



A Contractor's View of PWL (Michigan Experience)

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PWL View

- New way of thinking - Needs a different approach
- Learn how Acceptance Criteria and Pay Factors work from the beginning
- QC is the key to success



New Way of Thinking

- **Evaluation and pay factors** based statistics
- **“Tweaking”** mixtures leads to poor QA results
- **Cause/Effect/Trends**
- **PWL effects all aspects of operations** – everyone is involved with QC – materials, estimating, production, management
- **Mean/Consistency work together** – Control Variables

Sources of Variability - Material



Sources of Variability - Production



Sources of Variability - Testing



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PWL Specs—What QA Criteria?

Michigan - SuperPave

- **AIR VOIDS:** $\pm 1\%$ of the target value for the mixture type (3% or 4%), two sided spec,

90 PWL - AQL – 100% Pay Factor or greater

- **VMA:** - Mix design minimum +2.0%, two sided spec,

90 PWL - AQL – 100% Pay Factor or greater

- **MAT DENSITY:** minimum of 92% of the mixtures Gmm, one sided spec, **90 PWL - AQL – 100% Pay Factor or greater**



Standard Deviation & Mean

- Mean and standard deviation are the heart of PWL
- Look at the historical performance QA data

(Be mindful that QA data not generated under PWL specifications does not always accurately indicated how a mixture would perform related to the PWL specification)

Pay Factor Formulas

Acceptable Quality Limit (AQL) 90 PWL

Bonus/Full Pay Equation

PF=Linear up to 2 % Incentive Pay - use when PWL greater than or equal to 90.

Rejectable Quality Limit (RQL) 50 PWL

Disincentive PWL – Curved PF

$$PF=100-0.000020072(100-PWL)^{3.5877}$$

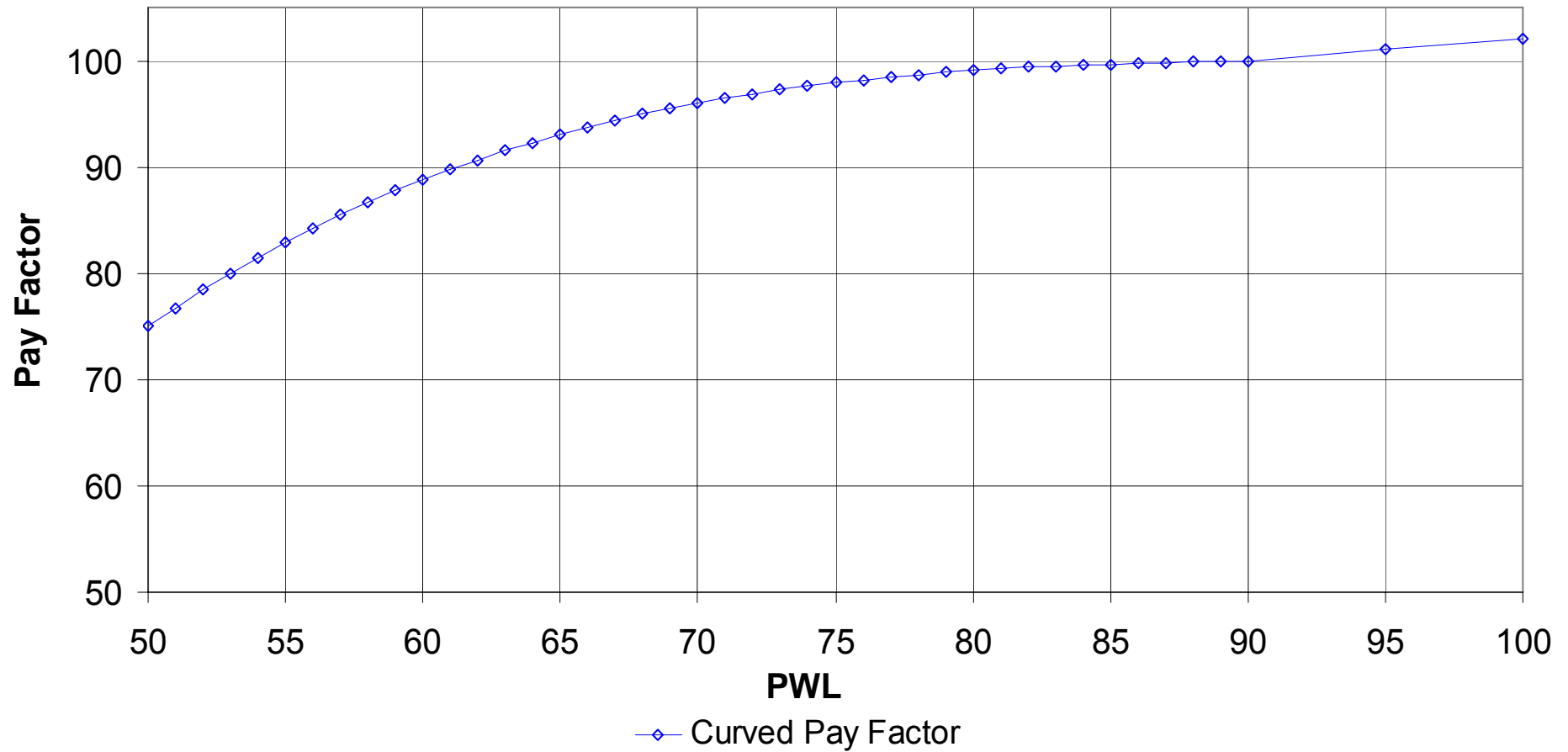
Use when PWL is between 50 and 89.

