: Too Expensive
  - Too Much Risk: Poor Quality

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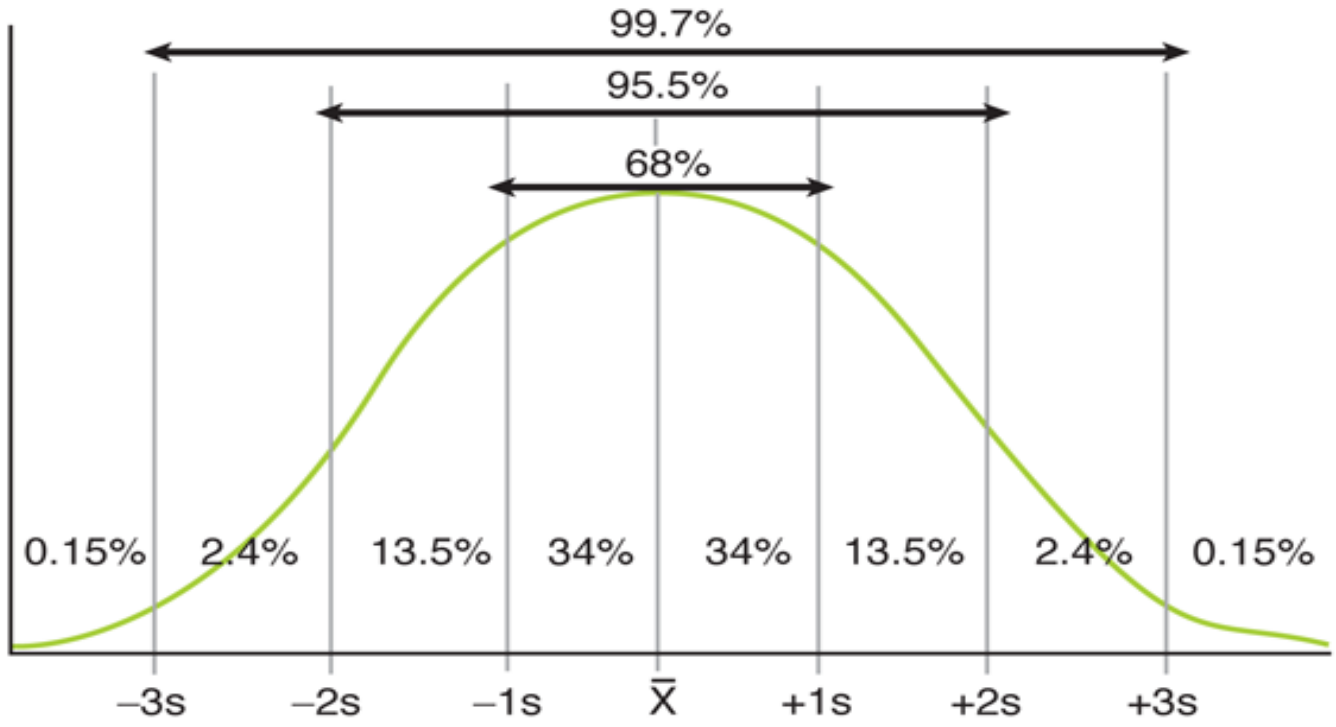

Normal Distribution Curve

Statistical Methods

- Random Samples to Establish Population
- Population Compared to Specification
- Quality Indices Calculated (QLA)
- Pay Factor Based on PWL

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Comparing to Specification

Calculate Average and Standard Deviation

$x_a = (Sx_i)/n$

$s = (S(x_i - x_a)^2/(n - 1))^{1/2}$

Calculate Quality Indices

$Q_u = (USL - x_a)/s$

$Q_l = (x_a - LSL)/s$

Determine Percent-Within-Limits From Table (Sum of area under curve within spec.)

Percent Within Limits - PWL

- Determine PWL of Each Pay Factor Item

$$PWL = (PWL_u + PWL_l)\text{-}100$$

Q	3	4	5	6
0	50	50	50	50
0.01	50.276	50.334	50.356	50.368
0.02	50.552	50.668	50.712	50.736
0.03	50.828	51.002	51.068	51.104
0.04	51.104	51.336	51.424	51.472
0.05	51.38	51.67	51.78	51.84
0.06	51.656	52.002	52.136	52.206
0.07	51.932	52.334	52.492	52.572
0.08	52.208	52.666	52.848	52.938
0.09	52.484	52.998	53.204	53.304
0.1	52.76	53.33	53.56	53.67
0.11	53.038	53.664	53.914	54.036
0.12	53.316	53.998	54.268	54.402

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Calculation Examples

Sublot Densities – 94.0, 95.0, 93.0, 92.5, 95.9, 96.0

n = 6, average = 94.4, s = 1.48, Q_u = 2.44, Q_l = 1.29

Q	3	4	5	6	7	8	9	10
1.27	100	92.334	91.04	90.638	90.44	90.322	90.246	90.186
1.28	100	92.666	91.29	90.862	90.65	90.528	90.444	90.384
1.29	100	92.998	91.54	91.086	90.86	90.734	90.642	90.582
1.3	100	93.33	91.79	91.31	91.07	90.94	90.84	90.78
1.31	100	93.664	92.028	91.522	91.272	91.132	91.028	90.964
1.32	100	93.998	92.266	91.734	91.474	91.324	91.216	91.148

Q	3	4	5	6	7	8	9	10
2.4	100	100	100	100	100	100	99.95	99.89
2.41	100	100	100	100	100	100	99.956	99.898
2.42	100	100	100	100	100	100	99.962	99.906
2.43	100	100	100	100	100	100	99.968	99.914
2.44	100	100	100	100	100	100	99.974	99.922
2.45	100	100	100	100	100	100	99.98	99.93
2.46	100	100	100	100	100	100	99.982	99.936
2.47	100	100	100	100	100	100	99.984	99.942

$PWL_d = (91.086 + 100) - 100 = 91.09$

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Total PWL

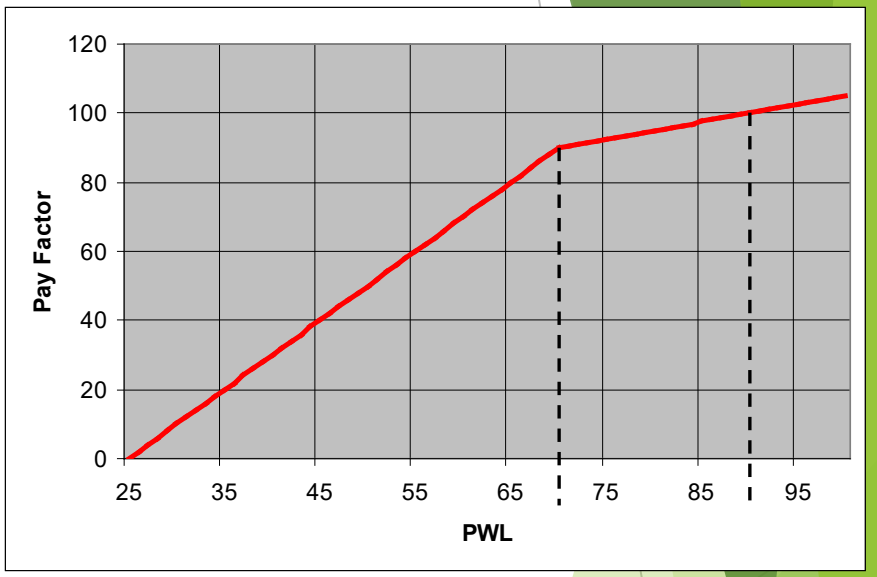
- Mainline Pavement
  - $PWL_t = 0.25 * PWL_{av} + 0.25 * PWL_{ac} + 0.25 * PWL_{vma} + 0.25 * PWL_d$
  - $PWL_t = 0.25 * PWL_{av} + 0.25 * PWL_{ac} + 0.5 * PWL_d$