Overall Composite Lot Pay Factor – (with constraints)

Weighted Pay Factors - AV = 20%, VMA = 20%, Mat Density = 60%

Pay Factor Graph – Example

All Properties Pay Factor (Full Pay 90 PWL) Vs. PWL





QC - Key to Success

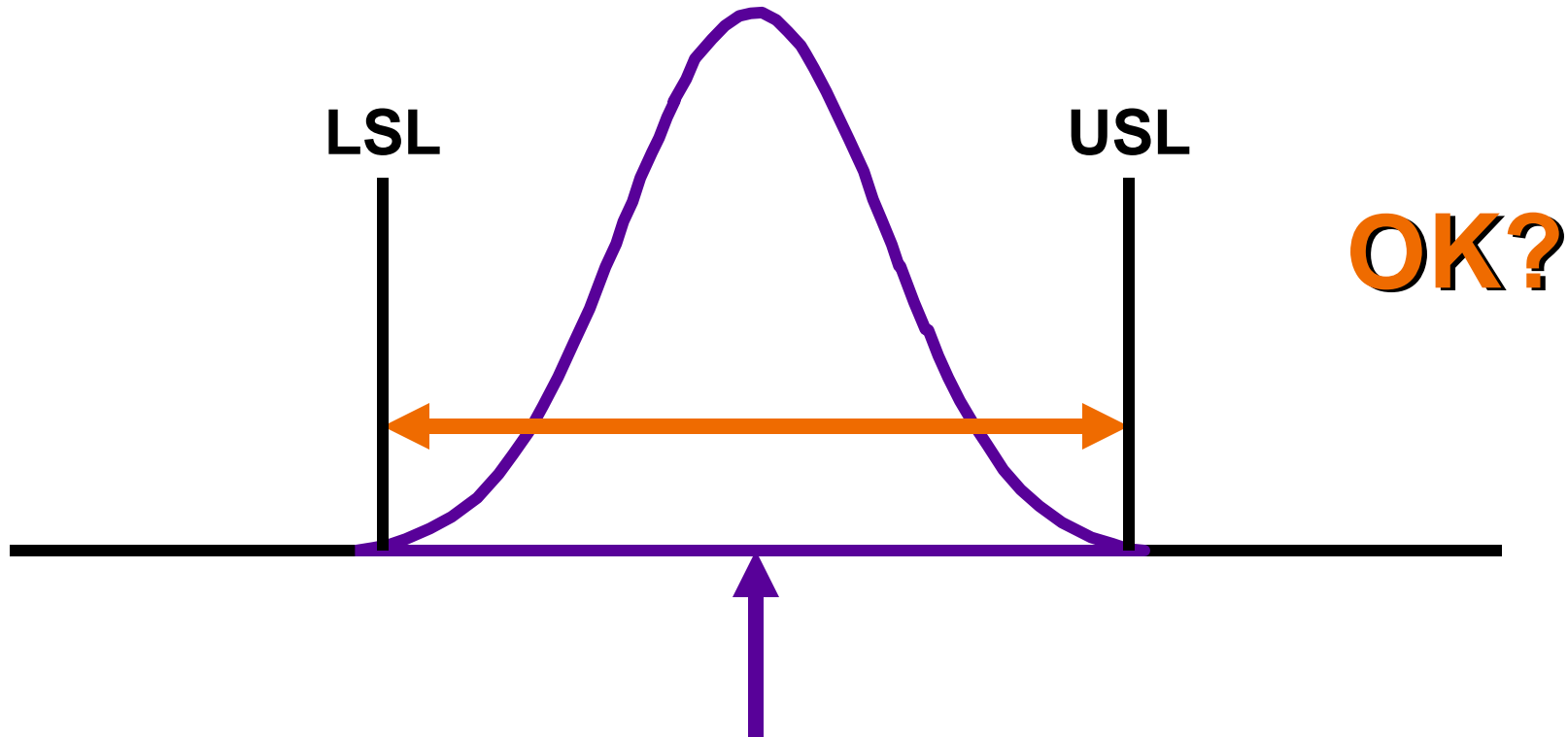
- Everyone is in QC – staff properly
- Estimate the project with PWL in mind.
- QC \neq QA
- Control the mean and be consistent – Control Variables
- QC testing shouldn't be limited to mixture or QA properties only
- Once adjusted, don't keep “tweaking”
- Poor materials in, poor materials out