- Shoulders when density not part of PWL

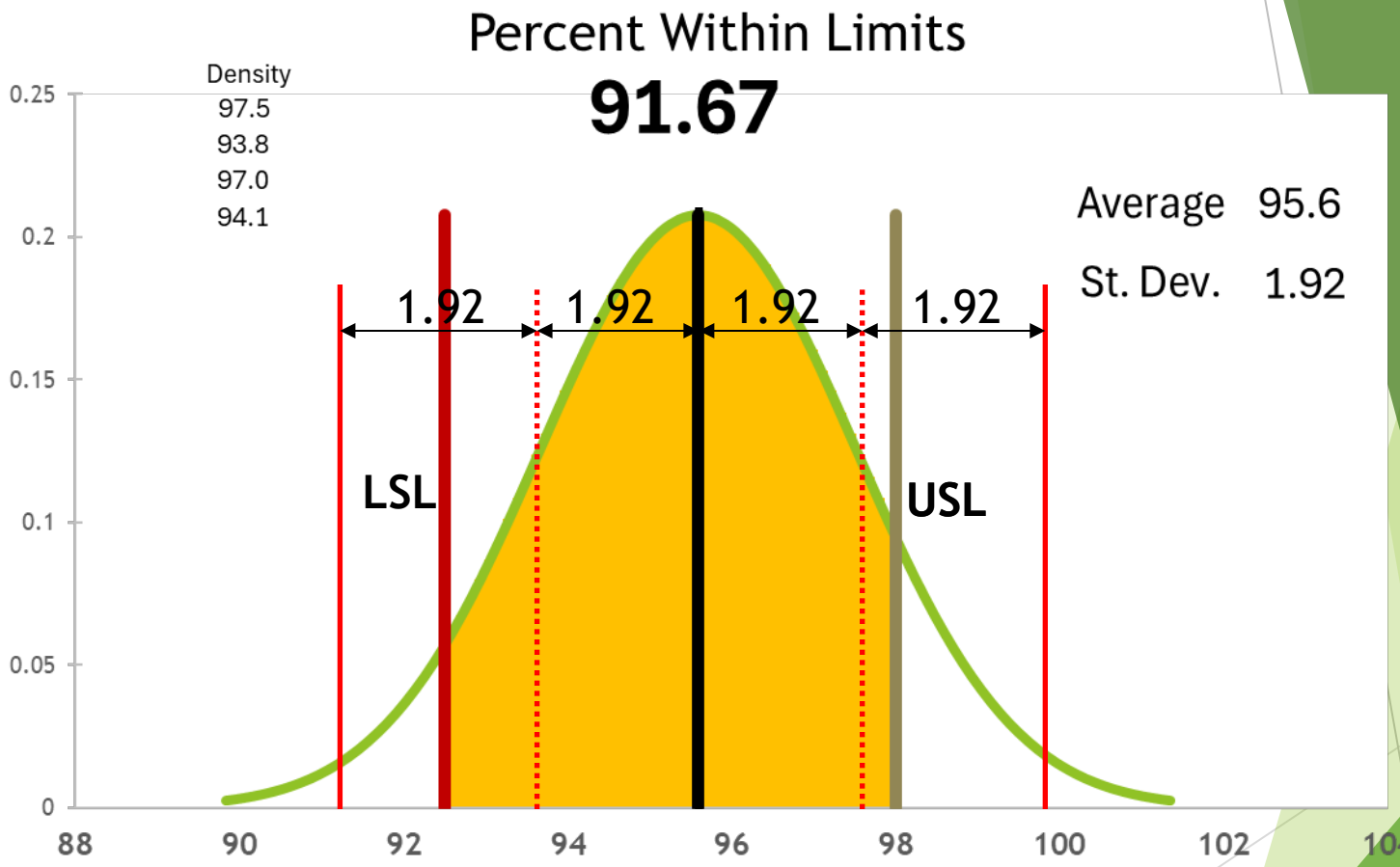
  $PWL_{total} = 0.5 * PWL_{air\ voids} + 0.5 * PWL_{AC}$

Pay Factors

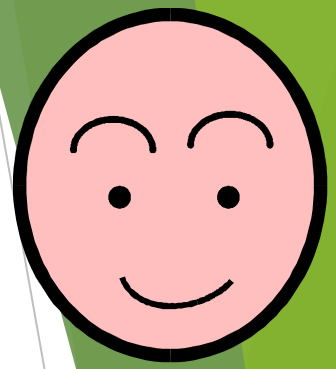
- Pay Factor for Each Item When PWL_t is ≥ 90: $PF = 0.3\ PWL_t + 73$
- When PWL_t is ≥ 70 but < 90: $PF = 0.5\ PWL_t + 55$
- When PWL_t is ≤ 70: $PF = 2\ PWL_t - 50$
- As Quality Decreases; Penalty Increases More Quickly

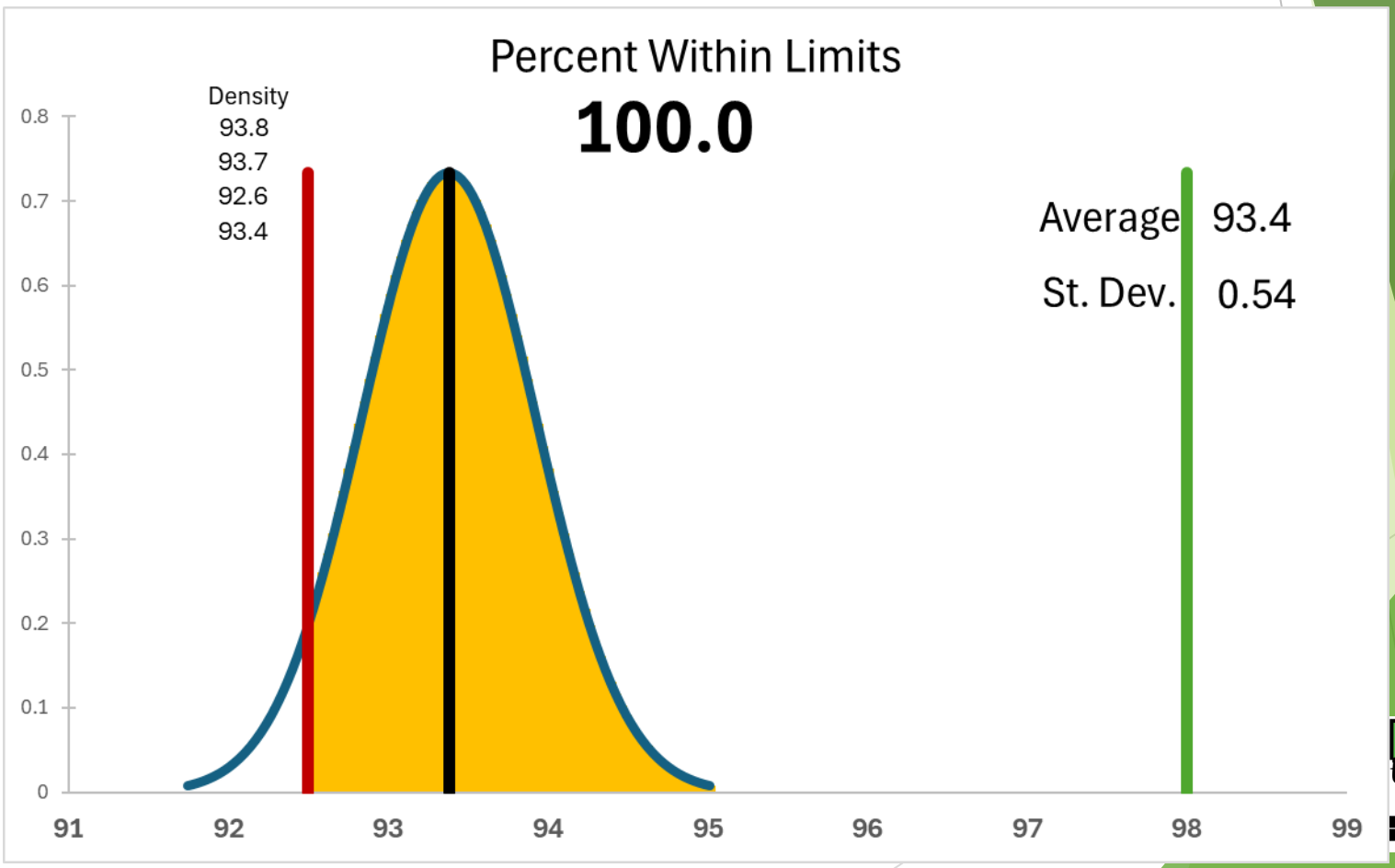


Density PWL 91.67



Excellent Control w/in Spec.
Density PWL 100.00 (PF = 103.0)