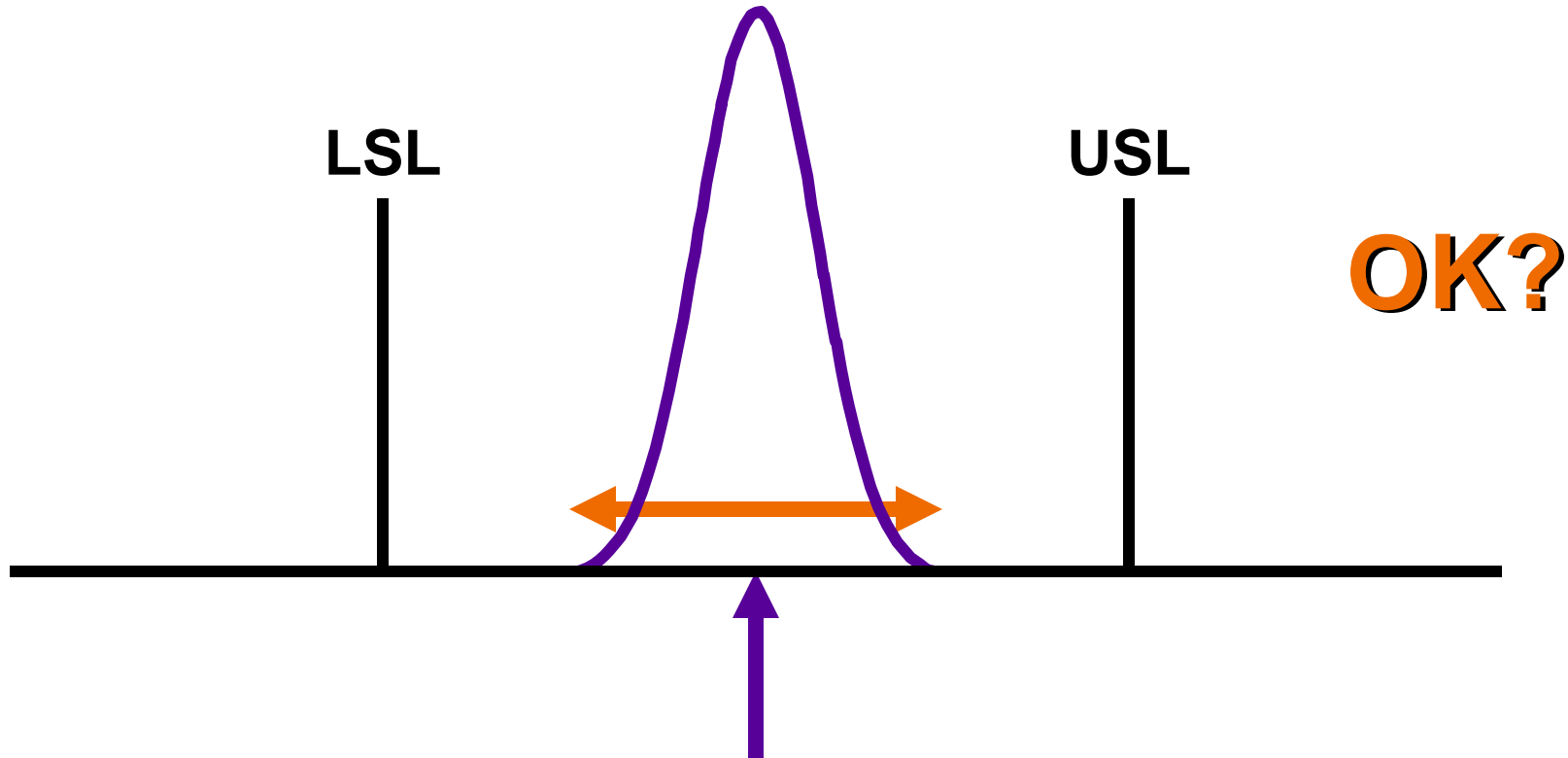
QC - Establish Targets & Action Limits

- What Confidence Level? Action/Suspension Limits
- When to adjust?
- The lower the Std. Dev., the more latitude there is in targeting