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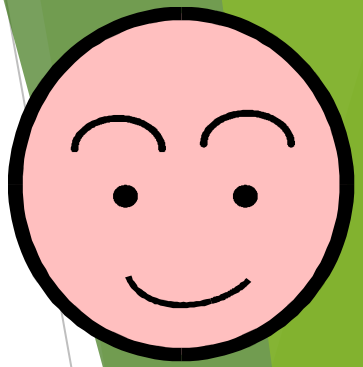
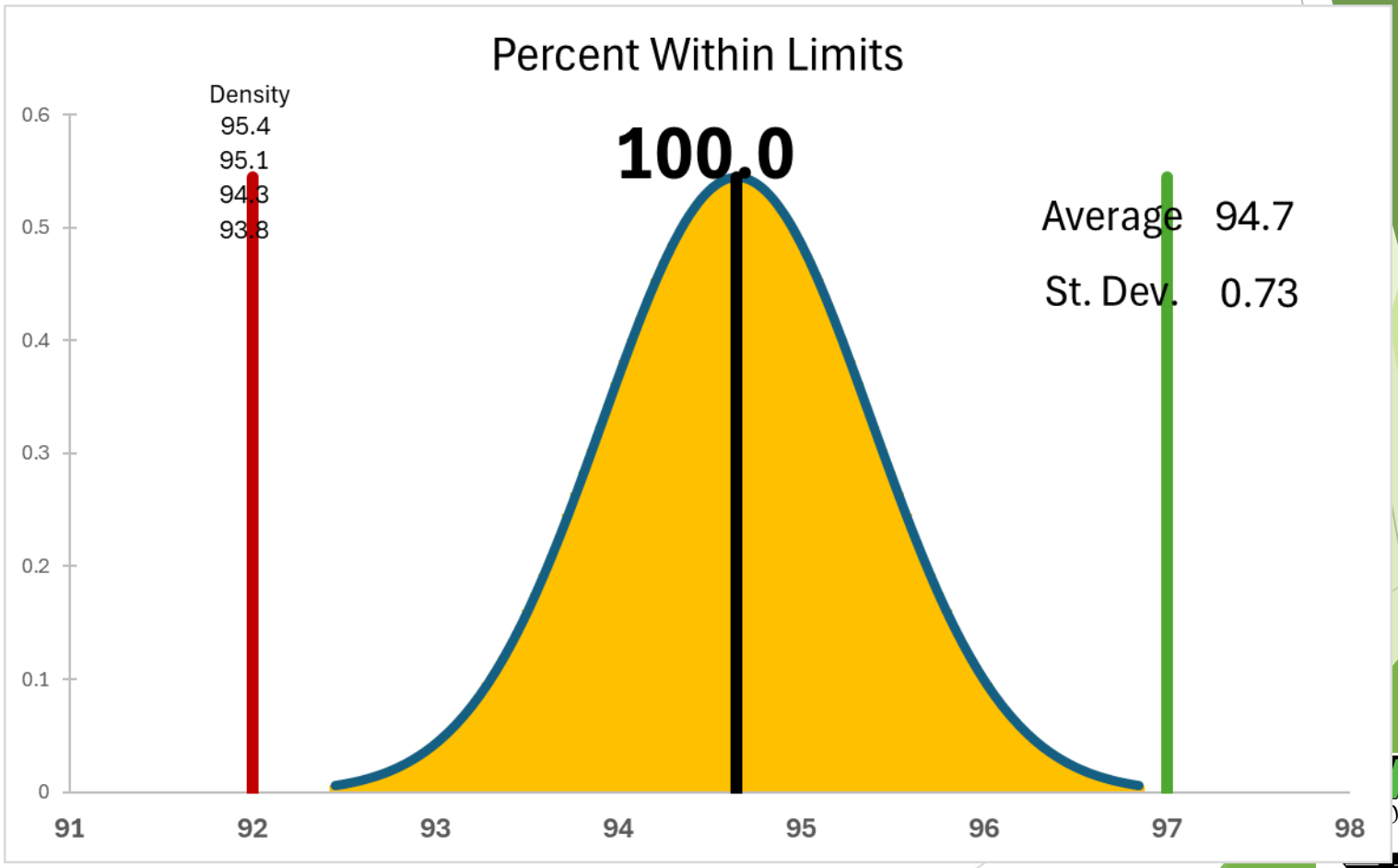
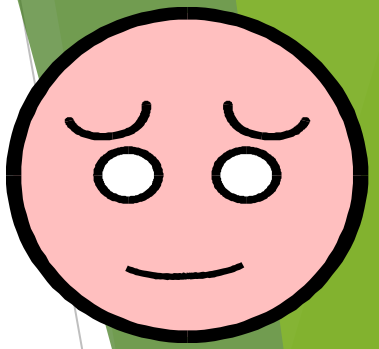
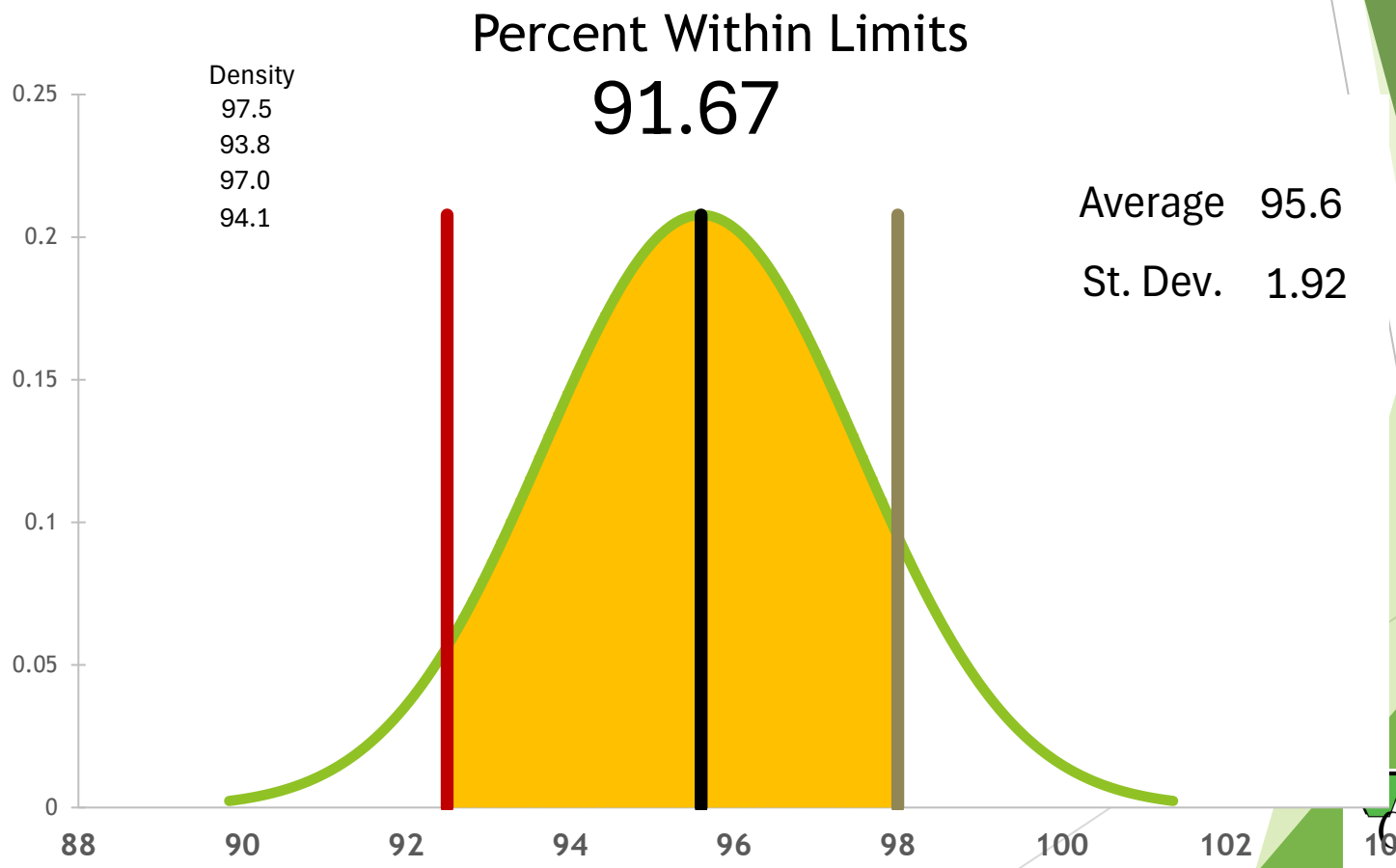




Poor Control w/in Spec.
Density PWL 91.67 (PF = 100.5)





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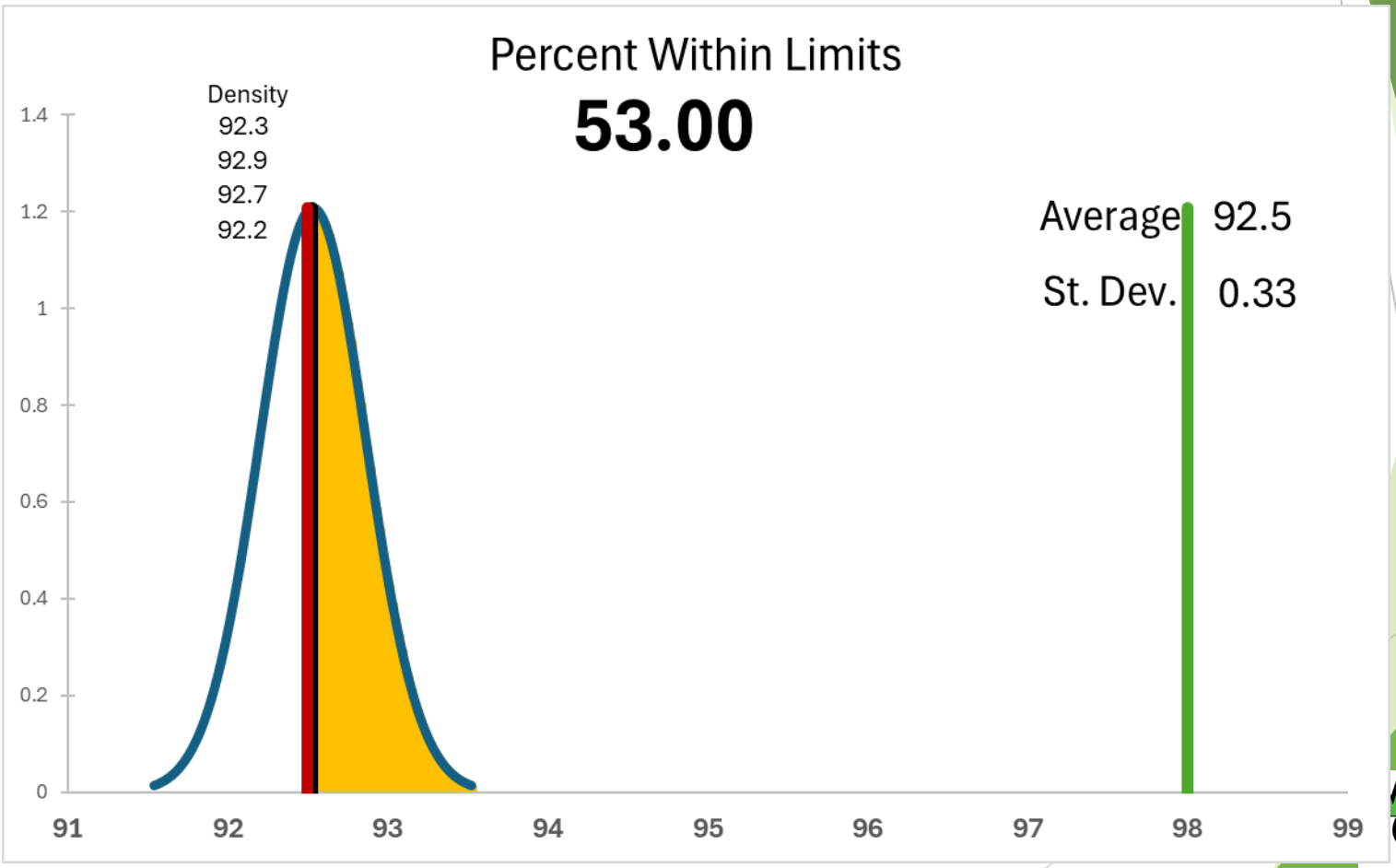
Good Control at Edge of Spec.
Density PWL 53.00 (PF = 56.0)