QC – Mean & Spread Relationship



QC – Mean & Spread Relationship

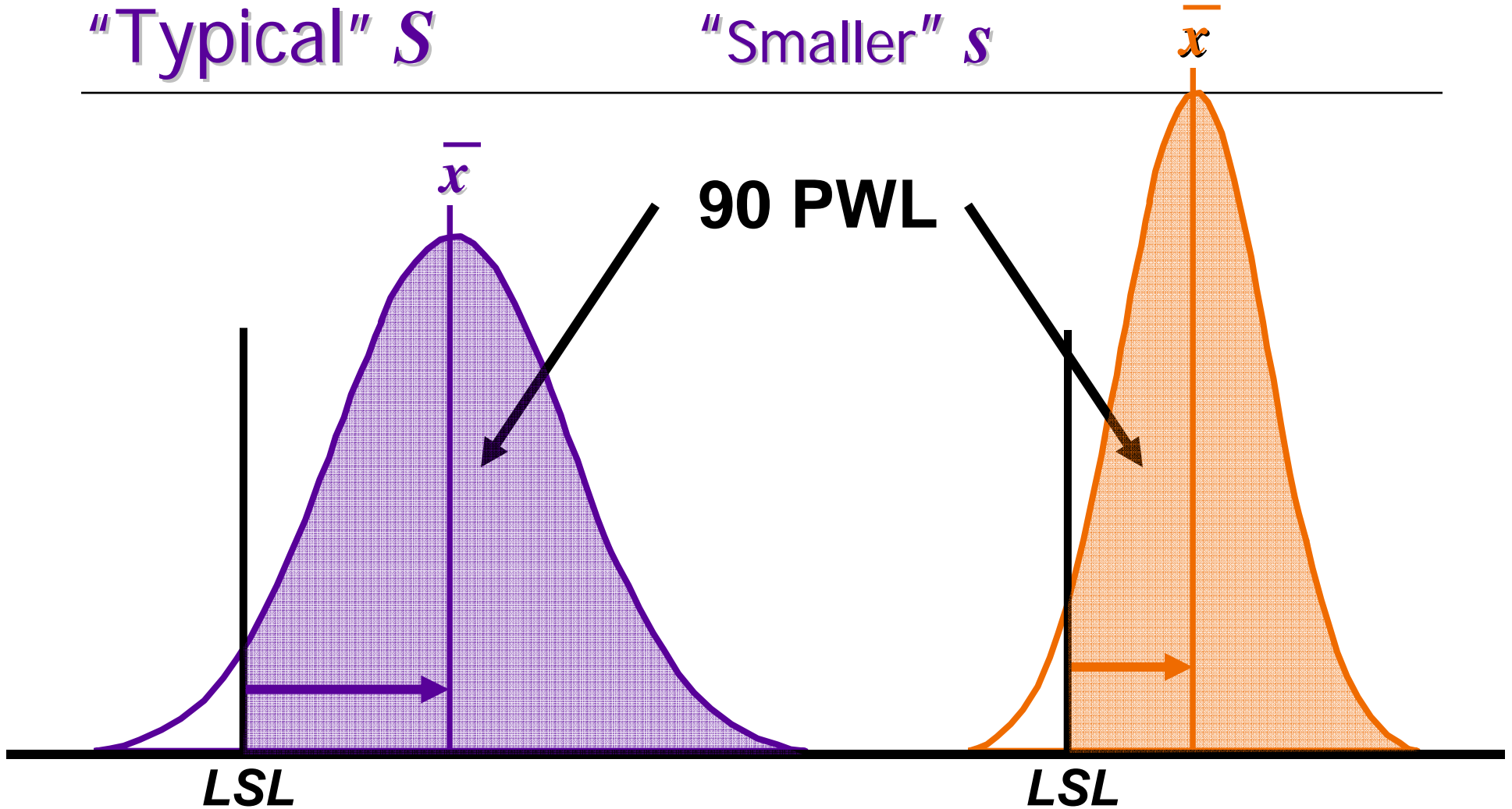


QC – Mean & Spread Relationship

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Pros / Cons

Pros

- Consistency is rewarded
- PWL promotes QC at all levels
- Risk Analysis can be performed
- Dynamic specifications
- Pools of data are used rather individual test results



Cons

- Complex - Large departure from current methods
- Extra training needed
- Can be penalized even if all tests are within the specified limits
- Are the specifications achievable ?
- Interdependent Properties



Summary – How has it worked?

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- PWL made us think differently – focus on Quality
 - Unrealistic Spec = Spec doesn't work,
Realistic Spec = Spec works
 - PWL specification forces one to learn a lot about the cause and effect of all your QC decisions (self inflicted problems)
 - PWL projects can be successful

Thank You

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