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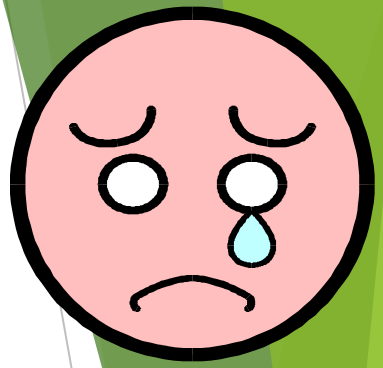
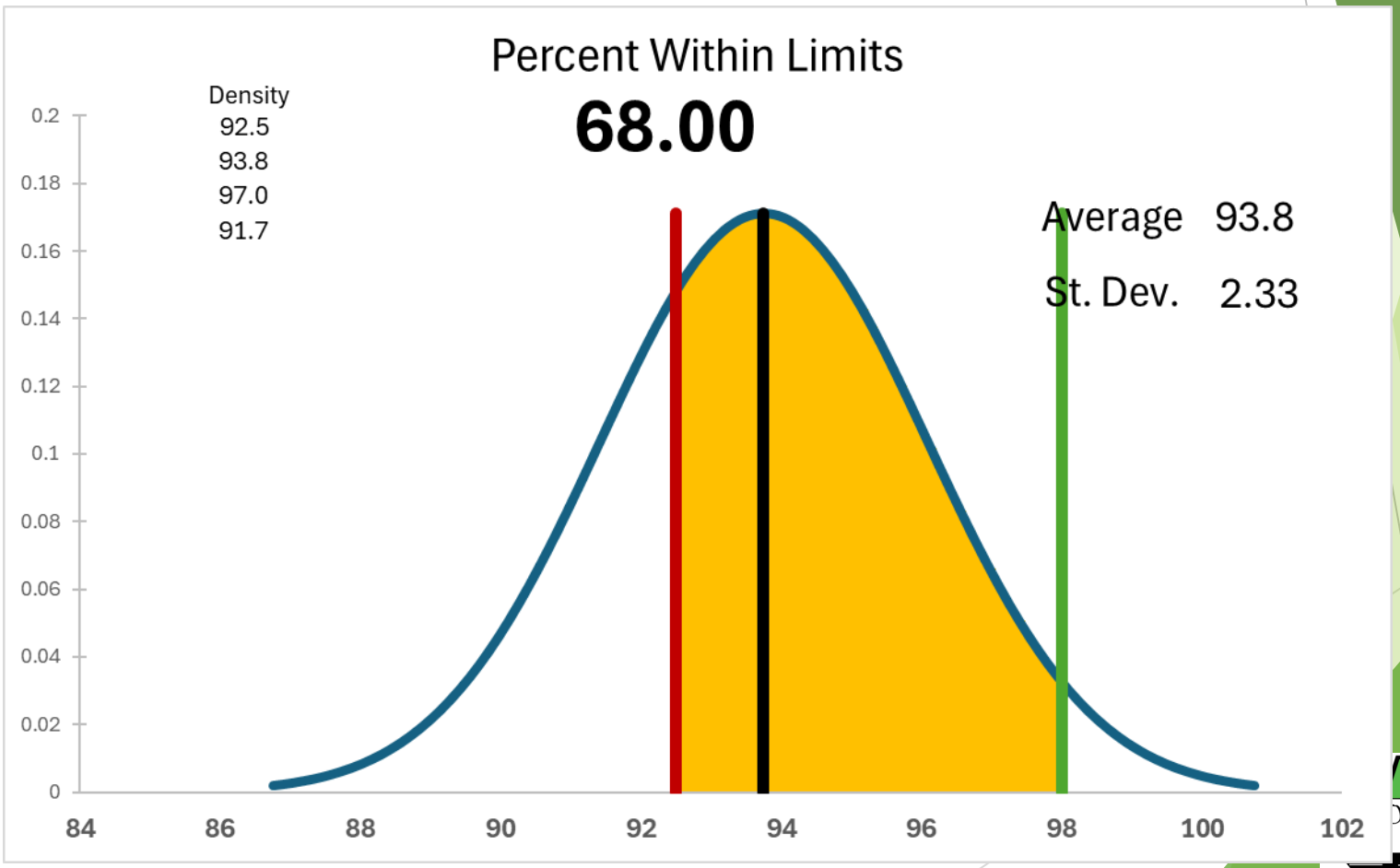
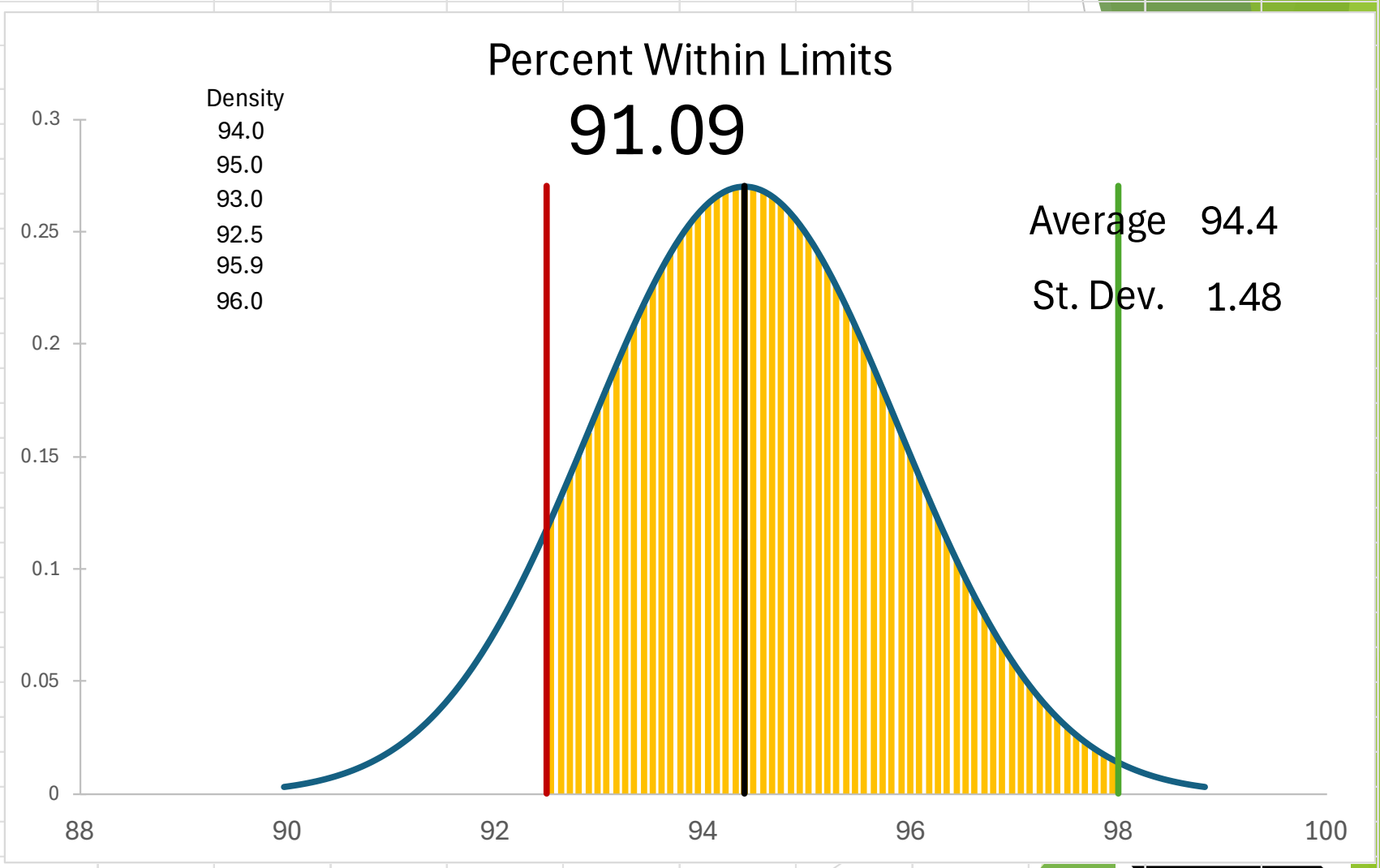
Poor Control Out of Spec.
Density PWL 67.66 (PF = 86.0)



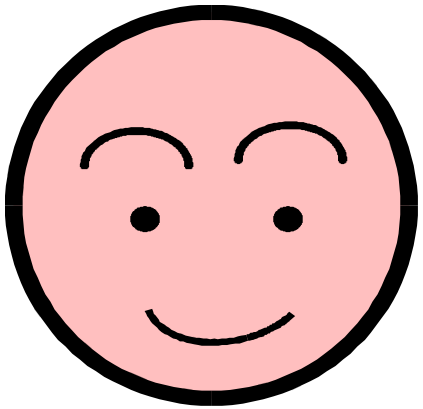
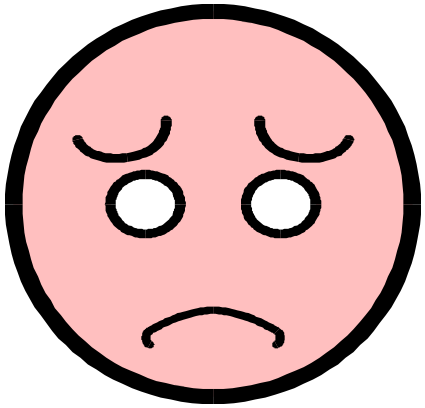
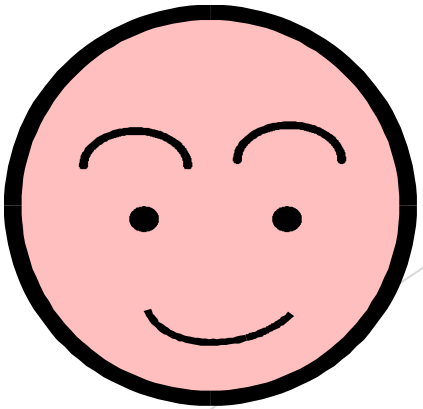


Density
94.0
95.0
93.0
92.5
95.9
96.0

n	LSL	USL
6	92.5	98



Remember: Quality Counts!

	Good Material	Bad Material
Accept		
Reject		

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